Knowledge Co-production on Air Quality – The Role of Planning Research in Participatory, Healthy, and People-Centered Cities

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[3] Geoffrey Nwaka (Abia State University, Uturu). *Towards Decolonizing Climate Science in Africa: The Place of Indigenous Knowledge.*

Abstract. Global inequalities today derive in part from the unequal power relations in the way knowledge for development has historically been produced and applied. For a long time African knowledge systems were undervalued and mis-perceived as irrational and incompatible with the conventional strategies of development. But the worsening global economic and environmental crisis, and widening inequalities between and within nations have exposed flaws in the Western model of development, and gaps in our knowledge of how sustainable development can best be achieved in different cultural contexts. The current pattern of development in Africa sometimes looks like building a house from the roof down, as all the institutions of modernization appear to be suspended over societies that have no firm connection to them. There is now renewed interest in an alternative approach which emphasizes the cultural dimensions of development, and the overlooked potential of indigenous knowledge as perhaps the single largest knowledge resource not yet mobilized in the development enterprise. Marshall Sahlins has rightly emphasized the need for all peoples "to indigenize the forces of global modernity, and turn them to their own ends", as the real impact of globalization depends largely on the responses developed at the local level. This paper argues that climate science, like other branches of knowledge, needs to be broadened and decolonized; that Africa should search within its own knowledge systems for appropriate ideas and approaches to many of its development challenges. Political independence in Africa should imply greater epistemic freedom that goes beyond Africans running their modern services and institutions merely as gatekeepers of the colonial heritage. The paper focuses on how indigenous knowledge and practice can be enlisted in natural resource management, environmental protection and climate change adaptation.

Africa contributes least to, but suffers the most from the disastrous consequences of climate change. How can the continent cope better with the worsening threats of Hooding, drought and other emergencies that result from extreme weather conditions. Although poverty may sometimes force people to deplete and use natural resources in an unsustainable way, most traditional African societies have deeply entrenched ideas about environmental protection and sustainability because their livelihood depends largely on the land and on the stability of the ecosystem. They believe that land and other forms of nature are sacred, and are held in trust by the present day users on behalf of dead ancestors and future generations. Chief Sir Nana Ofori-Atta of Ghana once told a colonial official that "land belongs to a large family of which many are dead, a few are living, and countless hosts are yet unborn”.

Local communities in different parts of Africa have over the years developed intricate systems of forecasting weather systems in order to prevent and mitigate natural disasters; traditional techniques of soil management, pest and disease control, adopting suitable crop and animal varieties, and other coping strategies that have ensured traditional resilience. The paper recognizes that the unprecedented scale of climate change today may have undermined the reliability of many traditional indicators for predicting the pattern of climate variability, and techniques for preventing and adapting to climate induced natural disasters. There is a need for those who hold and use traditional knowledge to partner more actively with scientists and practitioners in order to co-produce updated knowledge for better climate risk management. This may require a trans-disciplinary and more collaborative approach to research that would make the traditional and modern knowledge systems to complement and enrich each other. It also means that indigenous knowledge will need to be documented and preserved in a form that can be used by policy makers and development practitioners for national climate policies, and to compare and possibly apply in other contexts.

We conclude that while Africa stands to gain form global science and international best practices, indigenous knowledge offers a model for rethinking and redirecting the development process, and for enlisting traditional values and institutions in a way that enables and empowers local actors to take part in their own development. Development agents, donors and their consultants, who often assume a knowledge or capacity vacuum in Africa, should instead try to tap into the vital and time-tested resource of indigenous knowledge for locally appropriate ways to strengthen local climate resilience, and ensure truly sustainable development.

Keywords: Africa, indigenous knowledge, climate change, environmental protection

[5] Marco Cavallaro (Università della Svizzera Italiana), Peter Edlund (Uppsala University) and Benedetto Lepori (Università della Svizzera Italiana). *Organizing competition in public research funding: The case of EU Framework Programs.*

Abstract. Since the 1980s, competition has become a widespread mechanism for the allocation of research funding in most advanced countries (Geuna, 2001; Slaughter and Rhoades, 2004; Musselin, 2018). It has been implemented at the institutional level through the introduction of performance-based funding (Hicks, 2012; Krücken, 2019; Teixeira et al, 2021) and at the individual level through various types of competitive grant schemes managed by research funding organizations (Lepori and Reale, 2019). This occurred in a context where new policy rationales, such as New Public Management (Ferlie et al, 1996; Christensen and Laegreid, 2001), foresaw the adoption in the public sector of management practices derived from the private economy, and in which "competitive allocation" of public funds through quasi-markets plays a central role (Teixeira et al, 2004; Lepori, 2011).

The literature has also offered important insights into the consequences of competition among individuals and organizations in research systems. Competition for funding may increase productivity under specific circumstances (Aghion et al, 2010), but also promote incremental research and reduce epistemic innovation (Franssen et al, 2018; Boudreau et al, 2016; Heinze et al, 2009) and generate and reinforce differences in access to positions and resources (Bloch et al, 2014; Bol et al, 2018).

However, the literature has usually considered competition as a phenomenon that occurs semi-automatically in contexts of high demand for relatively scarce resources (Stigler, 1972), while paying scant attention to understanding how competition is constructed (Arora-Jonsson et al, 2020) and enacted by actors within (strategic action) fields (Fligstein and McAdam, 2011). This process involves providing answers to questions such as: which actors legitimately participate in the competition and with which roles? Which resources are considered as desirable and by whom? How is scarcity defined?

The literature suggests that the answers to these questions are shaped by social construction processes and largely dependent on the field's social hierarchy (Krücken, 2019) and networks (White, 2001). And how these processes unfold is likely to impact core aspects of the competition for research funding, such as self-selection of applicants and the emergence of stable groups of winners (Viner et al, 2004), strategies deployed by scientists to acquire funding (Laudel, 2006) and narratives to request money (Velarde, 2018). And, indirectly, the outcomes in terms of scientific outputs.

Within these broad questions, this paper focuses specifically on the role of public regulation in organizing competition for research funding. When quasi-markets are employed to achieve policy goals (Ferlie, 1992), public regulation plays a more substantive role as a policy tool to align actors' behavior with underlying policy goals and priorities (Capano and Pritoni, 2019). Indeed, competition for research funding takes place in a highly regulated environment where the state and/or research funding organizations, which pursue specific objectives, play a central and asymmetric role as organizers and adjudicators of the competition (Lepori and Reale, 2019). This includes, for example, defining the program goals and themes, delegating the management to a funding agency, setting up panels, and defining selection criteria.

To understand how the interaction between the design of competition through public regulation and endogenous social construction shapes research funding markets and their policy outcomes, we draw insights from the sociology of law and market institutionalization (Edelman and Suchman, 1997; Lascoumes and Le Galès, 2007). We, therefore, address questions such as: how has regulation been enacted in the two cases? Who have been the relevant actors involved? How has this influenced the competition for resources within these programs? And, finally, what have been the implications of this process in terms of achievement of original policy goals and the program's outcomes?

Empirically, we provide a contrastive case study of the organization and institutionalization of competition by the European Commission (EC) within two types of schemes in European Framework programs for research and innovation (EU-FPs), i.e. the European Research Council's (ERC; Laudel and Gläser, 2014) bottom-up individual grants and the collaborative projects addressing societal and global challenges defined largely top-down by the EC. These two sub-programs represent contrastive cases in terms of the enactment of public regulation since ERC'S implementation was largely delegated to the research community within a broad regulatory frame, while collaborative projects are subject to a much tighter and exogenous set of rules and procedures set by the EC. An extensive literature has examined the ideational and legal framework of EU-FPs (Ulnicane, 2015) and showed the core role of social networks in the acquisition of EU funding (Breschi and Cusmano, 2004; Enger, 2018). However, the way competition is effectively organized and constructed by the EC and enacted by relevant actors, notably competitors, deserves further attention.

The paper aims to contribute both to the research policy and the sociology of markets literature. While economics and sociology of science have provided extensive evidence on the outcomes of competition for funding in terms of efficiency (Aghion et al, 2010), productivity (Butler, 2010), development of scientific knowledge (Whitley et al, 2018; Wang et al, 2018), as well as on behavioral responses of scientists and research organizations to competition (Laudel, 2006), the paper sheds light on a core dimension of this process, i.e. how competition for research funding is constructed and how this affects the achievement of program goals (Krücken, 2019). Further, by leveraging on the sociology of law literature (Edelman et al, 1999), the paper addressed a specific gap in the sociology of markets literature (Arora-Jonsson et al, 2020), i.e. understanding how partially exogenous rules set by the state are enacted and affect the social construction of competition in settings, such as our case study, that lie at the intersection between the state and other societal fields.

Keywords: Competition, EU Framework Programs, Research Funding, Research Policy

[6] Itay Fischhendler (Hebrew University). *The Gaza Strip and the Interplay Between Geopolitical Conflict and Renewable Energy Transition.*

Abstract. Renewable energy transition is one of the keys to mitigating climate change. While attention has been given to various economic, institutional, technological, and sociocultural barriers to this transition, it is unclear how acute interstate conflict shadowed by geopolitical forces shapes the deployment of renewables. The literature is split between those who speculate that conflict conditions discourage renewable energy proliferation and their critics. This ambiguity is surprising, since renewable energy is often suggested as a panacea for many conflict and post-conflict areas with dysfunctional centralised electricity systems. A systematic assessment of these competing hypotheses is challenging because of the absence of reliable data in fragile states and areas. This study is the first to use remote sensing to examine the temporal and spatial diffusion of renewables in the Gaza Strip against the backdrop of conflict conditions with Israel. It finds that Gaza has become a renewable energy leader despite conflict conditions exacerbated by deep poverty. The balance between discouraging and encouraging factors rests on different variables: the impact of the conflict on the free movement of labour, goods, and fuel, the intensity of the conflict, the role of economies of scale, opportunity costs, and alternative energy production costs

Keywords: geopolitics, insecurity, renewable energy

[7] Amber Geurts (Rathenau Institute), Frans Van Der Zee (Rathenau Institute) and Vincent Baarslag (Rathenau Institute). *Challenge-driven evaluation: policy evaluation for societal challenges.*

Abstract. Challenge-driven innovation policies place societal challenges and transitions at the center of the focus and goal of innovation policy. This new genre of innovation policy not only requires new approaches in agenda-setting, programming, implementation and management, but also requires a renewed view and practice of monitoring and evaluation. In this paper, we focus on the usefulness and necessity of a different view and way of monitoring and evaluating challenge-driven R&I policy (the why) and its implementation (the what and how) – which we term challenge driven evaluation. To define this new approach, we first maps out the challenges, potential pitfalls and design requirements for the monitoring and evaluation of challenge-driven innovation policies. Next, we outline routes to arrive at an appropriate and future-proof monitoring and evaluation framework for societal challenges and transitions that might meet these requirements.

Keywords: Evaluation, Monitoring, Societal Challenges, Innovation Policy, Evidence-base

[8] Diego Chavarro (SCIF) and Ernesto Andrade-Sastoque (Twente). *Overarching directionalities for Transformative Innovation Policy on biodiversity, climate change, and cities.*

Abstract. Overarching directionalities for Transformative Innovation Policy on biodiversity, climate change, and cities

1. Introduction

Directionality is one of the core principles of current approaches to innovation policy for sustainable development. The Sussex Manifesto (Ely & Bell 2009), Transformative Innovation Policy (TIP) (Schot and Steinmuller 2018), and Mission Oriented Innovation Policy (Mazzucato 2018a, Mazzucato 2018b, Larrue 2021) have drawn attention to it. This principle refers to the collective process of guiding actions towards transformations inspired by the SDG's agenda, ensuring participation of non-academic stakeholders and going beyond the "consideration to questions over the pace, efficiency and distributional consequences of innovation in any one particular direction" (Elly & Bell 2009).

Directionality is like a "lighthouse" to guide, and it "implies the creation of shared visions for a sustainable future in the long term" (Colciencias 2018). In this process of vision creation, it is important to identify those "lighthouses" through careful examination of proposals of academia, industry, civil society, and the government. Although all voices are equally important for directionality construction, scientists identify key knowledge gaps and ways to address them, leading to potential breakthroughs towards sustainable development. Understanding these scientific directionalities give policy-makers, funders, and other stakeholders grounded information to think of suitable STI policies for sustainable development, enhancing the science-policy interface.

Based on a work that was commissioned by the International Science Council (ISC), with the aim to produce a literature review on research gaps on sustainable development, we produced a synthesis on research transformative missions. This work aims to explore part of the literature on sustainable development focused on the fields of biodiversity (BD), climate change (CC), and sustainable cities (SC), which are part of the prioritised fields of the SDG's 2030 agenda.

We have designed a strategy to search and analyse a set of relevant papers on the three fields aforementioned, which gives an overview of the types of research needs that are being proposed by scientists. In analysing the papers we identified different categories to classify the research needs. The categories were inspired by STS reflections, and more in particular, by innovation policy thinking which was used to find common patterns between BD, CC and SC. The categories that emerged from our analysis are the following:

● Subject areas: specific thematic subjects within biodiversity, climate change, and sustainable cities identified by researchers as important for sustainable development. They may be emerging or lacking sufficient research.

● Knowledge construction practices: interactions between scientists and other stakeholders to produce knowledge with an impact on sustainable development.

● Holistic frameworks: comprehensive conceptual models and metaphors to understand sustainable development from the perspective of scientists.

● Policy and Governance: governmental use of knowledge, and power balances between actors aiming to cope with and solve environmental and social problems.

● Technology development and improvement: developments aimed at solving specific issues of sustainable development, usually materialized in the form of artefacts or services.

● Evaluation: systematic assessment of scientific knowledge production in relation to sustainable development.

Based on scientific evidence we synthesise the above categories in four broad directionalities to be developed within the transformative innovation policy framework. These directionalities are focused on the need of i) transforming traditional modes of production and consumption; ii) constructing holistic frameworks for doing research; iii) mainstreaming mode 2 science and iv) governing the science-policy interface. The next section explains our methodology, followed by a discussion expanding on these four directionalities.

1. Methodology

This work aims to identify key directionalities to be developed in the TIP framework based on scientific evidence facing biodiversity, climate change and cities' challenges. To do this, we first had several conversations with an expert committee for identifying keywords, and a few key papers. Second, we found the papers with the highest potential to have an impact on sustainable development by looking at the ones that had received awards by Elsevier. Third, we turned to developing search strings in Scopus to identify them,and used different keywords related to research agendas, knowledge gaps, research trends, research priorities, among others. In total we found 810 documents (articles, reviews, books, chapters, editorial notes). We decided to focus only on reviews because their aim is to synthesise current knowledge and to point out research gaps or directions, allowing us to have a suitable number of documents (96, including papers identified by ISC and the committee that were relevant to our aims, and the ones gave us the bases for the interpretation of the results).

In the following section we summarise our findings in a discussion that explains the directionalities we propose to be developed in the TIP framework regarding climate change, biodiversity and cities.

3. Discussion

Transforming traditional modes of production and consumption patterns

We found a number of subjects that researchers propose as key research areas. We see that most of the identified subject areas revolve around the production and consumption of energy, food, water, manufacturing, services, the built environment, and biomass. Given the focus of the subject areas, we interpret that researchers are asking support for research to transform traditional modes of production and consumption patterns in society. One way in which researchers are addressing these issues is through technology development and improvement, where we identified research towards improving the efficiency of technologies, reducing their cost, making them more manageable, and closer to the citizens.

We also found that researchers identified a set of common theories or frameworks as useful to achieve the transformation of traditional modes of production and consumption patterns: green economics, sustainability transitions, quantitative models of complex systems, and risk management. The fact that researchers are asking to use these theories in the study of sustainable development shows that systemic approaches, such as the ones mentioned, are not being incorporated sufficiently into the mainstream, despite encouragement by multilateral organizations (Hynes, Lees et al. 2020).

Constructing holistic frameworks for research on sustainable development

Beyond production and consumption, we also found that researchers are in search of frameworks to explain sustainable development as a system from the scientists' point of view, which we call holistic frameworks. They include Earth Systems, Planetary Health, Sociometabolic research, and Coevolution. These frameworks show efforts of researchers to transcend the silos of disciplinary understandings of sustainable development and offer more integral approaches to it. Something we did not find is a discussion of whether and to what extent these frameworks effectively provide a common understanding of sustainable development across disciplines.

Mainstreaming mode 2 science

Mode 2 science is characterised by a more dynamic interaction between scientists and non-scientists and a clearer focus on addressing societal demands, as opposed to disciplinary science. The recurring call from researchers to enhance this interaction shows that, in practice, mode 2 science is not the main paradigm in sustainable development research.

In terms of knowledge production practices, we found a demand for interdisciplinarity, transdisciplinarity, and specifically for more integration with the social sciences. This shows that despite a general agreement on the benefits of trans and interdisciplinarity, these approaches continue to be the exception rather than the rule in sustainable development research. In particular, the social sciences are identified as key to enrich biodiversity, sustainable cities, and climate change research, although the types of engagement, the specific potential areas for work, and the ways to achieve successful integration of knowledge are not detailed.

Governing the science-policy interface

Regarding the interface science-policy, we identified a call for policy intervention based on scientific evidence, training of scientists and non-scientists in sustainable development thinking, and effective communication between researchers and policy-makers. In connection with this, governance mechanisms emerge as a cross-cutting area of research that can help coordinate demands for scientific knowledge addressing societal needs. The main demand is for policy instruments and implementation of agendas through concrete actions, coordinating local, regional, and international programmes. Also, the inclusion of non-scientific knowledge and in particular of indigenous communities in policy making was highlighted.

What we see is that scientists are aware of the relevance of governance in science-society relationships, and that there is a need for policy instruments that factor-in policy experimentation and uncertainty to learn. Evaluation, in particular impact evaluation, appears as an important source of evidence to enact this learning.

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Keywords: directionality, sdgs, biodiversity, cities, climate change, research gaps, literature review, TIP

[9] Chad Baum (Department of Business Development and Technology, Aarhus University), Sean Low (Department of Business Development and Technology, Aarhus University) and Benjamin K. Sovacool (Department of Business Development and Technology, Aarhus University). *Between the Sun and Us: Expert perceptions on the engineering, policy, and deep uncertainties of space-based solar geoengineering.*

Abstract. Space-based geoengineering is gaining attention, if not necessarily traction, as a possible "break the glass" solution to mitigate the worst impacts of climate change and facilitate the transition to a low-carbon future. Though still on the periphery of discussions around climate mitigation and geoengineering, space-based methods that would deflect or block incoming sunlight, and thereby diminish how much radiation ultimately reaches the Earth, could offer advantages, notably, by avoiding the need for difficult trade-offs and decisions in terms of land and resource use on Earth. Aside from a few specialist-oriented studies, the literature on space-based geoengineering remains limited. In this study, we utilize a large and diverse expert-interview exercise (N=125) to provide a first critical examination of the promise and relevance of space-based geoengineering for tackling climate change, including perhaps as a source of renewable energy, its feasibility and prospective risks, as well as key actors and issues related to commercialization and governance. To our knowledge, no other study has employed empirical data of any kind to examine perceptions of space-based geoengineering, let alone in relation to other kinds of climate-intervention technologies. Not only does the current research represent the first of its kind, it also provides a foundation for more informed, comprehensive deliberations around this interesting, possibly even necessary solution to climate change.

Keywords: sunshades, climate change, solar radiation management, solar geoengineering, space-based geoengineering, expert perceptions, renewable energy

[10] Rick Hölsgens (TU Dortmund University). *Non-users and the pro-social innovation bias.*

Abstract. If social innovations are innovations that are not only social in their means, but also in their ends (BEPA 2011), one wonders why these socially beneficial and politically desirable innovations are not more general. This concern can even be larger when considering sustainable social innovations, that not only benefit people, but also the environment and are normative by definition. Socially innovative initiatives emerge all around us and across the globe. Some are more successful than others, but across the board, many diffuse very slowly – if at all. The question thus arises: Why do (sustainable) social innovations – in general – diffuse so slowly? This paper argues that, in order to address this question, we need a more critical stance towards the dominant pro-social innovation bias. Besides asking how social innovations can be supported and spread, this also requires asking why there is such a large group of 'non-users'?

In as far as social innovation research actively addresses actor roles and agency, this is predominantly done from an innovator perspective (Hölsgens 2021). This is remarkable, given that we know from various branches of innovation studies that adopters play a vital part in the diffusion of innovations (e.g. Davis et al. 1992; Pinch and Bijker 1987; Rogers 1969). Considering the importance of adopter willingness/motivation with regards to the acceptance and diffusion of technological innovations, it seems inevitable that adopter willingness is also crucial in the diffusion of social innovations, as these, more so than technological innovations, tend to require some kind of action by adopters, changing their practices. The success or failure of the (social) innovation will be dependent on whether individuals are willing and able to adopt the innovation.

In this light, it is necessary to more actively study the importance of contestation and opposition to social innovations. Social innovation rarely gets contested. This is problematic, for it leads to a blind spot regarding resistance and the importance of power imbalances in processes of social change (Ghys 2020; Hölsgens 2017; Avelino 2021). Taylor's (1970, p. 70) Introducing Social Innovation already underlined that "a new social form is not introduced so easily. An innovative kind of school, a new way of dealing with poverty, a new procedure for resocializing delinquents, a new technique for rehabilitating the schizophrenic–all are likely to disrupt complex and valued roles, identities, and skills. The disruption may have widespread and ramifying effects, so that whole communities may be challenged and angered." However, even beyond active resistance to social innovations or social change, a general lack of interest or conscious decision making not to participate in the changed practices may occur.

Although the word 'innovation' may have been heavily inflated in omnipresent 'innovation speak' (e.g. Vinsel and Russell 2020) - Godin and Vinck (2017) even call it a cliché – it is true that 'new ideas, devices, or methods' are key components in tackling societal grand challenges. It has long been recognized that, in order to address the challenges of the twenty-first century, we cannot only rely on technological innovations alone (e.g. Wehling 1997; Ornetzeder and Buchegger 1998). The Limits to Growth-report already concluded 'that the need will quickly become evident for social innovation to match technical change, a radical reform of institutions and political processes at all levels' (Meadows 1972, pp. 193–194).

Although, as Godin (2012) shows, the concept of social innovation has a rather long history, the concept of social innovation has only really been receiving attention (again) since the 2010s. Despite the growing interest in social innovation (both politically and scientifically), and the increasing expectations of social innovations as contributors to combatting a variety of twenty-first century challenges (e.g. climate change, biodiversity loss, inequality, …), their actual impact is still small. Most social innovations – or rather socially innovative initiatives – do not transcend the niche level (e.g. ecovillages, repairing, zero waste shops, …). In order for such (sustainable) social innovations to achieve measurable impact, broader generalization is vital. In addressing the question of diffusion and generalization of social innovation, this paper particularly addresses the idea of 'non-users' and their motivation to be(come) non-users, i.e. non-adopters of particular (sustainable) social innovations.

This paper maintains that, in order to better understand the diffusion of social innovations, a critical perspective is paramount (i.e. a need to go ‘beyond instrumentalism’ (Wittmayer et al. 2020; Schubert 2019)). This includes not only addressing willingness and capacity of adopters to adopt and implement social innovations, but also studying ‘non-use’ (cf. Wyatt 2003). Just as non-use of cars or the internet – the examples used by Sally Wyatt (2003) – is majorly overlooked due to the dominance and ‘taken-for-grantedness’ of these technological innovations, a pro-social innovation bias leads to the neglect of non-users and their conscious or unconscious decisions to be(come) non-users of social innovations.

The paper starts by outlining the pro-social innovation bias and the instrumentalization of the concept in research and policy making (Schubert 2019; Wittmayer et al. 2020). Subsequently, it will analyze non-use along the example of cargo bike usage in Germany. The increased use of cargo bikes can be considered a social innovation to the extent that it involves new social practices for (urban) mobility. Their uptake has increased notably over the last years. Yet, they are also controversial. However, besides the fairly visible contestation between proponents and opponents, this paper also delves into the role of non-users, i.e. of those who do not vehemently oppose cargo bikes, but that also do not want to change their mobility practices. Within the broader debate on cargo bikes’ potentials, two particular uses dominate: firstly cargo bikes are being discussed as non-polluting alternatives for ‘last-mile’ delivering in urban areas, secondly, following the Dutch example, cargo bikes are becoming increasingly popular among young families to transport children. The current paper focuses specially on this second application of cargo bikes.

Discourses in popular and social media surrounding the use of and acceptance of cargo bikes specifically, as well as around (sustainable) mobility more broadly, will analyzed to study contestation and non-use with regards to the socially innovative practice of cargo bike usage.

On the basis of a theoretical reflection (based on a literature review) regarding the pro-social innovation bias in both science and politics, supplemented by the empirical analysis of cargo bike diffusion as exemplary case study, this paper will conclude with both policy and research recommendations for the generalization of social innovations. Preliminary conclusions and policy issues that can already be identified concern the need to abandon the instrumentalization of social innovation and the idea of social innovation as a ‘tool’ for combatting twenty-first century challenges. Yes, social innovations are paramount in addressing these challenges, but they cannot (or at least only to a limited extent through laws) be enforced. A critical appraisal of potential contestation and conscious or unconscious decisions for ‘non-use’ is necessary for a realistic appreciation of the potentials and limits of social innovations.

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Keywords: social innovation, adoption, diffusion, generalization, non-use

[11] Matthew Sample (Leibniz Universität Hannover). *Reformulating the Global in Cosmopolitan Governance of Technoscience.*

Abstract. “It happens that our country claims a part of us, our friends another; and, moreover […] everything that arises on earth is created for the use of human beings, but human beings are born for the sake of other human beings, so as to benefit one another.” (Cicero, On Duties 1.22)

-Background: Global Problems, Cosmopolitan Solutions?-

Some societal problems, often but not always existential in nature, are considered to be “global” in scope and demanding in-kind responses. Consider how climate change motivates international accords, conversations, and institutions like the IPCC or, less frequently, drastic attempts to alter the global climate unilaterally. The governance of science and technology also takes on a global character when seen as a problem that spans multiple national communities of practitioners, multiple publics, and international industries. Discourses around particular fields of technoscientific research seem to combine these elements; genome editing research, taken as an illustrative case, not only implicates multiple national communities of technoscientific practitioners but also, when the interventions are heritable, pose a potential threat to all of humanity.

Unsurprisingly, new forms of governance for gene editing research have invoked cosmopolitan rationales, including the “International Summits on Human Gene Editing,” a “Global Citizen Deliberation” (Dryzek et al 2020), and a “Global Observatory for Human Genome Editing” (Jasanoff and Hurlbut 2018) to name just three recent responses. But beyond shallow similarities in framing, what does an international summit of experts share, if anything, with a network of citizen jury events or an observatory that promises to “collect, analyze, and convene”? Even less obvious is how these activities legitimate themselves to diverse global publics or how they should be politically accountable. This presents an opportunity for scholars of science and innovation policy to offer a critical intervention, but only if they are willing to bridge traditional separations between political philosophy, international relations, and science policy.

In response, I attempt in this paper to make sense of emerging "cosmopolitan" forms of technoscience governance and advance our understanding of "well-ordered science" (Kitcher 2003) beyond the nation-state. To this end, I first consider several prominent attempts at "cosmopolitan" governance of technoscience, as mentioned above. Then, building on these cases, I identify two lines of inquiry: 1) what ethico-political ideals could underpin and license the activities of these new initiatives and 2) how do those ideals relate to the actual contextual and discursive conditions that make such globally-oriented interventions possible? Pursuing this dual research program is necessary not only to advance important scholarly conversations about global governance but also to support humanity's urgent task of re-imagining technoscientific practices within and beyond the nation-state.

-What Ethico-Political Foundations for Cosmopolitan Governance?-

To the first question, philosophy overflows with moral and political theories that demand a "larger loyalty" (Rorty 1998). More to the point, there are also theorists who directly investigate our commitments to humanity as a whole, evaluating roles and responsibilities in "liberal cosmopolitanism justice" (Rawls 1999) or "global ethics" (Held 2006). Across their works, cosmopolitan(ism) is not one type of thing but variously: a kind of person, a global social process ("cosmopolitization"), a rejection of nationalism, or an ancient ethical framework for right action. Together, these works constitute a sort of possibility space, representing the thoughts of mostly Western men, which can be broadened through the inclusion of subaltern critique. Thus presented, this possibility space can help us identify a range of conceptions of global order that could underpin and structure the governance of science and its appplications.

Appiah's (2006) cosmopolitanism, for example, rejects any appeal to universal humanity, prescribing instead that we recognize and value connections across inevitable human differences, while allowing for partiality towards our close peers. In practice, this means we may interact with peoples that are unlike us in important and ineradicable ways, but only if we cultivate an openness to those form of relationships and have the material and social means to seek them out. Using this framework, we might justify the existence of new global governance institutions in the name of valuing individual fellow humans around the globe, building connections and fostering welfare across national borders and cultures. Such an approach would contrast with the model of funding explicitly nation-first science policy initiatives, as well as any international ethics summit that assembles representatives of nation-states as the primary participants.

However evocative it may be, Appiah's and other prominent theories of cosmopolitanism often read as unfinished political fictions, fleeting sketches of how things might be and lives one could live. Left unanswered is a crucial question: for whom are theorists of cosmopolitanism writing, and in the context of which places, values, institutions, and power imbalances? Given the subject matter and often explicit reference to the particularity of culture, it is ironic that the geographic and social and cultural context of cosmopolitan theorization is often left aside or answered hastily without further evaluation.

-Mapping Real-World Cosmopolitan Initiatives and Their Shortcomings-

Because they are typically presented as abstract and acontextual ideals, theoretical prescriptions for a global sensibility neglect a second, empirical question: as "global" or "international" institutional responses to technoscience are launched, what are the actual contextual features that made them possible and with what value-laden rhetorical performances? Work in science and technology studies and political theory has already begun to address these questions and document the cultural and discursive landscape of global political norms. Calhoun (2008), for one, observes that the modern imaginary of cosmopolitanism boils down to elite privilege and international travel, while Rao (2010) argues that cosmopolitanism rhetoric is used to justify the one-sided exercise of state power.

Overall, this literature suggests that a problem and accompanying solutions are made "global," the result of context-specific social dynamics and deliberate work by motivated actors. Neveu and Surdez (2020), for example, argue that in addition to the basic interdependency that humans experience, global problems arise from three "flows": the material (e.g. commercial goods, viruses), "problem/solution definers" (e.g. state actors, environmental experts), and the cognitive-symbolic (e.g. images of suffering, datasets). From a similar perspective, Jasanoff (2013) concludes that abstract cosmopolitanism hopes are likely to be impeded by the hard realities of global politics, especially power differentials between countries and competing national modes of public reason. As long as these differentials remain, attempts to govern science for "all of humanity" are likely to be cosmopolitan in name only.

-Conclusion: (Re)Formulating Normative Foundations for Cosmopolitan Technoscience-

The effects of globalization, international collaboration, and the increasing significance of technoscience in daily life make the “global” a pressing issue for both understanding and governing technoscience in 2022. For this reason, any adequate account of “well-ordered” science must account for emerging “cosmopolitan” institutions and discourses. More specifically, scholars also have an opportunity to (re)formulate the guiding commitments of new international forms of governance, like the Global Observatory. Doing so effectively, I argue, requires that that we make use of both the rich philosophical literature on cosmopolitanism as well as empirical studies of cosmopolitan rhetoric in its socio-political context. The stakes of this inquiry are not merely intellectual and implicate the future of science as it grows from its traditional role of legitimating democracy within the nation-state (Ezrahi 1990) to an uncharted role in our now “global” technological landscape.

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Keywords: cosmopolitanism, case studies, global governance, political philosophy

[13] Eugen Octav Popa (University of Twente), Vincent Blok (Wageningen University & Research), Georgios Katsoukis (University of Twente) and Cornelius Schubert (Technical University Dortmund).
Complex Equality as a Heuristic Tool for Responsible Innovation.

Abstract. Marie is a chemist. She spent her career unravelling the mysteries of matter and energy – learning chemical jargon, studying chemical processes, training on cutting-edge laboratory instruments, conducting experiments etc. – only to discover one day that the science as she know it has changed. The inclusion of societal values in research and innovation, she is told, must now ‘move upstream’ (Joly and Kaufmann 2008; Krabbenborg and Mulder 2015; Pidgeon 2007; Wilsdon and Willis 2004). Furthermore, Marie might read about “the waning of the authority of the expert” and “the inclusion of new voices in the governance of science and innovation as part of a search for legitimacy” (Stilgoe et al. 2013: 1571). Doing science is now seen as a highly specialized mode of doing social work with all the laurels and responsibilities that come with such work. Of course, she is not completely unfamiliar with the interface between science and society. Her lab was never fully insulated from the influence of societal concerns and cultural phenomena. After all, her recent work in photo-electrochemistry and the production of fuels form solar energy seeks to contribute to the societal need for sustainable fuels. Isn’t the abandonment of fossil fuels a societal challenge rather than a purely a scientific one? But the parties advertising this new mode of doing science – ‘mode 3’, as they mysteriously call it (Carayannis and Campbell 2009) – do not mean just that. Tackling societal problems in the lab will not be enough. The new way of doing science consists of a complex interaction between the values that already animate Marie’s lab work and the values that animate society more generally.

This new way of doing science, Marie soon discovers, is fraught with difficulties; not because she is against responsible innovation or because she thinks that science should be isolated from society. (She might of course hold these beliefs, but that is a different scenario altogether). Rather, difficulties arise because Marie, as mentioned, is already involved with values in her job as a chemist. These are values - 'Mertonian values' as they are sometimes called after Robert Merton's sociological work (1973) – already direct Marie's behaviour. They direct her behaviour towards truth, towards perseverance and dedication, towards effectiveness and display critical spirit, towards selflessness in sharing discoveries, towards curiosity and novelty. These are then the scientific values that were part of Marie's lab before the new deal came along. And Marie's intuition might suggest what experience will eventually confirm namely that the native values of the institution of science can come into conflict with the batch of external values that must now be taken into consideration (Fisher et al. 2006; van der Burg and Swierstra 2013; van Hove and Wickson 2017). If Marie's lab is animated by (inter alia) the values mentioned above, society might be animated by values such as liberty, justice, tradition, love, safety, etc. and there is no guarantee that these two batches will mix well and form a harmonious composition. And the problems might not stop there. For soon Mary might also notice that there are also conflicts between two or more societal values that seem to be making a valid claim to Marie's attention. At a cross-roads, one decision in the lab might primarily serve liberty while a different decision might primarily serve justice, with both liberty and justice pressuring Mary's conduct with equal force and legitimacy. How should Mary navigate this competition between a plurality incompatible value claims that are now demanding her attention as a scientist and as a citizen? And what does it mean for Mary to act responsibly in such a state of pluralism?

Socio-ethical perspectives on science have urged scientists like Mary to align their work with an ideal of responsibility derived from the notion that science should be practiced "with and for society" (see overview in Stilgoe et al. 2013). Yet the current literature has provided little or no guidance on what it means to mediate responsibly between different, incompatible value claims. In this paper we propose to address this gap by borrowing insights from the philosophy of pluralism and more specifically the notion of complex equality between a plurality of incompatible values. We model innovation as simultaneously being oriented towards four types of value: academic value, societal value, political value and market value. With this as a starting point, the question is cast in distributive terms, viz. How must scientists mediate between the four helixes such that the gains and losses in value resulting from their innovations are distributed responsibly? In order to answer this question we draw on political philosophy of pluralism where the notion of complex equality has been developed (Lamont 2012; Miller and Walzer 1995; Walzer 1983). Complex equality, we argue, can be a useful heuristic principle for responsible innovation in the context of incompatible value claims.

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Keywords: responsible innovation, complex equality, moral overload, value inclusion, artificial photosynthesis

[17] Gabriela Estefania Duque Orozco (Universidad Politécnica de Valencia). *Guidelines for the inclusiveness of international science to strengthen capacity development in contexts where the achievement of the SDGs is complex (global south).*

Abstract. This proposal seeks to generate a collective discussion on the analysis of research and innovation policies with an emphasis on social challenges such as the Sustainable Development Goals (SDGs), through the presentation of inclusive guidelines for international science to strengthen development. capacities in contexts where achieving the SDGs is complex (global south).

This contribution responds to a reading from the knowledge of the advantages of research in the global north and the experience of doing science in the global south. Therefore, it is expected that this reflection contributes to the field of research and innovation policies from interdisciplinarity, indigenous knowledge and the role of vulnerable civil society in the global south to try to understand why the research task does not have the same effect on compliance with the SDGs in these sectors.

The analytical basis that it is intended to provide for the debate is in an early stage of development; however, it answers the question: How to mobilize international science to strengthen capacity building in contexts where societal challenges such as the SDGs are worst? These inclusive guidelines are framed in four objectives: (1) Identify the gaps in the achievement of the SDGs between the countries of the global north and south. (2) Strengthen calls for funds for research on comparative studies, seeking the participation of peers from countries with low economic resources. (3) Democratize the information bases in the languages of the countries with social challenges and intervened contexts and (4) Define participatory and empowering methodologies for the construction of science for the development of the capacities of those involved.

In terms of identifying the gaps in the achievement of the SDGs between the countries of the global North and South, the guidelines could guide the following: (1.1) Sustained approach to the academy of low-income countries to learn about the temporary and permanent problems that arise research in their research centres. (1.2) Search for lines of connection with grassroots organizations and communities to understand their main social challenges. (1.3) Definition of capacities that can be strengthened for a respectful exchange and that enable the realization of specific SDGs.

In relation to strengthening the calls for funds for research on comparative studies, seeking the participation of peers from countries with low economic resources, the guidelines should aim at: (2.1) Motivation for pre- and postdoctoral researchers from the global south who are trained in the global north to carry out research proposals that seek to strengthen capacities for the achievement of specific SDGs. (2.2) Extension of calls to research personnel who do not have a contractual relationship with a research centre, but who do have formal sponsorship. (2.3) Identification of efficient ways of transferring resources to countries of the global south for the development of research financed by the global north.

On democratizing the information bases to the languages of the countries with social challenges and intervened contexts, the guidelines should aim to: (3.1) Generation of open and intuitive access for the search of information that guides the investigations towards the success of contributing to the fulfilment of the SDGs. (3.2) Contextualization of information through cultural understanding of the countries of the global south. (3.3) Translation of essential information for compliance with the SDGs produced from research and innovation into the secondary official languages of the countries of the global south.

Finally, in what has to do with defining participatory and empowering methodologies for the construction of science for the development of the capacities of those involved, the guidelines should support: (4.1) Identification of methodological processes that facilitate the participation of the sectors involved on the research. (4.2) Facilitation of non-formal education processes through research activities. (4.3) Constant feedback of the investigative process to those involved for the timely identification of the contributions to the achievement of the Sustainable Development Goals.

Keywords: International science, SDGs, global south, global north

[18] Delia Mangelkramer (Freie Universität Berlin). *Addressing responsibility in innovation processes for sustainability: Lessons for responsible management of sustainable innovation from a systematic literature review.*

Abstract. Current developments, such as climate change, population growth and a widening economic gap continue to raise the significance of sustainability. Notably, this aspect has become increasingly relevant for innovation studies and is at the core of the sustainability transition studies (Boons et al., 2013; Seebode et al., 2012). The UN's Sustainable Development Goals (SDGs) can be seen as a result of such a change in attitude, aiming to put sustainability at the center of decision-making. In this respect, the SDGs as a guide for innovation and research, illustrate not only the importance of clear goals for the active contribution towards sustainable future systems, but also the high complexity across and between systems and its actors, which gives room for trade-offs (Morton et al., 2017).

One way to minimize the risks of conflicting goals is to identify possible consequences at an early stage. This would allow an early identification of potential negative consequences, e.g., through anticipation from a broader infrastructure perspective. Current developments in the literature taking a multi-level-perspective on sustainability transitions emphasize the interrelationship between organizations and their broader environment (Geels, 2011). According to this line of thinking, businesses have a major responsibility in the design of systems and in terms of understanding complex structural interrelationships. Thereby, the way innovation processes are managed within businesses and the resulting outcomes have an impact on the entire infrastructure and thus on the overall system.

This study argues, that Sustainable Innovation (SI) literature (Berkhout, 2014; Boons et al. 2013) contains essential features that qualify the framework to analyze business management procedures and their wider implications on the system. The framework includes features enabling it to map infrastructure dynamics, guide innovation in a sustainable direction, and engage key change agents to apply SI in their daily innovation and research activities (Boons et al., 2013; Hallstedt et al., 2013). Therefore, SI can be regarded as a search paradigm for innovation that has the potential to contribute to the creation of sustainable systems (Berkhout, 2014).

Nonetheless, SI often fails to strategically integrate aspects of responsibility such as social justice and equity into the innovation process (Lubberink et al., 2017). Without a strategic integration, however, there is a risk of contributing to "irresponsible" system change as a result of business innovation activities. Furthermore, a lack of consideration of unintended impacts may also risk overlooking significant system interconnections that can lead to unintentional trade-offs.

Cuppen et al. (2019), for instance, highlights that it is still unclear how to include ethical considerations in innovation practices for sustainability, "as the uncertainty of future outcomes contrasts with the backward-looking and static nature of most ethical inquiry" (Cuppen et al., 2019, p. 151). While it is suggested to focus on the innovation process in order to establish a more balanced view of technology development including social responsiveness and sustainability, it remains open how this can be established. Unless there is a clear framework for strategic contributions towards social sustainability, innovation practice will lose its contribution to system-wide and responsible transformation. Keskin et al. (2013) elaborates on the innovation process and how it needs to be adjusted in terms of sustainability. It is argued that the innovation process toward sustainability is influenced by constantly changing internal and external factors, which can only be balanced by a clear understanding of the intended and created values. Nevertheless, the integration of responsibility and a consideration of possible consequences during the process is missing.

Consequently, there is a gap in the SI literature as it is not clear how the framework can be used to integrate considerations of responsibility more strategically into the management of innovation processes and thus provide the basis for contributing to socially sustainable system change. Based on this observation, this study argues for an expansion of the current understanding of innovation processes for sustainability to account for responsibility. The framework of Responsible Research and Innovation (RRI) is highlighted as an emerging research field to address this task.

This study reviews the literature and derives an innovation process model, which embeds responsibility (as defined by RRI) in the innovation process for sustainability. This framework aims to answer the question "gow to manage innovation in a way that contributes to creating sustainable socio-technical systems"? This study reports on findings from a systematic literature review of a representative sample of empirical studies from the SI and RRI literature. Following Coopers (1988) steps of a systematic literature, the important variables for developing an responsibility extended innovation process model for sustainability are identified. By using SI and RRI literature, it sheds light on 1) factors which appear to be relevant in order to understand how innovation processes for sustainability can influence socio-technical systems, 2) shortcomings within the innovation process for sustainability in terms of responsibility, 3) insights from the RRI literature on how the innovation process for sustainability can become more responsible and 4) insights on how managers can promote and organize innovation processes for sustainability in a responsible manner.

The framework of RRI addresses societal needs and an orientation toward the "right impacts" in research and innovation processes (Owen et al., 2013). RRI highlights the mechanisms of inclusion, anticipation, reflexivity and responsiveness and thereby puts the normative dimension of research- and innovation processes at the center of attention. Some authors in the RRI literature emphasize, however, that the framework is often difficult to integrate into the overall innovation process, which notably excludes the business sector from using it (Inigo & Blok, 2019; Lubberink et al., 2017). In order to counterbalance this, the framework would need to be applied beyond the early stages of the innovation process to include the entire process from the design stage to the commercialization stage. However, both the differences and similarities between SI and RRI show that the two frameworks can complement each other. This can also be seen in the current literature, which has already revealed considerable synergies (Cuppen et al., 2019; Lubberink et al., 2017). Yet, an analysis of how the two frameworks can complement each other in a joint innovation process model for sustainability and responsibility is currently missing. Especially under the perspective to push system change through respective business innovation practices.

Results from the literature review reveal that both frameworks have a different approach through which system change could be enacted. While SI places more emphasis on a goal-oriented approach, RRI takes an inclusive approach – in which change is fueled by societal consideration. The results further support the assumption that innovation processes in the SI literature often do not incorporate responsibility strategically as profit often dominates innovation practices in times of critical decision-making. In addition, SI can face difficulties in the processing of generated knowledge, which can ultimately lead to the underrepresentation of external needs during the course of the innovation process. Regarding the inclusion of external stakeholders, it also becomes clear that despite the general agreement regarding the importance of inclusion, inclusion often remains insufficient. Even though it cannot be ruled out that RRI can face similar challenges, it still gives reason to assume that RRI is a tool to address the stated challenges. Integrating responsibility into innovation processes for sustainability can create a moral compass that helps to set clear standards for decision-making. Furthermore, the integration of responsibility can also be seen as a competitive advantage when businesses go "beyond standards" through responsibility.

Based on the innovation process model towards sustainability presented by Keskin at al. (2013) as one of the most developed innovation process models towards sutainability, the study concludes with a management proposal for a responsible innovation process model for sustainability. The model outlines possibilities how RRI tools can be used to further strengthen the innovation process for sustainability. Thereby, it becomes clear that responsibility can become more than a process, but a design element of innovation. The process starts with the definition of intended values including sustainability and responsibility aspects by multiple stakeholders. Finally, standards of responsibility can be defined which can influence the entire innovation process at its different stages. The process takes advantage of anticipation, which informs the management about a strategic network and helps to strengthen its position within that network to increase its assertiveness for change. The process lives from a well-educated management and human resources that help to direct the innovation process toward the defined goals. At the end of the process the created value can be compared with the intended value and principles such as responsiveness can be used to train the management for building up routines.

The aims of the study can contribute to the literature in various ways. First, this study aims to conceptualize an innovation process model that uses tools and techniques commonly used for managing innovation for sustainability and strategically incorporates aspects of responsibility. This will expand the current understanding of innovation processes for sustainability and optimize it in terms of its strategic integration of social sustainability. This is particularly beneficial for ethical considerations, which are often difficult to capture in previous models. Thereby, the ability of the model to contribute to desirable system change by anticipating consequences of innovation will be increased. Second, this study aims to contribute to the RRI literature by improving its applicability to the business sector and extending the framework to go beyond the early stages of the innovation process. In addition, by applying mechanisms as outlined in the SI literature, options are identified through which RRI can be linked to a broader systems perspective.

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Keywords: Responsible research and innovation, Sustainable innovation, Innovation process, System change,

[19] Knut Blind (TU Berlin & Fraunhofer ISI). *The Role of the Quality Infrastructure (QI) within Socio-Technical Transformations: A Review and Research Agenda.*

Abstract. According to Markard et al. (2012), sectors like energy, water supply, or transportation can be conceptualized as socio-technical systems. They consist of (networks of) actors (individuals, firms, and other organizations, collective actors) and institutions (societal and technical norms, regulations, standards of good practice), as well as material artifacts and knowledge (Geels, 2004; Markard, 2011; Weber, 2003).

Whereas previous research has focused mainly on actors, the role of institutions in general, and, in particular, the differentiation between regulations and standards has been relatively neglected in the literature on socio-technical systems. However, following the Porter Hypotheses (Porter & Van der Linde, 1995), several studies have investigated the impact of, in particular, environmental regulations on innovation (see Ambec et al., 2013). Meanwhile, the relevance of regulations for innovation in various areas has been acknowledged (see recent overview in McEntaggart et al. 2020, but also Blind 2016a). The role of standards for innovation has been moved in the focus of research (e.g., Blind 2016b). Approaches to disentangle the different impacts of regulation and standards on innovation are still at the very early research stage (Blind et al., 2017). Finally, analyses of the comprehensive impact of quality infrastructure, i.e., standards, certification, accreditation, metrology, regulations, and market surveillance, on innovation and the transition of socio-technical systems are still missing as already claimed by Blind (2015) related to general impact studies.

UNIDO (2018) defines the QI as: ''the system comprising the organizations (public and private) together with the policies, relevant legal and regulatory framework, and practices needed to support and enhance the quality, safety and environmental soundness of goods, services, and processes. The quality infrastructure is required for the effective operation of domestic markets, and its international recognition is important to enable access to foreign markets. It is a critical element in promoting and sustaining economic development and environmental and social well-being. It relies on metrology, standardization, accreditation, conformity assessment, and market surveillance''.

However, recently quality infrastructure has been the focus of a strategy paper by the Department of Business, Energy & Industrial Strategy (BEIS et al., 2021). In addition, it has been explicitly mentioned as an important element for the development of the hydrogen economy in the national strategy by Germany (Federal Ministry for Economic Affairs and Energy, 2020), but also addressed in the context of the data economy (Puhl et al., 2021). Finally, Aswal (2020) highlights the role of the quality infrastructure for inclusive growth in India. In contrast, Marian et al. (2022) focus on its role in general but highlight the relevance of international standards for developing the solar plant industry in India.

Based on this background, we derive the following research question:

• What is the role of the quality infrastructure and its components for the transition of socio-technical systems?

The remainder of the paper is structured as follows. At first, we provide an overview of the literature on the links between the components of the quality infrastructure, focusing on regulation and standards on the one hand and the transition of socio-technical systems on the other hand. In addition, few studies address the role of certification or accreditation in this context, and only a single one is related to metrology. Then, based on these insights, we position the various elements of quality infrastructure in the heuristic model of technological transitions within the multi-level perspective (Geels 2002), following the structure of six policy intervention points by Kanger et al. (2020). Finally, the paper concludes with an outlook towards future research.

Based on the insights from the review of the literature about the role of the different components of the quality infrastructure, in particular regulation and standardization, but in addition concrete measures or initiatives within the different components of quality infrastructure, we start to integrate them into the multi-level perspective of transitions (Geels 2002) of socio-economic systems (Geels 2004). Since the quality infrastructure can be considered part of the policy system, we follow the six steps of policy interventions introduced by Kanger et al. (2020), stimulation of different niches, acceleration of niches, destabilization of the regimes, addressing the broader repercussions of regime destabilization, coordination to multi regime interaction, tilting the landscape. The findings of attributing the different components of the quality infrastructure to the six steps of policy interventions are summarized in a comprehensive matrix.

Overall, we find the important role of radical regulations following the tradition of the Porter Hypothesis for the stimulation of different niches. Moreover, since research and development are important for the emergence of niches, the effective interfaces to standardization, including metrology (Blind and Gauch, 2009), have to be assured at least for public-funded research and innovation programmes, like Horizon Europe, as highlighted in the standardization strategy published by the European Commission (2022).

Based on the output of standardization processes, the acceleration of niches can be promoted by exploiting the various economic functions of standards, e.g., economies of scale and network effects. Here, certification schemes by accredited conformity assessment bodies can play a supporting and further enhancing role.

The destabilization of the regime certainly requires significant changes to the regulatory framework. In standardization, the substitution of existing standards by incompatible follow-up solutions has taken place on very few occasions, e.g., standards battles. The same is true for certification and accreditation. However, we have seen some significant changes in the metrology system, which have been quite different from previous ones.

Since the destabilization of regimes might have broader repercussions, which policymakers can address by changing the regulatory framework or launching other public policies, e.g., financial support for those organizations heavily affected. Standardization and the other elements of quality infrastructure might be less effective because of limited instruments and lack of incentives and responsibility of the involved stakeholders, i.e., mainly industry.

Since regimes are not isolated but interact with other regimes, their interactions must be coordinated to make socio-technical transitions possible. It is not only necessary to coordinate national regulations across sectors, e.g., between the construction and the energy sectors, to increase energy efficiency, but also at the international level, as recently pointed out by the OECD (2021), to address global challenges. Since we have no international regulations but international standards, the latter plays an important role in the transition of global socio-technical regimes (Fuenfschilling and Binz, 2018). It is important to mention that international standards do not have to be developed in national or regional niches and then transferred in the next step to the international level. They can even develop at the international level and then be implemented at the national level (see, for example, Miörner and Binz 2021). Furthermore, it has to mention that standards can also be used to specify the technical details of the more general regulations, which require the coordination of another interface. In addition, coordination within standardization is needed, similar to the alignment between different sector-specific regulations. This pressure will increase with the progressing convergence of technologies (Gauch and Blind, 2015). Furthermore, the interfaces between different certifications schemes, like related to the international quality or environmental management system standards and accreditation, have to be coordinated. Finally, the metrology system has to be aligned with the regulatory framework and the stock of standards.

For tilting the landscape as the last policy intervention point, the regulatory framework conditions - if possible coordinated on the international level - have to be altered to enable the change in the directionality of locally bounded socio-technical systems, e.g., to address the challenges of climate change. Regarding standardization, such tilting of the landscape has been tried by aligning the international standardization activities towards the objectives of SDGs, just putting climate change into the focus. At the European, but also at the national level, the development and release of standardization strategies are indications for trying to put standardization into the play to allow the landscape to tilt towards the SDGs and address other geopolitical challenges, e.g., related to assuring technological sovereignty. Following the tilt of the landscape within standardization towards the SDGs reducing the relative importance of the economic function of standards, certification schemes accompanied by eco and energy labels followed this change towards sustainability, including the emergence of new standardization and certifications institutions. In addition to the tilt of the landscape towards sustainability, the progressing digitalization has also reached the quality infrastructure and its components, e.g., in the digitalization of metrology.

Based on the findings of this review of the role of the different elements of quality infrastructure, we will derive propositions that might inspire and guide future research.

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[21] Knut Blind Knut Blind (TU Berlin) and Florian Münch (TU Berlin). *Rules and innovation in a globalising economy: Do standards and regulations affect innovation differently?*

Abstract. Introduction

Economic rules condition the incentives for firms to invest into and undertake innovation. The emergence of transnational production and the dominance of liberal economic ideas has led to a transformation of the economic rules of market economies in the age of globalisation (Baldwin, 2000; Gereffi et al., 2005). National regulations have been partly reduced via de-regulation or harmonised across countries to facilitate cross-border exchange of goods, which was intended to reduce administrative burdens on firms arguably freeing up resources for investment in R&D (Alesina et al., 2005) and promote entry and competition, which in turn is also argued to fuel innovation (Aghion et al., 2005). Simultaneously, private national and, in particular, private international standards expanded (Büthe & Mattli, 2011) as private standards were considered to be more dynamic and adept to the realities of businesses (Blind et al., 2017), therefore promoting innovation. Finally, the harmonisation of regulation and international standards reduces the costs of commercialising products in multiple markets, which should increase companies' incentives to invest in R&D and file international patent cooperation treaty (PCT) patents.

This paper contributes to the existing literature in the following way. We hypothesize and empirically examine the impact of product market regulation, national and international standards for R&D expenditure and patenting in panel regressions of 26 countries between 1998 and 2018. Earlier research had shown national standards were a source of comparative advantage (e.g. Moenius, 2006; Swann et al., 1996); we show that this does not hold true, at least for the average, in a globalised economy as our results suggest international standards outperform national standards and regulation both in terms of R&D expenditure and patenting. National standards, in contrast, seem to localise economies and slowdown innovation in a globalised world economy. While existing research has shown that regulation decreases firms' investment in R&D (Aghion et al., 2021; Litina et al., 2021), we illustrate that de-regulation, however, does not produce the symmetric effect: the results suggest de-regulation has not increased R&D expenditure. Instead, firms must have invested freed-up resources elsewhere but not in R&D. At the same time, de-regulation seems to increase patenting, which leads to the puzzle how innovation output can have increased, while R&D has been left unchanged. Based on existing literature, we argue that lost protection based on de-regulation was replaced with protection based on patent fences.

Hypotheses

Based on our review of the literature and the empirical data base, we test the following hypotheses:

Hypothesis 1: De-regulation increases expenditure on R&D on average.

Hypothesis 2: De-regulation increases the number of patent applications.

Hypothesis 3: National standards reduce average expenditures on R&D.

Hypothesis 4: International standards increase average expenditures on R&D.

Hypothesis 5: National standards decrease the average number of patent applications.

Hypothesis 6: International standards increase the average number of patent applications.

Empirical Strategy

Empirically, we focus on the overall, aggregate single positive or negative effects of different regulations and standards on innovation across countries and years.

Data

Table 1 presents the sample of observed countries and years.

Table 1 Panel structure

Table 2 provides an overview of all variables and data sources.

Table 2 – Variables and Data Sources

Table 3 presents summary statistics for the variables used for the analysis.

Table 3 - Summary Statistics

Model

To model R&D as % of GDP, we opt for a random effects model with robust, clustered standard errors to account for heteroscedasticity and auto-correlation:

$$(1) \quad r\&d_{it} = \alpha + \beta_1 pmri_{it} + \beta_2 \ln(nstd)_{it} + \beta_3 \ln(istd)_{it} + \beta_4 controls_{it} + u_{it} + \varepsilon_{it}$$

where indices i and t stand for the sample countries and years, r&d is the percentage of gross national R&D expenditure in GDP, α is a constant, pmri refers to the product market regulation index, the number of national and international standards nstd and istd are log-transformed, controls is a vector of the control variables gdp, terteduc and exppercgdp, uit is the between entity error and ε_{it} is the within-entity error.

We opt for a two-way Poisson panel fixed effect model to estimate patent count:

$$(2) \quad patents_{it} = P(\alpha + \beta_1 pmri_{it} + \beta_2 \ln(nstd)_{it} + \beta_3 \ln(istd)_{it} + \beta_4 controls_{it} + \varepsilon_{it})$$

where P stands for the Poisson transformation and all variables but pmri, terteduc and exppercgdp are in natural logarithms. The model contains the intercept α and a standard error term ε. The controls are the same as for model 1 but also include a year dummy (given a test for joint significance rejects the null hypothesis) and R&D expenditure in % of GDP.

Results

Economic rules and R&D (innovation input)

Table 4 column (2) and column (3) suggest that international standards are the only type of economic rule that is significantly associated with gross national R&D expenditure. A 1%, in international standards increases gross national R&D expenditure by 0.0011% in the same year.

Note that neither national standards nor regulation affect gross national R&D expenditure (once control variables are added). The results clearly oppose earlier research (Moenius, 2006; Swann et al., 1996) and suggest the changing structure of the world economy transformed the incentives related to national vs. international standards to invest in R&D. The results also reveal that the implicit assumption businesses would use resources freed up resources from lower regulatory compliance costs to invest in R&D does not hold: de-regulating provides businesses with resources that end up somewhere but not in R&D expenditure.

Table 4: Main regression results for R&D expenditure and economic rules

All estimations are based on panel linear fixed effects models. Column (1) provides the mean and standard deviation in squared brackets of R&D across countries and over the sample period. Column (2) corresponds to equation 1 without control variables. Column (3) adds control variables and is equivalent to equation 1. Column (4) corresponds to equation 1 but with R&D in year t+1. Column (5) corresponds to equation 1 but with lagged explanatory variables in t-1 (= 5 calendar years earlier).

Economic rules and patenting (innovation output)

In the following table 5 provides regression results for patents. While national standards have a negative and significant impact on PCT patents in the same (at the 10% level) and the following year (at the 5% level), international standards have a positive and significant effect on PCT patents both in the same and the following year at the 5% level. A one (ten) percent increase in national standards is associated with a 0.41% (4.1%) decrease in the number of PCT patents filed both in the same and the following year.

Table 5: Main regression table for PCT patent count

Finally, we turn to regulation. Re-call from the previous section that de-regulation did not affect R&D over the sample period according to model estimates. Yet, column (4) suggests that a one-unit decrease in regulation was associated with a 33% increase in the number of PCT patents filed.

At first thought, the regression results are clearly puzzling: although de-regulation does not affect investment in R&D (input), de-regulation promotes patenting (innovation output). Based on recent literature (Boldrin & Levine, 2013; Cohen et al., 2002; Gilbert & Newbery, 1982; Torrisi et al., 2016; Walsh et al., 2016), we argue that de-regulation induces patenting to replace lost protection from low competition based on regulation with protection based on patent fences.

Conclusion

This paper is the first to attempt to hypothesize and distinguish empirically the effect of the different forms of economic rules on innovation in the recent period of globalization. First and foremost, international standards seems to beat both national standards and regulation. The model estimates suggest that international standards have promoted an additional 45 billion USD invested and approximately 6132 PCT patents in the 26 sample countries that embraced international standards between 1998 and 2018. In contrast, national standards have – on average – no effect on R&D expenditure and a negative effect on PCT patents. This stands in contrast to earlier research on standards (Moenius, 2006; Swann et al., 1996). The estimates among a broader sample of 26 countries that can still be considered the global technology frontier suggest that national standards – in a globalised economy – rather tend to localise and lock-in countries in domestic forms of innovation.

Puzzlingly, the results suggest that de-regulation induced patenting while it left R&D expenditure changed. We argue that de-regulation induces competition, and competition pushes firms to pre-emptively and strategically patent to resurrect protection lost due to de-regulation with patent fences. Had competition simply motivated firms to make more effort, one would have expected to see R&D increase in response to de-regulation too. We consider the results call for future research to investigate whether this hypothesis could answer the above-mentioned puzzle.

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Keywords: regulation, standards, innovation, R&D, patents

[22] Bruno Fischer (School of Applied Sciences, University of Campinas), Susann Schäfer (Institute of Geography, University of Jena), Paola Rücker Schaeffer (Unisinos Business School), Nicholas Vonortas (Department of Economics, The George Washington University) and Alsones Balestrin (Unisinos Business School). *THE GEOGRAPHIES OF VENTURE CAPITAL IN THE CONTEXT OF ENTREPRENEURIAL ECOSYSTEMS.*

Abstract. BACKGROUND

The goal of this research proposal is to analyze the spatiality of entrepreneurial ecosystems through the local, regional and global flows of venture capital. Growing importance has been attached to Entrepreneurial Ecosystems (EE) as a 'conceptual umbrella for the benefits and resources produced by a cohesive, typically regional, community of entrepreneurs and their supporters that help new high growth ventures form, survive, and expand' (Spigel & Harrison, 2018). Drawing from biomimetics, the EE approach dedicates attention to unraveling the mechanisms through which socioeconomic environments organize to introduce new knowledge and innovations in markets (Oh et al., 2016). Yet, if we are to take the entrepreneurial ecosystem metaphor seriously (as called for by Kuckertz, 2019), an issue of critical importance concerns the spatial morphology of these complex economic arrangements. While challenges associated with identifying the spatial scale of natural ecosystems have long been part of discussions in the field of ecology and evolutionary biology (Bailey, 2004; Strayer et al., 2003), the geographic reach of EE remains largely uncharted in literature. This is odd since entrepreneurial ecosystems comprehend 'an inherently geographic concept' (Godley et al., 2021, p. 725).

ENTREPRENEURIAL ECOSYSTEMS AS A SPATIAL PHENOMENON

From a biomimetic standpoint, we know that ecosystems' boundaries must be defined according to their formative processes (Bailey, 1983), not predefined political or administrative boundaries (Carayannis et al., 2018). Economic geographers have long grasped the agglomeration of concentrated economic activities in the context of the following concepts, industrial districts, creative milieus, clusters and national/regional systems of innovation (Schäfer, 2021). This literature recognizes spatial features of economic systems as key for urban planning and governance (Kuckertz, 2019; Autio & Levie, 2017; Roundy et al., 2018). Accordingly, an in-depth exploration of the territorial scope of EE – an issue that is likely connected to its stage of maturity - can set the parameters for informed initiatives that can efficiently promote stronger linkages.

Following this discussion, from a spatial perspective, regions ought to be understood as socially constructed entities where agents establish connections (Maskell, 2001). Economic resources are used or produced through relational processes involving social interactions. It is not the access per se to substantive resources that generates competitiveness and differentiation, but how they are combined in a superior manner (Bathelt & Glückler, 2005). The geography of innovation then becomes the geography of linkages that are formed to generate new products, processes and services. Even if such elements are spatially constrained within a district, a city or a larger region, the territorial scope is defined by the structure of networks, not by predetermined geographical boundaries (Dicken & Malmberg, 2001). For this reason, the definition of analytical units needs to be based on different types of flows, territorial connectivity and multiple geographical expressions, becoming impossible to choose the boundaries of interest for socioeconomic processes a priori.

TOWARDS A RELATIONAL VIEW OF SPATIALITY IN ENTREPRENEURIAL ECOSYSTEMS

As our argument goes, if the core of the entrepreneurial ecosystem is based on linkages and interactions, then relational data is key (Schäfer, 2021). Our proposal here is to address the possibilities of analyzing the spatial configuration of entrepreneurial ecosystems by using geocoded data on venture capital (VC) flows between entrepreneurial ecosystems. This perspective/indicator is particularly suited to understand the interregional linkages of entrepreneurial ecosystems because entrepreneurial finance occupies a pivotal position in the evolution of EE, functioning as knowledge brokers due to their role in the management of entrepreneurial ventures (Zook, 2005). Also, although discussions on VC have placed emphasis on the co-location of investors and investees due to principal/agent monitoring dynamics (Sorenson & Stuart, 2008), recent contributions identify a much broader geographical scope in VC flows (Balachandran & Hernandez, 2019). This situation opens up the opportunity of identifying different spatial morphologies in EE according to the spatial patterns of VC (a continuum that ranges from hyperlocal to global). We believe this focus can provide novel perspectives for both theoretical advances in EE research and setting a methodological research agenda in this topic. Ultimately, we expect such an approach to generate spatial typologies of entrepreneurial ecosystems according to their territorial connections with investors.

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Keywords: Entrepreneurial ecosystems, Venture Capital, Geography of innovation

[24] Oshri Bar-Gil (Bar-Ilan university). *Global codes and local meaning? What can we learn from the AI codes of ethics as an intersection between social expectation, Law and regulations and imagination of science and technology? .*

Abstract. Ethical codes that regulate the use of artificial intelligence is an emerging trend. Although there is a broad consensus that risk management and regulation should be maintained for its uses, there is lower consensus on the key issues involved in the principles and regulation itself (AI HLEG, 2019; Coeckelbergh, 2020). One of the main tools for such regulation is ethical codes, which constitute a declarative meeting point between the moral conception, the prevailing cultural norms, the different organizational and cultural expectations, imagination of possibilities of their actual implementation (Boddington, 2017).

In recent years, more than 200 codes of ethics have been published by major academic, research, military and industrial bodies in the world that deal with the way in which responsible artificial intelligence is required to be developed in a variety of contexts (Hagendorff, 2020). Although some might find an agreement on the stated values of the codes a large variance can be found in the principles selected by each state and actor on the filed and in the meaning that lays behind the stated principles. For example, while many reports and code of ethics state their goal as “responsible AI” they actually use words that are more connected to accountability or other principles, or that while they emphasize the fact that they want to keep “Human rights”, in their text referring to AI as an agents or actors and enforcing regulations on them as “entities” has higher prevalence than humans.

In order to understand the different dynamics of the field, codes and regulations from various countries and institutions were selected. This study examined 12 key codes of ethics related to the use of artificial intelligence systems in military contexts or related to these contexts, by military and state organizations. The selection was done by a team of multidisciplinary experts in the field. Out of the 12 codes selected 3 were written by countries, 3 by armies or defence ministries, 4 by NGO’s, research and academic bodies and 2 from leading companies the industry. The discourse analysis was using a quantitative literature review approach based on text analysis in order to identify the main principles that appear in each of the documents. After identifying the prevalence of key values in these documents, a comparative evaluation of different terms and their importance in the case of identifying the similarities and differences between the documents of these principles was performed.

Developing and introducing the quantitative discourse analysis as a research method for STI policy research is a one thing that we would like to share in our article presentations. As well as presenting some of the concrete findings of the study (I attaches some figures from the findings to illustrate it better as PDF).

The findings of the study show the principles and differences between the documents of the various principles. These findings illuminate the way in which fundamental terms are perceived differently in international law, in the perception of collective distributed cognition mechanisms, and in human-machine teaming (Plant & Stanton, 2017; Verbeek, 2011). Terms such as intention, autonomy, agency, and independence take on different meanings from the research literature and perceptions that currently exist in society and the (Bratman, 2014; Kupfer, 1987; Searle, 1983).

Other findings show that the main concern of each type of bodies are different. While the industry codes of ethics emphasis principles that can be fixed with technology, at least to some degree (e.g fairness and equity, explainabilty, governance) the academic oriented codes deal more with agency and accountability, the national codes care more about privacy etc. Using document clustering technique, we were able to uncover which cultures, nations and bodies are more similar to each other and which were apart and saw some surprising findings as well.

At the end I will discuss the main trend that we think that the study uncovers with the different cultural variances – the movement towards global codes of ethics and local interpretations and regulations that lead to different implementation of ethics. This issue is expected to influence the policy ecosystem for years to come in the field of AI. Understanding the strong global forces in the science and technology ecosystem we might learn that the dynamic will be similar for other disruptive and emerging technologies such as quantum computing.

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Keywords: AI, Ethic code, Responsible AI, Cultural Ethics, Discourse analysis

[25] Martijn Wiarda (Delft University of Technology), Vladimir Sobota (Delft University of Technology), Matthijs Janssen (Utrecht University), Geerten van de Kaa (Delft University of Technology), Emad Yaghmaei (Delft University of Technology) and Neelke Doorn (Delft University of Technology). *Public Participation in Mission-Oriented Innovation Projects.*

Abstract. 1. Introduction

Research and innovation (R&I) are increasingly expected to contribute to addressing societal challenges such as climate change and pandemics (European Commission 2009). Many of these contemporary challenges are acknowledged to be wicked, meaning that they are complex, systematic, and socio-technical in nature (Rittel & Webber 1973). Overcoming these challenges therefore requires the transformation of socio-technical systems, rather than enhancing the mere rate of innovation. For R&I this implies a demand for policies that allow for mobilizing and aligning a wide variety of stakeholders, that together might contribute to the development and diffusion of possible solutions for ambitious and widely shared goals. Currently, the notion of mission-oriented innovation policy (MIP) is rapidly gaining attention in this respect (Ergas 1987; European Commission 2018).

Relying on missions to drive transformations that address wicked societal problems requires cooperation between different actors (Linder et al. 2016; Loorbach & Rotmans 2010; Mazzucato 2016, 2017; Rabadjieva & Terstriep 2021; Wanzenböck et al. 2020). For instance, the involvement of public actors – here understood as non-conventional innovators (e.g. municipalities, citizens) – is believed to be crucial for the success of transformative R&I (Wanzenböck & Frenken 2020; Weber & Rohracher 2012), and for increasing the social desirability of its processes and outcomes (Von Schomberg 2013; Stilgoe et al. 2013). If mobilizing actors into a uniform direction is the aim of missions, then it is essential to understand how stakeholder participation, such as public participation, takes place (Janssen et al. 2021).

However, very little is known about the extent to which mission-oriented R&I projects by themselves are, as an inherent feature, encouraging public participation in R&I. It is unclear how public participation differs between mission-oriented and non-mission-oriented R&I, and how missions differ from each other in this regard. This study addresses these knowledge gaps by looking at public participation in R&I projects. The paper yields insights regarding mission-oriented projects' participatory performance; identifies characteristics that affect this performance; and provides valuable (normative) policy recommendations vis-a-vis MIP.

2. Theory

2.1. Mission-oriented innovation policy and public participation

There are various normative, instrumental, and substantive arguments in favour of public participation (Stirling 2008) that resonate with MIP. For example, instrumental and substantive arguments can be made in relation to preventing and overcoming transformational system failures (Weber & Rohracher 2012). More specifically, public involvement has been suggested to mitigate the chances of demand articulation failures (Fisher et al. 2018), reflexivity failures (Garud & Gehman 2012; A. Smith et al. 2014), and directionality failures (Grillitsch et al. 2019; Janssen et al. 2020; Sykes & Macnaghten 2013).

While many scholars acknowledge the importance of including 'the public', the notion of public itself has quite a different meaning in different academic disciplines. Science & Technology Studies tends to refer to citizens and civil society organisations; Innovation Management frequently gravitates towards users and consumers; while Innovation Studies tends to include cities and governmental bodies. In this paper, our working definition for the umbrella term 'the public' refers to all these actors above and hence excludes conventional innovators, i.e., the industry (e.g., incumbents and SMEs) and knowledge institutes (e.g., universities and research institutes).

Public participation is broadly described as an inclusive process that allows the (potentially) affected actors to partake in the decision-making process of R&I (Newig & Kvarda 2012; Rowe & Frewer 2000; G. Smith 1983). While there are many forms of participation (Lynam et al. 2007; Reed et al. 2009; Rowe & Frewer 2000, 2005), this paper specifically considers forms of participation that Arnstein (1969) labels as 'higher degrees of power'. As such, we understand public participation as public actors formally partaking in R&I projects by either having full control, delegated power, or influence through partnerships.

The imperatives of public participation in missions-oriented R&I raises the question to what extent missions encourage the public to participate in R&I projects, and how their participation can be measured.

2.2. Measuring public participation

2.2.1. The challenges of measurement

Measuring public participation is challenging as it is complex and contested on itself; no consensus is established on what evaluation criteria to use; no dominant evaluation method has emerged; and few reliable tools for measurement exist (Rosener 1981; Rowe & Frewer 2004). As a result, analyses are often context-dependent and rely on practicalities such as data availability. To deal with this Rowe and Frewer (2004) propose to first define public participation's 'effectiveness' (1), to operationalize it accordingly (2), and to subsequently conduct the evaluation and interpretation (3). We adopt three dimensions proposed by Callon et al (2009) that characterize the participation's effectiveness, and which have gained popularity in the academic discourse over the last decade. An advantage of these dimensions is that they particularly focus on the process of public participation rather than its creation or outcomes. These respective process dimensions are referred to as intensity, openness and quality.

2.2.2. Intensity

The intensity of public participation refers to "how early laypersons are involved in research [and innovation (systems)]" (Callon et al. 2009 p. 158). Although the process of innovation is a complex and iterative process containing feedback loops (Kline & Rosenberg 1986), many simplistic and disputed linear models have emerged in the literature. These roughly share the proposition that R&I processes can be conceptualized into the following phases: basic research, applied research, invention, development, production, and diffusion (Godin 2005; Godin & Lane 2013). Early participation therefore refers to participation in the upstream stages of basic and applied research (Delgado et al. 2011; Wilsdon & Willis 2004). This paper aims to examine this for missions by hypothesizing the following:

Hypothesis 1: Mission-oriented R&I projects have a higher intensity of public participation than non-mission-oriented R&I projects.

2.2.3. Openness

Openness refers to the public's ease of partaking in the R&I process and can be measured through the number and diversity of public groups that are participating (Callon et al. 2009). A large number of scholars claim that successful innovations need a diverse stakeholder participation to obtain the broad range of different perspectives, knowledge, values and expectations that reflect those of society (Bugge & Fevolden 2019; Diercks et al. 2019; Schot & Steinmueller 2018). We ask whether mission-oriented projects adhere to this claim and hypothesize the following:

Hypothesis 2: Mission-oriented R&I projects have a greater openness of public participation than non-mission-oriented R&I projects.

2.2.4. Quality

Quality refers to the gravity of participation and the extent to which the public can push their ideas into the innovation process (Callon et al. 2009). It directly relates to the public's power and influence on decision-making (Fiorino 1990; Reed 2008) in mission-oriented R&I projects. Power contributes to the public's ability to influence technological developments, and largely stems from their available resources (Rowe & Frewer 2000). Whether this is reflected in mission-oriented projects is assessed with the following hypothesis:

Hypothesis 3: Mission-oriented R&I projects have a higher quality of public participation than non-mission-oriented R&I projects

3. Method

3.1. Research design & case description

We have chosen the Dutch Topsector policy as our empirical setting. One of its main instruments is the Public Private Partnership allowance (PPP-allowance) which supplements 30% (previously 25%) of the total investments made by actors in earlier public-private R&I projects. While the Topsector policy's initial emphasis laid on sectors, it announced in 2017 that it will target specific missions. During the subsequent years it shifted its focus towards four cross-sectoral themes (i.e., Energy transition & Sustainability; Agriculture, Water & Food; Health & Healthcare; and Security) that embody multiple concrete missions.

The empirical data on which the analysis rests is provided by the Netherlands Enterprise Agency (RVO). The dataset contains information about all R&I projects that have taken part in the PPP-allowance scheme in the 2013-2019 time period. RVO has retroactively assigned contemporary missions to past and ongoing projects if the projects' activities align(ed) with the current missions' goals. Past project were therefore not subjected to policies that actively promoted mission themes. Furthermore, the participation of public actors did not form a condition for the acquisition of funding. As a result, both these aspects provide this study with the opportunity to assess whether R&I projects that are mission-oriented have already a de facto tendency to mobilise the public.

3.2. Variables & data analysis

This study measures public participation through three effectiveness indicators that form the dependent variables of our analysis, i.e., intensity, openness, and quality.

Intensity relates to how early the public is involved in R&I, which in our data can be operationalized by considering in which of three possible developmental stages the public partakes. Openness refers to how easily the public can partake in projects and measured through the number and diversity of public participants in the R&I projects. The quality of public participation refers to the power and influence of the public. Their economic power in the form of investments is particularly important as it directly contributes to their ability to innovate in line with, and influence decision-making regarding, a mission. Power is relative, hence the economic power of the public should be considered in light of the economic power of other actors. Therefore, this study uses the project's total public investments divided by the total investments as a proxy for quality.

To understand how public participation in R&I projects differs between missions and non-mission, and between each mission, we construct a categorical variable as the independent variable, called mission. This variable indicates whether a project falls under the category 'non-mission' (1) or one of the four mission themes, i.e., Energy Transition & Sustainability (2); Agriculture, Water & Food (3); Health & Healthcare (4); Security (5). These themes represent a constellation of coherent missions.

The data analysis consists of three individual statistical analyses as we examine three independent variables of public participation, i.e., intensity, openness, and quality. For each analysis, we estimate the effect of mission (type)/non-mission, and we control for sectoral and temporal differences. The regression models concern a multinomial logistic regression, a negative binomial model, and a fractional logit model for intensity, openness, and quality respectively.

4. Results

[Results are currently still in development, based on improvements in the variables and models]

5. Discussion and conclusion

This paper examines to what extent missions have the natural tendency to involve public actors in R&I projects. More specifically, it explores whether these missions are associated with earlier (intensity), more open (openness), and more empowered (quality) public participation than R&I projects that do not relate to missions.

Despite the optimism in the MIP discourse, this study finds little evidence that missions have the natural tendency to formally involve public actors in R&I projects. Mission-oriented projects appear to lack, what Arnstein (1969) calls, 'higher degrees of power' in which the public contributes through full control, delegated power, or partnerships. A lack of these higher participation forms has important implications for missions. More fundamentally, it may affects how missions understand and deal with the contestation, complexity and uncertainty that arise from the societal challenge's wicked nature (Head 2008).

First, without the public's involvement in mission arenas, MIP runs the risk of overlooking and disregarding the values, needs, and expectations of society that give rise to contestation (Bauer et al. 2021). Second, it may miss out on complementary (lay) knowledge needed to better understand problem-solution spaces' complexity. Lastly, without the input from the public, missions' anticipatory capacity may suffer causing actors to overlook probable, possible, and plausible unexpected consequences associated with the uncertainty of wicked problems.

Because mission-oriented R&I projects do not exhibit a natural tendency to involve the public, future MIPs should pay specific attention to stimulating public participation. If neglected, missions may risks generating transformational failures and undesirable outcomes.

Keywords: mission-oriented policy, transformation, innovation policy, wicked problems, public participation, responsible innovation, societal challenges

[26] Adriaan van der Loos (Utrecht University), Marko Hekkert (Utrecht University) and James Patterson (Utrecht University). *The polycentric governance of innovation systems.*

Abstract. The governance of innovation systems pertains to the underlying mechanisms that determine who is granted access to decision-making circles, the rules that govern the interactions between different actors and how this evolves over time. Governance is of crucial importance to grasp how innovation systems emerge and mature and yet has received limited attention. Since innovation systems are composed of a multitude of private and public actors and operate according to a wide variety of needs, it is likely that multiple centers of decision-making are present and operate in a semi-autonomous manner from one another. The development of an innovation system may thus involve the ad hoc emergence of a patchwork of decision-making centers, which may or may not be aligned and may evolve along different pathways over time. Therefore, understanding the governance of innovation systems requires a lens that can recognize and evaluate the presence of such a governance patchwork. Traditional fully hierarchical or fully fragmented perspectives on governance are unlikely to be able to capture the nuances of such a plethora of actors that have different goals and interact in a semi-autonomous manner.

Polycentric governance theorizes that any given system is composed of multiple centers of decision-making that operate semi-independently from one another and yet interact to varying degrees and in different ways. It can therefore provide a potentially powerful means to analyze this patchwork of governance arrangements. We further embed our research into the literature on arenas of development, governance arrangements and the broader governance of sustainability transitions and transitions management theoretical frameworks.

We draw on the case of offshore renewable energy in the Netherlands to determine if a polycentric innovation system can indeed be identified and analyze its characteristics in a rapidly accelerating innovation system. This innovation system is composed not just of classic offshore wind, but also tidal and wave energy, floating solar photovoltaic and airborne kite technologies. We begin by identifying and characterizing multiple centers of decision-making, the key actors involved per decision-making center and the rules that govern each center. An innovation system can be considered as polycentric if different decision-making centers can indeed be identified, a variety of actors are present, each center has a different cluster of actors, the rules and institutions are distinct and yet there is also a certain degree of awareness of one another.

We conducted 34 interviews with expert stakeholders, which we complement with industry and government reports, an offshore wind stakeholder database, a government sponsored research & development (R&D) project database and industry news to inductively identify key centers of decision-making.

We observe that the system is indeed polycentrically governed and highlight five distinct decision-making centers: legislative, market formation, industry formation, research & development and full-scale demonstration. The federal government and diversifying incumbents are present in each center and play a particularly strong role in hindering legislative and market formation development in the early stages. Foreign governments and incumbents were the most dominant actors that affected industry formation, particularly during the formation of offshore wind. Denmark, the United Kingdom and Germany played the strongest role here with incumbent actors from the oil & gas, dredging and maritime industries happily taking on new contracts. The R&D center of decision-making was, and still is, the most diverse center of decision-making. For example, many startups, research institutes, networking organizations, incumbents and government funding bodies all facilitated low technology readiness level R&D. All centers became more diverse and institutionally open over time.

A key turning point in legislative and market formation occurred in 2013 with a significantly more inclusive institutional arrangement, meaning that civil society, NGOs, ports, networking organizations and many others were granted access to the negotiating table. Both the European Union and the United Nations entered the legislative arena and began to establish a cohesive offshore renewable energy vision. This was a critical moment that legally bound the Dutch government to reduce its carbon emissions by massively increasing the amount of renewable energy in the energy mix. In this respect, the European Union effectively imposed itself as an actor in influencing the formation of strong legislation. A new oil & gas price crash in 2014 further pushed the Netherlands into the acceleration phase and began to catch-up with the other leading European offshore wind countries. Providing space to a greater diversity of actors indicates an improved institutional openness to new ideas regarding establishing policies, rules and regulations.

This embarked the Netherlands on a journey of stable market formation, clear legislative priorities and common expectations, all of which were previously lacking. However, disruptive offshore wind startups and startups from other maritime renewable energies like tidal are still often kept out of the core decision-making centers of action. Despite constructing two of the first ten offshore demonstration windfarm in Europe in the 1990s, significant low and medium-scale test facilities and onshore demonstration sites – often facilitated by ports – testing new innovations full-scale and offshore remains exceptionally challenging. These challenges are further exacerbated by resistance from the newly emerging offshore wind regime with its origins in oil & gas. This means that the full-scale demonstration center of decision-making remains more restricted and institutionally conservative.

We suggest that emerging and maturing innovation systems that have high capital expenditure and may be able to benefit from coupling related technologies – such as how offshore wind was able to couple oil & gas expertise with onshore wind – will show similar traits to the polycentric nature of the offshore renewable energy innovation system. More fragmented innovation systems, such as (rooftop) solar photovoltaic may display different characteristics, such as more community-oriented programs, greater citizen engagement, etc. This means that there may be more inclusivity, governance experimentation and institutional openness than higher capital expenditure innovation systems.

For offshore renewable energy, the future may generate additional instances of polycentricity as costs come down, legitimacy increases and technologies improve. New actors may join a center of action, such as a citizen's group communally owning an offshore wind farm. Inspiration may also originate from other innovation systems, such as a recently commissioned onshore wind farm by an indigenous group in the eastern Canadian province of New Brunswick, indicating greater possibilities for indigenous reconciliation, empowerment, financial independence and social justice.

We suggest that all innovation systems are governed polycentrically, albeit with different characteristics, institutions and actors. Innovation systems that are even more concentrated than offshore wind, perhaps nuclear power, may remain extremely hierarchical and centrally organized due to the complex, dangerous and sensitive nature of the technology. We do expect that the centers of decision-making largely remain the same, namely that there will always be legislative, market formation, industry formation, R&D and demonstration centers of action, but their diversity and evolution are likely to show different characteristics. Some innovation systems may show more clearly distinct traits, characteristics, actor participation and rules than other innovation systems that are more homogenous. Depending on the innovation system in question, it may be challenging to distinguish between certain centers of decision-making, for example legislative and market formation may ostensibly merge into one center of action in certain scenarios. It is also evident from this study that increasing actor diversity stimulates experimentation, supports fair and just rule setting, improves legitimacy and helps establish commonly recognized and accepted goals, targets and expectations. A wide variety of actors that largely agree on a common set of principles and outcomes can generate positive feedback loops and virtuous circles, thereby further stimulating the system.

Broadly speaking, we can conclude that innovation systems benefit from a wide diversity of actors and institutional openness amongst and across centers of decision-making. This allows for the greatest degree of experimentation, open discussions on rule setting & expectations and the widest variety of actors participating in market and industrial formation.

Keywords: Polycentricity, Governance, Institutions, Innovation systems, Offshore wind, Maritime renewable energy

[28] Vitaliy Roud (National Research University Higher School of Economics), Valeriya Vlasova (National Research University Higher School of Economics) and Nicholas Vonortas (The George Washington University). *Innovation Barriers Across Firms with Different Levels of Innovation Capabilities: Empirical Evidence and Policy Implications.*

Abstract. This paper contributes to understanding the degree of heterogeneity among different types of enterprises in terms of their perception of the framework conditions for innovative activity. Such heterogeneity is present even within individual national innovation systems. A core research questions is the following: how do views on barriers and obstacles to innovation vary among different types of firms, with different levels of innovation capabilities, and market orientation? How does this diversity challenge innovation-related policymaking?

The available empirical evidence on the contribution of different drivers and obstacles influencing innovation performance heavily relies on the Community Innovation Surveys executed by Eurostat or similar exercises from other national environments. The research mainstream (Amara et al., 2016; Antonioli et al., 2017; Baldwin & Lin, 2002; Blanchard et al., 2013; Cherubini Alves et al., 2021; De Fuentes et al., 2020; D'Este et al., 2012, 2014; Galia & Legros, 2004; Hölzl & Janger, 2014; Iammarino et al., 2009; Madrid-Guijarro et al., 2009; Pellegrino & Savona, 2017; Savignac, 2008; Segarra-Blasco et al., 2008, 2008; Tourigny & Le, 2004) emphasizes the idea of complementarities between barriers of different nature and grouping according to their impact – importance of non-financial barriers in addition to financial. There is a growing concern for detailed analysis of barriers of different nature as opposed to general categories. There is also clear evidence that firms that are successful and unsuccessful for innovation provide vastly different views on the innovation systems "bottlenecks".

The data set used for the study includes information on innovation activities of more than 39800 industrial enterprises operating in the Russian Federation during 2019. The data come from the innovation survey run by the Russian Federal Statistical office. Anonymized object-by-object data was provided by the Institute for Statistical Research and Knowledge Economy at the National Research University Higher School of Economics.

The paper proposes the empirical framework aimed at identifying the differences in the barriers relevant for the enterprises with different levels of innovation capabilities operating in the same economic environment.

Source: compiled by the authors.

The econometric strategy treats the enterprise types as multivariate qualitative variable. The factors of statistical significance of individual barriers for different types of enterprises are analyzed in a multinomial logistic regression model of discrete choice, so that the types of enterprises are treated as the dependent variable and barriers to innovation — as determinants along with a given set of control variables (enterprise size, type of economic activity, affiliation with the state).

We find that different barriers, aggregated as financial and non-financial, have different effects for different types of enterprises. The limited value of aggregated barrier categories such as "financial/non-financial" is confirmed. Moreover, the importance of barriers significantly differs for different levels of innovation capabilities. Finally, exporters differ significantly from non-exporters, recognizing greater pressure from competition and information asymmetry in terms of market information.

The next step in the analysis of the results is to systematize the barriers that are most significant for different types of enterprises.

To the best of our understanding, this is the first time the particular enterprise microdata and the specific country are analyzed in this field. Besides the specific country example, however, we believe that this analytical approach can be widely applied to assess the performance of any national innovation system in terms of identifying (or emphasizing) the problem areas of innovation domain, and the "bottlenecks" of the business environment that hamper the opportunities of intensification of innovation and reduce the system's efficiency.

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Keywords: innovation barriers, innovation capabilities, industry, Russia

[31] Emanuela Reale (CNR IRCRES Research Institute on Sustainable Economic Growth), Antonio Zinilli (CNR IRCRES Research Institute on Sustainable Economic Growth) and Andrea Spinello (CNR IRCRES Research Institute on Sustainable Economic Growth). *The diversity of policy instruments for public R&D funding: the role of Research Councils.*

Abstract. 1. Introduction

The paper deals with the structure of government funding instruments in seven European countries, namely Austria (AT), Germany (DE), Switzerland (CH), Norway (NO), Denmark (DK), Estonia (EE) and Check Republic (CZ). We focus the analysis on funding instruments designed and managed by the national RFOs that can be classified as Research Councils (RCs), thus the organizations specifically devoted to allocating government funding to universities and public research organizations, on the base of a delegation that constitute them as intermediaries between the government itself and the research performers. Some illustrative examples of evidence for analyzing funding programs are presented in order to shed light on national research policies and mix of instruments (Flanagan et al., 2011; Capano et al., 2020) used to reach given policy goals. The references therefore are mainly related to the experiences developed within European initiatives devoted to mapping and characterizing national funding research instruments and their diversity.

The paper uses a new dataset (EFIL-RISIS) developed within the RISIS European Research Infrastructure, collecting information on government R&D funding instruments, and building metrics that would allow to deepen the configuration of funding portfolios and policy mixes of programs by focusing on instruments characteristics, actors involved, and topics addressed, at different levels of policymaking (national and regional level).

2. Research questions and conceptual framework

The research questions are twofolds: 1) what is the importance of RCs in the respective national research systems and how different are they according to their missions, tasks and characteristics of the funding instruments managed? 2) what is the structure of the funding instruments and how far are they oriented toward addressing societal relevant themes?

The questions want to shed light on the specific position of RCs with respect to other RFOs. As to the latter, generally, despite the delegation of some tasks, the state still retains the direct political control, while RCs remains essentially autonomous organizations, and largely self-managed by scientists. Relevant dimensions of policy autonomy are the design of funding instruments, and the right to decide independently on the grant allocation; managerial autonomy pertains more on internal management and grant management processes. However, according to Lepori and Reale (2019), we face in the European countries different processes affecting the RFOs, with on the one hand a change in the delegation from the government to the RFOs leaving them more management autonomy, which goes on the other hand, with the re-regulation of previously independent RCs, which are now subject to framework regulations, accountability and external evaluation of how the policy instruments they have implemented reached the intended objectives, thus improving the control over the organization's performance.

The paper tries to answer the mentioned questions looking at three main dimensions, namely:

1. The delegation type from government to the RC. Following Braun (2003), we can distinguish between three main types of delegation mode, representing different ways of the relationship between government, funders and beneficiaries.

2. Diversity of funding instruments as to the capability to address societal grand challenges or general objectives for the sustainable development. Here the reference is to the literature highlighting the changes in the RCs role as funding organizations mainly related to academic research (Lepori and Reale, 2019), and the assumption of a more direct role of the mentioned agencies toward research addressing societal challenges also when curiosity-driven research is supported.

3. The type of criteria applied for selecting the beneficiaries in the evaluation of the proposals submitted to understand whether different orientations beyond the academic criteria have been applied. The descriptors signal the presence of different types of ideas about what research quality is (Langfeldt et al., 2019) which can be more related to the values of the researchers or more related to the requirements of policy makers. The characteristics also go with the presence of non-academic experts inside the selection committees and allow to understand how RCs manage the selection of the proposals.

We expect that RCs are less homogeneous funding organizations than expected. Different patterns of transformations shall be based on a) the importance they have in the national government funding systems, b) the changes of the internal organization with the participation of non-academic actors in the governance and c) the diversification of the portfolio including mission-oriented type of funding instruments.

The proposed investigation is mainly explorative due to the provisional stage of the dataset used (cfr. Section 4). However, data used can provide interesting indications about the transformation of the RCs and the instruments they manage, showing an interesting orientation toward topic of societal relevance.

3. Methodology and Data

The analyses of the research council funding instruments presented in this paper are entirely based on data from EFIL – European dataset of public R&D funding instruments, one of the databases provided by the Research Infrastructure for Science and Innovation Studies – RISIS2 . This resource has been properly designed and built to allow investigations on public R&D funding in Europe at the level of R&D funding instruments and RFOs managing them, addressing research questions related to policy design and implementation. The database contains data related to the funding instruments' characteristics from the instrument portfolios of selected RFOs from various European countries.

The list of the relevant RFOs is derived from OrgReg – the RISIS Register of Research Organization (see RISIS, 2017); despite the organizational diversity, organizations included in OrgReg are characterized by the presence of three elements: i) they are organizations managing and distributing public R&D funding; ii) they have a significant funding volume with respect to the national government funding for R&D; iii) they manage funding schemes by using regular calls and evaluation procedures.

The EFIL data collection is RFO-based and focuses on publicly available resources that can be accessed via web-exploration. Data on instrument characteristics and funding volumes mobilized by the RFOs are obtained primarily from official documentation uploaded on websites. The collection method either challenges the dispersion of the contents across multiple locations and sources or, in some cases, collides with the lack of availability from publicly accessible sources (e.g., for the elimination of the contents from the RFO websites). The database includes a parallel collection of official textual documents linked to the instruments (calls, applicant guidelines, description from websites) to allow text analyses, which are likely to result in the identification of keywords, for a better understanding of R&D funding priorities.

a. Decomposition of R&D project funding

The methodological approach for the EFIL database is largely based on the experience of PREF experimental study on the evolution of public R&D funding (Scherngell et al., 2016; Reale, 2017), which is based on the concept of 'decomposition' of public research funding into funding instruments. 'Funding instruments' are defined as the funding schemes for R&D, having similar characteristics in terms of how they are managed, the beneficiaries, and how they are allocated. EFIL considers only project funding instruments which earmark direct public funding for R&D to research performers. Project funding instruments are i) assigned based on a competitive submission of a project proposal describing the research activities to be done, ii) limited in scope and duration of the research supported, and iii) assigned by a research funding organization other than the performing organization to which the beneficiary belongs. (Lepori et al. 2007; van Steen 2012).

The degree of fragmentation of project funding instruments in various RFOs varies significantly (as an example see the systematic international comparison by Janger et al., 2019), and this has an impact on the capability to represent correctly all the instruments in one dataset. Thus, to reduce complexity, allowing for structured comparisons, the EFIL collection follows a granularity for the identification of the instruments based on some leading criteria, which jointly created a set of 'funding routes' for each RFOs, where one single instrument or a group of instruments can be included. The process to identify the funding routes considers some driving principles, namely a) the repartition of instruments presented by the RFOs in the annual reports/websites or other official documentation; b) the overlapping of missions and objectives between instruments, their continuity over time, and similarity of selection processes; c) the thematic orientation of the instrument in terms of field of study; and d) funding mobilized by relevant funding instruments. As a result, a single project funding instrument in EFIL may include many different sub-schemes, functioning as a broad-level scheme.

b. Selection of European RCs and descriptors of interest

For the purpose of the paper, the authors selected nine RCs from seven European countries to represent different situations in the European Research Area landscape, which include medium-sized countries with a well-developed science basis, large countries, and Central and Eastern European member states.

The RCs considered are: Austrian Science Fund (FWF) and Vienna Science and Technology Fund (WWTF) from Austria, Czech Science Foundation (GACR) from Czech Republic, Independent Research Fund Denmark (DFF) and Danish National Research Foundation (DNRF) from Denmark, Estonian Research Council (ETAG) from Estonia, German Research Foundation (DFG) from Germany, Research Council of Norway (RCN) from Norway, Swiss National Science Foundation (SNSF) from Switzerland.

c. Text analysis on official documentation

A text analysis was performed on chosen official documents (calls for proposals, description of the instruments) archived in EFIL to delve deeper into the implementation features of the instruments associated to the thematic orientation. Documents related to 21 instruments from 4 RFOs of 3 countries – Austria, Germany and Switzerland – have been analyzed. The analysis dealt with identifying themes from one or more categories of Key Enabling Technologies (KETs) and Societal Grand Challenges (SGCs). The keyword search considered seven possible SGC priorities and six possible KET objectives as well as their thematic subareas (or subclasses). Furthermore, the research algorithm checked for keywords associated with the Sustainable Development Goals (SDGs), which were adopted by all United Nation Member States in 2015 as a worldwide call to action to end poverty, protect the environment, and ensure that everyone lives in peace and prosperity by 2030.

4. Results and conclusions

Al the evidence collected indicate that changes affecting RCs do not transform the main features characterizing this kind of funding agency. However, attention toward the improvement of mission-oriented research is visible in both dominant and cardinal RCs. Following the Braun's argument (1998, p.818), RCs still maintain the characteristics of science-based funding agencies, dealing with problems raised by the scientific communities and elaborating disciplinary-based solution, but they are also moving more and more toward dealing with problems raised by stakeholders and external actors, and solutions based on disciplinary and interdisciplinary research, assuming in this respect a role of strategic funding agencies.

In fact, transformations of the R&D funding portfolio are visible and are more evident in the countries where RCs have a dominant role for project funding allocation. In these countries RCs assumes new tasks over the last ten years, and new funding instruments addressing these tasks are introduced. In other countries, where RCs co-exist with other specialized RFOs, changes of the funding instrument structure are also visible, but are more related to national strategies toward improving the quality and the internationalization of the research system (i.e., the instruments devoted to promoting the 'excellence' of the research in Germany and Estonia). The mentioned changes led to the emergence of different funding configurations that are shaped not only by government policies but also by organizational changes within and between the RCs.

Keywords: policy instruments, R&D funding, Research Councils, policy mix

[33] Loet Leydesdorff (University of Amsterdam), Lin Zhang (School of Information Management, Wuhan University) and Paul Wouters (Leiden university, CWTS). *Trajectories and Regimes of Interdisciplinarity in Research and Knowledge Evaluations: Contributions to an Evolutionary Theory of Citation?*

Abstract. 1. Introduction

Citation analysis provides us with a model of the evolutionary dynamics in a non-biological domain. Unlike the measurement of impact and past performance (cited), the directionality of references is active, intentful, and oriented toward the future (Rafols, 2021). Observable variation can be aligned along historical trajectories. In the citing direction, however, references select knowledge content from the perspective of hindsight—that is, against the arrow of time. Marres & de Rijcke (2020) suggested that referencing can "indicate" horizons of options.

By recursively selecting on historical trajectories on the basis of expectations, an evolutionary regime can bottom-up be shaped in processes of "mutual shaping." Unlike biological code (such as DNA), the genotypical code is not given in cultural evolutions, but constructed. An analyst is able to conjecture structure in citation data in addition to observable variation. When sufficiently populated, a next-order regime can take over control from the historical development. Orders of expectations can be expected to co-evolve as regimes on top of historical trajectories; as feedbacks and feedforwards.

The codes have the status of hypotheses and remain in flux. Selections can operate both on the variation at each moment of time and among the codes over time (Leydesdorff, 2021; cf. Hodgson & Knudsen, 2001). For example, selections can be selected for stabilization in a process of "mutual shaping." Stabilizations along localizable trajectories can be further selected for globalization, etc. A global regime of expectations exerts local selection pressure.

2. Citation as a model of the dynamics of interhuman communication

Operationally, one can map the two dimensions of cited and citing on an x-y plane and thus develop an indicator which appreciates the dynamics of both historical performance and evolutionary perspectives. We explore the feasibility of such indicator using (i) a set of papers in the environment of a single journal (Public Understanding of Science), (ii) a random sample of journals, and (iii) the entire journal set of the Web-of-Science (more than 10,000 journals). Indicators covering both forward dynamics and feedbacks can be relevant for distinguishing knowledge from research evaluation, and for the further development of a theory of citation.

2.1. Codification

Citations are an order of magnitude more specific than words (Garfield, 1955; Leydesdorff, 1989). The asymmetrical citation matrix contains observable variation in the valued cells and redundancy in the empty ones. The matrix can be transposed for the study of cited vs. citing as indicators of two different selection mechanisms.

2.2. Data and Methods

As data, we use first the aggregated citation matrix among 24 journals citing (columns) or cited by or citing articles in Public Understanding of Science (PUS) during 2019. We chose PUS as an example because this journal is programmatically oriented towards the subject that we discuss here. Among indicators for the measurement of interdisciplinarity, we chose DIV*. This indicator has some advantages when compared with alternative options (Zhang & Leydesdorff, 2021). The construction of interdisciplinarity is measured from the perspective of citing (i.e., action).

The Journal Impact Factor (JIF) is a size-normalized indicator of citedness. The most straightforward impact indicator in the cited dimension, however, is "times cited" (TC). An advantage of this indicator is that citations and publications can be counted: counts can be added and subtracted, whereas issues of normalizations may lead us astray into discussions about proper statistics and baselines. Garfield (2006) himself had hesitations about using JIF for measuring impact (Bensman, 2007), and discussed total citation as a possible alternative (Gross & Gross, 1927). "Total cites" (TC) is a size-dependent indicator; JIF is size- normalized. We have no a priori reason to choose for one or the other, other than the advantage of parsimony when using TC.

3, Results

3.1. PUS

Figures 1 shows TC values plotted against DIV* for the 24 journals under study. Along both the x- and the y-axis, the distributions are skewed as a consequence of ongoing selections. Some of the 24 journals specialize in one of the two dimensions (along the respective axes). The indicators for cited and citing are inversely correlated (Table 1) in this design: scoring high on TC is related to a low score on DIV*. One can find PUS, for example, represented at the right-most end along the x-axis (at x = 8.17), while psychology journals lead the ranks along the y-axis (TC > 50,000). Closer to the origin, we find journals which are thematically close to PUS, but low on interdisciplinarity. In these latter journals trade-offs between the two dimensions are indicated as x- and y-coordinates.

The analysis reveals different roles of the journals in terms of historical relations and the evolution of latent communication structures. The distances to the origin (√(x^2+y^2)) provide a two-dimensional indicator. Table 1 lists these values for the top-10 among them.

Figure 1: Evaluation of 24 journals citing from and cited by PUS during 2019

in terms of interdisciplinarity (DIV* on x-axis) and Times Cited (TC).

Table 1: Euclidean distances of x-y combinations to the origin of the map, respectively.

3.2 Random Sample (N = 100)

Is the inverse relation found above between the cited and citing dimensions, specific for PUS or would it be structural and also hold for a random sample of journals drawn from the set of journals in the Journal Citations Reports (JCR) of ISI/Clarivate? Since the computation of DIV* for more than 10,000 journals is time-consuming, we first attempted to work with a random sample of 100 journals. The two dimensions are in this case statistically independent: r = 0.001 (p > .99). In the next paragraph, we will use 2016 data, for which indicator values were available from a previous project (Leydesdorff et al., 2019).

3.3. On the basis of the full set of journals included in JCR 2016

The factor structure of the citation matrix based on the full set of JCR 2016 (N = 11,487 journals) is visualized in Figure 2 (using SPSS, v. 22). Note that factors indicate latent structures and thus selection mechanisms.

Figure 2: Visualization of the two-factor solutions (SPSS v.22) of the matrix of indicators versus 11,487 journals (without the network measures; oblique rotation)

The first factor with highest factor loadings for TC and JIF is followed by a second factor with highest loadings for DIV*. This two-dimensional factor structure confirms Rafols' (2021) conjecture: the two components are negatively correlated. When the selection was random and thus disregarding cognitive differences, however, the correlation was (above) not significantly different from zero. The evolutionary driver is grounded in the differentiation and codifications among fields.

4. Discussion and Conclusions

The analysis draws on distinguishing among (e.g., local and global) selection environments. For example, Gibbons et al. (1994) distinguished Mode-2 as application-oriented versus Mode-1 as the traditional "ivory tower" in which scholars develop their own research agendas. With a reference to Hayami and Ruttan (1970), Nelson and Winter (1982, pp. 258f.) distinguished selection environments as production functions at the trajectory level from meta-production functions at the regime level. However, Nelson and Winter (1982) did not specify selection mechanisms, but the selection environments of firms. They did not specify these environments as horizons of expectations.

One can consider the various dynamics as parallel processes that can differently be coupled by selections. The couplings can also develop over time; for example, as "instantiations" of background structures (Giddens, 1979). The evolutionary dynamics of the discourse can be modelled, measured, and simulated by using citations as a model. The surplus of combining evolution and citation theory is the operationalization and measurement. Historical developments generate variation which can be measured as positive entropy; evolutionary change can be measured as synergy and thus potentially negative entropy (Leydesdorff & Ivanova, 2021; Petersen et al., 2014).

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Keywords: interdisciplinarity, synergy, bibliographic coupling, co-citation, research evaluation, knowledge evaluation

[34] Knarik Poghosyan (TU Dortmund), Nadine Riedel (Universität Münster), Martin Kalthaus (FSU Jena), Michael Rothgang (RWI Essen) and Anne-Marie Scholz (ISG Institut für Sozialforschung und Gesellschaftspolitik). *How effective are cluster policies? Evidence from Germany.*

Abstract.

Introduction

Over the last decades, considerable attention has been paid to clusters and cluster policies. Contrary to public R&D subsidies for individual firms and projects, cluster policies promise to be particularly successful in stimulating new innovation as they support the systemic nature of the innovation process (Smits and Kuhlmann, 2004). Despite the increasing popularity of cluster policies, the jury is still out regarding their effectiveness (Graf and Broekel, 2020). Many studies have found that cluster policies, due to their geographically concentrated setup, stimulate more interactions between cluster members, which contribute to the growth of firms' performance and innovation activity (Engel et al., 2019; Akcigit et al., 2018; Crass et al., 2017; Cantner et al., 2015; Engel et al., 2013; Uyarra and Ramlogan, 2012; Nishimura and Okamuro, 2011; Breschi and Lissoni, 2009; Baptista and Swan, 1998). The latter idea has been supported by Breschi and Lissoni (2005) and Acemoglu et al. (2016), who found that knowledge flows are localized and geographic proximity of collaborating actors may lead to more innovations via knowledge spillover. In contrast, many scholars claim that cluster policies are very costly and usually have only a short-term positive effect (Engel et al., 2013; Duranton, 2011; Martin et al., 2011).

To shed more light on the ongoing debate about cluster policy benefits, our principal objective is to analyze the causal effect of cluster policies on innovative activity, firm performance, and cooperation across actors. We use the implementation of the German Leading-edge cluster competition, which is one of the largest cluster policies worldwide, as a testing ground. The main research questions are (1) whether the policy increased innovative output and firm performance of funded firms, (2) whether there are knowledge spillovers of the policy, which affect non-funded neighboring firms, and (3) whether the cluster policy indeed induced more collaborations across funded firms as well as funded and non-funded firms (thereby potentially moderating the effects in (1) and (2)). The latter question follows the ideas raised in the studies of Breschi and Lissoni (2005) and Acemoglu et al. (2016), where the authors claim that close location to the cluster firms might lead to a better performance of non-funded neighbors via knowledge spillover.

To address the research questions, we combine multiple datasets. We collect firm-level data from Orbis for the period 2000-2016 and combine it with patent data from PATSTAT. Furthermore, we create a novel, geo-referenced data set, which contains information on firms funded by the Leading-Edge Cluster Competition, which allows us to exploit geographical information to measure spillover. Methodologically, we employ an event study design following Sun and Abraham (2021) and matched difference in difference analysis.

This paper contributes to the existing literature in different ways. First, existing research on cluster policies concentrates mostly on regional analysis in a static framework (Graf and Broekel, 2019; Rothgang et al., 2017; Toepfer et al., 2017; Cantner et al., 2013). Our paper is the first to implement a firm-level data analysis of the German Leading-Edge Cluster Competition (LECC) policy in a dynamic event study framework. Furthermore, our research also involves the analysis of spillover effects for neighboring firms. This is naturally infeasible when using regional data as in prior work. Lehman & Menter (2017) touch upon this question by investigating the effects of the LECC on regional productivity, documenting that the policy positively affected funded, and negatively non-funded regions. Detailed analyses tackling the spillover effects for innovation activity and productivity on the firm level and in a dynamic setup are, to the best of our knowledge, still missing. Our results offer valuable insights both, for the academic literature and for policymakers.

The Leading Edge Cluster Competition

We concentrate our analyses on the German Leading-Edge Cluster Competition, which is the biggest cluster initiative in Germany with an annual budget of € 600 M (€ 40 M per cluster). The policy supported in total 15 clusters over the period of 2008-2017. The funding was implemented in 3 rounds (2008-2012, 2010-2015, 2012-2017), where 5 cluster initiatives were selected by an independent jury in each round. The LECC had also no regional and industry focus. Clusters were spread across all Germany and were mainly operating in the following areas: health (Ci3, Medical Valley, BioRN, Munich BioTech), digitization, production and communication (It's OWL, Cool Silicon, MicroTEC SouthWest, Software Cluster), mobility, and logistics (Hamburg Aviation, Effizienz Cluster Logistic Ruhr, Electro-mobility Southwest), and energy and resource efficiency (BioEconomy, Sollar Valley, Organic Electronics, Mai Carbon). The main goal of the policy was to stimulate collaboration and innovation via targeted funding of R&D projects in funded firms, firms from other industries in the cluster region, and firms outside the cluster region. (Rothgang et al., 2017).

Figure 1 shows the main recipients of the LECC support, where we see that the vast majority of policy funding (62%) went to the private sector (BMBF, 2015), which is the focus of our analysis.

Data and Method

Data: The data used in this paper covers the period of 2000-2016 and comes from different datasets:

- Bureau van Dijk's "Orbis" database, which is geo-referenced firm-level data containing information on firm financial accounting variables, industry code, location, etc.

- EPO Worldwide Patent Statistical Database (PATSTAT), which we use to calculate the number of patents per firm.

- Manually collected LECC data, which contains information on cluster firm geographical location, cluster affiliation, funding period, etc. Due to the unavailability of the information, our data covers only 12 out of 15 clusters (Forum Organic Electronics, Effizienz Cluster Logistic Ruhr, and Software Cluster are not included).

Method: The paper applies two methodologies. To analyze the impact of the LECC on funded firms, we apply the event study design following Sun and Abraham (2021). In our study, we account for 8 pre and post-treatment periods (leads and lags) and three policy interventions (cohorts treated in 2008, 2010, and 2012 respectively). In the first step, we look at the cohort effects separately, and then we pool all cohorts together to determine the total effect (Equation 1).

To observe spillover effects for neighboring firms, we construct geographic rings indicating the distance between funded cluster firms and non-funded neighbor firms. We have in total 5 geographic rings indicating neighbors in 1km, 1-5km, 5-10km, 10-15km, and 15-20km distance. Here we firstly use a basic difference in difference method to see the static spillover effects for neighbor firms. The sample is restricted to firms that are not funded by the policy. The estimation model is presented in Equation 2.

Then, in the second stage, we plan to implement an event study framework to identify dynamic spillover effects.

Results and Discussion

Our preliminary results are depicted in Table 1, which shows the average treatment effect of the policy for funded firms. The results suggest that the policy led to the increase of fixed assets and labor costs, however in general it had no significant influence on the performance of funded firms. The latter one can be explained by the fact that most of the funded firms are large firms that performed well and patented even without policy funding.

Conclusion

In the present study, we examine the impact of the German cluster policy (Leading- Edge Cluster Competition) on innovative activity and firm performance. First preliminary results suggest that the policy had no significant impact on the performance of funded firms. However, we should keep in mind, that this is ongoing research, and many more steps should be implemented to evaluate the final result.

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Keywords: Cluster Policy, Spillover Effects, Policy Evaluation, Regional Innovation, Patent Data, Event Study

[35] Caetano Penna (Utrecht University and UFRJ), Johan Schot (Utrecht University), Diana Velasco (Ingenio) and Jordi Molas-Gallart (Ingenio). *"Transformative" Mission-Oriented Policies: a conceptual framework and case study.*

Abstract. In the past decade, the focus of innovation policy has moved from increasing the rate of technological change to shifting its direction and, ultimately, to transforming sociotechnical systems – such as those that provide energy, mobility and food – in a sustainable direction. Scientific progress and innovation are not anymore regarded as ends in themselves, but as means towards promoting social and environmental welfare. In this context, policymakers began to embrace the idea of innovation missions to orient policies, inspired by the major projects of the twentieth century that sought to accomplish formidable technological feats – namely, the Manhattan Project (development of the atom bomb) and the Apollo Programme (putting a human on the moon and safely bringing her back). Contemporary missions to transform sociotechnical systems are however very different than the technological missions of the past (Foray et al. 2012; Soete and Arundel 1993), among other reasons, because the latter were insulated from society so that the economic diffusion of their results was not a core objective, while for the contemporary missions, diffusion of results – solutions to sustainability challenges – is at their core.

Recent contributions therefore proposed new ways to portray different types of mission-oriented policies (MOP): for instance, identifying successive generations of such policies, which would each require distinctive institutional capacities and capabilities (Mazzucato and Kattel 2020); discussing how missions are affected due to convergent or divergent views (framings) of problems and solutions (Wanzenböck et al. 2020); or analysing the implications of a mission's focus (on scientific-technological progress or behavioural change) and its requirements for governance and coordination (Wittmann et al. 2020). While the resulting typologies differ, they all include a specific category of contemporary missions: due to divergent framings, a combination of behavioural and scientific-technological ambitions, and uncertainty about possible solutions, these missions require new types of institutional capacities and capabilities and entail highly complex policy design, implementation and governance processes. They can be regarded as open-ended transformative mission-oriented policies (OETMIP), for which pre-conceiving end-states and their measurements is an elusive task. Instead, the emphasis in this kind of MOP is on emergent processes, experimentation and learning as a way to develop multiple solutions and open-up fruitful directions of transformative change.

Because we still lack a policy framework for (open-ended) transformative missions, this paper seeks to address this gap, by bridging the mission-oriented policy perspective with the transformative innovation policy approach (Steward, 2012; Schot and Steinmueller, 2018). As a societal challenge-oriented approach, transformative innovation policy (TIP) moves away from clearly defined cross-sectorial missions to focus on emergent open-ended transformations in 'sociotechnical systems' (Geels 2004), as conceptualized in the literature of sustainability transitions (Köhler et al. 2019; Zolfagharian et al. 2019). In contrast to the emphasis on measurable, pre-defined outcomes and state-led, top-down governance processes of the mission-oriented innovation policy, the transformative innovation framework emphasizes the need for policy to engage with ongoing transformations, through experimentation that enhance participation from new (niche) actors and civil society at large and thus open up for multiple directionalities of innovation development (to create not one targeted pathway-to-change but multiple). Transformative innovation policy therefore does not kickstarts the change process but modulates ongoing transformations.

The research question we seek to answer is: how can open-ended transformative mission-oriented policy be conceptualized and designed? To answer this question, we develop a new conceptual framework: open-ended transformative mission-oriented policies combine elements from both systemic and technological missions: (a) state-led stewardship that allows for bottom-up experimentation; (b) promote both radical and incremental innovation, be it technological, social or behavioural; (c) create the conditions for technical viability, economic feasibility and social acceptability; and (d) promote the diffusion of results. Our proposed conceptual framework is further translated into tools for designing and implementing open-ended transformative MIPs, based on the application of a formative evaluation protocol that allows for the identification of institutional capacity gaps both within organization implementing the missions and the surrounding context.

To illustrate the framework, we explore the case of the Swedish innovation agency Vinnova, an organization currently experimenting with methodologies to design mission-oriented initiatives following transformative innovation policy principles. Vinnova has followed strategic design principles (Hill, 2012) to advance the definition of country missions. Focused on accomplishing missions represented by the Sustainable Development Goals (SDGs), the agency seeks to overcome narrow state-led and top-down strategies. A transformation approach that deals with uncertainty and complexity has been utilized to set different angles towards sustainability challenges and pathways. In this endeavour, a formative evaluation guided by "transformative outcomes" (Ghosh et al., 2021; Molas-Gallart et al., 2021) has been introduced in the policy design and its implementation. While it is still early to assess the ultimate impacts of the experimental policy engagement, this paper uses the case to illustrate propositions derived from the framework.

The paper is structured as following: the first, conceptual section explores the literature on mission-oriented and transformative innovation policy, focusing on design and implementation. We discuss how different typologies that inform innovation policies put mission-oriented and transformative innovation in different boxes, leading to a dichotomous view of policy design and implementation process (either top down or bottom up). We discuss the implications of the new framework for institutional capacities and capabilities requirements: while the traditional capacities/capabilities are still relevant to design and implement such policy, new set of "transformative" capacities/capabilities are needed. In the second section, we briefly outline the methodology of the case-study methodology, which is presented in the third section. The case analyses mission-oriented policy for the food system that was designed and pursued by the Swedish innovation agency Vinnova, a frontrunner in challenge-driven innovation policies, which has embarked on designing and implementing both missions and transformation in a co-creation process with the Transformative Innovation Policy Consortium . The concluding section discusses limitations of the framework, draws policy implications, and proposes important areas for future research.

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Keywords: transformative innovation policy, mission-oriented innovation policy, institutional capacity, formative evaluation, policy design and implementation tools, Vinnova

[36] Laurens Hessels (Rathenau Instituut and Leiden University), Rik Joosen (Rathenau Instituut) and Anne-Floor Scholvinck (Rathenau Instituut). *The future of science in the Netherlands: a review of key trends and uncertainties.*

Abstract. Digitalization poses both challenges and opportunities for scientific research, with significant policy implications. The rapid development of artificial intelligence over the past ten years in combination with the ever-increasing computing power suggests that the trend of digitalization is approaching a turning point. While digital technologies have generated incremental changes to the speed of production and communication processes, the rise of a new generation of technologies may bring more radical changes to the way our society is organized, as suggested by concepts like the 'Metaverse'. Also, whereas digital communication techniques promise a world that feels ever closer at hand, geographical disparities in the speed of digitalization may actually increase the economic and social divide between the global North and the global South and heighten geopolitical tension.

Related to changes in the way people work, communicate, recreate and travel, one can also expect significant effects of digitalization in scientific practices. Digital technologies will open up new methodological opportunities, such as working with large datasets, virtual reality and machine learning. They will also generate new expectations from science, to feed technological progress in such a way that they generate economic or societal value. Moreover digitalization gives rise to new objects of study, such as virtual identities and digital social environments. And it may change the dominant communication mechanisms in science, by enabling and accelerating the open science movement. However, in spite of the potentially dramatic impacts of digitalization on scientific practices, the implications of this trend for science policy has so far remained understudied.

We argue that, in order for policy makers to deal responsibly and effectively with digitalization, they need to consider this development in relation to other ongoing developments in and around science. For example, we witness an unprecedented societal need for scientific knowledge, due to global crises related to health (COVID-19) and climate change. Second, there is an increasing orientation of science and innovation policies on societal challenges and policy goals, in particular sustainability and system transformation. In addition, there are other significant changes in the global context of science that will change its course, such as geopolitical uncertainty. Together, this creates a need to re-think the rationales and instruments of science policy as the interplay of these different developments can shift the societal expectations of publicly funded research, the position of the main actors and stakeholders, and the material practices of scientific research.

The aim of this foresight study is to explore the influence of digitalization in relation to other major trends and uncertainties. We want to support evidence-based science policy by identifying the major future trends, and exploring and assessing their effects in the science system. With science policy, we refer to interventions by different actors, in particular the government, research councils, and research performing organizations (basic, strategic, applied).

Our main focus will be on the national level. In particular, we will address the case of the Dutch science system, which is generally known as a high-performing system with a strong international orientation. As a medium-size science system, we consider the Dutch case an informative case for other countries. Unlike the United States or China, Dutch science policies cannot generate change in the global science system on their own and must find a way to respond to these changes. At the same time, the country is sufficiently large to host a complex network of universities, academic institutes and research funders, to develop a dedicated science policy strategy, and to exert some mediating influence on the trends it encounters internationally. Recently, the Dutch science policy has been a frontrunner in new policy initiatives such as Open Science and responsible innovation.

Our project has started with a broad inventory of trends and uncertainties in the Dutch science system and its societal context. The latter includes national trends such as changing public values, and global dynamics such as shifting power relationships between Europe and China. Next, we have clustered and selected trends, based on their (1) relevance for policy-making, (2) influence on multiple scientific disciplines, (3) influence on a key characteristic or foundation of the science system, (4) prominence in public debates, (5) potential for generating radical change in the way science is conducted or organized. Using these criteria we have selected three overarching trends in addition to digitalization:

1. geopolitical uncertainty: the increasing instability of international relationships on a global level

2. sustainability transitions: changes in socio-technical systems towards a green economy

3. wider notions of welfare: public debates contesting the narrow concept of economic growth as the main orientation point for public policies in general, and science and innovation in particular

These three megatrends, in combination with digitalization, are currently analyzed in more depth, in order to unravel their nature and their relationships with the other trends of our broad inventory. The aim is to explore their influence on the Dutch science system and identify relationships with ongoing international policy developments. Finally, we identify a number of key dilemmas and policy challenges. Rather than formulating policy recommendations, our paper shows the current decision space for policy.

This exercise is based on a number of different data sources and will be conducted in close consultation with stakeholders. We review scientific literature in the field of science (policy) studies, published in journals such as Research Policy, Science and Public Policy and Research Evaluation. In addition we review key documents from international and Dutch science policy organizations and relevant advisory bodies. Where necessary we study additional grey literature related to changes in the environment of the science system. We conduct about 10 interviews with key stakeholders to explore the manifestation of trends in the science system and to elucidate the implications for science policy. Finally, we will conduct two workshops to validate our analysis and identify gaps, one with science policy experts from different European countries, and one with science policy stakeholders in the Netherlands.

The expected result of this project is a description of the current state of the Dutch science system, including strengths and vulnerabilities and a discussion of the expected effects of digitalization in relation to other major trends. We intend to contribute to the scholarly debate by relating the trend of digitalization to science policy, in the context of other ongoing changes. The practical relevance of this paper will lie in a discussion of key dilemmas and challenges that this development raises for science policy.

Keywords: foresight, science policy, digitalization, trend analysis

[37] Simon Schmitz (DLR Project Management Agency), Roman Noetzel (DLR Project Management Agency) and Oliver Rohde (DLR Project Management Agency). *Navigating Change- Introducing the DLR-PT Strategic Impact Navigation Assessment Model.*

Abstract. Context- Why do we need the Strategic Impact Navigation Assessment?

Effective innovation policies provide foundations for resilient knowledge economies. Hence governments and their funding bodies continuously take stock of previous and ongoing research & innovation instruments, results and lessons learnt to implement future-ready policies. However, more could be done to improve prospective innovation performance and capacities. The paper will dive into the nexus of current evaluation approaches, Strategic Foresight methods and effective accompanying measures. While several impact-oriented methodologies have been embraced, little evidence has been generated on how they can be mutually reinforcing in the policy cycle.

At the core of the paper at hand will thus be the question: How can the methods of Strategic Foresight be harnessed in evaluations in order to maximise the intended impacts? The paper will introduce the DLR-PT's Strategic Impact Navigation Assessment Model (SINAVI), which unites the benefits of Strategic Foresight and Evaluation. Hereby, it will contribute to the ongoing discussion on fostering the ex-change between practitioners and experts to bridge this gap and enable an exchange on experiences. Following a detailed presentation of SINAVI, the paper will present a case of SINAVI's added value in a piloting project on quantum computing.

Contextualising Strategic Foresight and Evaluation

Before introducing the Strategic Impact Navigation Assessment, a conceptual distinction is drawn be-tween foresight evaluation and using foresight in evaluations. The evaluation of Strategic Foresight initiatives mostly uses traditional methods and approaches that are inherent to traditional evaluations of programmes. In order to further investigate the field of foresight evaluation, the Association of Professional Futurists (APF) has set up a Task Force on Foresight Evaluation (of which the DLR-PT is an ad hoc member) in order to share experiences, compile background literature on the subject and develop a toolkit for practitioners. To date, using Strategic Foresight for Evaluations, in turn, remains an understudied field, despite the benefits that this nexus can offer. The DLR-PT's Strategic Impact Navigation Assessment, which this paper will introduce, harnesses the benefits of both areas and provides tangible approaches for policy-makers to integrate SINAVI into their upcoming projects and programmes.

Introducing the DLR-PT's Strategic Impact Navigation Assessment Model

The DLR-PT has developed a Strategic Impact Navigation Assessment Model in order to harness the benefits that both, Strategic Foresight and Evaluation, can yield. SINAVI combines the approaches of evaluation, which examines whether past approaches have succeeded or not and Strategic Foresight, which offers possibilities of future developments.

SINAVI at a glance

The SINAVI model is based on the intervention logic model and theory of change approach. Alike in traditional evaluations, the central questions for ex post evaluation are whether the chain of effects have occurred as intended (as displayed in a logic chart) or whether the framework conditions have changed (using e.g. the PESTLE method). The added value of the SINAVI model comes in the assessment stage of the project/programme, which is under evaluation. Here, the evaluators make use of Forecast and Strategic Foresight methods in order to assess which future trends are foreseeable and which futures are conceivable. Thereby, not only the intended yet also unintended impacts are revealed. This offers the evaluators the opportunity to take measures and adjust the project/programme in order to maximise the impact.

The stages of evaluations and the role of SINAVI in detail

1. At the beginning of the evaluation, preparatory analyses are conducted, which include the collection of qualitative and quantitative data. Evaluators gather information, based on the questions: Which data is available and which supporting documents are required.

2. In a second step, scenarios on how the project/programme might unfold are elaborated. Central questions include: Which future trends are foreseeable (forecasting)? Which potential futures are conceivable (foresight)?

3. Alike in traditional evaluations, a log-chart or theory of change for the project/programme design is created in stage three.

4. This is followed by the implementation stage of the project or programme, in which first out-comes become apparent. Depending on the project or programme's focus, these outcomes are based on outputs such as workshops, research conducted etc.

5. In stage five, the SINAVI model will come into play. Hereby, again, methods traditionally used in Strategic Foresight and Forecast are used. The methods used can range from horizon scanning, trend analyses (such as in technology assessment) to PESTLE analysis or the consultation of senior experts or citizen panels. Should the SINAVI assessment reveal that the implementation of the project/programme is "not on track", evaluators and project managers have the chance to take measures to adjust the programme in order to ensure the best impact.

6. The final stage of the project or programme offers the chance to reflect on question whether the intended goals have been met (or not). Additional points of reflection could include whether or which spill-over effects (intended or unintended) were generated by the project or programme.

The benefits of using SINAVI in projects' or programmes' evaluations

The active integration of SINAVI in projects' or programmes' evaluations yields a variety of benefits vis-à-vis orthodox evaluation approaches. The early integration of scenarios in the evaluation offers the project or programme managers the possibility to enhance the preparedness for developments, which have not yet been considered during the project design phase. Especially in the dynamic field of Science, Technology and Innovation, not all evolution in the medium- or long-term can be anticipated during the initial stages of the project design. SINAVI thus sensitizes for emerging trends, which might have an impact on the project's or programme's success. SINAVI therefore contributes to a guarantee that the projects and programmes yield the intended impact. The reflection at the intermediate stage of the project/programme on the impact achieved so far and potential required adjustments allows for additional agility.

Putting the Strategic Impact Navigator into practice- the piloting case

The SINAVI model is currently being piloted in the scientific support of a funding program by a German institution for new applications in quantum computing. Since the degree of maturity of the technology of quantum computing is rather low and the young research innovation and economic field is developing dynamically, the funding measures are accordingly open-ended.

The support of the program through the SINAVI assessment pursues three objectives:

1. examination of the goal achievement and effectiveness of the measure (summative evaluation) in the form of an evaluation at the final stage of the project

- Goal achievement control: input, activities and output on project level, respectively program level (accompanying measures)

- Effectiveness control: outcome and impact

2. regular review and derivation of recommendations for action for the future implementation of the pilot measure (formative/accompanying evaluation) in the form of two interim evaluations.

- Target achievement monitoring: input, activities and output at project level, or program level (accompanying measures).

3. integration of Strategic Foresight elements (based on e.g. the Delphi method) with a view to the possibility of achieving objectives at outcome and impact level and as a trend radar in order to identify emerging developments in the field of quantum computing

The evaluation conducted in the piloting case is in its initial stages. Currently, questions for each level of the impact model are being elaborated.

Borrowing from the toolboxes of Strategic Foresight, the Delphi method will be used internally (participating companies and other stakeholders) and externally (experts). Hereby, the assessment explores the evolving innovation field, observes the development of the quantum computing ecosystem as well as the technical feasibility, viability and meaningfulness of quantum computing in the piloting case. There will be a continuous comparison between the internal and external results (to be precisely de-fined in terms of time). In the first survey after the first six months of the project, which is addressed to participating companies, forward-looking questions will be integrated, e.g. with regard to the state of technology development in the respective projects, benefits of quantum computing for potential users, spill-over effects, etc. Experts will be interviewed during the same stage of the project. In order to con-duct the surveys, the IT-supported monitoring tool developed by DLR-PT is used, which enables continuous data collection (ongoing, routine, descriptive data collection). The results from the comparison are fed back to the program managers in a timely manner in order to make appropriate corrections or, if necessary, realignments.

In sum, the use of SINAVI, which enables adaptation to be made to the content or procedures of the program at an early stage, lends itself to the monitoring of program implementation. In addition to a rapid response to changes in the ecosystem, the model also offers the opportunity to identify current developments and future trends and to monitor them as they unfold.

Outlook to the final paper

The final paper will contain a more detailed description of the added value of the SINAVI assessment in each of the stages of evaluation of a given project or programme. More detailed and updated accounts of the piloting project on quantum computing will be outlined. Additional lessons-learned which the piloting project generated will moreover feed into the analysis and presentation of the DLR-PT SINAVI assessment.

Keywords: Forward-looking activities, Foresight, Forecast, Impact Evaluation, Evaluation

[40] Raúl Tabarés (TECNALIA, Basque Research and Technology Alliance), Ezekiela Arrizabalaga (TECNALIA, Basque Research and Technology Alliance) and Hanna Kuittinen (TECNALIA, Basque Research and Technology Alliance). *Understanding conditions for implementing Responsible Research and Innovation (RRI) into regional innovation ecosystems: The case of Cantabria.*

Abstract. During last years, significant attention has been allocated to the Responsible Innovation (RI) concept in the academic literature (Owen et al., 2012; Stilgoe et al., 2013). An emerging corpus of knowledge has been devoted to understanding the policy implications of the concept, framed in a social constructivist vision of technology which hinder its roots to Science and Technology Studies (STS) and Technology Assessment (TA) literatures among others (Ribeiro et al., 2017; Uyarra et al., 2019). Some of the implications of the concept questions classical understandings of innovation (de Saille et al., 2020) and its economic imperatives behind it (Eizagirre et al., 2017), as well as its presupposed value-neutrality of innovation (van Oudheusden, 2014). Despite the limited uptake of RI in non-academic settings, especially into industry (van de Poel et al., 2020), the concept has matured during the last decade for becoming a policy reference (Wiarda et al., 2021) that has been embraced in diverse ways.

Significant enthusiasm has been adopted by several public administrations such as in the case of the European Commission (EC). During Horizon 2020, important efforts were delivered to advance the normative vision of RI known as Responsible Research and Innovation (RRI) into the 8th Framework Programme for Research and Innovation. Despite the uptake of the RRI concept has been limited and uneven across European Research Area (Mejlgaard et al., 2018; Novitzky et al., 2020), this experience has set up a fertile and prosperous common ground for many RRI practitioners, not only in academia. Different RRI-related EU funded projects have contributed to the development of tools, methodologies and resources that have engaged a plethora of stakeholders on them, providing significant experiences of RRI interventions in different research and innovation (R&I) contexts (Owen et al., 2021).

At the same time, RRI is also proposing new directions for Science, Technology and Innovation (STI) policy that emphasizes and prioritizes societal engagement and distributed governance of R&I (von Schomberg, 2013). STI policy is increasingly influenced by pressing demands of societal challenges that are attracting a bigger attention from a policy perspective whilst demanding a reorientation of STI policymaking (Kuhlmann & Rip, 2018; Schot & Steinmueller, 2018). Some examples of this recent phenomenon are the emergence of the United Nations Sustainable Development Goals (SDGs) or the EU Missions . The latter is shaping in a great way the 9th EU Framework Programme for Research and Innovation commonly known as Horizon Europe (Robinson et al., 2021).

It is in this frame where current policy agendas are being redefined by these new policy priorities. Smart Specialization Strategies (S3) constitute another good example of this new reality. These strategies were conceived as a way to address the innovation gap between US and EU after the failure of the Lisbon strategy, becoming one of the regional backbones of EU STI policy during the lifespan (2014-2020) of Horizon 2020 (Tabarés & Bierwirth, 2022). Numerous programs and instruments have been intimately deployed and aligned to these strategies during this period such as “European structural and investment funds” (ESIF) . But these instruments have recently been redefined by the inclusion of another dimension on them, sustainability, as an effort to confront these new societal demands and expectations around STI policy (McCann & Soete, 2020).

But how regional innovation ecosystems can adapt and reorient to meet these new requirements from STI policy? How RRI can play a role on this transformation of regional innovation ecosystems? To try to address these questions we focus on the findings of a case study oriented to understand already-at-place visions of responsibility into a particular regional innovation ecosystem. This ecosystem is framed into the Autonomous Community of Cantabria, a small region located in the north of Spain. This region gathers around 1% of total population and total territory of Spain, but at the same time, it offers significant prospects regarding R&I in sectors such as bioeconomy, health or renewable energies. In addition, it also faces significant and common challenges across the Spanish geography such as rural depopulation, climate change effects, brain-drain talent or aging. These particularities confer to the region interesting prospects regarding the adoption of RRI into its STI policy making for facilitating its transformation.

The research context of our case study is the TETRRIS EU funded project which enabled us to work from December 2020 to April 2021 to develop “a mapping exercise” (Martin, Stahlecker, Arrizabalaga, Frey, et al., 2021). This mapping comprised a document analysis (combining peer-reviewed articles, grey literature and relevant policy documents), 12 semi-structured interviews with 16 key informants that represented 19 organizations of the ecosystem (involving public administration, academia, industry and others) and a final workshop with different regional stakeholders for presenting and validating the results of this exercise (Martin, Stahlecker, Arrizabalaga, Hansmeier, et al., 2021).

The objective of this case study is threefold: 1) understanding the socio-cultural particularities of the regional innovation ecosystem, 2) observing “de facto RRI” features (Randles et al., 2016) embedded in their actors and 3) identifying possible domains of action for developing RRI interventions. As it is stressed in the literature, integrating RRI into a regional innovation ecosystem should pay particular attention to the context and the special circumstances of where R&I practices are embedded (Uyarra et al., 2019). Specially, because geography is mostly missing in RRI (Fitjar et al., 2019) and identifying the main relevant actors, its dynamics, interests and particularities should be the first step towards the development of future RRI interventions.

Our findings indicate that there is a regular presence of some RRI keys such as ethics and gender equality into R&I regional stakeholders, a common awareness and initiatives related with responsibility and sustainability can be found, and an increasing interest in social impact strategies in R&I (SDG´s, social innovation, etc.) is observed among different stakeholders. On the contrary, we report significant barriers for adopting RRI into STI policy making such as the low diffusion and adoption of the S3 strategy, a low level of “distributed governance” that can empower stakeholders, and an absence of an open innovation strategy or dedicated mechanisms to dynamize the regional ecosystem.

Employing previous literature that establish synergies with open innovation (OI) and RRI (Long & Blok, 2018) as well as other policy plans and strategies developed by the Cantabria government during last years (Gobierno de Cantabria, 2013, 2016, 2018, 2020) we identify four “domains of opportunity” that can facilitate the embracement of RRI into the regional innovation ecosystem. These domains are conceived to identify particular areas of intervention where different, technologies, R&I stakeholders, companies, public administrations, associations and citizens can be affected or interested about its future potentialities and challenges regarding S3 strategies and RRI.

We discuss how these domains can facilitate the introduction of RRI into STI policy making, identifying areas of socio-economic transformation where different stakeholders can be mobilized to address different socio-cultural and ethical challenges of R&I in the regional landscape. We also indicate how RRI can help to build a collaborative, open and reflective culture into R&I regional stakeholders that can facilitate to incorporate societal demands and expectations into STI policy making.

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Keywords: RRI, Smart specialization, Innovation studies, Regional studies, Open innovation

[41] Caetano Penna (Utrecht University and UFRJ), Oscar Y. Romero Goyeneche (Utrecht University) and Cristian Matti (EIT Climate-KIC). *Exploring Indicators for Sociotechnical System Transitions through Portfolio Networks .*

Abstract. Indicators of science, technology and innovation (ST&I) serve different yet interrelated purposes (Table 1): to gain insights into the nature of the ST&I process; inform the formulation and execution of corporate strategies; and provide evidence for public policies (their design, implementation, monitoring and evaluation). Such ambitions led to the development of a series of innovation indicators, which guide and standardize data collection and their application, with the OECD indicator frameworks – such as the Frascati (1) or the Oslo (2) manuals – providing the basis for measuring scientific, technological and innovative activities.

The evolution of science, technology and innovation indicators reflected and influenced the evolution of models of the innovation process at the micro, mezzo and macro level (3). Table 2 provides an overview of the three frames of innovation policy: the period when each emerged; their focuses, rationales and strategy implications; underlying heuristic models of the STI process; and, finally, the indicator frameworks developed by the OECD that reflect these models. On a fundamental level, indicator frameworks have been influenced by two standard “frames” for innovation policy (4): supporting R&D activities or developing the innovation system, respectively. However, a third, emerging frame of innovation policy – that of transformative innovation policy – still lacks an indicator framework for assessing innovation (development, policy, strategy) in relation to transformational goals.

Therefore, there is a need for indicator frameworks that allow for monitoring, learning and improvement of transformative innovation initiatives. As the European Environment Agency (5) states in its report on sustainability transitions:

There are currently very few data and little evidence on how to achieve transformations at the rate, magnitude, scale and penetration called for by global change science. Policy mandates such as the Paris Agreement aim to limit climate change to 1.5 °C and the SDGs [Sustainable Development Goals] provide numerous targets and indicators, but the evidence for transformations often appears only in hindsight. To collect data for anticipating transformations in socio-ecological systems, there is a need to identify some ‘early warning signals’ for positive social change […].

This need is scantily covered by existing science, technology and innovation (STI) indicator frameworks that do not capture the directional and transformational aspects of transition processes, nor do they account for the complex nature of sociotechnical systems. To address this gap, this paper proposes a methodology based on network analysis that depicts the evolution of sustainability-oriented project portfolios as an “early-signal” indicator of sociotechnical transitions processes. This frame 3 indicator pilot was developed through the PROPORTION project (which ended in December 2020), funded by the EIT Climate-KIC as part of its Transition Hub activities, and draws from the work on “transformative outcomes” developed in a second EIT Climate-KIC project, MOTION (ending in December 2021). Based on sociotechnical transitions literature, we put forth propositions on project network evolution as a transition process evolves, and test them by constructing networks formed by the EIT Climate-KIC portfolio of projects in the food system.

Our contribution shows that Social Network Analysis (SNA) can complement sustainability transitions and provide a visual indicator to map niche development. SNA also allows for the study of the complexities of co-evolution processes within niches and for understanding how certain network structures can contribute to reduce selection pressures, thus shielding niches.

The proposed methodology focus on modular networks, which might emerge in mature stages of niche development. In our case, these modular networks seem the to be the result of more equal investment share between an intermediary organization (EIT Climate KIC) and partners, and of long-term interactions of partners in (EIT Climate-KIC) projects. A high percentage of EIT Climate-KIC's partners interact intensively and these interactions are deeply associated with their participation and investment in EIT Climate-KIC's projects. However, further research may study the mechanisms behind the emergence of common vision and trust within the modules in our study case, i.e. whether the relationships are strong.

The paper therefore develops a visual indicator prototype composed of network mapping techniques, which was tested through a study of EIT Climate-KIC's portfolio of investments in the food system. Our prototype allows for the identification of phases of niche development, from emerging though initial institutionalization. In doing so, it allows the analysis of simultaneous cross-sectoral, multi-location programmes implemented under a common orchestrated portfolio. While we recognize that the niches developed through a portfolio of investments represent a small sample of the many niches that contribute to a transition process (and in fact, these portfolios operate at a subniche level), we argue that our prototype contributes to addressing the questions: Where are we in the transition process? What are the mechanisms enabling that process (i.e., programmes, projects)? And how do those mechanism foster systemic relations? – especially important from an innovation agency perspective facing the challenge of orchestrating several simultaneous programmes and action lines.

The visual indicator prototype based on network mapping techniques accounted for the characteristics of frame 3 "transformative" innovation policy and complexity aspects of systemic dynamics, namely: purpose and directionality (as stated in the investment strategy), resilience (connected to the building of the network and its governance), heterogeneity (multiple themes and subthemes, actors and localities), non-linear dynamics (multilevel logics of investment programmes and projects), and spatial and temporal dynamics (embedded in the investment strategy). The quantitative (network/visual) analysis of the portfolio of investments to identify early transformative outcomes should however be combined with a qualitative assessment of the projects being supported (types of niches, technologies, social innovations, skills, capacities/capabilities). This analysis is however beyond the scope of the paper, but is key for a nuanced understanding of the niche development process beyond the (subniche) investment portfolio dynamics.

More work is also necessary on matching various niche relating transformative outcomes (with niche development phases as well as on exploring how to include regime-related outcomes in the framework). We therefore do not claim to offer an alternative to "top-down" innovation framework (that is, those derived from models and theories), such as those developed by the OECD for frames 1 and 2 innovation policy. Instead, it is meant as a complement to such frameworks, and indeed developing a top-down frame 3 indicator framework is an important avenue for future research.

The paper is formed of five sections besides this introduction: in section 2, we discuss what an indicator framework is, in terms of methodological and conceptual choices, and, based on complex system theory, what properties are desirable for a systemic innovation indicator framework. It also proposes the building blocks for a systemic transformative innovation indicator framework, derived from how the field of sustainability transition understands transition processes as synthesized by the notion of "transformative outcomes" (7). Section 3 develops our methodology: the description of the case (EIT Climate-KIC food system project portfolio) and project portfolio dataset used, the strategy to test them through a portfolio network analysis. Section 4 presents and discuss our results. Section 5 concludes.

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Keywords: STI indicator frameworks, social network analysis, sociotechnical transitions, transformative innovation policy, food system

[42] Caetano Penna (Utrecht University and UFRJ). *Geopolitics and the economics of innovation: a "New" Political Economy of Technological Innovation Strategies in the Post-Pandemic World?*

Abstract. The importance of technologies for the capital development of national economies is a fact that even neoclassical economists came to accept, after an initial period when technology and technical change were left outside their models, as if they were 'manna from heaven' (Reinert 2016). Early neoclassical growth models considered only labour and (generic) 'capital' as sources of economic growth. In the 1950s, Moses Abramovitz (1956) estimated the contribution of those two sources in the level of output (economic growth) of the US economy: per capita input of labour and capital together accounted for only 10% of the growth of output per capita – that is, 90% of economic growth was caused by other factors, a result that a few months later Robert Solow (1956) also found using its exogenous growth model (which earned him the Nobel Prize in 1987). Abramovitz (1956, p. 11) called that big residual "some sort of measure of our ignorance about the causes of economic growth." Since the seminal works of Joseph Schumpeter, however, we are not so much ignorant of them anymore, and we now know that technological progress is key for economic growth and development of national economies.

The 'gales of creative destruction' triggered by radical innovations described by Schumpeter (1934 [1912]) – which revolutionizes economic structures from within, disrupting old technologies, firms, industries while creating new ones – is a well-studied process by evolutionary economists. What is less studied, however, is the importance of geopolitical motivations as underlying causes for technological development. It is true that authors such as Mowery (2010), Mazzucato (2013), Weiss (2014) or Block and Keller (2011) have analysed the military research and development (R&D) of the US Department of Defence, the investments of the American 'entrepreneurial state', the works of the country's military-industrial complex, and the policies of its 'hidden developmental state' (respectively). What they left out of their analysis is the fact that interstate competition and issues of power are the root of such actions – and not purely economic motivations, such as the pursue of economic rents or market shares.

Technological development is inseparable from geopolitics. Indeed, geopolitical motivations as causes of technological development and technical change were well-known to classical economists like William Petty and even Adam Smith, appearing also in the works of industrial economists like Alexander Hamilton and Fredrich List. But the link disappeared from the overly abstract theorization of neoclassical economics and (neo-)Ricardian trade theory based on natural competitive advantages (Padula, 2019; Padula and Fiori, 2019) – and, surprisingly, from Neo-Schumpeterian economics as well. Indeed, combining classical geopolitics and international political economy with economics of innovation and development is an open yet non-explored research agenda.

There is however another aspect of the relationship between geopolitics and technical change that will be explored in this paper, which are the geopolitical consequences of disruptive innovations. Expanding on a Neo-Schumpeterian periodization of capitalist technological revolutions (Perez 2002), I argue that the current wave of digital innovations, which are part of the fifth capitalist technological revolution (of information and communication technologies – ICT), while they opened up opportunities for socio-economic development, they also brought about the risk of ample disruption (for incumbent firms, regions and nations) at all levels of society: from individuals through firms to nation-states, all face the threat of disruption. In the past decade, the diffusion of such 'general purpose technologies' (GPT) (Ruttan, 2008) accelerated, as a result of interrelated trends: increasing production capacity and decreasing adoption prices, amidst exponential growth of technological performance and decreasing size of components (Instituto Euvaldo Lodi (IEL) et al., 2017). Such trends exacerbated the threat of obsolescence not only for old technologies and firms with sunk investments in them, but also – and maybe more importantly – to workers and certain geographic areas. Historically, these dynamics also tended to be associated to hegemonic conflicts and geoeconomics disputes. Thus, currently confronted with the threat of disruption, nation-states turn back to active industrial and innovation policies.

Based on this understanding, I show that the new coronavirus pandemic magnified the interrelated geopolitical and techno-economic trends from the past decade, and suggest the following propositions that I elaborate in the paper:

1. The manufacturing global value chains overly dependent on China would eventually be a central target of national policy, which would aim at making a country's economy less dependent on Chinese imports.

2. Upgrading industrial structures and reshoring of value chains would become "the flavour of the month" in the policymakers' menu of measures, providing a leitmotiv to a return of active industrial policy.

3. Industrial and innovation policies would increasingly be "mission-oriented", that is, aimed at not only seizing technological opportunities associated with the new wave of disruptive digital technologies, but also contributing to the solution of urgent societal challenges (like mitigating climate change or caring for an aging population).

4. As a consequence of the US-China technological and geopolitical competition, the policy space for multilateral governance of digital technologies would be diminished, while the impact on the prospects of a global accord to address societal challenges is unclear.

While these propositions are a logical conclusion from observed empirical trends, they can also be explained from the theoretical perspective of (international) political economy. I therefore further draw on these theories to discuss the "new" political economy of innovation strategies in this post-pandemic world. I argue, based on the notion of Polanyi's "double movement" (Polanyi 2001 [1944]), that contradictory forces govern capitalist development – on the one hand, a liberalizing principle promotes the expansion of free markets, on the other, social self-protection principles keep this expansion constantly in check. Such double movement can be interpreted as a secular pendulum (Kretschmer 2019; Nölke and May 2019; Stewart 2010), with periods when liberal policies promote free markets being superseded by periods when state regulations seek to protect society from the "ravages of this [free market] satanic mill" ((Polanyi 2001 [1944]: 73) (Figure 1). Yet, more than a pendulum, Polanyi's double movement represents a constant dialectical process "the two principles have material and social roots that coexist in a necessary, permanent and contradictory way within capitalism" (Fiori 2004: 60 – my translation). From this perspective, the four trends pointed out above were already in gestation since at least a decade ago. The political economy of current national technological innovation strategies is therefore not new, but the actual and longstanding political economy of such strategies.

The paper is structured as following: in the first section, I briefly present examples of recent developments – in particular, the return of industrial policy and a new "technological sovereignty discourse" (Figure 2) – that underscore and reinforce four identified geopolitical and techno-economic trends. I also show that the new wave of national strategies to promote industries and technological innovation display common motivations and orientations, with some also seeking to address societal challenges ("mission-oriented"). I further discuss the trends from a theoretical perspective. In section 2, I discuss Polanyi's double movement, drawing on the work of Fiori (2004, 2010) and relating it to the notion of "creative insecurity" proposed by Taylor (2016), to explain the political economy of national technological strategies. Section 3 concludes with policy implications, in particular in terms of regulating the digital technologies and for addressing global societal challenges.

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Keywords: geopolitics of innovation, STI policy, technological sovereignty, Polanyi’s double movement

[43] Paula Kivimaa (Finnish Environment Institute SYKE & University of Sussex), Jani Lukkarinen (Finnish Environment Institute SYKE) and David Lazarevic (Finnish Environment Institute SYKE). *Analysis of Covid-19 Recovery and Resilience Policy in Finland: A Transformative Policy Mix Approach.*

Abstract. Soon after the Covid-19 pandemic began, many countries started to implement measures to aid suffering industries and sectors as well as deliberate means for economic recovery. The EU set its own stimulus programme entitled “the EU Recovery Plan for Europe: Next Generation EU (NGEU)”, investing over €800 billion to address the economic and social damage brought about by the pandemic. The NGEU comprises seven instruments, of which the Recovery and Resilience Facility (RRF) is the largest. EU member states have planned differing ways to implement the RRF, requiring approval from the European Commission (EC). The EC has set conditions related to climate change mitigation, just and green transitions, digitalisation and avoidance of environmental harm. In minimum 37% of the funding allocated needs to be targeted to climate change mitigation and 20% to digitalisation. Furthermore, the packages under the RRF must apply the principle of “do no significant harm” (DNSH), which means that no funding shall worsen any of the six environmental objectives established by the EU Taxonomy Regulation. An important aspect of the national Recovery and Resilience Programmes (RRPs) is that the EC expects countries to connect financial investments to traceable policy reforms to ensure long-term impact of shared financial commitments.

The RRPs can be seen as horizontal policy measures that cross the boundaries of finance, innovation, economic, employment, health, climate, and environmental policies. They also offer potential for advancing sustainability transitions, but their influence is far from certain. It is likely to depend on how genuinely attention is paid to transition dynamics, climate change mitigation and resource use in the design and implementation of the RRPs. Besides the policy objectives and instruments included in the RRPs, the preparation and implementation process of novel cross-cutting programmes requires analyses. Such programmes increase horizontal coordination between ministries and agencies at the member state level and vertical coordination between the EC and member states. They also call for more experimental and learning-based approaches to governance.

This paper analyses the preparation, contents and implementation of the Finnish RRP, entitled “The Sustainable Growth Programme”. Given the attention placed by the EC on green transitions as part of the RRF, we adopt a transformative policy mix approach as a lens. In doing so, we draw from the literatures on policy mixes in sustainability transitions and transformative innovation policy.

We ask:

1. How the Sustainable Growth Programme addresses different elements of the policy mix, and

2. To what extent can the Sustainable Growth Programme be seen to contribute to sustainability transitions and transformative innovation policy?

On this basis, we discuss the potential and limitations of RRPs as part of transformative policy mixes in advancing sustainability transitions.

Literature background and analytical framework

Transformative innovation policy has been suggested as an approach, changing the logic of existing innovation policy to better address the global grand challenges, and taking a more experimental and inclusive approach (Schot and Steinmueller, 2018). This policy orientation also necessitates new approaches to policy evaluation (Molas-Gallart et al., 2021) and implementation with a focus on processual outcomes that policies should aim at (Ghosh et al., 2021). We argue that the transformation-orientation of innovation policy also expands to horizontal policy programmes such as the RRPs.

To analyse the Finnish RRP we draw on the literature on policy mixes, advanced in different contexts. The design features and processes of policy accumulation have been addressed in political science (Howlett and Rayner, 2013), while innovation studies have focused on regional policy mixes (Magro and Wilson, 2013). Flanagan et al. (2011) argue that policy mixes are formed in ‘real world’ interactions and differ from actor to actor and from place to place and can be coordinated by mutual adjustment.

In the context of sustainability transitions studies, policy mixes have been argued to involve special characteristics. Transitions require more expansive policy mixes than small-scale issues; they need to couple support for innovative solutions with disruption of unsustainable systems; and new analytical tools are needed to evaluate the degree to which existing policy mixes advance transitions (Kanger et al., 2020; Kern et al., 2019; Kivimaa and Kern, 2016; Rogge et al., 2017).

Rogge and Reichardt (2016) introduced a policy mix framework that comprises three building blocks: elements, policy processes and characteristics. Elements include policy strategies containing the overall objectives and principal plans, and the policy instrument mixes. Policy processes contain the phases of preparation and implementation. As policy characteristics, Rogge and Reichardt list consistency of elements, coherence of processes, credibility, and comprehensiveness. Further, they specify dimensions used to evaluate the building blocks, i.e., the policy space, including policy domain, governance level, geographical region, and time.

Here, we add to the above and suggest amendments to the dimensions of Rogge and Reichardt (2016) framework. Our amendments are derived from elements related to covid-recovery: first, industrial perspectives, and second, security and resilience. First, while geographical region and policy field may partly cover industry, the industrial perspective/setting refers to the value/emphasis given to industries in the policymaking context. The industrial dimension is also essential in creating policy mixes supporting innovation and destabilising existing regimes (Kivimaa and Kern, 2016), because the fundamental question is one of identifying/supporting new industries (Huang, 2019; Lazarevic et al., 2020; Ossenbrink et al., 2019) and disrupting/reorienting existing ones (Rogge and Johnstone, 2017; Scordato et al., 2018).

The second dimension links to the Covid-19 pandemic and other societal threats: security and resilience. Covid-19 has become a key human security issue that impacts on other dimensions of security and resilience: the internal stability of states, international relations and security of supply (Kanda and Kivimaa, 2020). Neither security nor resilience are visible in the literature on policy mixes for sustainability transitions. Purkus et al. (2017) mention planning security, in reference to energy security, as one dimension when addressing the uncertainty of decarbonisation policy mixes. While Johnstone et al. connect securitisation in policy mixes in a negative sense, we argue that security can be applied to policy mixes also in a positive sense, enabling wellbeing (Gjørv, 2012) and being prepared for security risks by improving societal resilience (Johnstone et al., 2017).

Research approach

We used a qualitative analysis of the Finnish RRP documents, participatory observation, and seven interviews conducted during November 2021 to analyse the preparation, design and implementation of the programme. The interviewees were selected from key organisations involved in the programme: Ministry of Finance, Ministry of Economic Affairs and Employment, Ministry of the Environment, Business Finland, Academy of Finland, and the Finnish Environment Institute. The interview guide included questions on how the programme was prepared, how the interviewees assess the contents and added value of the programme, the relationship between financial investments and reforms, the impact of the programme in terms of innovation policy and transitions-policy, and the implementation of the programme. The interviews were recorded, and written notes were produced to support the document analysis.

Tentative findings

The analysis is not yet complete and will be conducted before the EU-SPRI conferences. The Finnish RRP has been prepared in rather extensive cross-governmental fashion, coordinated by the Ministry of Finance, but there was extensive involvement of different ministries. The plan consists of four main pillars that align the different investments and reforms: 1) green transition, 2) digitalisation, 3) employment, and 4) health and social care. The Ministry of Economy and Employment handled a lot of the green transition pillar concerning energy and industry actions, and the employment pillar. The Ministry of the Environment was also much involved in the green transition pillar and the application of the DNSH Principle. The Ministry of Transport and Communications had a role in the digitalisation pillar and the transport part of the green transition pillar. The official process was initiated and coordinated by an inter-ministerial coordination group established by the Prime Minister in September 2020, and the government outlined priorities for the programme during its annual budget session. In September-October, wide consultations took place to discuss and review the proposed measures and objectives with stakeholders including events in all 19 regions to consider justice issues and gain geographically balanced feedback on plans.

In March 2021, Finland submitted the first version of the recovery package to the EC. The plan was revised and streamlined based on comments from the Commission and the finalised plan was submitted in May 2021. During the process, Finland raised the level of climate ambition from 37% to 50%, which influenced composition of suggested actions significantly by ruling out green transition investments that would not be 100% climate positive according to the EU Commission Climate Tracking rules.

Besides investments, of which a large proportion addressed climate and environment, the RRP included 26 reforms, of which 10 address the green transition. While reforms, such as ‘significant reduction of energy use of coal by 2026’ and ‘comprehensive reform of energy taxation’ existed before the RRP, including these in the RRP made them more binding for Finland. The Finnish RRP appears rather transformative: It adopts the twin-transition of low-carbon circular economy and digitalisation as distinct pillars. While the green transition pillar partly provides signs of traditional technology push thinking, the important elements of skills and services for transitions may be addressed by other pillars provided they are sufficiently connected in implementation.

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Keywords: Innovation policy, Policy mixes, Covid-19, Recovery, Horizontal governance, Sustainability transitions

[44] Nino David Jordan (University College London) and Metehan Ciftci (University College London). *How territorial is the soil decontamination innovation system?*

Abstract. Besides providing 95% of the global food demand, the world's soils also serve as vitally important natural carbon stores. According to a report recently published by Food and Agriculture Organization of the United Nations (FAO) and United Nations Environment Programme (UNEP) (2021)(2021), the soil health and its function as a provider of ecosystem services face the growing threat of pollution. Regardless of its anthropogenic and geographic origins, soil contamination is often observed as a cross-border phenomenon which requires immediate risk reduction and decontamination actions, the report underlines.

Vis-à-vis the transnational characteristics of the contamination problem, our study will discuss the territoriality of the soil decontamination innovation system. The main research question of the paper can be stated as follows: To what extent is the soil remediation innovation system characterised by either customised or standardised valuation? Answering this question would help us to narrow down the suitable location of the soil remediation innovation system into two of the four quadrants of Binz and Truffer's (2017) innovation-valuation framework.

One can operationalise the innovation / valuation typology by Binz and Truffer by plugging in cross-nationally comparative variables. Are differences in local valuation subsystems associated with differences in the innovation subsystem? If one can find a strong association, this should strengthen the case for arguing that the valuation subsystem is a local one.

This study draws on a combination of the following datasets:

• EPA, OECD and literature data on soil policy

• OECD data on patenting activity

• EEA data on soil contamination

• EEA data on expenditure on the remediation of contaminated sites

• Eurobarometer data on popular environmental concern

These variables are characterised by different degrees of standardisation, wherefore, from an epistemological perspective, they may also be categorised according to the standardised versus customised valuation typology. The same goes for the variable covering the innovation, which, here, can be unequivocally associated with the science and technology driven innovation (STI) mode.

In providing a partial response to the question of whether the soil decontamination innovation system is rather characterised by local or global features, we engage with the latest theorization on the territoriality of innovation systems, and point out how some of the epistemological challenges for innovation researchers are deeply connected to the ontological subject matter.

The Technological Innovation Systems (TIS) approach provides a framework for the analysis of the conditions for the development and diffusion of technology-driven eco-innovations. Bergek et al. (2008) draw on Carlsson and Stankiewicz's (1991, p. 111) definition of a technological innovation system as "(…) network(s) of agents interacting in a specific technology area under a particular institutional infrastructure to generate, diffuse, and utilize technology". For Bergek et al. (2008), the term "technology" has a broad meaning, relating both to material (e.g. products and tools) and immaterial objects (e.g. procedures/processes) that can be used for problem solving and also to technical knowledge itself.

While today's innovation systems are global, they are still regionally and nationally differentiated. National innovation systems continue to shape local and regional research and innovation activities. Information is available instantaneously, yet regional knowledge clusters are still important.

Binz and Truffer (2017, p. 1288ff.) argue that the spatial configuration of innovation subsystems can be usefully classified as a typology that results out of the combinations between two continuums: the technological innovation dimension and the product valuation dimension.

The continuum of the technological innovation dimension is characterised by the following two polar ends: on one side are industries that are characterised by a science and technology driven (STI) innovation mode with an analytical, scientific knowledge base and on the other hand are engineering-based industries where learning by doing, using and interacting (DUI) are the main drivers of innovation. In the STI mode, knowledge is easier codifiable into, for example, patents and blueprints, and is therefore more amenable to circulate in a disembodied form. In contrast, in the DUI mode, knowledge is embodied within individuals, organisations, and their interactions. In consequence, the more embodied mode of innovation is more affected by co-location and personal interactions, and thus more spatially "sticky". Importantly, the orientation towards DUI and STI mode can vary across the different value chain segments of an innovation sub-system.

The product valuation dimension is constituted by the polar ends of customised and standardised valuation. Binz and Truffer (2017) conceptualise innovation system resources in the form of market access, financial investment and technology legitimacy as the key components of such valuation processes. Where valuation processes are more customised and therefore likely to substantially vary across regions, we can expect more locally idiosyncratic developments that act as barriers to the transfer of products and practices across geographical boundaries. The Figure 1 (please see the file titled "Additional Materials") shows the four quadrants that result from the combination of the innovation and valuation dimensions (based on Binz and Truffer (2017, p. 1290)).

Our research shows that the soil remediation innovation system seems to be spatially sticky. Greater transparency and standardisation may help to increase the role for international collaboration and to expand markets. In the mid- to long-term this may reduce the spatial stickiness of the innovation system. In the current phase, national remediation efforts are highly correlated with patenting success. As markets become more transparent and developed, such a high correlation may decline.

The first section introduces the problem of soil contamination and then, focuses on the policy environment in Europe and how the problem affects European countries. Section three provides an overview of the treatment of soil decontamination in innovation studies. Section four spells out the theoretical framework, section five the research question and the methodology. The following section offers a range of cross-country comparisons. Section seven looks at the development of legislation and patenting activity over time at the country level. The eighth section discusses an explanation for the temporal differences in the patenting activity from the perspective of popular environmental concern. Section nine summarises the results. Section ten highlights the findings and the following section outlines further research opportunities. The twelfth section discusses policy implications of this research, followed by the conclusions in the final section.

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Keywords: technological innovation systems, Soil Contamination, Soil Use and Management, territoriality of innovation systems, soil remediation, soil decontamination, global innovation systems, national innovation systems, brownfields, cleanup, contaminated sites, eco-innovation

[45] Derrick Boakye (Brunel University London), David Sarpong (Brunel University London) and Chima Mordi (Brunel University). *A catalytic conceptualization of the role of regulation in accelerating sustainable innovation.*

Abstract. The development and commercialisation of new product innovations that address grand climate challenges have become an ever more important concern in contemporary discourse on innovation management. However, commercialisation of such innovations partly relies on regulatory agencies whose activities as gatekeepers of public safety may impede or facilitate innovation (Boakye et al., 2022; Polidoro, 2020). Burdened with the responsibility of effectively conducting technical evaluations to ensure that NPIs conform with approved standards, regulatory agencies wield the power to select out products from transitioning from laboratory to market and thus influence the success of product on the market (Polidoro, 2020; Olson, 2008). As such the competitiveness and survival of eco-innovating firms is implicated in the continuous support of these regulatory institutions (Dewick, and Miozzo, 2002). This support may be in the form of efforts to prioritising green innovation by easing and expediting the review process and approval of eco-product. Such regulatory initiatives that promote innovative responses to improve commercial viability are therefore needed to overcome valley of death in the eco-innovation process (Roca and O'Sullivan, 2022). In the light of the centrality of regulatory activities in the viability of the innovation ecosystem, some important research needs can be raised and addressed. Particularly because despite the innovation literature being replete with scholarly works on the potential of regulation to supporting and stimulating innovation (Wiegmann et al., 2017), the bid for regulatory agencies to reserve an often times paradoxical and suboptimal neutral ground within the interaction between the market and the technological innovation landscape (Roca and O'Sullivan, 2022; Dewick and Miozzo, 2002) has led little efforts to providing a settled argument to advocate for regulators to capture an integral role in fostering sustainable innovations.

This conceptual endeavour proposes an incisive reconceptualization of regulation as a much-needed approach to refining our understanding of regulation, and to advance discussions on how regulation could propel the green industrial revolution. Thus, we submit that the activity patterns of regulators are to intervene and ease the process commercialising eco-innovations but not to be persistent in order to allow the operation and competitiveness of the market economy at self-sustaining levels. We therefore conceive a reconceptualization of the role of regulation as one that reinforces efforts to develop sustainable innovation by facilitating market authorisation and commercial success of sustainable innovation output. Our stance in the discourse on regulation is overtly situated in a view that conceives regulation as contributing to a web of stakeholder roles and relationships (Wiegmann et al., 2017; Ketata et al., 2015; Lee et al., 2010) which is geared towards fostering a new paradigm of innovation that is oriented at meeting the pressing needs of climate change.

In piecing together our arguments to offer fresh insight to the discourse on regulation, we draw on the working principles of a catalyst in a chemical reaction to argue that the lingering incertitude about regulators playing an active role in accelerating innovation may be resolved through a conceptualisation of their activities as one that is only catalytic. A catalyst as described in the intellectual domains of natural sciences is a substance that accelerates the rate of a chemical reaction without itself becoming permanently involved in the reaction (Richardson, 2013). In other words, they are substances that take an active part in a reaction by introducing a less difficult path for molecules to flow but are not fully consumed in the reaction. A catalyst does not only have the ability to actively engage in the process of triggering exponential rates of speed in a reaction, but also can be used to selectively change the rate of undesired reaction as well as the rate of a desired outcome (Twigg, 2018, p. 26). It is worth noting, however, that the time frame within which a catalyst keeps a sufficient level of active involvement and selectivity is of importance. As such the catalyst takes active part only long enough for the desired reaction to be complete. In relating how a catalyst actively precipitates the rate of chemical reaction to a selective outcome within a temporarily sufficient span of time to the context of regulation, a catalytic regulation would mean an abstraction of the role of regulation in innovation just as a catalyst intermediate and speed up the reaction between substances without being permanently consumed in such reaction (Cantner and Vannuccini, 2018). In this regard, by virtue of the ability regulation to influence the flow of innovation and shape innovation strategies of the firm (Dedehayir et al., 2018; Backman et al., 2017), it may play an instrumental role in selectively pushing forward sustainable innovations by establishing less complex evaluation frameworks. In establishing a clear link between the catalytic regulation conceptualisation and the discourse on sustainability, we further draw on and embed our discussions in the literature on sustainable innovation. This effort reveals that our conceptual treatment of regulatory activities as catalytic to the innovation process is essential to enhancing and providing a mechanism for speeding up the rate of commercialization of sustainable innovations, which are in urgent need to mitigate climate challenges.

Our contribution to the literature on regulation is therefore grounded in our efforts to drawing attention to the potential to restructure regulation to systematically concentrate on innovation incentivising objectives. We highlight on how regulatory activities may influence the market as well as the strategic choices of innovating firms to bring into fruition the much-anticipated green industrial revolution. The arguments and conceptual model we present provides an intuitive framework to inform strategic thinking about ways innovating firms could capture value from sustainable innovations. Precisely by making deliberate efforts to align innovation output with the interest and preferences of regulation. Thus, we propose that new product innovations could be designed to internalise the ideals and tenors of sustainability in order to effectively exploit the commercialisation channels established by a catalytic regulatory system. Furthermore, our model depicts how a catalytic approach to regulation may help to eliminate the existential threats of the valley of death and remove dead-ends in sustainable innovations. Specifically, it elaborates on the reconfiguration of the tenets of regulation to adopt a catalytic approach that focuses on easing the rules and standards of evaluations as well as actively influencing the responses of the market selection environment. In addition, as we take a firm position in this paper to advocate for regulatory intervention in the bid to fostering sustainable product innovations, we provide an understanding of how regulation could provide a support mechanism that would encourage innovating firms to logically adapt to the sustainable trends in order to achieve success on the market. This rather early stance helps to highlight, assess, and initiate enquiry into the relationships and independency between regulation and innovation in order to suggest measurable solutions to mitigate market failure of eco-innovations. In this regard, we broaden the theoretical interpretation regulatory activities by presenting it as a catalyst that could push forward sustainable solutions to ecological challenges. This understanding of regulation will set the common stage for future research to focus on identifying the temporal dynamics of when to 'dock' regulatory interventions in order to allow the market economy to control its selection patterns.

Despite these insights, the paper has limitations which in turn opens many avenues for future empirical endeavour. Specifically, we relinquish two key questions into the realm of future research. First, we acknowledge that arguing for keen focus on transitioning the existing socio-technical system towards a more sustainable end may not always be ideal as some designs may need to emerge in the form regular innovations and incrementally evolve by reacting with the conditions of the selection environment (Calabrese et al., 2005; Debruyne et al, 2002). Such innovations may be the next technological breakthroughs that a catalytic regulation that focuses on sustainable innovation would not provide the channels to bridge the Valley of Death, hence their benefits may never be realised. The contention now is how to design regulation in ways that do not lead the demise of such innovation but offer commitments to commercialise regular innovations while continuously nudging them to make sustainable incremental in the core design concepts. Second, although we emphasise that our catalytic regulation should discontinue after reaching sustainable levels, the question about when and how to determine this ideal withdrawal time to remains answered. Future research could draw on retrospective study of how dominant design concepts have historically been established to offer some insights about the span of time within which a catalytic regulation is sufficient and provide some pareto exit strategies.

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Keywords: Regulation, Innovation, Sustainability, Catalytic

[46] Klaus Schuch (ZSI - Centre for Social Innovation), Dietmar Lampert (ZSI - Centre for Social Innovation), Tatjana Neuhuber (ZSI - Centre for Social Innovation), Katharina Koller (ZSI - Centre for Social Innovation), Utku Demir (ZSI - Centre for Social Innovation) and Laure-Anne Plumhans (ZSI - Centre for Social Innovation). *How much "social innovation" is in research projects?*

Abstract. How much "social innovation" is in research projects?

Research question, relevance and policy issues

The title of this paper emphasises the underlying research question, which focuses on the identification of contributions to social innovations from various disciplinary and inter-disciplinary research projects from all scientific domains (SSH, life sciences, natural and engineering sciences). The empirical basis for our study were a few hundred randomly selected research projects funded by the Swiss National Science Funds (SNSF) during the years 2015 - 2018. The results, which will can presented at the conference are based on a recent study commissioned by the SNSF, which will be finalised at the end of May 2022. The motivation of the SNSF was to identify potential impact dimensions of the research funded by SNSF beyond pure scientific impacts. Potential effects of social innovation can appear in society, in culture, business, but also in interaction with the environment.

By placing the analytical value creation concept of social innovation in the centre of our study, we aimed in particular to analyse corresponding processes and mechanisms of knowledge creation. Such an approach can potentially add an alternative and innovative view on the value that SNSF (or in theory any other research funding agency or programme) adds through its funding.

Although in theory, contributions to social innovation can be one of several impact dimensions of research (Bornstein et al., 2014), in practice, however, the question of "how much social innovation is in research projects" has hardly been robustly empirically investigated up to now. The reasons for this deficiency lie, on the one hand, in the obvious vagueness and epistemological fuzziness of the term "social innovation", and, on the other hand, in the difficult access to a sufficiently large empirical database. We have tried to solve both problems, firstly, by creating an analytical category system for social innovations and, secondly, by examining several hundred SNSF projects.

Theoretical framework

The research policy debate on social innovation has gained in importance over the past 15-20 years. On one hand, some (primarily SSH) researchers see social innovation as an opportunity to free themselves from their defensive stance towards predominant discourses revolving around primarily economic valuation and impact of research. On the other hand, there are also findings indicating that research has so far paid quite little attention to the development of social innovation, particularly in terms of empirical productive interactions (Howaldt, 2019; Schuch, 2019; Brundenius, 2017; Cunha and Benneworth, 2013). As a transversal topic, social innovation seems to have increasingly moved from the margins of research closer to the centre although research funding still lags behind this development. However, the published findings are still inconclusive and, above all, there was a lack of larger empirical studies investigating the nexus between scientific research and contributions to social innovation.

The term "social innovation" is not new and not undisputed. It can be traced back to the early 19th century (Godin, 2012). References are made to eminent scholars such as Gabriel Tarde (Howaldt, Kopp and Schwarz, 2015), Karl Polanyi or Joseph Schumpeter (Moulaert et al., 2013), but until today there is no commonly shared understanding of social innovation. Likewise, there are only first attempts of integrating social innovation in a comprehensive innovation policy theorem (Howaldt et al., 2014). Moreover, the conditions under which social innovations develop, flourish and finally unfold their social impact are still far from being crystal-clear (Howald, 2019). Lizuka (2013) argues that the scope of social innovation suffers from a number of conceptual overlaps. Moulaert et al. (2013) argue that the term 'social innovation' is often over-simplistically used as a buzzword by laypersons, but has analytical substance for researching social change in society. We share this latter assessment.

When we speak about social innovation, we explicitly refer to the definition developed by the SI-DRIVE project funded by the EC under FP7. It defined social innovation 'as a new combination or figuration of practices in areas of social action, prompted by certain actors or constellations of actors with the goal of better coping with needs and problems than is possible by using existing practices. An innovation is therefore social to the extent that it varies social action and is socially accepted and diffused in society' (http://www.si-drive.eu/):

This definition has a few important properties that provide epistemological and analytical orientation, which we also used for the analytical categorisation process. These properties are summarised below and can be discussed in more detail during the presentation

Analytical dimensions

1. Social innovation results in a changed social practice (= object of a social innovation);

2. A social innovation must be new in a specific context or for a specific actor;

3. A social innovation is developed to fulfil a social purpose in that sense that it aims to better cope with needs and problems than is possible by using existing practices;

4. Social innovations are intentionally solution-oriented and prompted by actors or a constellation of actors. They do not just happen and they are not the same as social change, but they can contribute to it;

5. A social innovation is more than an idea and must be put into practice (i.e. difference between idea, invention and innovation in analogy with techno-economic innovation).

Since we understood research as an upstream process in this project that might lead to innovations (or not), we were not approaching the contribution of research to social innovation from its end but from its scientific inputs. Research contributions to any innovations, regardless of whether we speak about techno-economic innovations or social innovations, are usually at a preliminary stage and one innovation input among others. Both the scholarly contribution to social innovations and the scholarly contribution to techno-economical innovations precede the actual applications, which are usually outside the domain of scientific research. Moreover, not every innovation is necessarily based on scientific input, but it is undisputed that our society and economy are increasingly permeated by technology and knowledge. However, in contrast to the large-scale empirical investigation conducted in the SI-Drive project, which - based on identified social innovations - traced back towards the contribution of research, we chose a supply-side approach. We investigated what does research funded by the SNSF contribute or would like to contribute to the development of social innovation. In order to operationalise this, we tried to localise points of intersection with social innovation in the different research processes, whereby so-called productive interactions with non-academic partners play a special role (Spaapen and van Drooge, 2011; Kalliomäki, Ruoppila and Airaksinen, 2021). In particular, we used the 6-stages model of social innovation of Murray et al. (2010) and the societal readiness level (SRL) concept of the Danish Innovation Fund, to track down and identify social innovation intersections in research processes and phases.

Methods

Methodologically, we started with a literature review to further ground our understanding on the research topic and to feed-in the gained knowledge in the development of a robust classification of social innovation and its location in research processes.

Then we launched a survey to a sample of 1,000 projects concluded SNSF projects between 2015 and 2018 to better understand how social innovation

- is perceived or used as research topic and/or approach;
- reaches its epistemological and/or operational limits within SNSF projects;
- is developed by using which sorts of productive interactions;
- is assessed or already used for valuation of own research for accountability purposes;
- and to identify, what further support measures would be necessary to further tap the potential of scholarly contributions to social innovation and development.

In order to dig deeper into the matter, we then conducted interviews with principal investigators from 45 SNSF projects dealing explicitly with social innovation as well as with some of their practice partners. The interviews focussed on

• scope of social innovation research;

• contribution of research to the development of social innovation and analysis of pathways;

• identification of milestones and critical incidents in the research process with regard to the development of social innovations and the role of productive interactions;

• limits of contribution (in operational and epistemological terms);

• use of social innovation as an outcome and valuation category for accountability purposes.

Finally, we made an interpretative synthesis of the findings and aimed to establish a concept for assessing the value of funded research by the SNSF in terms of its contribution to the development of social innovations, which we also discuss with the SNSF.

Results

During our presentation, we will present our main findings by discussing

first, the scope and scale of SNSF funded projects that deal with social innovation research or the development of social innovation;

second, the extent of contribution of funded SNSF projects to the development of social innovations, their productive interactions with non-academic stakeholders and/or beneficiaries and the operational or epistemological limits; and

Third, the value of social innovation as potential valuation and outcome category of research.

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Keywords: social innovation, valuation of research, productive interactions

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From persisting gender inequality to inclusion in research and innovation content: challenging the gender equality norm in the STI fields.

Abstract. Introduction

During the last decade, innovation policy paradigm has changed to acknowledge societal challenges as a starting point for innovation. New solutions are required not only to create economic growth but also to solve vicious problems such as climate change or poverty (Diercks et al., 2019; Ghosh et al., 2021). Societal challenges are systemic by their nature, and thus, require extensive and diverse solutions. The science, technology and innovation (STI) fields play an important role in developing these solutions.

However, the literature shows that STI fields are rather exclusive than inclusive and that the fields are still dominated by a hegemonic masculine culture, which impacts research, development and innovation (R&D&I) content to be non-gender sensitive (Linberg and Schiffbaenker, 2013; Balachandra et al., 2019; Pecis, 2016; Cockburn and Ormrod, 1993; Wajcman, 2009). In fact, one of the key challenges for STI in responding and finding solutions to grand challenges is the fields' persisting gender inequality and restricted outlook on inclusiveness, which are reflected for example in lack of discussion or assessment of innovations' wider societal impacts (Sveiby et al., 2012).

There have been various attempts to improve gender sensitivity in research and innovation content in the past. However, traditionally, integration of gender dimension in R&D&I content has mainly been approached in terms of quantitative approaches, such as gender-balanced participation in research and innovation output, namely in publication output, publication impact, patent output and the difference between women and men researchers in funding success (Fältholm et al., 2010; She Figures, 2018). Yet, despite various gender equality interventions, women are still under-represented in innovation teams and scientific authorship. For example, international academic collaboration outside the EU (She Figures, 2021) and technology start-up scene in Europe (State of European Tech, 2021) are still male dominated. While there has been a very slight growth (0.5%) in the proportion of women inventors for all technology domains in the 2005-2018 period, majority of inventors' teams are still all male (She Figures, 2021).

Moreover, despite interventions aiming to increase women's participation in the STI fields, the research content itself remains gender insensitive. With this, and in line with the goals of transformative innovation policy, we argue that it is necessary to rethink the foundations of the current socio-technical systems and to evaluate whose knowledge is being taken into account, and whose knowledge matters in shaping the future solutions to tackle societal challenges (Harding, 2004; Haraway, 1988). Drawing from feminist critique of science, achieving social sustainability goals can be argued not to be possible without fundamental reordering of the current hegemonic masculine paradigm within the STI fields.

This means, that for the transformative innovation policy to be socially sustainable there is a need to move from quantitative gender equality to qualitative inclusivity to enable an inclusive research content. This argument lies on two premises. First, due to the historical construction of technology and masculinity as co-constitutive concepts, the underlying normative culture in STI fields is prone to promote gender inequality in work life as well as in research and innovation content (Connell, 1995; Carter and Kirkup, 1990; Cockburn and Ormrod, 1993; Cockburn, 1983). As such, the hegemonic masculine cultures and norms in STI are not inclusive and responsive to the society. Secondly, and related to the first point, gender equality approaches, especially those of the liberal feminist theory, do not fundamentally challenge existing foundations (e.g., norms and cultures) nor create conditions for inclusive knowledge production but merely aims to add women into the picture by quantitative measures (Fältholm et al., 2010; Petterson, 2007).

In this article, we explore the arguments and pathways for moving from quantitative gender equality towards qualitative inclusivity. In line with this, the article explores:

RQ: How to move from quantitative gender equality towards qualitative inclusivity in R&D&I contents?

Case description, data and methods

The study responds to the research question by exploring a co-development of practical solutions to increase inclusivity in different STI settings around the world. The solutions presented in the study are based on a series of six three-hour workshop conducted as part of the EU funded Horizon 2020 "Gender STI" project. Participants in the workshops came from a variety of countries ranging from Global South to North. They were consortium members and external experts. We (the authors of the article) participated in the workshops as challenge owners, meaning that we steered the discussion in order to co-develop new solutions to enhance inclusion of gender content in research, development and innovation. We used a methodological combination of action research and norm criticism in order to find practical solutions (such as educational materials) to problems that have also theoretical relevance (Huovinen et al., 2007; Greenwood and Morten, 2006).

A norm critical approach enabled a critical reflection of how current hegemonic norms, cultures, everyday practices, and stereotypes increased or decreased integration of gender dimension in research and innovation content (Vinnova, 2018; Isaksson et al., 2017). While an innovation process perspective was applied to enable exploring gender equality at different stages of research and innovation, the work mostly focused on exploring avenues to integrate gender and improve inclusiveness in research and innovation content at research organizations and universities.

Contributions

The study discusses the arguments and pathways about moving from quantitative gender equality towards qualitative inclusivity and finding solutions how STI field becomes more inclusive towards variety of knowledge and perspectives. This is important for enabling transformative innovation policy to better respond and find solutions to complex societal challenges. In line with this, the article explores qualitative inclusivity, rather than quantitative equality, as a pathway to enable including different perspectives, worldviews and ideas in research and innovation content. In other words, the article explores ways in which research and innovation content becomes more socially responsive to the society as a whole by shifting focus from merely fitting women in to the existing normative culture towards shaping inclusive culture in the STI fields.

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Keywords: - inclusivity, - research development & innovation content, - transformative innovation policy

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Abstract. There is a sense of urgency for the evaluation field "to revisit, redesign and reconfigure evaluation theories and practices to support the large scale, transformative changes our societies and ecosystems need" (Ofir and Rugge, 2021). Risks are rapidly multiplying, stemming from severe biodiversity loss, growing inequalities, and the advancing of climate crisis (Ripple et al, 2020). In addition, the COVID-19 global pandemic has provided evidence for the premise that significant system transformations are urgently needed to address the global emergency we are facing (Patton, 2021).

For evaluation to enable system transformation, business as usual is no longer possible (Patton, 2021). When policy environments are complex and very diverse, and policy objectives are ambitious and radically innovative, there is a high degree of uncertainty about how an intervention will develop and its effects. Policy, then, needs to be experimental in nature and evaluation practices have to support the development of the experiment rather than judging its final results against a set of well-defined criteria derived from clear expectations.

How can policy evaluation support transformative policies that are experimental in nature? A key goal of evaluation is to inform and provide developmental feedback for system transformations (Ofir and Rugge, 2021). For this, we argue that social learning is essential. It occurs when a heterogeneous set of actors share their knowledge and assumptions in an interactive process aiming to create new knowledge, generate trust among the actors, and lead to joint action (Pahl-Wostl 2006). To support social learning, evaluation practice takes on specific characteristics and requires values and attitudes that are different from those needed for other kinds of evaluative practice.

This article (1) identifies specific values and attitudes that evaluators need to develop to enable social learning, and (2) describes how social learning can happen through evaluation practice. We address these objectives through a detailed study of two contrasting cases. Our explorative testbeds were:

1. A pilot initiative launched by the Swedish Innovation Agency (Vinnova) developing innovative food production and commercialisation strategies to transform the Swedish food production, distribution and consumption systems to make them more sustainable.

2. The Adaptive Cities Through Integrated Nature-Based Solutions (ACT on NBS), a project that aims at upscaling the application and quality of NBS to increase urban resilience against the effects of the climate crisis.

The work was conducted in the global Transformative Innovation Policy Consortium (TIPC). This consortium consists of research and policy partners, including innovation and research agencies from Finland, Sweden, Norway, South Africa, and Colombia (http://www.tipconsortium.net/). TIPC aims to shape and deliver a new transformative innovation policy (TIP) framework based on the notion that addressing our societies' key challenges requires profound changes in current socio-technical systems" (Schot and Steinmueller, 2018).

Key elements of the formative evaluation approach developed in TIPC

Building upon the Multi-Level Perspective (Rip and Kemp 1998; Geels 2002; Geels et al. 2016), the TIPC developed and experimented with a formative evaluation methodology focused on twelve Transformative Outcomes (TOs) that are divided into three macro-processes: (1) building and nurturing niches; (2) expanding and mainstreaming niches; and (3) unlocking and opening up of regimes (Gosh et al, 2021). Each of these macro-processes contains four TOs transformative outcomes (adding up to twelve) to be used in a formative evaluation of transformation innovation projects, programs and policies (Molas-Gallart et al. 2021).

The building of a Theory of Change with TOs is a participatory process between researchers and policymakers seeking to provide evidence of the extent to which a specific intervention is contributing to a systemic change in the desired direction (Molas-Gallart et al, 2021). TIP evaluation focuses on assessing the progress with building TOs to enhance the prospects for system change or a sustainability transition. This focus thus allows us to assess whether and how interventions (projects, programs and policies) contribute to system change within a specific period and space.

When policymakers and researchers co-construct the ToC, they will identify how expected changes due to the policy intervention can be mapped against the twelve types of TOs. It is important to note that we are not proposing that ToCs comprehensively cover all outcome types. In most cases, this would not be feasible. The TOs framework offers a guide that enables users to become aware of how their activities are positioned against the range of processes required to achieve socio-technical transformation and how they can improve the contribution of their intervention to a specific transition. The framework also clarifies what is missing and may lead to a search for combining various projects, programs, and policies to cover all outcomes (Molas-Gallart et al, 2021).

Short description of the two cases:

a) Vinnova

In 2019 Vinnova, started an experimental process to design mission-oriented policies for mobility and food challenges guided by the SDGs. Through this process, Vinnova aims to deliver an in-house demonstrator for working towards systems transformation. In December 2019, the agency engaged TIPC researchers to explore the rationale, practice, and feasibility of a formative evaluation to enhance transformative capacity of their mission-oriented experiment.

This experimental engagement can be summarised in three phases:

- Phase 1 (February-July 2020): The goal of this phase was to define the area in which the engagement would develop (food retail mission) and agree on a number of selected transformative outcomes. Besides the joint workshops, a fluid and closer relationship was built with one of the Vinnova team members who acted as an intermediary translating our approach to the Vinnova context and helping the TIPC team relate the transformative outcomes to the Vinnova work.

- Phase 2 (August-December 2020): the team defined assumptions for four outcomes and indicators for measuring progress.

- Phase 3 (2021-onwards): The TIPC and Vinnova team efforts expanded because they decided to analyse more previous activities developed as part of the food mission, not just the ones related to food retail but also the ones related to changing the school food system. The underlying assumption was that by analysing the historical data and activities for both initiatives, the food area would better reflect on the learned lessons and re-shape their future activities to avoid transformation failures.

b) ACT on NBS

ACT on NBS is a project funded by EIT-Climate KIC; it aims to upscale nature-based solutions (NBS) in cities to increase urban resilience against climate change. Our engagement started in February 2020, and it was developed in four phases:

- 1st phase (February – April 2020 devoted to understanding the project dynamic, introducing our approach properly, and clarifying our role in this engagement, acting not as external evaluators but as co-partners to help ACT on NBS be more transformative. At the time when we started our collaboration, the project was in its mid-term execution, and it was designed with a log-frame logic, with measurable Key Performance Indicators to demonstrate how effectively an organisation meets its objectives (i.e. number of start-ups created, number of products launched to the market, etc.).

- Phase 2 (April-May 2020): we produced a general Theory of Change by analysing and synthesising the five log-frames.

- Phase 3 (July-August 2020): In this phase, we introduced the notion of TOs linking them to the Multi-Level Perspective; moreover, we asked participants to relate their previous outcomes to the TOs intending to produce a new Theory of Change. To complement this, we undertook a series of interviews to understand whether and how the introduction of the TOs had contributed to the partner's systems thinking and reflections regarding the project's activities, long-term goals and desired impacts.

- Phase 4 (October 2020- April 2021): we produced the final ACT on NBS narrative, including our final interpretation of possible transformative pathways of change, through several rounds of internal drafting and revision.

Preliminary insights

This section presents some preliminary insights related to our two research questions on how social learning happened through the two engagements. For formative evaluation, fostering social learning is essential since the assumption is that actors better specify how their efforts can contribute to the transition process through the social learning process.

Firstly, we can identify several critical drives for social learning such as mutual understanding, trust-building, safe spaces and the bricolage of a range of methodologies.

Also, in Vinnova's case, we have found that the role of intermediaries has been vital to navigate challenges and tensions that emerged during the process. Having such an intermediary proved to be crucial to guide the process and define the best approach to advance in the engagement. The team meetings were co-designed and co-developed with the intermediary, which was conducive to building trust between both teams and navigating expectations more effectively.

Secondly, the solid theoretical background of the formative evaluation approach (the Multi-Level Perspective and the twelve TOs) supported the social learning process by bringing a more transformative directionality in the two engagements.

Finally, the two EPEs have also challenged our role as evaluators as we were pushed to develop different attitudes as those usual in the evaluation field. Questioning our prevailing assumptions, empathy and humility were profusely and smoothly exercised during the engagements. Also, adaptability and openness to new opportunities, ideas and ways of thinking have been a must through the engagements.

Keywords: formative evaluation, transformative innovation policy, experimentation, social learning, transformative outcomes, Vinnova, Food policy, Nature-Based solutions

[50] Rik Braams (Copernicus Institute of Sustainable Development), Joeri Wesseling (Copernicus Institute of Sustainable Development), Marko Hekkert (Copernicus Institute of Sustainable Development) and Albert Meijer (Public Governance en Management). *Civil Servant Tactics for Realizing Transition Tasks.*

Abstract. The herculean stance of entrepreneurial civil servants (ECS) positions them in a force field of change and stability. Transition Literature pinpoints the essential role governments have to play in facilitating sociotechnical transitions to overcome societal challenges. ECS, however, have trouble legitimizing their newly acquired tasks due to restraining Public Administration traditions. Nevertheless, some ECS adjust their tactics to tango with the objections of these opposing rationalities within a Ministry to execute transition tasks. We study these tactics and draw tentative lessons from potential path dependencies. Our case study 'Mobility as a Service' illustrates dialectic patterns of tactics, provoked reactions, and adjusted tactics.

Governments are expected to guide sociotechnical transitions to solve wicked societal problems through policy (Borrás & Edler, 2020; Kanger, Sovacool, & Noorkõiv, 2020). Therefore, the civil service is an important actor in execution, but their specific role is underexplored in the transition literature.

Relevance

Many of these transition tasks are hard to legitimize for civil servants (Braams, Wesseling, Meijer, & Hekkert, 2021) through the standard Public Administration (PA) frameworks (see Bourgon & Milley, 2010; Stoker, 2006; Stout, 2013; Torfing & Triantafillou, 2016). However, successful implementation of transition tasks is dependent on the discretion of these civil servants (specific for transitions: Braams et al., forthcoming; or more fundamental see: Pressman and Wildavsky, 1984; Lipsky, 1980), and the transition literature is mainly unaware of the tactical struggles to implement transition tasks. It, therefore, neglects the inherently constrained position of civil servants. This draws attention to the structural difficulties of executing transition tasks for ministries, leading to the fallacy of expecting too much structural change from government. PA, in turn, has largely ignored the concept of emergence (Van de Walle & Vogelaar, 2012), let alone transitions (Braams et al., 2021). Transition literature and PA need to be integrated to develop realistic ideas on how transitions unfold within ministries. Such integration requires a deeper understanding of the tactics entrepreneurial civil servants (ECS) apply to deal with organizational resistance against the execution of transition. We aim to place these tactics into a broader rationale for transitions.

Research question

Which tactics do entrepreneurial civil servants apply to deal with organizational resistance against the execution of transitions tasks?

Method

The primary purpose is to understand which tactics were employed to counter opposing rationalities. Since few studies report on which rationalities (de-)legitimize transition tasks for civil servants, an exploratory, heuristic case study approach is helpful. This approach inductively identifies new variables, hypotheses, and causal paths.

This paper conducts a case study of Mobility as a Service (MaaS) within a Dutch Ministry to study how civil servants can deal with opposition while executing transition tasks. We interviewed 15 Dutch civil servants within the MaaS trajectory. Interviewees were asked what arguments were used to oppose and resist their transitional projects. Adversaries were asked how they perceived the strategies and tactics used by the MaaS-team member.

The mobility sector is transitioning from different modalities towards a fully digitalized and sustainable integrated system. MaaS could be a catalyst to this end. MaaS promises to provide people seamless door-to-door mobility services, which would decrease the need for personal cars. A data and algorithm layer enables this integration of modalities (Audouin & Finger, 2018). MaaS is categorized as a disruptive niche innovation that can stimulate a transformation in mobility systems (Kivimaa & Rogge, 2022). The Ministry's primary goal is to test MaaS in different pilots and build an ecosystem of MaaS providers and transport companies to prevent new monopolies.

Objective paper

This paper aims to extend the insights into manifestations of resistance that ECS have to overcome to implement transition tasks through adjusting their tactics. Furthermore, it aims to enrich the literature on change agents with tactics to bypass legitimate objections of other civil servants. The research presents several tactics change agents employ and how they can work in a system that does not automatically facilitate them. We reflect on the generalizability of the encountered resistance and the potential consequences of taking specific tactical countermeasures.

Theoretical framework

The theory has three parts. First, the way PA affects system change is described. As PA prescribes way is considered legitimate, this can form opposition to system change. Second, we describe tactics change agents use to execute transition tasks aiming at system change. Third, we construe a dynamic model of how change agents readjust their tactics when facing opposition.

Results

Several change agents' tactics were deployed. However, these tell only part of the tale without context; opposing rationalities within the Ministry must, therefore, be understood. MaaS claims the potential transformation of 'the heart of the mobility system' with data, integrating different modalities and introducing other market parties. Such a system change triggers all kinds of opposition within the current regime, explaining why this case has so many facets. In the beginning, the MaaS-team was susceptible to the suspicion of being a lobbying instrument of commercial parties, which would imply arbitrariness. These consequences interfered with the need to destabilize the current system because the MaaS-team needed support from other parts of the Ministry. Therefore, they adjusted and invested in the relationship by installing an account manager in these parts.

Conclusion

In this study, entrepreneurial civil servants are interviewed on their tactics to deal with opposing rationalities. When combining tactics with the notion of opposing rationalities, contestation can be seen as a clash of legitimate arguments. In the MaaS case, we found several tactics triggering contestation from opposing rationalities. To mitigate this opposition, entrepreneurial change agents adjusted their tactics, progressing in executing transition tasks or entrenchment. From a change agent point of view, anticipative capacity within public organizations could soften such contestation. Our tentative lessons hint in such a direction, building redundancy and reflexivity in an open system, with a tolerant view towards uncodified information. However, from a traditional civil servants' perspective, demanding drastic changes quickly in the system's core without much evidence of trusted sources cannot be accepted. This dynamic may be the tragedy of innovation within ministries. There may be a need to disrupt the current system, but while doing this, you isolate yourself because of the opposing rationalities.

Policy issues

The contribution of the MaaS-case is threefold; first, the MaaS case illustrates how these intended and adjusted tactics can trigger contestation and create path dependencies, which are hard to break out of because of the different views of what is considered legitimate. Second, the case gives insight into the fragile relations between the innovative projects and the more formal zones of a Ministry. Third, we distilled several tentative insights for entrepreneurial civil servants on how to work with opposing rationalities. Some tactics, such as an urgency frame, hiring consultants, safeguarding the innovation against the political constellation, or focusing on the ecosystem when the internal organization is not yet interested, may be beneficial in the short term. These can, however, have less fortunate consequences in the longer term.

Keywords: Change agents, Transition tasks, Public Administration, Opposing rationalities, Readjusted tactics

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Abstract. 1. Introduction

This article conceptualises the role of Social Innovation (SI) in transformational innovation policy, identifies policy options and points out potential risks of mobilising SI for transformations. The paper illustrates the conceptual claims based on selected policy examples.

We build on the definition of social innovation as "an intentional, purposeful reconfiguration of social practices in specific fields of action or social contexts, emanating from specific actors or constellations of actors, with the aim of solving or satisfying problems or needs better than is possible on the basis of established practices." (Howaldt et al. 2010, p. 89) This allows for further differentiation in the context of policy approaches.

Often, SI initiate, enable or promote important transformative developments. Since adaptations of behavior and social practices are central to transformations, SI may represent a political lever as well. SI policies may eg aim to improve the conditions for SI that support desired transformations by testing and demonstrating the feasibility of new practices. However, SI may not only be a possible mechanism for achieving transformation ambitions. Rather, they can also contribute to the recursive improvement of political mission definitions by successively incorporating learning experiences and, hence, shaping missions in an evolutionary way.

Therefore, policymakers are increasingly focusing on the importance of SI for promoting transformations.

2. Policy relevant differentiations

We propose a set of distinctions that can help thinking about the basic role of policy for SI in the context of transformation:

a. Directionality of SI support:

Policy can prescribe the goals, for which it promotes SI. In many countries, these goals increasingly refer to selected Sustainable Development Goals, but often remain relatively non-binding (Wunder et al. 2019). Other initiatives set more specific targets and formulate more concrete expectations of success. These directed policy approaches are mobilized for transformational policies. In contrast, policy measures can promote SI in an undirected manner in the expectation of manifold, ex ante often unforeseeable positive societal and economic effects.

b. "Initiating" new SI versus "supporting existing initiatives."

When SI are politically initiated, there is an assumption that there is a high potential for initiative in society to bring about important changes, but that a number of systemic and individual obstacles impede the potential being exploited. By contrast, numerous policies target already existing SI and seek to increase their impact and performance.

c. Scaling up and scaling out

SI can also be differentiated by the mechanisms, by which they may achieve system-wide effects (Moore et al. 2015):

Scaling up: SI usually start as local initiatives. Broad diffusion can be achieved by an extension of the reach of a particular initiative or via its multiplication in different places.

Scaling out: Local SI may change the system on a higher level in ways that make behavioral change along the lines of the local SI more likely to happen (Wittmayer et al. 2020, 7).

3. SI and policies for transformation

In order to understand how SI can be mobilised by transformation-oriented innovation policy, policy itself must be differentiated in terms of its intervention logics and with regard to the role of the state:

* TIP: Transformative innovation policy (TIP) embraces and amplifies socially desirable transformational dynamics (Chataway et al. 2017; Schot and Steinmueller 2018; Diercks et al. 2019; Steward 2012) This approach creates free spaces for bottom-up dynamics, and improves the conditions for further unfolding. Policy must thus develop a radar for new initiatives and create a normative filter to determine which approaches contribute to socially desired transformations.

* MOIP: Mission-oriented innovation policy (MOIP) (Larrue 2021; Türk et al. 2018) defines very specific goals (missions), which are then to be achieved through the mobilisation of innovation. In MOIP, SI must be specifically initiated or selected by their contribution to the mission objectives.

A mission-oriented innovation policy clearly assigns SI an instrumental character. SI, and in extreme cases their initiation, are an explicit means to achieve politically defined goals. Transformative innovation policy is also selective, choosing which emergent social dynamics to support.

We thus can distinguish the importance of SI for these two policy approaches. SI are

* a reaction to transformation dynamics or political mission ambition (i.e., more or less self-motivated adaptation of behavior, but often as a necessary condition for transformation). This dynamic can unfold and be promoted in both policy approaches.

� driver, origin of a transformation dynamic, which is then reinforced by policy, if necessary. This mechanism is typical of transformative innovation policy, but can also be mobilised for smart mission policy;

* explicit levers for desired transformations; here, SIs are used specifically by policymakers. This is compatible with mission-oriented innovation policy.

4. Critical reflection and conclusions for policy making

The potential of SI for politically desired transformations is countered by a number of challenges to be further explored in the paper including ia:

* Still unclear and controversial definition of what SI actually is, and why and how it should be supported (Mason et al. 2015);

* SI being used as a justification for the state's retreat particularly in the context of social policy;

* Dealing with the dual role of political actors, who my become "part of the social arrangement that configures social practices." (Howaldt and Schwarz 2017, 243);

* Dealing with potential system-wide negative impacts of SI, eg if they induce a (partial) decline in demand, hence posing challenges for the affected sectors of the economy. Here, the paper thus discusses the need and challenges of ex ante and ex post impact assessments of SI, similar to what innovation policy has long done for technical innovations with technology assessment (Bogner 2021; Walz et al. 2019; Mildenberger et al. 2020).

Changing social practices, adapting individual behaviour and initiatives developed from the breadth of civil society and working toward such changes within the framework of SI are essential for the necessary transformations. Unquestionably, countless SI are important drivers for the transformations ahead. It is important to view SI as part of shaping the transformation needs of various social groups and thus as promoting democracy and legitimacy. The greatest strength of SI is the initiative of citizens. Here, we try to differentiate SI and show that there are different intervention logics on the basis of which the state can and should support such initiatives that are conducive to socially desirable transformations. However, often, SI encounter obstacles related to resources, infrastructure, regulation or broader visibility. Removing such obstacles can and should be a political task if the impact of SI is conducive to the desired transformations.

Transformation-oriented policy, which starts at the system level, is then not only interested in the success of individual SI, but in their system-wide impact. This is where the real challenge lies. System-wide impact can happen through intelligent support for diffusion and multiplication of approaches or through experiential learning from local initiatives at the system level. The point here is to identify the respective success factors, incorporate them into a learning system, and thus bring them into the field.

It follows from the various differentiations that functionally appropriate policy styles must be developed in each case. Politics must differentiate between the various types of SI and their different significance for missions and transformations. To decide whether and how policy intervenes, ex ante and ex post analyses of the transformational effects of SI and the policies that act on them must be developed and applied. It remains crucial, however, that SI themselves are not misunderstood as "repair stores" for missed state responsibilities. SI are complex, self-motivated changes in behaviour and actor constellations, usually with strong normative content. Politics must handle the valuable resource of citizens' initiatives and their willingness to change behaviour with care. In addition, any intervention in SI must take into account the dual role of public actors, who are often participants in SI and at the same time its potential supporters. An overly exposed role of the state or the attempt to simply instrumentalise emergent SI runs the risk of weakening the normative, self-initiating character of SI and thus its mobilising effect. This danger appears to be smaller in the case of the "targeted initiation" of SI in the context of missions than in the case of political support for already emergent SI through transformative politics. Finally, SI are by definition always complex social experiments, and the state would do well to provide space and support for such ventures without counteracting the dynamics of social mobilisation through well-meaning interventions. It is crucial to find the right balance here and to accompany and promote the diversity of SI politically in such a way that they can constructively unfold their transformation potential.

5. Publication bibliography

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Keywords: social innovation, transformation, policy instruments, case illustration, sustainability, mission orientation, impact assessment

[52] Stephanie Francis Grimbert (Deusto Business School), Jon Mikel Zabala Iturriagagoitia (Deusto Business School) and Ville Valovirta (VTT Technical Research Centre of Finland). *Implementing innovation-related public procurement: ordinary, dynamic and functional capabilities.*

Abstract. Innovation is one of the main engines of economic growth and social welfare. Innovation policies are at the core of economic growth and environmental sustainability. The literature has for long discussed the instruments that can be used to define innovation policies and the policy-mixes in which these instruments can be combined. Within the large variety of instruments that can be used in innovation policy, either from the supply or from the demand side, public procurement has been recognized as one of the most powerful policy instruments to implement mission-oriented policies, to stimulate innovation and to enhance competition. However, in spite of this potential, public organizations find many challenges when implementing this type of policy interventions, mainly due to the presence of routines that may have been adequate in the past, but do not allow procurement to be adapted to the new and changing demands of modern societies. In fact, there is increasing evidence that suggests that public procurement is perfunctorily conducted, meaning that its process follows certain patterns and organizational routines by the force of habit (i.e. 'because this is the way procurement has always been done').

For innovation policies to be effective, it is not enough to define a particular policy intervention. Governments cannot play a passive role where they just provide financial resources for firms and other relevant actors to carry out innovation activities. Governments also need to innovate, for example, in their organizational and managerial structures, making them more effective (better coordination and governance) and efficient, in their internal processes (to reach a higher audience), or stimulating the demand of new products (through public procurement). All of these activities require the availability of certain capabilities needed to carry them out.

In this regard, the literature points that one of the main factors limiting and hindering effectiveness of innovation policies is the lack of the required capabilities at the administrative level, which is the level at which policies are implemented. The literature has for long provided knowledge and evidence about the aspects influencing the management of innovation at the corporate level, but we still lack knowledge on how public organizations (i.e. governments) can stimulate innovation and which are the needs in terms of capacity building. The aim of this paper is to identify the capabilities that are needed in the public side to effectively implement innovation policies. In particular, the paper focuses on the capabilities required to implement public procurement, which is one of the demand-side innovation policies with the largest potential to promote innovation.

The contexts in which we are currently living are characterized by the uncertainty, complexity, ambiguity, volatility, and speed of change, what led Bourgeois and Eisenhardt (1988) to refer to them as 'high velocity environments'. According to these authors, such environments are defined as those "in which there is rapid and discontinuous change in demand, competitors, technology and/or regulation, such that information is often inaccurate, unavailable or obsolete" (p. 816). On the one hand, the uncertainty associated to high velocity environments requires leaving space for experimentation in the public sector. As stated by Mazzucato (2018) in the context of mission-oriented policies the role of the public sector should evolve "from fearing failure to welcoming experimentation" (p. 807), with key organizational agents implementing "the necessary institutional reforms when confronted by shocks" (Boschma, 2015, p. 743). On the one hand, these uncertain and high velocity contexts make capabilities needed to be continuously reconsidered and rebuilt.

In high velocity environments, innovation policy needs to be very responsive, so it adapts to the changing needs and provides an agile response. In order to do so, it is necessary to have an holistic understanding of the challenge to be addressed, the needs to be satisfied, and the way in which the policy needs to be articulated so as to achieve the intended goals. As the paper evidences, functional procurement can be a mechanism that can facilitate this continuous adaptation, fostering innovation (when necessary) and providing a response to the targeted societal needs.

According to Edquist and Zabala-Iturriagagoitia (2021) functional procurement is "when a public organization describes problems/functions/needs that must be solved/fulfilled/met through the procurement and use of products" (p. 597). Hence, conducting procurement in functional terms opens for innovations but does not require them. Contracting authorities cannot predict where innovations may emerge, and hence, working with broad and generic functional requirements facilitate the experimentation by the suppliers to respond to a concrete societal need. On the one hand, this experimentation facilitates the development and emergence of novelty, by widening the scope of possible sources of innovation. On the other hand, the potential innovations that may emerge from functional procurement create the conditions for a fast and effective adaptation to changing environmental conditions, while avoiding the lock-in that has been traditionally associated to public procurement.

By taking into account the high velocity environment that contextualizes and renders functional procurement necessary, we consider functional public procurement to be an innovation policy instrument customized to the changing societal needs. We evidence that public procurement can overcome the institutional rigidities often attributed to the public sector due to its excessive regulations, hence defining functional procurement as an adaptive policy instrument. This is relevant in the current context of high velocity, which, as argued, will increase the demand for more agile, flexible and versatile policies. The paper identifies the key capabilities and constituent elements that are necessary within the public sector to deliver functional procurement, and which will lead to the professionalization of civil servants in procurement.

To identify these capabilities, a survey was circulated to the public procurement agencies in 15 European countries. To complement the results from this survey, interviews and focus groups were developed with policy makers and civil servants in charge of the definition and implementation of procurement policies in the previous 15 countries. These interviews and focus groups were developed in the context of a Mutual Learning Exercise coordinated by the European Commission, which started in January 2017 and concluded in March 2018. Overall, 33 individuals were interviewed, and more than 30 focus groups were developed.

The Mutual Learning Exercise dealt with innovation-related procurement, and it tackled the following four topics: (i) Developing strategic frameworks for innovation-related public procurement, (ii) Capacity building for innovation-related procurement; (iii) Financial mechanisms in support of innovation-enhancing procurement and pre-commercial procurement; and (iv) Monitoring, evaluation and impact assessment of innovation-related procurement. These four topics were developed in several workshops carried out in Brussels (Belgium), Den Haag (the Netherlands), Frankfurt (Germany), Madrid (Spain) and Vienna (Austria).

Several focus groups were developed in each workshop, where the policy makers and civil servants in charge of the definition and implementation of procurement policies discussed about the challenges related to the implementation of innovation-related public procurement, being the capabilities required to implement these policies one of these challenges. Overall, 30 focus groups were developed during the 15 months that the Mutual Learning Exercise lasted, in which 33 individuals participated.

In particular, the information related to the capabilities needed to design, implement and evaluate innovation-related public procurement policies comes from a survey that was circulated to the previous 33 individuals. This survey was internally validated by the European Commission and by the two Ministries that deal directly with innovation-related procurement in Austria (i.e. Federal Ministry for Transport, Innovation and Technology, and Federal Ministry for Digital and Economic Affairs). This survey included questions related to the capabilities required for innovation-related public procurement, the training required to design and develop innovation-related procurement policies, the methods used to implement innovation related procurement policies, the organizations involved in the design, implementation and evaluation of innovation-related procurement policies. Given the limited number of countries for which data could be gathered, we complemented the previous survey with interviews with researchers, firm beneficiaries, public procurers, and public financing units/agencies involved in the definition, implementation and evaluation of innovation-related public procurement initiatives. We acknowledge that still other relevant voices may not have been captured, what calls for further studies which may capture the voices and needs of different stakeholders. However, we believe that the results provided in the paper may be generalizable to other countries, as they include the opinions of actors directly engaged in the administration of innovation-related public procurement programs in 15 European countries, hence limiting the potential limits in the external validity of our research.

The aim of this paper is to show how functional procurement can act as an organizational routine fostering the adaptation of public procurement. The paper identifies the key capabilities and constituent elements that are necessary within the public sector to deliver innovation support procurement policies. These capabilities can also be useful for ministries and procurement agencies to execute training and capacity building initiatives among civil servants, which will lead to the professionalization of civil servants in procurement. The identification of these capabilities is also needed for public agencies and ministries to be able to respond to a high velocity context which is increasingly plagued by uncertainty.

While it is beyond the scope of this paper to evaluate public sector organizations' capacity to develop dynamic capabilities, our findings are consistent with the extant literature. Following the description made by Teece in his tribute to Nobel Laureate Oliver Williamson (2020) between ordinary capabilities as "doing things right" and dynamic capabilities as "doing the right things", we suggest that innovation-related procurement also requires different sets of capabilities.

We then discriminate those capabilities based on the four roles innovation-related procurement can have within a four dimensional problem/solution space, namely Catalyst, Broker, Purchaser and Lead user (Uyarra et al., 2020).

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Keywords: Public procurement for innovation, Functional procurement, Innovation, Policy implementation, Capabilities

[53] Per Dannemand Andersen (Technical University of Denmark) and Antti Silvast (Technical University of Denmark). *Stakeholder inclusion in estimating future techno-economic data for energy technologies for long-term energy planning.*

Abstract. Many countries worldwide and the European Union have set ambitious targets for CO2 reductions. Following policy targets set by the European Union, Denmark has set a target of a 70% reduction of greenhouse gas emissions by 2030 compared to 1990. Furthermore, Denmark aims to be independent of fossil fuels by 2050. These policy targets require a dramatic and rapid transition of the country's energy system. These targets enjoy a cross-party political consensus in Denmark, but the details in which these targets may be reached are still being contested and debated. As policymakers and scholars know, there are multiple techno-economic pathways for the transition to a sustainable energy system (Rosenbloom, 2017). In this sense, the future is open-ended: the number of potentially promising innovations and initiatives surpasses those that will eventually prevail. Furthermore, both innovation processes and political processes are decisively non-linear and may change unexpectedly (Köhler et al., 2019). To address this situation, like other countries, Denmark employs a range of future-looking activities (FLA) to inform policy decisions on possible ways to achieve the CO2 targets. The Danish Energy Agency uses model-based scenarios to uncover different techno-economic pathways to achieve climate goals. The scenarios describe alternative futures and their implications. The consequences of these alternative futures are examined using the IntERACT energy systems model based on the TIMES model. The scenarios and their consequences are used as a foundation for discussions and policy decisions on the green transition and related STI policies.

All modelling is based on a range of input and epistemic assumptions about the future (Silvast et al., 2020), and this is also true in the Danish case. Some inputs are based on internationally recognized forecasts provided by international organizations like World Energy Outlook from IEA. However, the Danish Energy Agency also develops the 'Danish Technology Catalogues'. For each technology (e.g., large wind turbines offshore), a description of the present state of the technology and future prospectives are described, including assessments of future techno-economic data (e.g., cost and performance data) for time horizons of 2020, 2030, 2040 and 2050. The techno-economic data typically contain technical issues (e.g., average unit size, outage percentage, technical lifetime, regulatory ability) and economic issues (e.g., CAPEX and O&M). If relevant, the assessments also contain environmental impact (e.g., emissions of SO2, NOx, and particles). The aim is to establish commonly accepted data sets and provide transparency in long-term energy studies. The methodology used for establishing the data sets is described in a set of guidelines developed by the Danish Energy Agency and include traditional foresight methods such as defining the technology, finding and selecting experts and stakeholders, expert reports, extrapolations, stakeholder workshops, wider public consulting, and dissemination of the results. The Danish Technology Catalogues are not only an exemplar of energy policy planning in Denmark. The data and the methods behind the data have become international influential and utilized as a more detailed and updated alternative to projections by international actors, e.g., IEA/OECD. Similar energy technology catalogues were developed for India in a governmental India-Denmark Energy Partnership.

Scenario planning and energy system models have been studied exhaustively in interdisciplinary energy research, economics, and social science literature (Fodstad et al., no date). There exist a wealth of studies on stakeholder involvement in scenario planning and other FLA in the domain of energy and sustainable development (Chilvers, Pallett and Hargreaves, 2018; Sovacool et al., 2020; Andersen, Hansen and Selin, 2021; McGookin, Ó Gallachóir and Byrne, 2021). While all FLA is posing problems of public significance (e.g., what counts as part of our energy futures), recent literature has tended to focus on engagement, particularly as public deliberation (Sovacool et al., 2020) and engagement of the public with everyday life objects such as solar PVs and EVs (Ryghaug, Skjølsvold and Heidenreich, 2018). Meanwhile, only a few studies exist on the very front end of the scenario process, where experts and stakeholder representatives are often involved in identifying assumptions about future trends and providing basic data (Andersen, Hansen and Selin, 2021).

In general, scenarios and other FLA are relevant and valuable for science, technology and innovation policy (Weber and Schaper-Rinkel, 2017). However, exploratory and participatory scenarios are often criticized as difficult to translate into policy-relevant information (Robinson et al., 2021). The described front-end input inputs (or techno-economic assumptions) can be considered as one particular type of scenario, predictive forecasts, rather than explorative scenarios (Börjeson et al., 2006). Although – or because of - the predictive nature of the assessments of techno-economic futures of the energy technologies, uncertainty is a key issue. Processes leading to plausible and reliable techno-economic data for future energy technologies are not trivial. There is a lack of studies of such data, particularly for emerging technologies (Fodstad et al., no date).

Research question

This paper confronts the overall research question of what is the nature and quality of the contributions of experts, stakeholders, and the wider public in detailed techno-economical input to scenario analyses used for discussions and policy decisions on the green transition and STI policies in general.

A range of more detailed questions are raised from this overall research question: How are experts and stakeholders identified, selected, and engaged during the technology catalogue process? What is the role – if any - of the wider public? What does the influence of these actors affect the quality (plausibility, acceptance, etc.) of the resulting techno-economic data and, further on, the final scenarios and their use in policymaking?

Theoretical framework

The theoretical framework behind this paper draws from two coherent and established theoretical fields that are of relevance for addressing the research questions.

First, we draw on the extensive literature on foresight, scenario planning and stakeholder involvement in scenarios. Scenarios are widely used as a method for 'strategic conversation' (van der Heiden, 1996) and to engage stakeholders in a strategic conversation on exploring uncertainties, plotting alternative futures, and devising resilience policy and strategy options (Cairns et al., 2013; Ramirez and Wilkingson, 2016). Also, extensive literature exists on stakeholder involvement in scenario planning and other FLA in the domain of energy and sustainable development (Chilvers, Pallett and Hargreaves, 2018; Sovacool et al., 2020; Andersen, Hansen and Selin, 2021; McGookin, Ó Gallachóir and Byrne, 2021). Furthermore, the distribution of power and influence in scenario planning is an extensive research topic in scenario planning literature (Wright, Cairns and Bradfield, 2013; Cairns, Wright and Fairbrother, 2016; Bourgeois et al., 2017; Cairns and Wright, 2019).

Second, we consider STS studies on public engagement in science and technology (Rowe and Frewer, 2005; Stirling, 2008; Stilgoe, Lock and Wilsdon, 2014; Kern, 2015; Selin et al., 2016). The literature on this topic is vast and has documented that involving stakeholders and citizens in debates and research about science and technology is crucial to secure an impact on actual policymaking and produce positive societal outcomes. Chilvers and Kearnes have summarized this long line of research and recognized two different and potentially incompatible research interests in it: one a normative interest in increasing participation and democracy, another a constructivist approach on a situated description of how the concept of the public is produced in different interventions (Chilvers and Kearnes, 2020). As both these lines show, the concepts of both experts and stakeholders are contested and debated (Stirling, 2008; Freeman et al., 2010; Colvin, Witt and Lacey, 2016; Miles, 2017), both as concerns who is a participant in democratic processes and as concerns how these participants are constructed, and several studies have pointed at the blurred distinction between experts and stakeholders and blurred distinction between stakeholders and researchers (Andersen, Hansen and Selin, 2021). The established concerns in STS have focused on expertise, contested expertise, expert-lay relations, and questions of how knowledge and expertise are recognized in societal processes (Åkerman et al., 2021). These discussions point to critical questions concerning recognizing who counts as a stakeholder, why, and with what consequences.

Data and methodological approaches

The study takes an exploratory approach as the first step towards a larger research agenda on stakeholder engagement, energy system modelling, and priority-setting in STI policy. The research is based on desk studies of documents (publicly available documents from relevant institutions) and interviews with key stakeholders. The research comprises both the technology catalogue activities in general and a deeper analysis on two specific sets of technology data: 'Offshore wind' updated 2021 and 'Energy Storage' (with our focus on Hydrogen storage) from 2018 with an update from 2020.

Expected results

The expected results of research comprise two elements. The first result is an overall description of the processes leading to Technology Data for selected technologies. This also includes a brief description of alternative approaches technology catalogue process found internationally. The second result is an analysis of the nature and quality of the contributions of experts and stakeholders during the process.

The research contributes to how scenario planning aligns expectations and builds shared visions of futures. This is particularly relevant when mission-oriented energy and STI policies require a coordinated, intensive and long-term interaction between policy makers, science, and societal stakeholders. As such, the paper also applies new research on the frontiers in energy system modelling (Fodstad et al., no date) and highlights advances in long-term energy planning and the evolution of mixed quantitative and qualitative exploratory scenarios.

Conclusions and policy issues

In general, scenarios and other FLA are relevant and valuable for science, technology and innovation policy (Weber and Schaper-Rinkel, 2017). However, exploratory and participatory scenarios are often criticized as difficult to translate into information relevant to STI policy (Robinson et al., 2021). While the dialogue between quantitative and qualitative approaches has received considerable scrutiny, we examine the usually hidden underpinning data that are input to energy scenarios and energy system models, respectively. This 'negotiated' data profoundly impacts STI policies for low carbon futures and infrastructural landscapes, and our paper is among the first openings of this important topic.

Keywords: Stakeholder inclusion, Public engagement in science and technology, Long-term energy policy, STS, Scenarios

[54] Tessa Mauw (Utrecht University), Jonas Torrens (Eindhoven Technical University), Mansi Jain (Utrecht University) and Martijn van den Hurk (Utrecht University). *New advances in evaluating urban experimentation.*

Abstract. Urban experimentation has emerged as a potential way forward in otherwise intractable problems, particularly sustainability and climate change. Be it as a stepping stone towards desirable socio-technical trajectories or as the concrete embodiment of utopian futures, urban experiments are more than traditional projects. Despite these inflated promises, it is unclear how to evaluate experimentation and appraise its outcomes. Without appropriate evaluation, it is hard to assess initiatives' success or effectiveness and capture insights and learnings, e.g., to refine the design and conduct experiments.

Over the past decade, various approaches and frameworks for evaluating experimentation have been proposed, drawing from different disciplines and evaluation traditions. In this paper, we review those efforts to explore the following questions:

- Which frameworks and approaches are used for evaluating urban experimentation?
- What challenges arise in evaluating urban experimentation with sustainability goals?
- What decisions are crucial in designing a bespoke evaluation process?

The first question addresses the range of evaluation approaches that have been proposed, but for which limited empirical validation and no systematic comparison exist. The second question explores how different approaches to experimentation attend different evaluative needs. It also addresses the constant pressure for experiments to behave as projects, e.g. with predetermined deliverables (Torrens & Von Wirth, 2021). The final question charts a possible way forward, not in terms of yet another framework, but as a series of reflexive moments that practitioners and researchers can follow together, to decide what experimentation and evaluation should be like in a given situation.

This research builds on a mixed-method approach. It includes a literature review, an expert consultation involving leading proponents of evaluative approaches, and two workshops involving practitioners and academics. The literature review mobilises bibliometric tools (Citationgheko and Connected papers) for identifying candidate evaluation approaches for the analysis. This corpus was summarised and clustered to determine the genealogy of evaluation approaches and identify examples of their application in practice. Following that review, we interviewed six scholars to probe the challenges further. The results were then discussed and refined in two half-day workshops with academics and practitioners in the beginning of 2022.

The paper proceeds as follows. The first section addresses our first question and focuses on the literature review results. The second section explores the challenges encountered. The third section discusses the design of a reflexive process. We conclude with a discussion of directions for further research.

Surveying existing approaches for evaluating urban experimentation

Recently, various evaluation approaches aiming to address the evaluation of urban experimentation have been proposed. The approaches and frameworks analysed for this literature study can be grouped into formative evaluation, developmental evaluation, and reflexive monitoring. The formative evaluation approaches in question implement transition theories, such as MLP (Molas-Gallart et al., 2020; Williams & Robinson, 2020) and SNM (Leuderitz et al., 2017). The foundation of the developmental evaluation approaches lies in social innovation theories (Mitchell & Lemon, 2020; Vahl & Kieboom, 2014; Ruijsink & Olivotto, 2017). The reflexive monitoring approach foregrounds system innovation theories and systems thinking (Van Mierlo et al., 2010) and Transition Management (Taanman, 2014). Hence, despite their similarities, they implicitly carry forward distinct assumptions of how change comes about in society.

The approaches above have distinct - and potentially conflicting and overlapping - aims and evaluation processes (see Table 1). Developmental evaluation and reflexive monitoring approaches have very explicit short-term and mid-term aims such as learning, providing feedback, and adapting and improving the experiment (Mitchell & Lemon, 2020; Ruijsink & Olivotto, 2017; Van Mierlo et al., 2010). Formative evaluation approaches have explicit long term aims, such as evaluating the sustainability impact of an experiment (Williams & Robinson, 2020), identifying processes that contribute to system change (Molas-Gallart et al., 2020), or tracing the influence of an experiment on transformational efforts (Leuderitz et al., 2017). The former work with the normative direction of the experimenters, reflection on it. The latter adopts a normative direction from sustainability debates and seeks to implement it in the process.

The evaluation process also differs per approach, depending on their central aims. Developmental evaluation and reflexive monitoring approaches have clear steps, phases or dimensions (Mitchell & Lemon, 2020; Ruijsink & Olivotto, 2017; Taanman, 2014; Van Mierlo et al., 2010). However, they often have difficulties implementing the multiple levels that transitions experiments entail, making it harder to evaluate whether and how an experiment contributes to systemic change (Molas-Gallart et al., 2020). Formative approaches also try to assess the impact on sustainability transitions (Williams & Robinson, 2020) or the achievements of long-term systemic goals (Molas-Gallart et al., 2020). In turn, an approach targeted at assessing systemic impacts is not as suitable for supporting the rapid development of an experimental programme.

Finally, the position of the evaluator or monitor differs across the approaches. Formative evaluation approaches argue for an external partner embedded in the program (e.g. as a facilitator). The evaluator may be part of the design team with whom they collaborate to conceptualise, design and test new approaches to achieve long term development, adaptation, and change (Mitchell & Lemon, 2020; Molas-Gallart et al., 2020). Reflexive monitoring and developmental evaluation approaches argue for an internal evaluator. This internal evaluator or facilitator is usually a team member involved in learning exercises with all stakeholders, providing recommendations and advice and triggering discussions on the programs, achievements, and goals. The evaluator should balance involvement and keeping a critical distance (Van Mierlo et al., 2010; Ruijsink & Olivotto, 2017). Therefore, deciding when to rely on an external or internal evaluator is critical in designing an evaluation.

Specific challenges that hinder evaluation

Attempts to evaluate and monitor experimentation encounter multiple challenges or dilemmas, which can be grouped into two levels: the regime/system and experiment level. The challenges within the two are not mutually exclusive and are often similar as the levels also influence each other.

Regime/system challenges concern the complexity of the systems and regimes in which experiments are embedded and their influence on experiments. Transitions involve complex socio-technical systems and cannot be predicted, making it difficult to develop tools and methods that capture change across all these domains (Williams & Robinson, 2020) and define the consequences of an experiment beforehand (Van Mierlo et al., 2010). Ghosh et al. (2021) have argued evaluations could help experiments identify specific ‘transformative outcomes’ to target, making explicit what changes are expected or desired. However, plans, activities and goals may change throughout the experiment, as it is adapted to a changing environment, demanding flexibility on the part of the evaluator (Van Mierlo et al., 2010).

Evaluation is not entirely a matter of design and is influenced by the institutional environment. Funding bodies, for example, often focus on success instead of learning from failures and prioritise accountability. This causes tension between evaluating for learning, meeting the needs of the experiments' proponents, and evaluation for accountability, meeting funders' requirements (Williams & Robinson, 2020). Another challenge stemming from the complexity of systems is the attribution challenge, as articulated by Molas-Gallart et al. (2020, p. 431): "How can we evaluate experiments with a narrow geographical and temporal scope when the end goal is ambitious systemic change?" As transitions happen over longer periods, it is challenging to capture the long-term contribution of an experiment (Williams & Robinson, 2020). This highlights the tension between framing evaluation processes around specific initiatives versus monitoring a transition process. In practice, these two are unfortunately often conflated in the expectations of practitioners.

At the experiment level, challenges concern the divergent expectations of the multiple actors involved and resources constraints (e.g. time, money, knowledge, legal requirements). Experiments often comprise many actors and, therefore, wildly divergent views of what should be accomplished or tested (Heiskanen & Matschoss, 2018). This hinders collective learning, requiring the evaluator to keep in mind participants' varied values and practices (Van Mierlo et al., 2010). Competing expectations, visions, and interests of the involved actors pose a challenge. It is easier for projects to garner support for options with the most credible expectations of financial benefit (e.g. bankable business models) or scaling-up potential. This bias can lead to selecting options inconsistent with other actors' initial expectations (Molas-Gallart et al., 2020). Evaluation, in this context, needs to be seen as potentially legitimising very particular interests. Hence, a reflexive co-design process – encompassing both the experiments and the evaluation – is required.

Discussion: towards a reflexive co-design process

To build such a reflexive co-design process, evaluators and the team conducting experiments should consider both system and experiment levels and their interactions. Two ways to foster reflexivity stand out, as indicated by Interviewee 2: "Using evaluation as a strategic tool and using evaluation as a tool for ongoing learning as part of the process". The first is about aligning perspectives and empowering the participants who mobilise around a particular vision of what is being pursued. It is important to make these assumptions explicit, for instance, by using/developing a Theory of Change. This gives a common starting point to think about the problem, what the project is doing and what it wants to achieve. The empowerment of the people involved in the experiment is crucial in this, by co-producing the evaluation approach.

The second way to increase reflexivity is embedding, i.e. involving evaluation from the beginning and throughout the project. One can achieve this by, for example, continuously asking questions, surfacing tensions, reflecting back to the design team and implementing changes. With this, it is vital for the participants of the experiment or programme to be willing to implement those changes promptly. The ability to do so requires institutional change, particularly in the culture of funding bodies. However, proponents of experiments often face inflexible expectations (c.f. Torrens & von Wirth, 2021).

To conclude, evaluating experimentation requires facing specific challenges that hinder the 'adoption' of predetermined frameworks. Moving through a co-creative, reflexive process, in which the experimental design and the evaluative needs are considered in tandem, is a way to address these challenges. Understanding that process as multi-layered and potentially contested is needed to create a bespoke and well-suited evaluation approach.

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Keywords: urban experimentation, developmental evaluation, formative evaluation, reflexive monitoring

[55] Daniel Weiss (Freie Universität Berlin). *Technological Innovation Systems: A critical review of quantitative methods.*

Abstract. Abstract

Technological Innovation Systems (TIS) have become a cornerstone to analyse the development dynamics of technologies within the sustainability transitions literature (Markard et al. 2012). Over the last two decades, several scholars provided conceptional work to advance the original TIS framework, including the functions of innovation systems (Hekkert et al. 2007, Bergek et al. 2008), development phases over time (Markard 2020), and interactions with the surrounding context structures such as spatial, sectoral and technological relations (Bergek et al. 2015). In turn, this set the ground for fruitful empirical research utilising a variety of cases, data sources and empirical frameworks but primarily relying on qualitative research methods (Walrave and Raven 2016). Although the qualitative TIS studies are able to identify cause-and-effect relationships in the system, their findings and analytical frameworks are bound to their specific research case, impeding generalizability without a laborious analysis of multiple cases (Eisenhardt and Graebner 2007, Weckowska et al. 2021). The latter is necessary to derive and validate more general statements about the dynamics of TIS the community can agree upon, such as the 'motors of innovation' concept (Hekkert et al. 2007, Suurs and Hekkert 2009). In fact, the TIS literature has been criticised for relying too much on diagnostic work rather than building and validating theoretical concepts that explain the changes in the system's variables (Kern 2015). Considering this, Weckowska et al. (2021) suggest incorporating more quantitative methods into TIS studies and utilising their highly structured and generalisable research designs to complement the prevailing qualitative approaches, possibly in a mixed-method approach (e.g., Binz et al. 2016, Rohe and Chlebna 2021). However, they also point out the shortcomings of quantitative methods that have to be addressed by future research, like their abstraction of micro-processes by focusing on aggregated outcomes rather than causality, and their narrow analytical focus that tends to omit other relevant parts of the TIS. Accordingly, we need a detailed discussion of how the existing quantitative approaches in the TIS literature can be advanced to complement qualitative research to strengthen our understanding of TIS and pursue further theory-building (Hekkert et al. 2007, Schwäbe 2021). In a more general sense, as observed in fields like physics or psychology (Cousineau 2005), the progression of quantitative methods could accelerate the rate of scientific progress in the TIS community by leveraging the exploratory insights of qualitative studies. In particular, quantitative methods can help to attain a more general description of the observed case-specific mechanisms and derive explanations that the TIS community can agree upon, e.g., a common set of variables from the TIS and its context that drive the creation of legitimacy. Such generalisations would allow for a straightforward falsification of hypotheses and concepts via empirical testing. In that way, we can reach the stage of theory-building from qualitative cases by including validation from a statistical perspective (Johnson and Onwuegbuzie 2004, Cousineau 2005). This resonates with Swann (2019) proposing to complement different methodological viewpoints to circumvent the issues of data availability and randomised controlled experiments in the social sciences.

Against this background, this study sets out to contribute to this ongoing discussion by embarking on the first dedicated methodological review of quantitative approaches in empirical TIS research. Herewith, it wants to complement the results of Weckowska et al. (2021) by providing an in-depth discussion of each quantitative method and its possible empirical extensions. The review revolves around the following research questions: What are the key features and contributions of quantitative methods applied in the TIS literature? How can we advance the quantitative toolbox of methods to strengthen their contribution to understanding TIS dynamics?

To guide the methodological review and capture the contribution of each quantitative method, this study outlines the essential theoretical TIS concepts to understand the dynamics of TIS: structure, functioning, development phase, and context (Hekkert et al. 2007, Bergek et al. 2015, Markard et al. 2020). In addition, further empirical features are retrieved from each study, including the data and indicators used as well as the respective methodological strengths and weaknesses. The review encompasses a total of 18 dedicated methodological articles from the initial sample of 375 articles extracted from Web of Science (WoS), with social network analysis (SNA) and system modelling (SD) being the most represented methods, followed by natural language processing (NLP) and regression analysis (RA). The retieved features are summarized in table 1

Based on the retrieved aforementioned empirical features, each method is described in detail, including important statistical definitions and concepts. Furthermore, the review sketches out possible empirical extensions on the data, method, application and concept level that should be taken into account by future research to strengthen the contribution of quantitative methods to TIS research.

As depicted, these extensions are arranged on different levels, building up from the data to overarching conceptional work. Notably, these levels are interdependent, e.g., new data is needed to employ additional methods and vice versa. This implies that improvements on all levels are needed to exploit the full potential of quantitative methods in TIS analysis. Accordingly, future research should not only be concerned with the mere application of quantitative methods to additional cases but should also accommodate conceptional work. Notably, the latter is especially needed to leverage empirical work to move beyond case-specific insights for policymaking to more general theory-building and validation of existing TIS concepts. By the same token, integrated frameworks are necessary to guide and prioritise future methodological work in the TIS community. This should go hand in hand with more overarching research aims, e.g., consolidating the set of indicators for the functional TIS analysis and establishing their interdependencies with each other.

Overall, the review highlights the further potential of quantitative methods as they can enable scholars to conduct broad cross-comparisons and examine causal relationships from a quantitative perspective. This constitutes a valuable contribution to the toolbox of empirical methods for TIS analysis next to prevailing qualitative approaches opening up further possibilities for theory building and testing.

The paper is structured as follows. The first section outlines the conceptional aspects of TIS that are used to structure the review while giving an overview of the current debate about qualitative and quantitative methods. Subsequently, the study describes how the literature review is conducted, including the selection and analysis of the quantitative studies. The following section encompasses the results with a dedicated part for each method. Finally, the paper ends with a discussion of the implications of the presented results while highlighting opportunities for future research as well as the limitations of this study.

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Keywords: Technological innovation systems, Quantitative methods, Method review, Literature review

[56] Carolina Castaldi (Utrecht University) and Kyriakos Drivas (University of Piraeus). *Innovation and Regional Branching: an Exploration of Technological, Design and Market Activities.*

Abstract. Extended abstract

How a region is able to diversify and develop new specializations is a question of keen interest to both academics and policymakers. The question has been at the heart of research in evolutionary economic geography (Boschma, 2017) and has concerned different types of activities that underlie a region's potential to renew its economic profile. When it comes to the specific role played by innovation activities, most of the focus has been on investigating the role of technological capabilities. Empirical observations across a spectrum of regional units have shown that new technological specializations are strongly related with a region's existing technological capabilities. This stream of studies has relied on (utility) patents as the preferred metric to capture technological diversification and capabilities and has tended to view technological development as the main innovation activity that regional firms can specialize in.

We argue that while technological invention can be a key source of innovation, it might be neither sufficient nor necessary for the creation of value-adding innovation. Therefore, in this paper we take a more comprehensive approach and aim at investigating more stages of the innovation process than new technology development alone. Technological advances may only create economic value when they allow improvements of actual products and services or when they enable introducing radically new ones. In fact, in many instances, there is a range of other innovation activities, including design, product development or marketing, that come into play before the initial invention can turn into a persuasive offer in the market (Castaldi and Mendonca, 2022). These considerations apply at the firm level, but also at the regional level. At this latter level, there is still a lack of empirical studies including metrics that capture different innovation activities, not only technological ones. Hence, our objective is to examine the contribution of technological, design and market capabilities to the development of new regional specializations in each innovation activity.

We capture the three innovation activities by three types of intellectual property rights (IPRs): i) (utility) patents, ii) industrial designs as referred to at the European Union Intellectual Property Office (EUIPO), or design patents as referred to at the United States Patent and Trademark Office (USPTO) and iii) trademarks. As such, we offer the first study on the emergence of regional innovation specializations that goes beyond examining a single metric of innovation and instead investigates the interplay across multiple innovation stages.

We apply our empirical model to two independent settings for the period 2003-2016. The first is 259 NUTS-2 regions across 21 European countries and the associated patent registrations at the European Patent Office (EPO), and trademarks and industrial designs registrations at the EUIPO. The second is 363 Metropolitan Statistical Areas (MSAs) areas in the United States (US) and the associated patents, trademarks and design patents registered at the USPTO. Analyzing these two settings increases the validity of our results and also offers insights into the implications of institutional differences behind the chosen IPR metrics. Most notably, a key institutional difference with respect to designs offers valuable insights regarding their relation to technological and market capabilities.

Our empirical approach is inspired by the 'principle of relatedness' (Hidalgo et al., 2019). We map three separate technology, design and markets spaces capturing their relatedness across technology, design and market classes, and a comprehensive 'innovation space' where the three different spaces come together. We provide three main results. First, we find that the innovation activities captured by the three IPRs, are indeed strongly intertwined at the regional level. While own related capabilities contribute to new specializations for each innovation activity, related capabilities in the other two activities also contribute significantly. Second, since the paper's framework relaxes the restriction that the relatedness relationships should be symmetric, we can assess the key directions of cross-relatedness linkages. We find that technological capabilities (i.e., the upstream innovative activities) are stronger contributors to new innovative specializations than the other two matter for new technological specialization. Yet, we also see significant 'backward' linkages from the downstream to the upstream ones, indicative of feedback loops between the stages of innovation. Third, when comparing the European and US contexts, we find innovation specializations in the US to be more strongly driven by technological relatedness from upstream to downstream, with somewhat weaker feedbacks from downstream to upstream. This can at least partially be explained by the nature of the innovation activities that the proposed metrics capture. In particular the US case reveals that related capabilities in novel design contribute only to new specializations in high-technology product markets.

Our study contributes to the strand of literature applying the 'principle of relatedness' to regional diversification in three ways. First, we investigate relatedness along more dimensions of the innovation process than technology development only, namely design and market activities. Second, instead of solely examining regional 'horizontal' branching, i.e. branching independently from the other ones, we also examine how branching works vertically. In other words, instead of only examining how a region branches into new innovation specializations, we also examine how it evolves from upstream to downstream innovation activities and vice versa. Our contribution is in line with a handful of other studies that have gone in the direction of examining 'cross-relatedness'. In particular, Catalan et al., (2020) have applied the principle of relatedness at the country level, to science and technology spaces, while Pugliese et al., (2019) have leveraged a similar complexity perspective to investigate multi-layered networks of relations between science, technology and product capabilities of countries. Our study shares an innovation perspective with Pugliese et al., (2019) but we focus on different activities and on the regional level. Research has demonstrated that both national and regional systems of innovation are important, but the regional level allows capturing much more variance in innovation activities that is left unexplained when taking a national lens. Finally, our approach also goes in the direction of unpacking relatedness (Farinha et al., 2019). Specifically, we can establish the existence of complementarities between different innovation activities and the related specializations. Moreover, we can also examine which contribution/direction is stronger, hence highlighting (a)symmetries in relatedness as well, corresponding to non-linearities and feedback mechanisms that are typical of innovation processes.

In terms of policy implications, the study can broaden policy analysis in line with the Smart Specialization approach. Originally incepted by the Knowledge for Growth expert group (Foray and van Ark, 2007; Foray et al., 2009), Smart Specialization urges regional policymakers to support existing place-based capabilities to uncover new related endeavours that can be leveraged for competitive advantage. Our contribution illustrates how policymakers can measure and leverage a whole range of related capabilities spanning more innovation activities than technology only. In fact, technological innovation tends to be highly concentrated in very few regions (Crescenzi et al., 2020), leaving little space for regions that are not at the technological frontier to uncover alternative specializations. Our findings show the importance of each capability in promoting the emergence of new regional specializations across different innovation activities. As such, our approach can illustrate how broader innovation metrics could be included in policy analysis aiming at a broader take on regional innovation activities (Asheim et al., 2011).

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Keywords: innovation, patents, trademarks, designs, relatedness, regional specialization, smart specialization

[57] Nico Pintar (Vienna University of Economics and Business / Austrian Institute of Technology), Jürgen Essletzbichler (Vienna University of Economics and Business) and Thomas Scherngell (Austrian Institute of Technology). *Evaluating different knowledge complexity measures for European metropolitan regions.*

Abstract. The uneven economic development among and within countries, usually expressed by national or regional income per capita levels, is often explained by productivity differences (see e.g. Prescott, 1998; Hall and Jones, 1999). While these differences are driven by a large number of processes at and characteristics of the national (or regional) economy (Porter, 1990; Scott and Storper, 2003), technological progress is considered generally as the most essential factor for productivity gains and economic growth. In turn, technological progress depends on the creation and dissemination of new knowledge. Recent work in Economic Geography posits that regional diversification into related knowledge fields - that demand similar capabilities and skills – is more viable and boosts innovative output (see e.g. Essletzbichler, 2015; Rigby, 2015; Content and Frenken, 2016; Kogler et al., 2017) and therefore economic development. However, (related) knowledge fields differ in their value for regional diversification as those easily imitated and diffused in geographical space might not offer long-term productivity gains (Foray, 2004).

While theoretical considerations around qualitatively high, valuable, and complex knowledge and its benefit on regions have gained popularity recently and empirical studies have also shown first evidence of potential growth effects, there are still a few questions left unanswered. One being as to how to measure knowledge complexity in the first place and whether it matters which alternative operationalization presented in the literature is used? In this paper we show a comparison of the most common empirical operationalizations of knowledge complexity measures with variations on those measures that have not yet been implemented by scholars in the field. The aim is to show whether a-priori viable different alternatives of knowledge complexity indices are in itself robust and or produce similar results when compared to each other. We do this by estimating 16 variations of each the Economic Complexity Index (ECI, Hidalgo and Hausmann, 2009), the Economic Fitness Complexity index (EFC, Tacchella et al., 2012) and the Structural Diversity Index (SDI, Broekel, 2019) and applying them to the same dataset of 197 European metropolitan regions' patent data from 1996 to 2017.

Keywords: knowledge complexity, patent analysis, smart specialization, regional innovation, network analysis

[58] Francesco Gerli (Copenaghen Business School - Department of Organisation), Susanna Kugelberg (Copenaghen Business School - Department of Organisation) and Susana Borrás (Copenaghen Business School - Department of Organisation). *When just means capable: investigating the capacities of public actors for green and just transitions.*

Abstract. There is an increasing interest among innovation scholars to extend the analytical focus of green transitions from an innovation and policy mix perspective to a closer investigation of public actors capacities and roles for a green and just transition to tackle grand-challenges (Borras and Edler, 2020; Diercks et al., 2019; Mazzucato et al., 2020). These are including both capacities for innovation and technology diffusion to the specific capabilities of actors within socio-economic institutions where innovations and technologies are embedded, negotiated and justified (Geels, 2020).

This is the reason why a broad approach to sustainability transitions cannot limit the analysis of effective and efficient technical innovations but requires understanding the operational enabling conditions for a deep transformation and alteration of existing institutional socio-economic structures.

Authors have stressed that an exclusive focus on the technical "green" attribution of sustainability transitions may obfuscate the broadly transformative dimensions behind the transition concept (Hearn et al., 2021). These under-investigated attributes enable sustainability initiatives not only to be "societally sustainable" but also to be fair and just, potentially affecting and altering societal and economic institutions towards greater equality.

The "just transition" is a novel framework of analysis that brings together climate, energy and environmental justice scholarships (Newell and Mulvaney, 2013; McCaulley and Heffron, 2018). From the practitioners' perspective, a just transition has been defined by the EBRD as capable "to ensure that the substantial benefits of a green economy transition are shared widely, while also supporting those who stand to lose economically – be they countries, regions, industries, communities, workers or consumers." The European Commission underlined that a "just transition" is one that "happens in a fair way, leaving no one behind".

Thus, just transitions can be understood as a transformation that results in the achievement of linked goals, including on one side the reduction of socio-economic material deprivation coupled to the advancement of societal well-being and the environmental benefits of the green innovation on the other (Swilling and Annecke, 2012; Swilling et al., 2016).

The study of justness in green and sustainability transitions has often been linked to the politics and the power distribution within the transition framing (Swilling et al., 2016).

While these two elements are pivotal to understanding the equality outcomes resulting from the sustainability evolutions, in this study, we contend that justness is also linked to the specific implementation and organisational capacities of the actors involved in transition initiatives. Justness is also a matter of management, besides politics.

We recognise that even the implementation of the just transition "needs to inherently take justice-related considerations into account" (Hearn et al., 2021, p.1) and that these considerations are still novel and unexplored within the specific boundaries of organisations that are protagonists of transitions (Hearn et al., 2021).

In this scenario, public actors are often asked to proactively govern and address green transitions towards fairness and equality objectives operationally implementing the just transition (Mazzuccato et al., 2020).

This requirement asks public institutions to adopt "justice-related" actions that are also linked to manifold specific capacities drawn from heterogeneous skills and resources.

Thus, we follow the general understanding in the literature of policy studies that define capacities as "the set of skills and resources necessary to perform policy functions". (Wu et al. 2018) p. 3

In the context of just transitions, capacities represent micro organisational elements enabling institutions to face and react to the societal consequences of the green transitions (Hearn et al., 2021).

While facing "just transitions" public organisations have to be capable of pursuing their green purposes while responding to competing and differential objectives relative to generating positive outcomes in terms of social welfare (Piening, 2013).

This dynamic, complex and multifaceted identity of just transitions explains the appropriateness of the analysis of the capabilities of public organisations that are necessary to build up appropriate capacities. Capabilities are related to an organization's specific form of action and they are linked to the various approaches pursued by the organization in mobilizing and utilizing resources (Borràs et al., 2021; Hölscher, K., & Frantzeskaki, 2020).

Thus, this exploratory study investigates which mixes of capabilities enable public actors to effectively balance and integrate societal and environmental aspects within green transition projects to make transitions "just".

Following the classification provided by Borrás and Edler (2020) about the role of the state in sustainability transitions, in the paper, we analyse two case studies in which the public (state) actor is playing differential roles while implementing green transition initiatives in which the “just” attributes of transitions are differently pursued.

We recognise that the public actor may act as a "mitigator" by compensating for the negative social consequences of the green transition initiative. Alternatively, the public organisation may act as a "negotiator" by negotiating between different social and political positions among agents regarding the direction of the green transition.

We also contend that further specific capacities are requested by public actors whenever they are "promoters" of a multifaceted "societally inclusive" green transition initiative. These initiatives aim to intentionally unleash the diffusion of green innovations while reducing societal and economic disparities.

In the first case that we analyse in the paper, a small municipality is committed to reducing potential societally negative consequences of a maritime transport electrification initiative in the Island of Ærø in Denmark, by implementing a compensation price strategy for the electric ferry prices.

In the second case, an Italian small municipality is promoting an "energy community" initiative that proactively enables citizens to equip themselves with plants for the production and self-consumption of energy from renewable sources. At the same time, the municipality launched a "GOC" (Community Operating Group), a social cooperative enterprise, aimed at creating a "short chain of technicians, designers, installers and maintenance technicians" required for the micro-grids to work. The "energy community" led by the municipality represents the catalyst for this process of aggregation of local skills on the territory. It also aims at creating development and jobs in a disadvantaged geographic and social context.

The capacities of public actors in the two cases are investigated qualitatively through the analysis of secondary data, semi-structured interviews (10 -12 per case) and a series of direct observations.

Primary data are collected in the cases to offer an understanding of their capacities in terms of the resources and the (cap)abilities that enable the public actors to successfully redirect a green transition towards a just direction. This shift requires overcoming the organisational risk of "silo-thinking" and solutions in the complex scenario of green transitions (Bundred, 2006).

Overall, the research aims to contribute to the emerging research interest on just transitions and the correlated organisational capacities for governing green transitions. The results will be used to develop practical recommendations to enhance capacity-building relevant for practitioners and policy-makers involved in green transitions.

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Keywords: public organizations, just transitions, organizational capacities, transformative innovation, organizational capabilities

[59] Florian Roth (Fraunhofer ISI), Ralf Lindner (Fraunhofer ISI), Miriam Hufnagl (DESY Innovation & Technologie Transfer), Florian Wittmann (Fraunhofer ISI) and Merve Yorulmaz (Fraunhofer ISI). *Insights from the Scientific Support Action to the German High-Tech Strategy 2025 .*

Abstract. Over the last years, numerous governments, particularly in the OECD world, as well as the Euro-pean Union have initiated so-called missions as part of their research and innovation policy strat-egies (Larrue 2021). Mission-oriented innovation policies (MOIP) aim to reach ambitious and clearly defined goals that address pressing societal challenges (Kattel et al. 2018; Mazzucato 2018). Given the complexity of these challenges und the urgent need to realize changes in the way production and consumption in our societies are organized, significant system transfor-mations are needed which typically reach beyond the established realms of research and innova-tion policy. Thus, MOIP that aim to contribute to these transformations require clear directionality of science, technology and innovation, coordinated cross-sectoral action and broad actor mobili-zation (Kuittinen et al. 2018; Lindner et al. 2021).

As noted by Janssen et al. (2021), existing research has mainly focused on conceptual reflections about mission goals and early stages of the implementation process, but paid little attention to the actual implementation of missions. In consequence, the implementation of MOIP still remains a challenge for many policy-makers (OECD and the Danish Design Center 2022 Lindner et al. 2021). To address this gap, this paper aims to provide empirical knowledge on a crucial case of recent attempts of mission-orientation, focusing on the Science, Technology and Innovation (STI) policies in Germany.

Framework, data and methodological approach

This paper provides an exploratory case study of the German High-Tech Strategy, drawing on insights from a recently concluded research project commissioned by the Federal Ministry of Edu-cation and Research (BMBF). The High-Tech Strategy is the flagship research and innovation strategy of the German Federal government, aimed at bundling its activities. Already in 2010, the German federal government announced a reorientation of its STI strategy, shifting from a primary focus on fostering key technologies to a challenge-oriented approach (BMBF 2010). With the in-troduction of the latest edition in 2018 (HTS 2025), a mission-oriented approach was explicitly put center stage by defining twelve specific missions to address key societal challenges, such as envi-ronmental pollution, climate and demographic change (BMBF 2018). The analysis focuses on four selected missions (Combating cancer, Reducing CO2 emissions in industry, Circular economy, Ensuring good living conditions throughout the country) that can be considered as representative example of different types of mission logics (Wittmann et al. 2021a) and therefore maximize the variation across cases.

The analysis is structured along the different translation processes identified as relevant for mis-sions distinguishing between the phases of mission formulation, mission design and mission im-plementation (Wittmann et al. 2021b). This approach allows to delineate different areas of nego-tiation and contestation, exploring potential bottlenecks when bringing missions into action. The analysis combines insights from document analysis, interviews, participatory observations and workshops with policy-makers and experts. It employs different analytical tools, including a sys-tem mapping approach to analyze the position of the relevant missions within their socio-technical system, the ex-post identification of (assumed) impact pathways describing the ex-pected ways of creating impact through the mission, and an analysis of the instrument mix.

Preliminary results

Most goals of the missions under study are ambitious, aiming to transform or at least change complex socio-technical systems. This includes the STI sphere, but clearly reaches beyond it. However, a few missions also display rather vague goals which makes it challenging to track whether and how complex societal challenges have been translated into concrete MOIP at all. Drawing on a comprehensive system analysis, we show that in many cases even missions with transformative ambitions and a cross-sectoral understanding of the underlying challenge to solve, primarily entail policies oriented towards typical research and innovation actors. This narrow in-terpretation of mission goals most likely falls short of actively addressing other potentially rele-vant actors (e.g., regional authorities, consumers, other stakeholders). Further, also the rather patchy integration with sectoral policies so far offers room for improvement. While some of the missions exhibit a certain degree of directionality and intentionality, including quantified mission goals and interim milestones, in other cases neither goals nor the underlying concepts are clearly specified. As a consequence, despite a generally high level of legitimacy, the formulation pro-cesses of the missions under study did not provide sufficient guidance for the later processes of mission design and resulted in a rather limited appeal for actor mobilization.

To enable an assessment of the design of the HTS 2025 missions, the research team compiled an inventory of all mission-related policy instruments, as mentioned in different official sources pub-lished by the BMBF and additional information provided by ministerial units in charge. In general, the policy instruments in place have a high specificity with the mission goals, with a strong em-phasis on distributive approaches. However, the analysis also shows that the delineation of rele-vant instruments contributing to HTS missions (together) appears to have been poorly defined, in several cases rather subsuming already existing or planned policy instruments under a mission headline without a necessary view to the overall composition. Another key observation derived from the case studies is the rather strong top-down ministerial perspective regarding mission content and resources, with most stakeholders beyond government merely acting as funding beneficiaries. Thereby, most of the missions under study do not fulfill the promise to increase leverage by mobilizing both private and public actors to achieve joint owner- and leadership of the missions.

Mainly due to the so-called departmental principle (Ressortprinzip), the implementation of MOIP in the German context first of all means to coordinate the priorities and interests of different min-istries. Important prerequisites for interdepartmental coordination processes are laid down in the joint rules of procedure of the federal ministries. Cooperation and coordination are often compli-cated by interdepartmental competition. There was little evidence that missions facilitate positive exchange between different ministries going beyond a delineation of responsibilities and negative coordination. Overall, frequency and intensity of inter-ministerial or trans-ministerial activities appear to be rather low. During the course of the scientific support action we could, however, observe a growing awareness and willingness to improve this, also due to the fact that the char-acteristics of MOIP are increasingly better understood by policy makers on strategic and executive levels.

Implications for research and policy-making

In line with existing research (Janssen et al. 2020), the findings echo the importance of mission formulation as a starting point, pointing to the problem how unspecified mission goals "travel" downwards the way the implementation. In many cases, this leads to a lack of guidance and poor orientation for actors active in mission. In addition, the results point to potential pitfalls associat-ed with legitimacy and an STI trap, which can inhibit efforts to mobilize actors to achieve the cross-boundary goals postulated in missions. Furthermore, the analysis points to the issues that emerge when missions emerge in an established institutional and policy context (Larrue 2021, p. 9). These findings imply that research needs to pay greater attention to the different modes of institutional change, such as layering or refurbishing of different past and present policies and activities (cf. e.g. Hacker 2004; Kern et al. 2009; Mahoney et al. 2010; Thelen et al. 2005) and their implications for missions. This touches also upon the question of appropriate institutional settings for mission implementation (Lindner et al. 2021). We argue that new institutional set-ups need to be found that are more compatible with the requirements of mission orientation. Finally, the find-ings relate to recent work on instrument and policy mixes (Amanatidou et al. 2014; Hekkert et al. 2020; Janssen et al. 2020; Wesseling et al. 2020). The paper highlights the importance of design-ing missions so that they reach beyond established STI practices, especially if missions are sup-posed to contribute to larger transformative processes.

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Keywords: Missions, Transformation, Germany, Mission-oriented innovation policies, MOIP, Case study

[60] Ismael Rafols (CWTS, Leiden University), Ed Noyons (Leiden University), Hugo Confraria (SPRU - Science Policy Research Unit, University of Sussex) and Tommaso Ciarli (UNU-MERIT). *Towards plural 'mappings' of research for Sustainable Development Goals (SDGs).*

Abstract. Introduction

The shift in S&T policy from a focus on research quality (or 'excellence') towards societal impact has led to a demand for new S&T indicators that capture the contributions of research to society, in particular those aligned with SDGs. The use of the new 'impact' indicators would help monitoring if (and which) research organisations are aligning their research towards transformative innovations.

Responding to these demands data providers, consultancies and university analysts are rapidly developing methods to map projects or publications related to specific SDGs. These 'mappings' do not analyse the actual impact of research, but hope to capture instead if research is directed or related towards problems or technologies that can potentially contribute to improving sustainability and wellbeing.

Yet this quick surge of news methods raises questions about the robustness of the mappings and indicators produced, and about the effects of using questionable indicators in policy making.

In a new study that aims to map publications to SDGs, we have found a high degree of inconsistency obtained through different approaches, as recently reported by Armitage et al., (2020). In this contribution, we propose that these inconsistencies are not due to minor technical issues, but instead they represent different interpretations of SDGs. In other words, there is no a single objective 'truth' about which research is relevant for reaching SDGs. Since different stakeholders have contrasting and often conflicting views about the relationships between research and SDGs, the contribution of bibliometrics should be to provide a plural landscape for each stakeholder to explore which areas are related to SDGs according to her own views (Rafols and Stirling, 2020). We describe here the beta-version of an interactive platform that allows evaluators and stakeholders to explore in a global map of science their own interpretations of the relationships between publications and SDGs – i.e. to trace the direction of transformative change that projects and organisations are pursuing.

Recent efforts for mapping research to SDGs

Following policy demands, there is currently a profusion of initiatives aiming at mapping publications to SDGs. Yet mapping publications to the SDGs is controversial. While some consensus can be reached regarding the delineation of a traditional scientific fields, fields defined by policy or societal issues such as environmental research are ambiguous.

The approaches developed by Bergen University (Armitage et al., 2020), Elsevier, the Aurora Network, SIRIS Academic or the STRINGS project are based on searching for strings of keywords, in particular keywords found in the UN SDGs targets or other relevant policy documents. The hypothesis is that publications or projects containing these keywords are those best aligned with the UN SDG discourse.

An alternative approach being developed at NESTA and Dimensions uses policy documents and keywords to train machine learning algorithms in order to identify articles related to the SDGs instead of creating a list of keywords to search the articles. The alleged advantage of this algorithm is that machine learning is assumed to be more accurate than search strings. The downside of this approach is that is it a black box regarding the preferences (or biases) of the machine learning algorithms – and this is serious handicap for transparency.

In terms of consistency across approaches, an article recently published by a team at Bergen University sounded the alarm by showing that slightly different methods may produce extremely different results (Armitage et al., 2020). When comparing the papers related to SDGs retrieved with their own analysis with those by Elsevier, they found that there is astonishingly little. The Bergen team concluded that 'currently available SDG rankings and tools should be used with caution at their current stage of development.'

Conceptual framework: a multiplicity of possible mappings of SDGs

Yet from a conceptual vantage point, perhaps we should not be surprised that different methods yield so different results. The SDGs refer to policy goals about sustainability in multiple dimensions – ending poverty, improving health, achieving gender equality, preserving the natural environment, etcetera. Science and innovation studies have shown that the contributions of research to societies are often unexpected and highly dependent on the local social contexts in which knowledges are created and used.

Nevertheless, most research is funded according to the expectations of the type of societal benefits that it may generate – and thus one can try to map these expectations or promises according to the language used in projects and articles. Unfortunately, the expected social contributions are often not made explicit in these technical documents because the experts reading them are assumed to know the potential applications.

As a consequence, the process of mapping projects or articles to the SDGs is ineluctably carried out through an interpretative process that 'translates' (or attempts to link) scientific discourse into potential societal outcomes. In other words, the analyst has to make assumptions regarding which terms are uniquely related to SDGs. Of course, such translation is dependent on the analysts' understandings of research and the SDGs. There is consensus on some of these understandings. For example, most analysts would agree that research on malaria is important for achieving global health. However, other translations are highly contested: should nuclear energy research be seen as a contribution to clean and affordable energy? Should all educational research be counted as contribution to the SDG on 'quality education'?

Furthermore, in a number of SDGs such as zero hunger (SDG 2) or reduced inequalities (SDG 10), there are stark disagreements on what the benefits of potential contributions: some stakeholders believe that GM crops (or organic farming will help) while others believe that it will make the situation worse. Moreover, there is relatively little research explicitly mentioning issues such as gender or inequality in comparison to research whose innovation outcomes may affect these issues.

In summary, there is lack of consensus and many ambiguities on how publications relate to SDGs, and in these cases, the mappings will depend on the particular interpretation of the SDGs adopted in the methods for searching publications.

Given these ambiguities, we have developed an interactive mapping tool that aims to help stakeholders pick and choose which research lines they consider relevant in their context for each SDG. The map shows publication clusters of potentially relevant publication clusters for each SDGs with some interaction for users to understand the research contents of each cluster. This approach is briefly introduced in the following sections.

Data and methods

We developed a search string extracting terms from policy documents explicitly mentioning SDGs. These search-strings were applied to retrieve publications (articles and reviews) for the period 2015-2019 from the CWTS in-house version of Web of Science (WoS) after an iterative process of refinement to avoid false negatives. This process was informed by comparisons with searches carried out by other initiatives, in particular SIRIS and Bergen. Details of this retrieval methodology are presented in a different article.

On the other hand, we rely on an article-level classification based on direct-citation clustering of about 4,000 categories. These clusters are positioned in a science map based on relative citations across clusters according to a VOSviewer layout. This information is imported on a Tableau visualisation interface. The Tableau interface shows the clusters retrieved for each SDG with information on the cluster and the publications related to SDGs in each cluster, as detailed below.

Results: a visualisation interface to explore plural mappings of SDGs

In this proceeding we introduce the beta-version of a visualisation interface aimed at facilitating the exploration of publication clusters related to SDG. The interface allows to choose the relevant SDG (top right). Then the user can set the thresholds for considering if a cluster is related to this particular SDG: the minimum number of publications retrieved by the search string of this SDG (seed publications), and the minimum share of seeds in a cluster.

The clusters with figures above these thresholds map are displayed in a map according to their position in the global map of science. The contents of specific clusters can be explored by placing the pointer of the mouse over the cluster of interest. Then you see the 5 most relevant labels (where the labels are terms with high frequency and high cluster specificity) and the 5 most frequent journals. By clicking on the node or by clicking on the corresponding row in the list of 'Selected communities', the right column 'Community Pubs' allows to click into specific publications, which are linked via DOI to website of the publication. In this way, it is possible to read titles and abstracts and better understand the content of clusters.

The map illustrates the many different types of research trajectories that may be related to sustainable energy, from higher education (top left), to smart grid management (top right) to thin solid films for photovoltaics made out of copper indium gallium selenide solar cells (In Ga, bottom right), to diesel engines (centre-right) and alternative fuels in aviation (centre). This large variety of trajectories shows that research can contribute to sustainable energy in very different (sometimes conflicting) innovation pathways.

However, stakeholders in specific contexts may think that some research trajectories are not as relevant for them as other trajectories. For example, developing countries might object to considering that cancer research as a priority for SDGs, given the relative under-investment in infectious or cardiovascular diseases – the latter issues having a much higher burden for them. Therefore, the proposal of an interactive map is aimed at facilitating that different stakeholders pick and choose those research trajectories that they consider really relevant for SDGs. Instead of just having one single delineation of each SDG, the use of the map by stakeholders makes it possible to have a plural and conditional mapping (Rafols and Stirling, 2020).

The interactive visualisation interface of the STRINGS project is available here: https://public.tableau.com/profile/ed.noyons#!/vizhome/UKStringsSDGtocommunities/Dashboard1

We can thus think of research over a given SDG in terms of a variable portfolio of research options as shown by clusters, with different stakeholders having different perspectives, values and needs regarding the balance between options, and the options that should be prioritized (Ciarli and Rafols, 2019). A given SDG will not be achieved by having more research on this SDG – but by having a balance of research options that is conducive to achieving the SDGs. In contrast, we believe that having only rankings of universities according to their SDG is not a meaningful source of information for policy decisions.

Conclusion

In summary, given the variety of understandings regarding the relationship between research and SDGs, we propose that analysts should not assume that there is one single, preferred or consensus way of mapping research to SDGs. Such assumption is likely to reproduce hegemonic perspectives on SDGs – often given by rich countries at influential institutional actors. Instead, we propose a mapping tool which suggests publication clusters potentially related to a given SDG, thus allowing plural interpretations (Rafols and Stirling, 2020).

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Keywords: SDGs, evaluation, foresight

[61] Alfredo Yegros (CWTS), Tim Willemse (CWTS), Wouter van de Klippe (CWTS) and Ismael Rafols (CWTS, Leiden University). *An investigation of the landscape of mental health research.*

Abstract. Motivation

This paper describes a study that aims to produce a comprehensive and inclusive mapping of Mental Health (MH) research for informing strategic planning by public funding agencies. In short, it aims to map and provide information on current research in mental health to inform and help funding agencies reflect on their research and innovation priorities, in particular in Sweden. The emphasis lies in spotting misalignments and gaps of current research efforts against perceived societal needs and demands in light of shifting mental health needs

A primary motivation for developing a more comprehensive mapping is the observation that current health research and innovation is framed in primarily biomedical or clinical terms. Given the context of the global COVID-19 pandemic occurring in the backdrop of this study, it has become apparent that disease is not merely a medical phenomenon; it is interwoven with social, political, economic, among other factors. Despite this, the dominance of a medical framing persists, even within MH research. Consequently, there is a tendency to prioritize research that is either fundamental or aimed at therapeutic approaches to address acute health crises.

Given ongoing debates towards more systemic understandings of health, it is necessary to shift toward a mapping of health that takes into account a broader view and includes a more diverse set of research topics and innovation actors. This requires considering prevention, rehabilitation, healthcare services, and socioeconomic determinants of health as central in the future of mental health research.

The project has three objectives: to produce and characterize a broad map of mental health research, to describe research activities across countries and organisations in particular subfields, to portray the views of stakeholders on research priorities. This includes their views on the balance between research areas, and how and why future investments should depart from current activities.

In summary, the overall motivation of the project is to produce and test a methodology that combines analytical tools with expert consultation methods in order to inform and help funding agencies reflect on research and innovation priorities, with an emphasis in spotting gaps and misalignments with perceived societal needs and demands.

Approach to mapping mental health research

Mapping publications related to MH is challenging. First, because the definitions of MH and well-being are contested. Second, because it is an issue that spans disparate disciplines, each of them with different understandings of mental health. And third, because mental disorders can be the second or third topic in a project, given that it is constitutive with many other health and wellbeing concerns or biological processes: for example, social identity among ethnic minorities is related to psychological stress (cluster 1536); protein folding to Alzheimer (c795); sexual orientation to social stigma and depression (c859) and the financial crisis to suicide (c2624). Given these challenges, we developed the bibliometric mapping in parallel to qualitative interviews and focus groups that were used to contextualise and triangulate insights.

Given the diversity of understandings, we report the views of stakeholders, both in academia and practice, on what MH research is or should be. Building on two focus groups and several interviews, we later present insights on what stakeholders perceive to be the current research foci, and what they believe are actual research priorities against what they see as most needed research directions, which tend to point to areas beyond the traditional areas of psychiatry, clinical psychology and clinical neurology.

Second, we present a high-level statistical analysis based on conventional medical terms and disciplinary categories on the distribution of publications across disorders, countries, organisations and funders. However, given the contested boundaries of MH and the goal to capture research topics outside mainstream (bio)medical disciplines, we complement the conventional statistical approach with an exploratory mapping.

Third, we introduce an inclusive research landscape with the aim of providing the readers comprehensive information on publication clusters related to MH and well-being, although some of the topics may be seen as remote to MH. We start this map with the publications tagged by Medical Subject Headings (MeSH) related to MH by the US National Library of Medicine. These publications are located in clusters of related publications within a cognitive map, i.e., a map where proximity indicates some similarity in contents. The purpose of the research landscape is to facilitate the exploration by stakeholders of research topics beyond our initial core. For each cluster, detailed information on the contents and the main countries and organisations is provided.

Next, we show how the research landscape allows for the exploration of the ‘portfolio’, i.e., the distribution of publications over the clusters of specific countries, selected organisations, and funders. With these portfolios we can compare the issues that are being most supported by institutional research against the stated policy priorities or perceived needs of stakeholders and users. A dedicated website provides interactive access to the research landscape of mental health and the portfolios.

Two methodological choices need to be taken into account when reading this study. First, following conventional classifications (WHO's and PubMed's), we have not explicitly included neurological disorders, except for dementia. Second, publication clusters are based on citation flows, and thus reflect a particular view of research dynamics. Publications can be grouped in many other meaningful ways providing contrasting views of the same data. Against our initial hopes, this citation perspective has not proved very useful to make clear distinctions between different goals of research in terms of treatment, prevention, rehabilitation, etcetera. Instead, our clusters reflect research topics.

Interactive visualisation of results

The presentation is complemented by three interactive visualisations integrated in a website that are aimed at facilitating the exploration and benchmarking of MH research according to users' interests.

https://public.tableau.com/app/profile/tim5920/viz/MentalHealthtool/MHtool

1) The Disciplinary profiles visualisation aims to provide a first perspective of the distribution across disciplines of disorders, countries, organisations, and funders.

2) The Research landscape visualisation shows the science map of the 280 publication clusters that are most related to MH. This map is aimed at supporting the exploration of the epistemic space of mental health. Thus, three interactive tabs show the distribution over the clusters of disciplines of disorders and the cluster characteristics, such as growth, publications authored by companies or hospitals, and mentions in patents, news, or policy documents.

3) The Portfolios visualisation describes the distribution of publications by countries, organisations, and funders over the 280 clusters of the research landscape, as well as their relative specialisation (i.e., whether they publish more than expected) in the cluster.

Summary of main findings

On the basis of a bibliometric study, interviews and focus groups, desk research, we have found that:

*) Policy reports and existing research indicate that there is a need for more systemic research, including social and environmental factors, to improve mental health. Experts and stakeholders also express a need for more broad-ranging mental health research, in contrast to the dominant model of highly medicalized research. They suggest that research should support:

a) Improvement of mental health services systems;

b) Increased prioritization of psychosocial interventions, with more attention placed in early stage (subclinical) mental health disorders.

c) Adoption of a model of mental health that takes into account factors that influence mental health at all stages of life, especially youth and adolescence.

d) Less prominence to research on drugs and new diagnostic tools within research.

*) There is a gap between research and practice. Experts express a need for research focused on implementing and evaluating practical interventions and for researchers to be supported to develop alternative forms of engagement, such as practitioners' inclusion in the research process, to fulfil this need.

*) The mapping of mental health is ambiguous given the multiple interpretations of mental health. To accommodate this plurality, we have developed an inclusive research landscape of mental health, presented within an interactive visualisation interface for users to explore potentially relevant topics.

*) Statistical analyses of disciplinary profiles and the portfolios of publications and funding over the research landscape allow us to identify topic specialisation of countries, organisations and funders.

*) Research topics related to therapeutics or diagnostics are more associated with specific mental disorders and are more easily identifiable when trying to set research priorities according to conventional classification methods. Research topics related to healthcare systems and the social determinants of mental health concern more general mental health benefits. The policy implication is that the framing of research funding is likely to favour research on different types of mental health interventions.

*) Statistical analyses confirm that mental health research currently focuses on psychiatry, medical and biomedical research, and neurosciences (broadly estimated to be 60%-75% of mental health publications), with less focus on social science, public health and healthcare services related research (estimated at 10-20%). Funding data suggest an even higher concentration of resources.

*) In this context, Sweden and Norway stand out for their larger focus on public health and healthcare research, and social sciences (28% and 24% of mental health publications, respectively). Finland follows with 22% (with a focus on public health) together with Australia (with a focus on healthcare).

*) Sweden is specialised in several topics related to prevention and healthcare research such as suicide, community treatment, and various social determinants of mental health, including inequalities, job satisfaction or insecurity, and immigration. Within the identified cluster of research on community treatment, a detailed case study revealed that research from diverse disciplinary departments, such as one working on social work, are central to this research.

Keywords: Mental Health, Priority Setting, Mapping

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Emerging Medical Diagnostics Innovation System Development in India: Challenges to Deal the Context-Specific Needs.

Abstract. Background/Context

Presently, the emerging medical diagnostic innovation system in India is 70-80 percent import-dependent (Jarosławski & Saberwal, 2013) which is characterized by the two major context-specific issues i) Unaffordability, as imported technologies are highly-priced, ii) inaccessibility due to unsuitability of imported technologies for resource-poor healthcare settings. Concerning these context-specific issues and a present episode of the covid-19 pandemic, the expectations with emerging technologies are enormous, i.e., on the one hand, it has to deal with the detection challenges associated with the increasing incidence of coronavirus itself and already existing highly burdened infectious and lifestyle diseases like TB, Malaria, cancer, diabetes, etc. On the other hand, technology has to deal with the issues of availability, affordability, and accessibility. In such a scenario, the argument of the present study drives towards the development of a need-based technological innovation system for emerging medical diagnostics.

At the core, the proposed study aims to investigate the problem of what all needs to be done to promote the integration of non-market calculations based on social criteria into market-based calculations and to address the challenges of getting the industry, research institutes, academia, and healthcare organizations to sustain their investment in the system-building activities for the development and diffusion of emerging medical technologies in India. India is still a catching-up country regarding the introduction of new technologies into the sector of medical diagnostics. Catching-up requires the medical diagnostics sector to catch up in creating knowledge for the development of innovations (Jiasu Lei, Bao Lin, and Siting Sha, 2016). In the post-Trade Related Intellectual Property Rights (TRIPS) world, the catching-up process needs government policies that can help the country form relationships between industry-research institute-university-hospital and cooperation and strengthen fundamental research in the public sector for the benefit of innovation making at home. Countries need to develop institution-building networks to maintain their learning and competence-building structures. It is necessary to retain the strategic control of domestic structures of knowledge creation for innovation. It can be done by encouraging domestic firms to construct a path wherein selective delinking of the emerging relationships between industry-research institute-university-hospital is assured through the development of R&D and innovation for the local priorities and challenges the catching-up country.

Research Questions

The study focuses on the conduct and performance of system-building activities of the innovation actors involved in developing the Medical Diagnostics innovation system. The study focuses on issues and challenges coming underway in the performances of innovation actors to build a socially responsible innovation system to deal with context-specific diagnostics issues. Considering this, the study undertakes the following research questions:

1. What are the uncertainties regarding emerging needs and gaps regarding the development and diffusion of emerging medical diagnostics innovations?

2. What is the status of developing innovative capabilities and innovation strategies of innovation actors in India?

3. What challenges are faced by innovation actors in the performance of innovation activities?

4. What is the Status and Assessment of government policies that support the performances of innovation activities?

Theoretical Framework

Since the development and diffusion of medical innovation systems have to deal with context-specific challenges, the study uses the Socially Responsible Innovation System Approach (SRISA) framework. The SRISA framework would be driven by combining the two frameworks in innovation studies:

First, the Technological Innovation System (TIS) Framework (Carlsson and Stankiewicz,1991; Bergek et al., 2008) would identify the innovation actors and institutions and their functions in the development of Medical Diagnostics innovation system. The primary use of the TIS perspective is that, on the one hand, it helps in examining the structural component and characteristics of the innovation system. On the other hand, it helps focus on the dynamics of innovation actors' critical processes or functions (Edquist,2005) that directly influence the development, diffusion, and use of new and emerging technology.

Second, the System Failure Framework (SFF) (Klein-Woolthuis et al.,2005; Van Mierlo et al., 2010) identifies the constraints and challenges faced by the innovation actors and institutions in building to develop emerging medical diagnostics innovation systems. The primary motive of combining these two frameworks of innovation system perspective is to study the context-specific steps undertaken in the influence of prevailing economic policies to tackle the identified challenges that are needed at the level of policymaking, institution building & system development for transformative changes.

Data & Methodological Approach

The study measures the “system building” (Musiolik et al., 2012) activities of all the relevant actors active in molecular diagnostic innovations to seek an understanding of the failures underway vis-a-vis the building of structures and functions of the national innovation system. The conduct and performance of system building activities of science base actors are measured and analyzed using a mixed-method approach. Bibliometrics and Scientometrics methods have been used to analyze location, size, volume, and type of scientific knowledge produced through research publications, extramural research projects, funding patterns for research, research collaborations, contributions of different scientific institutions, etc. Publications in IVD are mapped using an indexed database Web of Science, a collection of online journals and academic citations provided by Thomson Reuters. The data was downloaded for the period 2000 to 2020. Information on extramural research projects (EMR) has been collected from the database of the Department of National Science and Technology Management Information System (NSTMIS) for the period 2000 to 2020 available at the Department of Science and Technology (DST) website. The datasets on patents in the IVD were obtained using the search engine http://www.ipindia.nic.in/, supported by the Department of Industrial Policy and Promotion, Ministry of Commerce and Industry, Government of India for the period from 2000 to 2020. Further, the website’s search and study of annual reports of Industries, research institutes, universities, and government departments have been done.

Results & Conclusions

This study, through preliminary analysis, finds that India is lacking behind in the area of molecular diagnostics development; analysis of publication activities has shown that publication in molecular diagnostic research accounts for only 4%, which is significantly less as compared to drugs which account for 66%. Worldwide analysis of publication activates on molecular diagnostics indicates that India has not been able to keep up with the worldwide pace for developing medical diagnostics innovation systems. This made India dependent on imports, and lack of competition from domestic players to foreign firms in the supply of molecular diagnostics has raised diagnostics prices due to which these tests are unaffordable. Analysis of patenting activities in molecular diagnostics shows that very few patents are granted, and foreign companies own most patents. This confirms that Indian domestic research institutions and firms lack in-house technological capabilities for product development. The number of patents granted to Indian institutions and firms is insignificant compared to foreign firms. The study also reveals that the government has shown interest in promoting this sector through various promotional schemes in the last few years. Still, more promotions are required in diagnostic research (as it accounts for only 24%) to meet the country's demand. Analysis has shown that the practice and new policy regime adversely affect the evolution of socially responsible innovation systems for medical diagnostics. Overall, the system analysis reveals that the at present innovation system functions are underperforming because of the absence of a well-defined funding mechanism and goal-oriented targeted policy regime of the government. Since emerging medical diagnostics have a transformative effect on the present healthcare diagnostic system, the government has to address the system-based challenges and issues for developing a need-based technological innovation system for medical diagnostics.

Policy Implications

The recent pandemic of COVID-19 has alarmed the Government, scientific community, and policymakers to develop the technological capabilities to attain the stage of self-reliance to deal with the severe consequences of the disease. The accuracy of the treatment depends on the diagnosis of the disease. The availability of diagnostic tests is the primary concern for the countries to identify the infected population and start the treatment. In such a scenario, the study would significantly contribute to creating a knowledge base in the development of emerging medical innovation systems. The study will help identify both strengths and weaknesses in the existing innovation system for medical diagnostics innovation system and will help in a recommendation for the development of policy in building a context-specific National Innovation System for medical diagnostics in India.

Relevance

To the best of my knowledge, there is no study addressing the issues and challenges for emerging medical diagnostics innovation system development in India. The study analyzes the performance of System Building activities of innovation actors to develop medical diagnostics innovation systems in India using innovation system function and innovation system failure approach.

Keywords: Emerging Medical Diagnostics, Innovation Actors Actors, System building activities, Innovation system functions, Innovation system failures

[64] Sarah Seus (Fraunhofer Institute for System and Innovation Research ISI) and Elisa Wallwaey (Fraunhofer Institute for System and Innovation Research ISI). *SIPER: the Science and Innovation Policy Evaluations Repository: what is it and what can be done with it?*

Abstract. Abstract for a POSTER

Across the world, there are numerous instruments to promote research and innovation. These policy interventions are funded and implemented by governments, ministries, agencies and international or supranational organisations. And all these actors are interested in determining the effects of their policy interventions. Evaluations help to provide answers to questions of efficiency, effectiveness and impacts of policy interventions as well as their relevance and coherence or added value. Evaluation has a long tradition in the STI-community and evaluation standards have been established (e.g. evaluation standards of national evaluation societies, the EC Better Regulation Guidelines (European Commission 2021) or the STI specific evaluation standards of the ftval-Plattform (Kohlweg 2019)). Even with those agreed standards, evaluation studies remain very divers in their content and reporting structure. And they are published in a variety of locations (e.g. websites of research funding organisations or organisations performing the evaluations) and hence are not easily readily traceable.

The Science and Innovation Policy Evaluations Repository (SIPER) aims at providing a comprehensive repository of evaluation reports easily accessible via the si-per.eu website. The SIPER database includes approx. 1000 evaluation studies from EU and OECD member states from 2000 until today. SIPER provides two types of data:

a) a repository of evaluation reports that can be downloaded. They can be accessed and searched via the si-per.eu website (free text search or searches based on pre-defined categories, e.g. country, year, evaluation characteristics)

b) A database of codings. The evaluations in SIPER are coded according to predefined evaluation characteristics including the purpose and the timing of the evaluation; the evaluation dimensions covered; the chosen evaluation data collection and data analysis methods. Also, the “quality of the evaluation” is assessed and coded. A short classification of the evaluated policy measure (objectives of the interventions; funding and implementation modality, target group(s) and geographical area) is also provided.

The SIPER repository is freely accessible via the website www.si-per.eu (data related to the codings are available only on requests).

So far, data provided by the SIPER repository have already been used as data source for research on the STI system or for meta-analysis of evaluation studies (Boras & Laatsit (2019); Kubera (2017) Bührer et al (2021).

The main audience are policy makers, evaluation practitioners, and those engaged in research into science and innovation policy (evaluation). Recently, the SIPER team has discussed possibilities of connection to other databases of policy measures, especially the OECD-STIP compass and the EFIL-database.

SIPER is part of the Research Infrastructure for Science and Innovation Policy Studies (RISIS) funded by the European Union's Horizon 2020 Research and Innovation Programme (grant agreement No. 824091). Since 2018, the Fraunhofer Institute for Systems and Innovation Research ISI is in charge of the maintenance of the database, the website and its further development.

The aim of this poster is to make SIPER known to the STI-community and show the features and possibilities of this repository.

Borrás, S. & Laatsit, M. (2019): Towards Systems Oriented Policy Evaluation? Evidence from EU 28 Member States, Research Policy 48, pp. 312-321.

Bührer, S.; Wallwaey, E.; Seus, S. & Edler, J. (2021): SIPER Database: The Increasing Role of Studies on Social and Environmental Impacts, RISIS Policy Brief # 8 (Version 1), https://doi.org/10.5281/zenodo.5205596 [

Commission Staff Working Document SWD (2021) 305 final. Better Regulation Guidelines. European Commission.

Kohlweg, K. (2019) Evaluation Standards for Research, Technology and Innovation Policy. Technical Report. fteval - Österreichische Plattform für Forschungs- und Technologiepolitikevaluierung. Wien.

Kubera, P. (2017): Conceptual Framwork for the Evaluation of Economic Impacts of RDI Instruments - Research Paper, Journal Association 1901 SEPIKE, pp.90-96.

Keywords: policy evaluation, repository of evaluation studies, meta-evaluation

[65] Susana Borrás (Copenhagen Business School CBS), Francesco Gerli (Copenaghen Business School) and Susanna Kugelberg (Copenhagen Business School). *Public Organizations' Anticipatory Capacity in the Governance of Transformative Innovation for Sustainable Transitions.*

Abstract. The development and deployment of new solutions to mitigate climate change requires careful considerations about the future. The early phases of defining possible transformative innovations for sustainability almost invariably involve shaping and defining ex-ante visions about the future; for example, about what is desirable and feasible, what might be the costs and the benefits, or what are the risks and liabilities (the 'knowns' and 'unknowns'). These visions about the future might have fundamental effects on how the specific solutions and the socio-technical systems are transformed.

Imagining and pondering about the future is crucial in governance processes towards bringing concrete solutions to mitigate climate change. This is not only about the deployment, diffusion or adoption of a specific new and emerging technology per se. It is about collectively imagining, envisioning and strategizing the transformation of the whole socio-technical systems' context in which that technology is to operate, bringing an encompassing transition towards sustainability. This holistic approach in future-oriented considerations is crucial for agents of change in order to be able to shape their actions, planning and moving ahead in an integral and systemic manner. Hence, the capacity of those agents of change in terms of future-oriented assessment and visioning, invariably shapes the specific solutions and strategy for transforming socio-technical systems.

The literature on sustainability transitions is paying increasing attention to the future-oriented nature of addressing climate change (Vervoort and Gupta 2018). In this context, the notion of 'anticipatory governance' is gaining wide currency in different fields of study (like STS, sustainability studies, innovation studies, etc.). It broadly means "governing in the present to adapt to or shape uncertain futures" (Muiderman et al. 2020) p.1. In their extensive literature review these authors distinguish at least four approaches to anticipatory climate governance in terms of the tools and methods used, and how they are actually used.

A topic that remains underexplored, and that deserves more attention, is the anticipatory capacity of public organizations in these governance processes. Public organizations are particularly relevant actors in anticipatory governance as their ultimate organizational obligation is to manage and implement collective political decisions and bring concrete climate solutions to work. The incipient literature about capacity in this context has focused mainly in processes of capacity-building as the outcome of a relational process exercised through global networks promoting climate adaptation solutions (Croxatto et al. 2020). The global networks' efforts to build anticipatory capacity at local level is relevant to this research area of interest. However, the actual anticipatory capacity of individual public organization is a topic that has not received sufficient scholarly attention.

We follow the general understanding in the policy studies literature that defines capacities as "the set of skills and resources necessary to perform policy functions". (Wu et al. 2018) p. 3. Hence, capacity can be understood as the specific combination of resources (as knowledge, budget, legitimacy, etc.) and of skills (as the abilities or competences to make use in specific ways of those resources). According to Wu et al, there are three levels of capacities: the individual, the organizational, and the systemic level. In this paper we are interested in the organizational level, while acknowledging that it is interrelated with the individual and systemic levels of capacities.

Generally, the focus on capacities at the organizational level relates to the literature on public administration and governance, which has been broadly interested in the 'administrative capacities' or 'institutional capacities' of public organizations in relation to policy instruments and governance innovations (Lodge and Wegrich 2014). More concretely, this literature studies these capacities at organizational level as preconditions for governmental and governance action towards sustainability. Recent studies are for example looking into the municipalities' capacities for sustainable and climate policies in cities (Bettini et al. 2015)(Salvador and Sancho 2021); looking into social entrepreneurship as mode of building institutional capacities in organizations (George and Reed 2016), or exploring what general capacities are needed for accelerating sustainability transitions in specific intervention points (Rogge and Song 2021).

However, this literature has so far not considered specifically the anticipatory capacity of public organizations as an area of interest. Digging deeper into the anticipatory capacity of public organizations is necessary for understanding how public organizations engage in anticipation, and more concretely, for understanding to what extent - and if so - with what resources and skills do public organizations undertake a holistic and system-oriented future visioning in the governance processes towards sustainability.

From an organizational perspective Flyverbom and Garsten define anticipation as the organizations' "attempts to manage their future affairs and shape their surroundings" p.1 (Flyverbom and Garsten 2021). They conceptualize anticipation as a form of knowledge production that has organizing effects (both effects inside the organization and in the external context). They suggest that organizations engage in anticipation in various ways according to the types of tools they use, the temporal orientation of the anticipation, and the forms they engage these tools. We bring Flyverbom and Garsten's insights about anticipation into the field of transformative innovation for sustainability transitions, focusing on the capacity of public actors.

We are particularly interested in understanding how organizations combine and apply various future-oriented resources (the nature of those tools and their temporal dimensions, as well as other knowledge-related resources) into specific insights and courses for transformative action in governance processes. We argue that the combination and use of these resources can be seen as a translation process that is activated by the organizational skills (the abilities) of that organization. In other words, anticipatory capacity is not only about the resources' available (the specific tools for anticipatory knowledge production, like technological foresight, simulation modelling, scenario-building, etc. their data sources and their different temporal dimensions); it is also about the ability of the organization to make sense of them: how far and how it actually 'translates' and 'uses' those knowledge outputs in an anticipatory governance with a holistic and systemic-approach (Borrás and Edquist 2019).

Empirically, we study four cases of very large project for climate mitigation involving new technologies, namely, the Power-2-X project in Copenhagen, the Energy Island North-Sea project involving Power-2-X technology as well; the C4 project on Carbon Capture Cluster Copenhagen; and the BECCS (Bio-energy carbon capture and storage) project initiated by EnergiX Stockholm. The projects are relevant and comparable cases because they all aim at developing and deploying emerging new technologies (carbon capture and storage, and Power-2-X), which only recently are moving beyond the demonstration stages. They all are very ambitious in terms of their sheer size of the infrastructure they are going to build and their expected climate impact. In addition, they are all in the same initial phase, a phase when the anticipatory capacity of the public organizations leading those projects is crucial for the subsequent governance process.

The paper will develop a specific analytical framework about anticipatory capacities at organizational level developed in continuation of the discussions and literature review above. The data will be based in around 40-48 interviews (10-12 interviews per case) as well as a widespread collection of relevant written documents, which will be analyzed according to the framework. The findings will serve to advance not only our empirical knowledge about the four cases, but more importantly, they will serve to develop specific theoretical advancements about the links between resources and skills for a holistic and systemic approach in the anticipatory capacity of public organizations, as well as practical hints about what specific items are needed in public organizations in order to build an anticipatory capacity with a holistic approach.

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Keywords: climate change mitigation, anticipatory governance, future, green technology

[66] Robert Braun (Institute for Advanced Studies), Barbara Laa (Technical University Vienna) and Lukas Rohatsch (UAS Technikum Wien). *Governance challenges of urban dataspace – transdisciplinary perspectives.*

Abstract. Background: The European Sustainable and Smart Mobility Strategy sets out the vision for EU transport policy in the coming decades. Digitalization and enhanced use of data in all modes of transport is assumed to be essential enablers for a mobility transformation. The establishment of EU-wide common, interoperable mobility data space – local and regional urban data spaces (UDS) – to facilitate access, pooling and sharing of data from existing and future transport and mobility databases, is forwarded as key to fully secure the benefits of data for the sector and for society at large. Sharing mobility data is suggested to offer numerous benefits for the society and economy (sustainability, safety, effectiveness of operations, smart technologies and new innovations and business opportunities). Beyond dealing with data protection, liability issues or intellectual property rights, from a technical perspective, interoperability is addressed as current key challenge for a mobility data space to ensure data sovereignty and trustworthiness.

Critical data perspective: The European Commission supports the development of common principles and tools to support the convergence of governance and infrastructure (EC 2020b, a). However, data, data-ecosystems and dataspaces are socio-political (Dalton et al. 2020): they involve a number of social, political and ethical assumptions, tacit or open social trajectories, lock-ins. Data is never raw; interoperability is not neutral; and dataspace is not an empty container of data flows, but politicized spaces of relations (Dalton, Taylor, and Thatcher 2016). Data doubles are not twins of non-datafied entities, but new ontic entities (Heidegger 1962) with their own powers, movements, and biases. Data-ecosystems or datapsaces create a new relational space, with their alternative materialities, entities and their relations creating and population that space. Data doubles are dividuals (Deleuze 1992), parallel and inscrutable assemblages of big data (Deleuze and Guattari 1987); the space of data increases inscrutability and creates new ethical and trust problems (Stilgoe 2018). Assumed benefits in urban environments are coupled with multifold social, political, epistemic and ontological risks (Kitchin, Lauriault, and McArdle 2018).

Our project: Urban Data Space (U/DS) is imagined to be an innovative form of data sharing at scale to enable new services and products that require interoperability, standardization and seamless flow of data. Especially in the field of urban mobility, digitalization and the use of “Big Data” promise to advance sustainability transformation. U/DS is supposed to facilitate the access, pooling and sharing of mobility data. The technology is still in an early phase of development and until now, research of it has focused on technical aspects of its implementation and not considered possible impacts in a social context. We are interested in the risks and opportunities that U/DS may pose to human values, cities, their inhabitants and mobility. In an exploratory research project, we have carried out a series of three workshops engaging stakeholders from research, policy, civil society and industry in order to find a shared understanding of what U/DS is and what the guideline principles of its governance should be.

Method: Through a series of workshops participants created a shared interdisciplinary language including a common definition of the research object [‘Data Space’] and specific principles of assessing the technology; have found a shared problem definition, as well as a shared understanding of the challenges, obstacles and barriers; and developed guideline principles and feedback loops for UDS/Open science development by including societal impacts in the development and prototyping process. The project addressed problems stemming from problematizing data, datafication, platforming from critical data studies perspectives, while bringing policy concerns, technology and innovation visions as well as ethical and responsibility aspects to the fore in a shared (online) space. Stakeholders worked collaboratively to develop the principles for assessing UDS technology (focusing on aspects of governance) as well as issues of trust(worthiness) between citizens and the technology.

Findings and discussion: The various perspectives brought together created a shared understanding, common vision as well as transformational knowledge base for UDS technology, tackling both the technological and the social questions, for the next 5-10 years. The paper reports on both the process and the outcomes of the project that aimed to lay the groundwork for addressing the complexities of urban mobility dataspace from a governance perspective. We present the main discussion points and the derived principles that were co-developed in the workshop. These “DARE” principles (Decision-making over access/use, Authority over public good, Redistribution of value, Engagement of stakeholders) are inspired by and seen as supplementary to the existing principles for open science and indigenous data governance (FAIR/CARE principles). Our results provide an exploratory assessment of U/DS and its governance to guide future research, inform policy and further discussion on the subject.

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Keywords: data space, urban mobility, European Commission, governance, critical data studies

[67] Elisabeth Eberling (Fraunhofer ISI). *Assessing the sustainability of a digital eco-innovation.*

Abstract. "ICT can enable a 20% reduction of global CO_2e emissions by 2030, holding emissions at 2015 levels.", according to GeSI (2015). Simultaneously Gary Dickerson, CEO of Applied Materials, warned that processes of artificial intelligence (AI) could use ten percent of the global energy consumption in 2025 (Daum 2020). Those two statements reflect, that the impact of digitalisation on sustainable development - whether it is mere a blessing or a curse - is widely under discussion and needs to be investigated. Discussed opportunities of digitalisation are, among others, advances in resource and energy efficiency, dematerialisation, knowledge generation through combining data or new forms of political participation. Special attention grows concerning digital eco-innovations, i.e. digital innovations which aim at unfolding a positive environmental impact or result (unintendedly) in a positive environmental impact. However, it needs to be assessed if and under which conditions the associated environmental benefit of a digital eco-innovation holds. Such an assessment always requires a use case scenario, as environmental and economic benefits are co-produced by the behaviour of all actors in an economy and boundary conditions (Kemp et al. 2019). In addition, it is very important to identify and assess further impacts and arising trade-offs. Finally, it is possible to decide if and under which conditions the use of a specific digital eco-innovation is (overall) sustainable.

It is planned to assess one specific digital eco-innovation as a case study in the area of Industry 4.0, in order to investigate promises of more sustainable and circular manufacturing due to Industry 4.0 applications. At least two application scenarios (use of the digital eco-innovation vs. business-as-usual scenario) will be developed and extended by framework scenarios based on the Shared Socioeconomic Pathways (SSPs) (Riahi et al. 2017) for the year 2030. It is planned to investigate the whole life-cycle of the digital eco-innovation with a focus on the use phase. The system boundaries of the scenarios must be defined as well as a profound procedure for identifying the considered impacts of the digital eco-innovation. To gain information on the environmental benefit of the digital eco-innovation, interviews will be conducted with producers and users. Thereby it is possible to estimate the impact of one digital eco-innovation. Furthermore, with information on potential market shares etc. it is possible to derive the potential impact for a whole region and a specific sector, in this case the producing industry in Germany. In addition to the insights of the interviews, information concerning the environmental affinity of firms, e.g. the use of resource efficiency technologies, can be derived from the German manufacturing survey, which is part of the European Manufacturing Survey. Based on this information, on the framework scenarios of Riahi et al. and the application scenarios, assumptions on potential application rates, etc. can be made. In order to examine the sustainability of the digital eco-innovation, the developed scenarios will be assessed using a sustainability assessment framework. This framework operationalizes the seventeen Sustainable Development Goals and digitization-specific indicators for assessing innovations. It is developed based on existing approaches, which integrate the seventeen SDGs into sustainability assessment methodologies. The results of the case study provide information on the conditions under which the use of the investigated digital eco-innovation is sustainable.

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Keywords: digital eco-innovation, sustainable development, sustainability assessment, digitalisation

[68] Charles Edquist (CIRCLE, Lund University) and Mart Laatsit (CIRCLE, Lund University). *Towards a General Theory of Innovation: Do Activities and Functions Reflect what Happens in Innovation Systems?*

Abstract. (An advanced draft of this paper exists and we include the table of content of the whole paper to indicate its state of the art. In this proposal we concentrate on the conclusions in the paper hoping that a discussion on this basis will improve the paper before publication.)

Contents

4. Conclusions

4.1. Detailed summary and conclusions

4.2. General conclusions: towards a general theory of innovation

Appendix: Which activities/functions do the different lists contain?

1. Overview of the issue and research questions

It is sometimes argued that innovation is a too complicated matter to make it possible to talk about causality related to innovation processes. It means that innovation processes cannot be explained and that we must forget the whole issue of causality in innovation research and innovation policy.

However, we argue that we need to know about causal relationships to understand innovation processes, especially why and how the latter emerge. Similarly, it is impossible to design and pursue innovation policies without having an idea about the main causes or determinants of the innovation processes that we want to influence by public policy. The same goes for firm innovation strategies. For example, the selection of policy instruments must be based upon knowledge about which are the factors that influence innovations processes. Without such knowledge it is better to abstain from trying to pursue innovation policies or firm innovation strategies. The above means that we need a theory of innovation, in order to connect the causes and effects.

A formal theory should provide convincing propositions as regards established and stable relations between variables or concepts. It should be specific about the relations between causes and effects. In a theory of innovation, the effects are the innovations as such. The causes are the factors that influence the development and the diffusion of innovations. Conceptual clarity is required for the formulation of theories (about innovations). In the full version of the paper we pay special attention to the definitions of the concepts, and also present a little bit of basic theory of science.

Our point of departure is the systems of innovation approach, developed in the late 1980's. Early on, we judged the status of "system of innovation" in the following way: "The system of innovation approach does not provide convincing propositions as regards established and stable relations between variables. Hence, it does not fulfil the requirements to be labelled a formal theory, and we ourselves have preferred the terms approach and conceptual framework." (Edquist 1997, p 28)

However, perhaps the time has come to try to develop the systems of innovation approach into an innovation theory? The purpose of our paper is to discuss whether this is possible to do and, if so, how it could be done. The central question is: What is needed for a transformation of the systems of innovation approach into a (general) theory of innovation?

In particular, we look at how different authors have identified the 'activities' or 'functions' in innovation systems. This will allow us to determine whether there has been a general consolidation of "systems of innovation" as a developing theory to understand and explain innovation processes. We will argue that we, as an "invisible college" or "collective research community", have already tried to do this, and that we have made progress in this respect by addressing activities and functions in innovation systems. We will try to indicate how this work can continue to develop the systems of innovation "approach" into a "theory".

2. Preliminary conclusions

In this section we present some of the first results of our analysis.

• In theory of science, scientific explanations are basic, and, according to Jon Elster, "all explanation is causal" (Elster 2015, p 1). We stress the importance of making a clear distinction between explanandum and explanans in order to make it possible to causally explain a phenomenon. In the case of developing or constructing a theory of innovation, the explanandum is the innovation output. The explanans are the factors that influences the innovation output. Hence causal explanations are a matter of identifying those factors that influence innovation output.

• Christopher Freeman was first to use the term system of innovation (1987) and the first two books on systems of innovation, edited by Lundvall and Nelson, were published in 1992 and 1993. The development of this approach was a great success and breakthrough. It meant a great leap forward for our understanding of innovation processes and for our ability to pursue innovation policies.

• Both the Lundvall (1992) and the Nelson and Rosenberg (1993) definitions were based on selected determinants of innovation processes. Lundvall selected two determinants (structure of production and set of institutions) and Nelson and Rosenberg selected one (organizations that support R&D). Therefore, this latter definition can be characterized as partial and linear and the Lundvall one as partial.

• The Edquist definition includes all factors (determinants or causes) that influence the development, diffusion of innovations, and can therefore be characterized as holistic. It used a list of 10 activities to operationalize the causal relationship between the determinants (explanans, explanatory factors, causes) and the resulting innovations (explanandum, outcome, phenomenon to be explained, effects).

• The analysis of activities/functions in innovation systems has become one of the central pillars in innovation system studies. In a count in February 2022 the most cited studies on activities/functions were Edquist (2005), Hekkert et al (2007) and Bergek et al (2008) – with respectively 3969, 3006, and 2553 citations on Google Scholar. They are among the 10 most cited papers on the analysis of innovation systems.

• The primary motivation of the authors of the papers on functions/activities was to escape the perception that the system of innovation approach is static, because of its focus on elements in systems of innovation such as actors/organizations and institutions. The authors in this field tried to avoid this by focussing upon activities/functions, i.e., on what is happening in innovation systems. Some of them emphasize the determinants of innovation processes.

• Edquist (2005), Hekkert et al (2007) and Bergek et al (2008) emphasise the need for identifying and understanding the determinants or causes of innovation processes. Studying the activities/functions would constitute an important step towards that goal – and, towards the further development of an innovation theory. Actually, none of the other authors that have developed lists of functions/activities addressed in this paper focus upon functions/activities as causes/determinants of innovation processes.

• Edquist (2005) defines the activities of innovation system as determinants/causes – "activities in SIs are the same as the determinants of the main function" (p. 183). The SI approach itself provides a "holistic and interdisciplinary perspective" (p. 185) on innovation, as it tries to include all its important determinants. Edquist (2005) links the determinants clearly to causality, stating for example that "A satisfactory explanation of innovation processes almost certainly will be multicausal, and therefore should specify the relative importance of various determinants" (p. 191).

• The definitions of activities and functions are surprisingly similar in the writings of different authors. There is a broad agreement that both activities and functions should help us understand the 'factors' (Edquist, 2005) or 'processes' (Bergek et al., 2008; Hekkert et al., 2007) that contribute to the main function (Edquist, 2005), or goal (Johnson, 2001) of an innovation system. This main goal is defined by Johnson (2001) as "to develop, diffuse and utilise innovations" (p. 4). Lundvall and Nelson and Rosenberg respectively did not use the terms "function" and "activity" in specifying system of innovation.

• While Liu and White (2001) and Edquist (2005) use the term 'activities', Hekkert et al (2009) and Bergek et al (2008) refer to essentially the same concept by using the term 'functions'. The terms 'activities' and 'functions' can be treated almost as synonyms.

• Edquist explains his choice of the term "function" primarily through the need to avoid confusion with the 'functionalist' approach in sociology. The 'functionalism' in sociology places an emphasis on the consequences of phenomena, whereas the goal of looking at functions/activities in innovation systems has been to study the determinants/causes of innovation. This is a fundamental reason to use the term "activities" instead of "functions".

• There are substantial similarities between the lists of functions/activities of the different authors. For example, nearly all include provision of knowledge production and its diffusion through network interactions, as well as market formation, developing linkages and networks and fostering entrepreneurial activity. There are also certain differences between the individual lists.

• Compared to other discussions of the lists of functions/activities, the current study takes a step further as we also analyze comparatively how various authors define activities/functions, what is their rationale for studying activities/functions, and whether and how there is a difference between 'activities' and 'functions'.

3. Overall conclusions: towards a general theory of innovation

In the paper we argue that much of the writings on “activities” and “functions” in the literature of innovation systems contributed to the analysis of determinants of innovation as an explanans (explanatory factors, causes) of innovation outcomes. This literature thereby contributed to the development of the state of the art in the direction of a (general) theory of innovation.

What remains to be done is to achieve this to a larger extent and in the long run. This can be done by conceptual clarifications and developments that have been tried in this paper. The functions/activities proposed by different authors should also be further evaluated and compared. Progress in such conceptual work can then be used as a basis for formulating hypotheses to be tested in empirical studies. This is the main mechanism for gradually developing our knowledge about determinants (functions, activities) of the development and diffusion of innovations.

The possible end result of future work would be a general theory of (the determinants of) innovation. It would attempt to identify all important determinants of the development and diffusion of innovations and their relative weight for different classes of innovations. Thereby the instruments of innovation policy would also be identified since they are a subset of the determinants. Although causality is a complex matter in the social sciences, knowledge of causes, determinants and policy instruments is necessary for understanding innovation systems and for being able to pursue effective innovation policies and strategies.

Of course, such an effort would absorb several or many calendar years and perhaps a couple of hundred person-years. Given the enormous significance of innovation as a force of change in our socio-economic, environmental, and political systems, this is highly motivated. Naturally, such a combined theoretical and empirical effort would be gradual and start by identifying the most important and obvious determinants of innovation. As a matter of fact, such a process has already started through the development and consolidation of the systems of innovation approach, through different lists of determinants (activities/functions) that have been developed by different contributors.

Keywords: General theory of innovation, Activities/functions of innovation systems, Beyond innovation systems approach

[69] Markus Grillitsch (CIRCLE, Lund University), Mart Laatsit (CIRCLE, Lund University) and Lea Fünfschilling (CIRCLE, Lund University). *Great expectations: the promises and limits of innovation policy in addressing societal challenges.*

Abstract. Abstract

In the discussions on addressing societal challenges it has become common to think of innovation policy as the universal tool capable of solving any societal challenge. However, we argue that innovation policy has clear limits to what it can do, and for it to remain a useful tool for solving societal challenges, it is necessary to re-assess its role. On one hand, we argue that in order to be able to use the full potential of innovation policy, we have to recognise its limits as a policy area. On the other hand, it is important to acknowledge the potential of innovation policy to contribute to the broader transformations required for addressing societal challenges. Thus, the question in the focus of this study is, what is the role of innovation policy in responding to societal challenges and what are the factors that shape that role? We answer the question by analysing the foundations of the three most prominent innovation policy perspectives, in terms of their desired outcomes and the type of innovation necessary for achieving these outcomes. We conclude by discussing the role of innovation policy in addressing wicked problems and its potential to be more transformative in its own right.

Research problem

Innovation policy has become somewhat of a panacea to address global grand challenges, which are often described as wicked problems. The reason for the prominence of innovation policy is that the nature of grand challenges, and more generally wicked problems, is seen to require an important level of change, often referred to as deep-structural, systemic, socio-technical change. This type of change has been addressed in various academic communities, but probably most prominently in the transitions branch of innovation studies, because innovation is seen as one, if not the only and most important, driver of such deep-structural systemic change.

One of the core assumptions is that innovation and its institutionalisation/diffusion is at the heart of radical societal change, therefore it is crucial to think about the governance of innovation. However, the meaning of innovation has been broadened, ranging from innovation as marketisation of knowledge in products towards the notion of 'system innovation' basically referring to transitions, i.e. an overall socio-technical change.

This shift from innovation as a distinct socio-technical phenomenon towards innovation being used as a synonym for change (industrial/sectoral/societal) is highly problematic, because it loses the original focus on innovation and therefore also on the function of innovation in broader change/transition processes. At the same time, the conflation of innovation and change/transition hinders policy makers and policy scholars from talking about transition policies that are not at all connected to innovation policy in the classical sense.

Therefore, in this paper, we aim to disentangle these developments and put forward clearer boundaries and definitions of innovation, innovation policy, and its function for broader system change/transitions. By clearly outlining their essence, we will contribute to strengthening the role of innovation policy for addressing societal challenges today, i.e. we can start discussing what transformative innovation policy might look like without having to cross the boundaries to non-innovation areas.

Overview of the analysis and preliminary conclusions

In order to achieve this aim, we studied the foundations of the three most prominent innovation policy perspectives (Schot and Steinmüller 2018, Weber and Rohracher 2012, Edler and Fagerberg 2017), namely linear innovation policy, system innovation policy and transformative innovation policy. We examined their underlying definitions of innovation and innovation policy, the role innovation is assumed to play for societal development, and what kind of policy instruments are suggested to tackle societal challenges. Based on this analysis, we argue that there are three fundamental differences between these three perspectives that lead to substantial policy implications.

First, the distinction and conflation between innovation and system innovation. While the former refers to the generation and diffusion of new products, services and business models, the latter refers to broader system change that may or may not entail innovation in the sense of the former definition. We argue that innovation and system innovation are two different phenomena that can, but do not have to be interdependent. Hence, policy that targets innovation is naturally different from policy that targets system change.

Second, the three innovation policy approaches differ in their understanding and treatment of incremental (continuous) versus radical (disruptive) innovation. The discussion of incremental vs. radical innovation in the context of the generation and diffusion of new products, services and business models often refers to different degrees of technological and market uncertainty and whether past experiences can inform future actions. Policy instruments are adapted accordingly, often relying on a different degree of formal, regulatory interventions. System innovation, on the other hand, is almost always assumed to be radical and disruptive in the sense of necessitating a transformation, if not replacement, of the whole underlying socio-technical system. However, in order to be able to design policy interventions, we argue that it is crucial to look at what we call 'cumulative system innovation', i.e. incremental (continuous) innovation of different system elements that in the aggregate can re-inforce each other over time to generate new properties and eventually result in system innovation.

Third, we identified a major difference in the extent to which innovation policy approaches treat the problems they are targeting as wicked vs. non-wicked (e.g. Levin et al. 2012, Wanzenböck et al. 2020). We further investigated under which conditions societal challenges can be classified as wicked problems and whether there is a possibility to deconstruct them into lower-level problems that lose their wickedness and allow for specific policy interventions. In general, it is assumed that the more wicked a problem is, the more likely it is that a policy mix is necessitated that goes way beyond the realm of innovation policy. This is particularly evident with transformative innovation policy approaches that promote more non-innovation policies than actual innovation policies. We thus further delineated the role of innovation policy in addressing wicked problems and analysed its potential to be more transformative in its own right. We did so by assessing how traditional innovation policy instruments (following a taxonomy by Edler and Fagerberg 2017) can incorporate four decisive features necessary to address societal challenges, namely directionality, demand articulation, policy coordination, and reflexivity (Weber and Rohracher 2012). Overall, we can conclude that the current range of innovation policy instruments can be relatively well adapted to include a higher degree of directionality and demand articulation. At the same time, introducing a stronger element of policy coordination is likely to be beyond the realm of innovation policy and a broader issue of (national) governance. The reflexivity failure is also difficult to address with the current innovation policy instruments, but contrary to the coordination failure, the solution might not lie outside innovation policy, but rather within – i.e. novel policy instruments are needed to allow for more self-governance, experimentation and discursive exchanges.

To be sure, while innovation policy does not suffice to achieve system innovation, it would also be wrong to limit the role of innovation policy to such transformative goals. This is because one important role of innovation policy is to enhance the generic capabilities to develop new knowledge, enhance interactive learning between different types of actors, and thereby the generation and diffusion of innovation. Building such generic capabilities in the long-term requires interventions, which are not primarily focussed on creating system innovation. However, this will enhance the capabilities of addressing societal challenges. For example, while raising the innovative capabilities through generic (undirectional) policies for training and skills will not address any of the transformational failures directly, yet they will raise the overall readiness of the innovation actors to deliver innovative solutions to address societal challenges. The quick development of vaccines against Covid-19 could not be understood without the innovation capacities that have been developed over the long-run.

Innovation policy alone is thus not sufficient and, in some cases, possibly even not necessary to address societal challenges. A major reliance on innovation policy only would be a fatal error. However, venturing out into policy spheres that are not related to innovation, as is often done when referring to policy for system innovation, undermines the potential of innovation policy to become more transformative in its own domain. Many innovation policy tools can be tweaked to respond to transformative failures better. However, the coordination failure remains largely outside the domain of current innovation policy. The extent to which coordination and reflexivity can/should be addressed is generally questionable, especially from a theoretical perspective where innovation in various system elements can lead to new system properties that cannot be anticipated (i.e. in the case of cumulative system innovation). Also, tweaking many elements of the system (following the cumulative idea) may suddenly lead to discontinuities that need to be managed. Questions of accountability and adaptability of policy interventions are thus taking centre stage in policy making under uncertainty, within the innovation policy domain and beyond.

Keywords: Innovation policy, System change, Transformative innovation policy, Societal challenges

[70] Douglas Robinson (CNRS, LISIS - the Laboratory for Interdisciplinary studies of Science, Innovation and Society), Susana Borràs (Copenhagen Business School) and Boon Wouter (5. Innovation Studies, Copernicus Institute for Sustainable Development, Utrecht University). *Reimagining the diffusion of innovation: generalisation as a key element of policies for transformative change.*

Abstract. Innovation is a key component in tackling societal grand challenges around the globe. Challenges such as the fight against climate change, assuring food security and tackling diseases like cancer or pandemics like COVID-19, require the transformation of the outcomes of innovation into solutions widely accepted and used in society. Many of these challenges have high urgency, and decision makers aiming to direct innovation actions of any kind towards grand challenges have to anticipate which innovations (and combinations of innovations) have the potential to contribute to accomplishing them. Increasingly though, they also have to anticipate on the diffusion and wider embedding of the innovations – to maximise desirable impact, and to minimise negative effects and opportunity costs.

Notions of 'diffusion of innovations', 'scale up' and 'technology adoption' were developed several decades ago and have been widely used to improve our understanding of how innovations spread (Rogers 1962). Whilst these notions have been successful in capturing innovation diffusion through market mechanisms, they suffer from important limitations. Too great a reliance on market-based dynamics of diffusion missing non-market dynamics and hybrids of both, too much of a focus on single technology-devices meaning other innovations such as social, organisational and community-based innovation is poorly explained, or too much emphasis on firms' as predominant and solo change-agents, are some of these limitations. Those limitations are for example: a main focus on market-based dynamics of diffusion, which misses non-market and hybrid dynamics; an overemphasised attention on single technology-devices, which means that other innovations such as organisational, social and/or community-based innovation are poorly explained; and too great a reliance on firms as predominant and solo change agents, missing the collective and complex forms of interactions among various types of change agents.

Whilst there is widespread appreciation of the diversity of innovation processes (technological, organisational, societal, systemic), the predominant understanding of the scale up and embedding of innovations relies mainly on the theory of diffusion, where markets are the only route for diffusion and embedding. For example, increasing adoption does not explain how, for example, public practices, community-based experiments and other products or practices that do not circulate via a market, diffuse and transform. This is particularly important for sources of innovation that are outside of the firm and which may circulate and diffuse outside of market mechanisms. This is for example the case of Product Development Partnerships, which combine technological, social and organisational innovation in the complex process of developing and spreading medicines for neglected diseases in the global South; the case of electricity production in local energy communities; the case of 3-D printing technology and its embeddedness in social and non-market forms of generalising green and decentralized manufacturing; or the case of do-it-yourself agriculture and its rapid generalisation in sustainable urban and rural farm-based practices.

We argue that, whilst the theory of diffusion captures specific aspects of scale up and embedding, a broader notion of diffusion is needed to capture:

• The diverse routes and combinations of market and non-market dynamics in multiple possible pathways embedding grand challenge-oriented innovations in society

• The anticipatory and future-oriented nature of generalisation processes

• The inescapable deep co-evolution of technological innovations, social innovations, and public sector innovations in the generalisation processes for addressing grand challenges

• The multi-level dimension of geographical and temporal scales in the generalisation of innovation to address grand challenges that are often of global and long-term nature;

• The importance of the demand-side, need-definition and articulation of directionality in the collective and distributed processes of generalisation

• The crucial role of novel types of stakeholders not only in the production of new knowledge in its application context, but also in its simultaneous generalisation, blurring of the lines between producers and users

• The social, economic and institutional dynamics of change agency and of contestation and resistance against change that is driven by generalisation.

In order to understand the complexity and multiple dimensions of these processes, a new and broader approach is needed.

The notion of generalisation (Wigboldus et al 2016) captures some of these broader dynamics, however, a diverse community of academics and practitioners have used different concepts to capture similar, but not entirely the same, process. For example, roll-out (Winden and Buuse 2017), socio-technical embedding (Sengers et al. 2019), anchoring (Elzen et al. 2012), reconfiguration (Meelen et al. 2019) and scaling, replication and institutionalisation (Turnheim et al., 2018). Such broader notions of diffusion involve several (complementary) processes: circulation of technical objects (e.g., practice abstracts), technical standards, construction of markets, creation of intermediary organisations, or practice and knowledge sharing among peers. Also, in recent years there has been recognition, that a strong emphasis should be placed on the role of organisations as mediators of change (Kivimaa et al. 2019).

This is why we prefer to broaden and deepen the notion of "diffusion" and speak of a multitude of market and non-market mechanisms for the generalisation of innovations. We argue that, whilst the theory of diffusion and adoption captures specific aspects of scale up and embedding, the broader concept of generalisation is needed to capture: the diverse routes and combinations of market and non-market dynamics in multiple possible pathways, the co-evolution and entanglement of different innovation types (social, technical, organisational) during the process of generalisation, the multi-level, multi-scalar and temporal diversity in generalisation, the key roles of various stakeholders and infrastructures that facilitate, inhibit or drive generalisation, and the importance of the demand-side in the success of generalisation.

The notion 'generalisation' responds to the increasingly perceived need in the literature, by providing a wider approach that includes markets but also acknowledges the complex and broader-than-market mechanisms, as well as the intrinsic messiness, and multiple routes of generalising innovations. Hence, we broadly define 'generalisation' as the routes and processes that transform, normalise and embed the outcomes of innovation.

This paper presents a conceptualisation of generalisation by reviewing and integrating the diverse approaches that attempt to re-imagine diffusion. We present a first-round diagnosis, with the aim of stimulating a broader discussion on generalisation as a key component of transformative change and transformative policies.

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Keywords: Transformative Policy, Innovation Studies, Generalisation, Diffusion of Innovation, Scaling

[71] Johan Miörner (Eawag: Swiss Federal Institute of Aquatic Science and Technology), Christian Binz (Eawag: Swiss Federal Institute of Aquatic Science and Technology) and Lea Fuenfschilling (CIRCLE, Lund University). *Understanding transformation patterns in different socio-technical systems – A scheme of analysis.*

Abstract. Aim and relevance

In order to address global challenges, there is a need to adapt mission-oriented innovation policy strategies to reflect place-specific conditions as well as global sector characteristics. Surprisingly enough, 'one size fits all' still seems to be the dominant approach when it comes to policy targeting socio-technical transitions in different sectors. We still lack a systematic understanding of what characterizes and determines transformation patterns in different sectors and how these can inform mission-oriented innovation policy.

Transitions literature understands sector transformation as structural changes in socio-technical systems (STS). STS are configurations of actors, institutions and technologies that fulfil certain societal functions, such as energy provision, water supply, or transport. When studying transitions, scholars often draw system boundaries at the sectoral level, with a sector comprising one or several industries, as e.g. in the 'energy', 'mobility' or 'water' sectors. Theoretical frameworks in the field have characterized transitions as resulting from the interplay of activities at three levels: technological niches, socio-technical regimes, and landscapes (Geels and Schot, 2007). Many studies have focused on characterizing the relationship between these levels or have delved into the specifics of niche dynamics, regime adaptation or landscape pressures, highlighting the role of specific actors, institutions, and practices in structural change processes.

However, the current literature shows important gaps when it comes to analysing a socio-technical system's inherent transformative potential or comparing transition trajectories in different socio-technical systems with each other (Andersen et al., 2020; Alkemade, 2019). Three main knowledge gaps stand out. First, we lack a systematic understanding of the basic characteristics of a sector's socio-technical system and how they influence the likelihood, nature, and speed of transition processes. Second, we lack a comprehensive discussion on whether and how lessons derived from one sector can be used for understanding transitions in others. Finally, and closely related to the former two, we lack a theoretical framework for identifying the places and spatial scales at which transitions unfold and where leverage points for transformative change lie in different sectors.

Recent contributions make compelling arguments that the transformative potential is not uniform across socio-technical systems in i.e. the energy, water, agro-food or urban mobility sectors (Andersen et al., 2020; Binz and Truffer, 2017; Van Welie et al., 2018; Huenteler et al., 2016; Klerkx et al., 2012; Elzen et al., 2012). In fact, the gradual regime substitution process that is often portrayed for transitions in the energy sector appears to be a rather special case, which does not hold in all countries, sectors, or non-Western contexts (Geels et al., 2016; Van Welie et al., 2018; Runhaar et al., 2020). We thus deem it a crucial contribution to transitions literature to specify more deeply how, and why, transformation processes play out differently in different sectoral contexts.

This paper develops a heuristic for analysing a socio-technical system's inherent transformative potential and for comparing transition trajectories in different socio-technical systems with each other. The framework draws on insights from transition studies and organizational institutionalism to specify three features of a socio-technical system which shape its inherent transformative potential and most likely transition trajectories: the degree of institutionalization of socio-technical configurations, their coherence, as well as spatial characteristics of the system as a whole. The contribution of the paper is threefold: 1) it develops a systematic understanding of the basic characteristics of a sector's socio-technical system and how they influence the likelihood, nature, and speed of transition processes; 2) it provides insights to whether and how lessons derived from one sector can be used for understanding transitions in others; 3) it guides the identification of places and spatial scales at which transitions unfold and where leverage points for transformative change lie in different sectors. The framework is illustrated with empirical examples from existing literature on the water- and urban mobility sectors.

Conceptual framework

Socio-technical systems have been defined at a most generic level as the "linkages between elements necessary to fulfil societal functions" (Geels, 2004: 900). The main vantage point of this perspective is that essential societal functions like energy, water, food or transport are provided by complex configurations of actors, technologies and institutions that co-evolve and get aligned to each other over extended periods of time (Kemp et al., 1998; Geels, 2002; Markard et al., 2012).

For each sector, it is possible to characterise the STS in terms of its foundational elements, i.e. key actors (e.g. type, size, age, ownership structure), institutions (e.g. type, age, coordination mechanisms, performance, infrastructures) and technology (e.g. type, materiality, knowledge base, key natural and human resources). Innovation studies, in particular the Sectoral Innovation Systems (SIS) literature, have expansively explored differences between sectors with regard to the sources of innovation, the actors involved, and how innovative activities are organisationally and geographically structured (Malerba, 2002).

However, the sectoral systems literature has remained focused on the supply-side of innovation, that is, technological regimes and knowledge bases that enable the development and manufacturing of new products and services (Geels, 2004). Yet, deriving ever more fine-grained knowledge-based indicators is not sufficient to understand transformation patterns, which arguably also necessitate a thorough understanding of the institutional, material or demand-side elements that hinder the unfolding of structural change processes (Geels, 2004; Coenen and Díaz López, 2010; Binz and Truffer, 2017).

Consequently, the transformative potential and generic transition patterns of a sector cannot be fully understood by analysing the characteristics of its basic STS elements (actors, institutions, technologies) alone or by relying on traditional knowledge indicators from sectoral systems literature. One must rather adopt a configurational perspective, which emphasizes the alignment, institutionalization and spatial arrangement of specific configurations of STS elements, both at the supply and demand side (Furnari et al., 2020; Heiberg et al., 2020; Heiberg et al., 2022). Applying a configurational perspective then allows one to understand how the basic system elements relate to each other, and how they have co-evolved over time, giving rise to qualitatively different 'grammars' in different STSs.

Building on recent contributions that have combined transition studies with insights from organizational institutionalism and human geography, we introduce the following three essential features to describe the "systemness" of an STS:

First, the degree of institutionalization addresses the question how institutionalized specific socio-technical configuration(s) are in a STS, i.e. whether or not a given combination of technologies, institutions and actors has become deeply aligned, legitimized and taken-for-granted.

Second, the degree of coherence addresses the constellation of competing socio-technical configurations that exist in a given STS. We argue that the assessment of changing levels of structuration (arguably the hallmark of transition studies), has to be complemented with an analysis of the degree of coherence between different s-t configurations. Semi-coherence has been identified as a potentially important source for transitions (Fuenfschilling, 2019; Runhaar et al., 2020).

Third, the spatial configuration refers to the overall spatial constellation and forms of interaction between socio-technical configurations that are evolving in territorial subsystems and the 'global' STS. We here follow recent contributions in human geography, which argue that the forms of spatial variation and multi-scalarity in STS have important implications for a sector's transformative potentials (Coenen et al. 2012; Murphy, 2015; Binz et al. 2020).

Summary of framework and empirical illustrations

The STS in the water sector largely depends on one deeply institutionalized s-t configuration that has existed for several decades if not centuries (Sedlak, 2014). The regime configuration has proven highly invulnerable to policy intervention, is taken for granted in various cultural and geographic settings and has materialized into physical infrastructure, as well as (global) standards and regulations that are very hard to change. The STS furthermore features a monolithic regime structure that gets challenged by alternative s-t configurations only on the fringes. The STS overall shows low spatial variation with limited adaptation to place-specific conditions, and is strongly influenced by a hierarchically organized global regime structure providing water and sanitation solutions. Almost all of these elements point to a comparably low overall transformative potential and a transition trajectory that deviates from conventional niche upscaling models.

The urban mobility sector, in contrast, is characterised by many features that indicate a higher (though arguably not the most extreme) transformative potential (Fig. 1). While the s-t configuration of personal car mobility is highly institutionalized with supporting infrastructure, regulations, standards and taken-for-granted practices, there are several other institutionalized and highly legitimate alternative s-t configurations competing for dominance in the sector. As such, the urban mobility sector features significantly lower coherence than the water sector, with polycentric patchworks of different s-t configurations that are all highly institutionalized and competing with and/or complementing each other in the provision of urban mobility. Furthermore, the STS exhibits regime configurations that are considerably less globalized than in the water sector, with constellations of different s-t configurations coming in a range of 'local flavours' with solutions being strongly adapted to a city's particular geo-physical and cultural particularities. The lower overall coherence and stronger spatial variation thus clearly point to a relatively higher degree of overall transformative potential and a transition trajectory that is deeply embedded in specific places.

Conclusion and leverage points for transitions

The key contribution of our framework is that it offers a novel inroad for analyzing, systematizing and cross-comparing transition potentials and the dynamics of structural change in different sectors. While many conceptual frameworks exist for analyzing innovation and 'niche' dynamics, how to systematically assess 'regimes' or socio-technical systems in their aggregate has interestingly remained an under-addressed question. We here complement existing typologies of sectoral innovation and transformation patterns with a more comprehensive view of the relevant institutional and spatial dynamics that influence whether, how and where a locked-in system may be pushed toward transformative change. These lessons are also highly relevant for policy makers, who might adapt their concrete instruments, policy mixes and the targeted spatial scales to the systemness of a given sector.

The latter lies in the possibility to derive potential leverage points for governance interventions to foster sustainability transitions in different sectors. In sectors with a monolithic and highly globalized STS, such as the water sector, the strongest leverage points for transformative change arguably lie in the disruption of its global regime structure. Global regimes can most effectively be influenced with 'top-down' interventions by actors that own the resources, network positionality or credibility to influence the institutional environment of powerful corporate and government interests. Transitions governance accordingly requires strategic multi-scalar regime disruption rather than only geographically contained (niche) experimentation (see also Miörner and Binz, 2021). In this STS type, one can furthermore not expect full regime substitution, in which the current regime is fully replaced by an alternative solution (as, for example, in the ongoing energy transition). Transitions are more likely to take the shape of a gradual hybridization of the dominant regime.

In sectors featuring a polycentric STS and a high degree of spatial variation and adaptation, such as the urban mobility sector, transitions are in turn much more likely driven by a reconfiguration of place-specific constellations of already legitimate s-t configurations, such as changes in modal splits, than the introduction and upscaling of entirely new mobility solutions (such as e-scooters or flying taxis). The strongest leverage points for transformative change thus exist at both global and local levels, but while processes of (de-)institutionalization at the global level may still be important, greater emphasis should be put on the development of best-practices through local experimentation, and the 'flat' diffusion of these across different territorial sub-systems (Sengers and Raven, 2015). Transition governance in this sector type can thus utilize regional and tailored interventions incentivizing combinations of s-t configurations with lower environmental or social impact, rather than one-size-fits-all solutions that are propagated globally. This implies the need for an inclusive and participatory approach for governing transition process.

Keywords: socio-technical systems, sector transformation, transition potentials, systemness, water, urban mobility

[72] Paula Kivimaa (Finnish Environment Institute SYKE & University of Sussex), Chux Daniels (SPRU, University of Sussex) and Dhanasree Jayaram (Manipal University). *Framework for connecting security and geopolitics to Transformative Innovation Policy.*

Abstract. We are living an era of rapid changes in the global geopolitical and security context. These change the framework conditions in which public policies are made. In this paper, we argue that the changing conditions do not only apply to policy sectors traditionally associated with geopolitics, such as foreign and security policy or trade policy, but also impact science, technology, and innovation (STI) policies. However, instead of addressing STI policies as a whole, we focus in this paper on the proposition of transformative innovation policy (TIP) (Diercks et al., 2019; Schot & Steinmueller, 2018) and how that connects to global security and geopolitics.

Drawing on TIP and sustainability transitions research, we suggest a framework to consider how geopolitical and global security developments shape the conditions for TIP, and the implications of such policy on geopolitics and security. Security is seen as both potential risks and threats and positive developments towards societal wellbeing and justice. The framework is illustrated in three different contexts: the energy transition in Europe and Asia, and digitalisation in Africa-Europe cooperation.

Our research questions are:

1. How do changes in global geopolitics and security influence the achievement of transformative innovation policy and its key principles (environmental & social transformation, inclusivity)?

2. What differences can be observed between Global North and Global South perspectives on this issue, and the implementation of TIP?

This paper explores these questions in a conceptual manner and draws from illustrative examples based on secondary materials (e.g., academic literature, public sector and third sector reports).

Setting the context and analytical framework

The first ideas towards TIP were presented already in 2012, that pointed out the directionality failure of innovation policy (Weber & Rohracher, 2012) and the need for a challenge-led broad-based approach (Steward, 2012). However, it took several years before more concrete developments began to emerge, taking the forms of, for example, the Transformative Innovation Policy Consortium (TIPC) and an elaboration of the third frame of innovation policy (Schot & Steinmueller, 2018) drawing from sustainability transitions research. Another related development has been that of mission-oriented innovation policy, guided by the work of Mariana Mazzucato on innovating public governance (e.g. Mazzucato et al., 2020).

One of the key elements or principles of TIP is directionality by addressing global environmental and societal problems, such as climate change and poverty. This has been framed for example, as addressing the UN's Sustainable Development Goals (e.g. Ghosh et al., 2021). Diercks et al. (2019) talk about "opening up the policy agenda from primarily economic to broader societal and environmental concerns", that has been particularly absent from innovation policy, while to a degree addressed in science and technology policy. Directionality is then concretised by the formation of visions or missions in a co-created manner. In the context of geopolitics, we may ask to what degree TIP visions are compatible with more globally stable societies; to what degree they may create significant shifts with negative implications of security and geopolitics; or to what degree the achievement of visions may be adversely affected by geopolitical developments.

Another key element is experimentation which is expected to happen in different contexts, including, for example, entrepreneurs and incumbent firms (Grillitsch et al., 2019). However, a more important aspect here is how governing institutions create spaces to experiment and take part in experimenting, while the degree to which it happens is much affected by cultural factors (Grillitsch et al., 2019; Kivimaa & Rogge, 2022). In TIP, experiments are not approached as "isolated projects, but as interventions in larger multi-actor transformation processes (Ghosh et al., 2021). Experimentation may be a way to start tentatively addressing the connections of TIP to global security and geopolitics, for example, via foresight exercises.

A third element is inclusivity, which is so far addressed much less than experimentation or directionality in academic publications. TIP emphasizes inclusive societies (Schot & Steinmueller, 2018; Grillitch et al., 2021), more inclusive networks of actors (Ghosh et al., 2021), and inclusive policy making (Akon-Yamga et al., 2021) but what this means or how is this to be achieved requires further research. Yet, this element may be one of the most significant for geopolitics and security. Inclusion links to the advancement of human rights and social justice. The latter in turn are linked to security, peace, and the absence of armed conflicts, which are better advanced "through accountable systems of governance and effective institutions of mature democracy" (Cortright et al., 2017, p. vii). We will explore this more via our illustrative cases.

The conference paper will form a framework by combining these three TIP elements with key perspectives of sustainability transitions, such as the x-curve of transitions (Hebinck et al., 2022), and policy evaluation (e.g. Mickwitz & Kivimaa, 2007; Molas-Gallart et al., 2021).

Illustrations of the framework in different contextual settings

The illustrations will be further developed for the conference paper. This abstract contains early notes.

Energy transition in Europe

Energy transition in Europe is characterised by increasing renewable energy and electrification, including expansion of common energy markets. However, variation exists between countries regarding how big a challenge the fossil fuel phase down is, with regionally variable impacts on employment and economic conditions. The European Green Deal and proposed emissions trading for heat and transport includes a proposal for a European social fund to compensate those in most risk of rising prices. Tensions and contestations exist around natural gas (NordStream 2 pipeline between Russia and Germany vs. LNG imported from US) and the electricity network (e.g., to what degree Norwegian wind and hydro power can be relied upon with examples of Sweden already curtailing transmission to other countries due to domestic needs).

The directionality and scale of the European energy transition, increases the need for critical materials needs manifold, which is significant as currently over 90 % of rare earths is imported from Chinese sources. While the critical materials are recognised as an issue, it is uncertain how much this is linked to the innovation policy domain. There are also questions of technology sovereignty and cyber risks. Positive security is addressed (internally, within the EU) via attention to just transitions (e.g., just transitions mechanism, and the new social fund proposition), and in connection to regional innovation policy.

Energy transition in Asia

The evolving US-China trade and technological conflict and the associated emergence of the geopolitical construct of the Indo-Pacific has major implications for the evolution of TIP in the region. The Quadrilateral Security Dialogue meetings have also focussed on low-carbon transition in energy-intensive sectors, the adoption of green hydrogen, and strengthening climate services. Quad itself is regarded as an informal alliance that is aimed at tackling China's rise and assertiveness in the region. It has been looking into the issue of the monopoly of China in terms of the clean energy supply chain, which it proposes to weaken through cooperation in innovation and S&T.

Cooperation between countries in areas, such as climate action and clean energy is driven by geopolitical interests too. For instance, China's Belt and Road Initiative is a major financier of clean energy projects in many developing and least developed countries of the Indo-Pacific region. The emergence of China as a major renewable energy giant has led to it becoming a technological innovator, mass manufacturer of clean energy equipment, and provider of green technology to other countries, primarily in the Global South.

There are several border and other forms of inter-state conflicts wherein militaries are a major stakeholder. Security considerations are likely to drive military-led innovation to reduce the impacts of climate change on their readiness, operations, and strategy. For instance, India's green hydrogen fuel project is set to be located in Ladakh, which is heavily militarised. This project is expected to have military applications, as it could reduce the military's dependence on fossil fuels that usually involves transportation across high altitude, difficult terrain, as well as high cost.

Digitalisation: a focus on Europe-Africa Cooperation

As noted above, experimentation is one way to deepen the understanding on the connections between geopolitics and security in innovation policy. The TIP experience in Africa shows that geopolitics is more prominent in the innovation discourse than security. Geopolitics have played out as pushbacks on the TIP framework, perceived as a Global North development. The EU prides itself in regulatory power, a key mechanism for externalisation and cementing its geopolitical position of influence across the world. A recent example of this regulatory influence, sometimes referred to as the "Brussels effect" can be found in the adoption of the General Data Protection Regulation (GDPR), across the globe, including many countries in Africa, such as Kenya. Another geopolitical dimension of the EU's digital agenda is the adoption of a "human-centric vision" that speaks to inclusivity, in contrast to the "capitalist" approach by the US or the "monopolistic and state surveillance" approach by China. This human-centric approach to the EU's internationalisation efforts in building strategic international partnerships and engaging in international negotiations helps the EU to carve a niche, and position the EU, geopolitically, in a middle ground between the USA and China. Thereby, attracting regional blocks, such as the African Union, and many countries in Africa, which in the face of it, appears to be less interested in digitalisation for capitalism or security and control. However, although many African countries are adopting the GDPR, evidence indicates that some of these countries resort to Chinese technologies "security" and spying on citizens, with far-reaching implications on inclusivity. For Africa, the geopolitical rivalry in digital – between USA and China, and the EU in the middle ground – is fierce. Who is going to dominate Africa? And in what ways are STI policies responding to questions of this nature?

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Keywords: transformative innovation policy, geopolitics, security, energy transition, digitalization

[73] Amanda Martinez Reyes (TU Delft). *Using intersectionality theory to identify diverse citizen groups and their perceived level of involvement in regional energy transitions.*

Abstract. The problem: For energy scholars and decision-makers to propose just transition strategies for diverse stakeholder groups, we first need to understand from these groups’ perspectives what they define as their roles, identities, and experiences in energy transitions. In (just) energy transitions literature, scholars have referred to various stakeholder groups as underrepresented or marginalized groups to those whose voices decision-makers should include but have not in energy decision making. Some of these groups cut across gender and other dimensions of intersectionality, for example, women, low-income communities, immigrants, and Indigenous communities. Scholars have argued that decision-makers should include diverse stakeholder groups such as these in the energy transition process for several reasons: a) descriptive, to help understand the challenges of energy transitions; b) instrumental, to achieve social acceptance; c) normative, to reduce social inequalities, and; d) enabling, to mobilize and lead local action through innovation and entrepreneurship. However, this terminology from a) to c) comes from stakeholder engagement theory, which has been framed by those who have not been excluded (intentionally or not), underrepresented, or marginalized in decision-making processes. When scholars and policymakers continue applying such terminology from the dominant groups’ perspective, we may fail to help solve the biased problem as the terms we use may disagree with what these groups perceive. Therefore, we need to understand how they describe themselves, what their experiences in the energy system are, and what they think their role in energy transitions should be.

Motivation: Thus, we could co-develop the terms that help describe these stakeholder groups and their roles in agreement with their perspectives with a transdisciplinary approach. The research outcomes will ultimately help both these stakeholder groups and decision-makers clear misconceptions and build a common ground for communication. Such a common language could help meet multiple interests such as a just and low carbon energy transition and improved locals' livelihoods.

Study design: We will apply a transdisciplinary approach to co-produce knowledge with stakeholder groups not typically included in decision-making processes. We will conduct a case study and a representative survey with substantial participation of diverse stakeholders in an energy region in Mexico. This study focuses on energy transitions on a regional scale because of the growing relevance of energy regions worldwide. The stakeholder interviews and survey design are drawn from energy justice frameworks as a starting point to help distinguish stakeholders' experiences in the energy system. Additionally, our method applies intersectionality theory to help identify diverse groups in the energy region; social identity theory to help describe the collective identity characteristics of these groups.

Expectations: With this study, we expect to understand better how these stakeholder groups perceive themselves, their group identities, their experiences in the energy system, and these groups think their role is or should be in an energy transition. On the one hand, these results could diversify scholars' and decision makers' understandings of stakeholder engagement in energy planning and energy policy. On the other hand, these stakeholder groups could use the results on the diverse stakeholder groups' roles, identities, and experiences in the energy system, for their own interests.

Keywords: social inclusion, transdisciplinarity, intersectionality theory, regional energy transitions, energy justice

[75] Victor Dos Santos Paulino (TBS Education) and Sveinn Gudmundsson (Reykjavik University, Department of Business Administration). *How government customers delay the diffusion of strategic technology products: the case of commercial satellites 1960 to 2018.*

Abstract. Satellites, aircraft, sea vessels, and chemical plants are examples of high technology industrial products that play a critical role in the grand challenges of post-modern societies (Acha et al., 2004; Foray et al, 2012; Robinson and Mazzucato, 2019; Shove, 2005). Government customers are essential for the development of such industrial products, by funding experimental technologies often through government agencies, such as NASA, CNES and Roscosmos, etc. (ESPI, 2019; Mazzucato, 2018; OECD, 2019). Whereas governments have a positive influence in some respects, it is common that such products demonstrate abnormal market dynamics, for instance due to protectionism regulations (e.g. satellites, aircraft) (Brimelow, 1997; Dos Santos Paulino and Gudmundsson, 2021). In fact, Cowan and Foray (1995) argued that government customers may endeavour to hinder the wider adoption of strategic technologies. Thus, the intent of this paper is to explore this predicament in the market proliferation of high technology and high value industrial products.

The diffusion literature has demonstrated that abnormal diffusion processes can be explained by the influence of customers (e.g. reluctance to share information, negative word of mouth, calling for regulatory barriers, lobbying, etc.) (Chandrasekaran and Tellis, 2011; Ferreira and Lee, 2014; Frattini et al., 2014; Nejad et al., 2014). Moreover, this literature has shown that the absence of dominant design is a major hindering factor for mainstream adoption of technologies, especially in the case of high technology markets (Chandrasekaran and Tellis, 2011; Muller and Yogev, 2006; Srinivasan et al., 2006). In a product category, the absence of a narrow range of configurations representing significant sales hinders the adoption among customers with a low inclination for innovations. However, little encompassing research in diffusion literature exists on the influence of early adopters in explaining the absence of dominant design.

Technology management studies show that government customers can postpone the emergence of dominant design by prolonging innovation efforts (Anderson and Tushman, 1990; Cowan and Foray, 1995; Mowery et al. 2010; Suàrez and Utterback, 1995; Zervos and Siegel, 2008). Although an important step in unravelling our understanding, this literature does not confirm this result with empirical quantitative methods, nor does it explore the implications for market diffusion.

This study engages in this direction and examines how government early adopters (e.g. space agencies and defence departments) prevent the emergence of a dominant design that delays the adoption of technology products by commercial organizations.

The scholars showed that high technological diversity of the products and high volume of product innovations in the market are technological barriers to the adoption of mainstream adopters (Chandrasekaran and Tellis, 2011; Libai et al., 2008; Srinivasan et al., 2006). The diffusion literature tends to regard these adoption barriers as created by the producers but not induced by the early adopters themselves (Frattini et al., 2014; Nejad et al., 2014). In this research, the demand driven nature of communication satellites leads us to argue early adopters can raise technological barriers to adoption for mainstream adopters market (i.e. by prolonging innovation efforts, encouraging the duplication of existing technologies and limiting technology competition in captive markets) (Anderson and Tushman, 1990; Cowan and Foray, 1995; Mowery et al. 2010; Robinson and Mazzucato, 2019; Suàrez and Utterback, 1995; Zervos and Siegel, 2008). We suggest several hypotheses about these relationships,

H1: The higher the technological diversity of the products purchased by early adopters, the lower the purchases of mainstream adopters.

We decompose product innovations into science products (Hypothesis 2a) and R&D products (Hypothesis 2b). Thus,

H2a: The higher the volume of science products purchased by early adopters, the lower the purchases of mainstream adopters.

H2b: The higher the volume of R&D products purchased by early adopters, the lower the purchases of mainstream adopters.

We test these hypotheses with data that comes from the UNOOSA register of objects launched into space. This register is complemented by more detailed launch data gathered by various organizations and researchers. Our dataset consists of the all the communication, science and R&D (Research and Development) satellites launched by any country from 1960 to 2018. For this research we use 1285 observations. Each observation includes the characteristics of a communication satellite (e.g. satellite name, launch date, weight) and dimensions on the context of the purchase of the satellite (e.g. categories of adopters, US export control regulation). The dataset was cross-checked with other sources as suggested by Devezas et al. (2012).

In this research, we want to explain the evolution of the communication satellites purchased in each year by mainstream adopters. As our dependent variable is a count variable with overdispersion (i.e. variance exceeding its mean), we use a negative binomial regression method (NBRM) (Cameron and Trivedi, 1990; Osborne, 2017).

Our data show that mainstream adopters purchase on average 14.65 communication satellites per year between 1960 and 2018 and early adopters 31.17. Early adopters represent 68% of purchases which indicates a very slow diffusion process. Strictly speaking, early adopters should not represent more than 25% of global sales at the end of the diffusion process (Libai et al., 2008). We argue that this abnormal diffusion process is explained by the existence of adoption barriers such as technological diversity.

Hypothesis 1 predicts a negative relationship between the purchases of mainstream adopters and the technological diversity of the products purchased by early adopters. Our main model shows that the coefficient, technological diversity, is negative and highly significant (β -0.889, $p<.001$), therefore, supporting H1.

Hypotheses 2a and 2b predict a negative relationship between the satellite purchases of mainstream adopters and the volume of R&D products and science satellites purchased by early adopters, respectively. Our main model shows that the coefficients for R&D products (β -0.00361, $p<.001$) and science products (β -0.0205, $p<.001$) are negative and highly significant, therefore, H2a and H2b are supported.

Our results show that government customers (i.e. early adopters) can delay the adoption of industrial products for commercial customers (i.e. mainstream adopters). We show that this is attributed to their influence on the level of technological diversity and product innovations, causing barriers for commercial customers to enter the market, mainly because the value brought by the adoption becomes uncertain and limited under such conditions.

Our findings advance the understanding of the influence of first customers on the market dynamics of industrial products.

Our key contribution to the literature is to show that early adopters can delay the diffusion of technologies to mainstream adopters by raising technological barriers. By addressing a research question that is on the interface between the diffusion and technology management literatures, we improve the articulation between the era of technology ferment and the introduction stage in technology adoption (Anderson and Tushman, 1990; Chandrasekaran and Tellis, 2011; 2002; Cowan and Foray, 1995; Suàrez and Utterback, 1995; Muller and Yogev, 2006; Srinivasan et al., 2006).

This research also contributes to demand side innovation policies (e.g. regulation, public procurement, voluntary standardization) (Borrás and Edquist, 2013). Space agencies and ministries of defense have successfully created markets for communication satellites with such policies (e.g. prolonging innovation efforts, encouraging the duplication of existing technologies and limiting technology competition in captive markets) (ESPI, 2019; Mazzucato, 2018; OECD, 2019; Robinson and Mazzucato, 2019). However, we show that these demand side mission-oriented policies have hindered the entry of mainstream adopters. This result suggests the need to align demand side innovation policies with demand maturity.

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Keywords: Market dynamics, Diffusion of innovations, Dominant design, Barriers to Entry, Industrial policy, Defense

[76] Wouter Boon (Utrecht University), Jakob Edler (Fraunhofer Institute for Systems and Innovation Research ISI) and Douglas Robinson (Laboratoire Interdisciplinaire Sciences Innovations Sociétés (LISIS)).
Market formation for societal challenges – exploring policy interventions.

Abstract. Addressing grand societal challenges and the Sustainable Development Goals requires transitions to new kinds of socio-technical systems and has led to calls for transformative innovation policy (Borrás & Edler, 2020; Diercks et al., 2019; Köhler et al., 2019; Schot & Steinmueller, 2018). Transitions involve radical innovations, systemic socio-technical changes and extensive restructuring of economies. As a focal point for these dynamics, markets have been recognized as essential mechanisms for inspiring, upscaling and generalizing innovative solutions (Robinson & Mazzucato, 2019). Therefore, it stands to reason that many activities associated with transitions eventually lead to changes to existing markets and inspire the formation of new ones.

Transition studies have recognized market formation as an essential dimension (Bergek et al., 2008; Hekkert et al., 2007). Markets are commonly defined as arenas or structures that allow for and organize the exchange of products or services between sellers and buyers (Fligstein & Dauter, 2007). Market formation involves processes leading to new arenas for the exchange of products or services throughout an innovation's journey (Rip, 2012; Van de Ven, 1999).

However, how markets are formed in transitions have for long been subjected to rather cursory treatment. First, market formation is often studied in terms of which user groups to target and how to improve innovation adoption, in essence taking a diffusion perspective (Boon et al., 2020; Loorbach et al., 2020; Rogers, 2003). Such a diffusion perspective treats upscaling as an inevitable, linear process.

Relatedly, innovation systemic approaches to transformative change have shown a failure in anticipating and learning about user needs. Weber and Rohracher (2012) called this a demand articulation failure and saw a necessity to take user needs and practices into account. Second, transition frameworks like the technological innovation system (TIS) framework apply market formation largely as a black box. For example, Bergek et al. (2015) demonstrate that market formation policies need to be understood in the context of the underlying structures and processes of legitimization. They show that there is a need for a more systematic and differentiated conceptualization of market formation.

Transition studies have started to pay more attention to the process dimension of market formation (Dewald & Truffer, 2012; Hyysalo et al., 2018; Ottoson et al., 2020). Recently, an attempt has been made to unpack the black box of market formation by differentiating five major processes of market formation, developing a multidimensional framework for characterizing and analyzing different processes of new market formation (Boon et al., 2022). The five processes are: demand articulation and empowerment; formation of new user practices and experimentation; formation of institutions and institutional entrepreneurship; defining legitimate market boundaries and establishing product categories; and formation of dominant product or service design.

The framework consisting of the five market formation processes can be used to identify misalignments, bottlenecks and failures for which transformative innovation policy interventions can then be devised. The identification of the potential misalignments, bottlenecks and (market and systemic) failures regarding market formation serves as an entry point for transformative innovation policies. Particularly in times when the state is called upon to support and accelerate transformations, it is of paramount importance to have a thorough understanding of market formation processes and their deficiencies.

Based on interviews, document analyses and interactive sessions, we explore market formation in five case vignettes on: (digital innovation for) preventive healthcare, 3D printing for circular purposes, space travel, and orphan drugs for rare diseases. In the case vignettes we uncover the five market formation processes over time, as well as important misalignments, bottlenecks and failures. We especially add to our previous work (Boon et al., 2022) by investigating policy intervention measures that have been considered and/or implemented to overcome the misalignments, bottlenecks and failures. We use existing toolboxes of innovation policy, such as demand-side innovation policy (Creutzig et al., 2018; Edler & Georghiou, 2007; Edquist & Hommen, 1999) and related policy instruments, as checklists of possible instruments. At the same time, we allow for other instruments to be included as well. The paper explores which policy instruments are used, under which rationales, and what their implications have been for the market formation processes that they try to engage with. We do this by exploring market formation and associated misalignments, bottlenecks and failures, as well as the policy instruments over time.

A second addition to the framework is that we explicitly explore the extent to which social innovation and changes in social practices might be part of these markets-to-be-formed. Many societal challenges concern wicked problems (Wanzenböck et al., 2020) that are not to be solved through silver bullet solutions, as often envisaged by technology developers. It is precisely in interactions with social (practice) innovation that problems can be addressed. With this exploration we aim to elaborate on the process of formation of new user practices and experimentation that is part of our framework.

We propose that based on our market formation concept, one can underpin transformation oriented innovation policy with a more systemic understanding of market formation processes and a thorough diagnosis of potential misalignments, bottlenecks and failures. Those dysfunctionalities of the market formation processes then present entry points for policy intervention.

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Keywords: Market formation, Transformative innovation policy, Social innovation

[77] Taran Thune (University of Oslo), Håkon Normann (NIFU) and Lisa Scordato (NIFU). *Institutional logics and mission-oriented innovation policy formulation: A case study of the Norwegian long-term plan for research and innovation .*

Abstract. Purpose

The purpose of the paper is to make a contribution to the mission-oriented innovation policy literature by furthering research on policy development processes of transformative and mission-oriented innovation policies, as recently called for by Borrás & Edler (2020); Janssen et al., (2021); Wanzenböeck et. al., (2020).

Perspectives

We employ an institutional logics perspective to understand the diversity in understandings and approaches to mission-orientation in different organizational fields, here represented by different policy fields. By institutional logics we mean "socially constructed sets of material practices, assumptions, values, and beliefs that shape cognition and behavior" (Thornton & Occacio, 1999). Institutional logics is a concept that is meant to capture principles (or expectations) that influence a "particular realm of social life" (Besharov & Smith, 2014). Institutional logics is assumed to influence how organisations and their members (groups, people etc.) make sense of, evaluate and organize activities. Moreover, the literature assumes that institutional logics embraced by different groups/collectives may be in opposition and that the tension between different institutional logics may influence coordination and collaboration in a negative way (Pache, & Santos, 2010).

We use this perspective to investigate issues connected to policy coordination and broad involvement in policy processes, as recommended by mission-oriented innovation policy approaches (Mazzucato 2018; Wanzenböck et al 2020; Schot & Steinmuller 2018; Weber & Rohracher 2012). We assume that policy coordination may seem like an "easy receipe", but that in reality policy coordination face substantial challenges (Nylén et al., 2021) as understandings of the policy processes, the scope for public policy and the enactment of different policy roles (what we define as different "policy logics") are likely to be substantially different in different policy fields. These deep-seated differences will probably influence policy coordination, and we seek to unpack such process and their impact on policy formulation.

Empirical case and methods

The paper will perform an illustrative case study of policy formulation and development processes that address how different actors (public policy bodies and stakeholders) enact (make sense of, value, act upon and provide legitimation for their actions) mission-oriented innovation policy development processes.

The case study is a Norwegian policy formulation process that has embraced the notion of mission-oriented research and innovation policy – the so-called "Long-term plan for research and innovation" (the LTP) that involve multiple public policy bodies (different ministries) and stakeholders (agencies, public research organizations and more).

In the case study we will look at 1) the actors (policy bodies) that have been involved in the process; 2) their understandings of what mission-oriented policies are (cognitive) and the value put upon such policies (normative), and 3) how they plan to engage further in policy development and implementation processes.

We will select a limited number of policy bodies that represent traditionally different viewpoints of the scope for research and innovation policy (e.g. department of business and industry embracing a "market logic"; ministry of climate and environment embracing a "environmental logic" and ministry of science and the research council of Norway (representing a "science logic"). Case selection (sub-cases) will be specified further.

Empirical data to be used is 1) interviews with key stakeholders in different ministries that have taken part in the LTP-policy process, 2) participation in public events, such as the launch of the plan, and 3) documentary analysis (public records, consultation documents, the plan itself and public discussions in media and more). The data (interviews and document studies) have been initiated, but further data will be collected when the plan is launched, i.e., we plan to perform more interviews and studies of the reception and further work with the plan after the launch.

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Keywords: Mission-oriented innovation policy, Policy formulation processes, Institutional logics perspective

[78] Bastian Krieger (ZEW Mannheim). *Heterogeneous Regional University Funding and Firm Innovation - An Empirical Analysis of the German Excellence Initiative.*

Abstract. This paper estimates the effect of heterogeneous university funding stemming from the German Excellence Initiative on a regional firms' probability to innovate by using a multi-valued two-way fixed effects difference-in-differences model. The estimations show that funding an additional Excellence Cluster focused on internationally competitive research within a labor market region increases a regional firm's probability to innovate between 0.3 and 0.9 percentage points. There is no significant effect of funding Graduate Schools concentrating on training scientists, nor of funding University Strategies promoting the overall long-term plan of a university.

Keywords: University Funding, Firm Innovation, Knowledge Transfer

[79] Binbin J. Pearce (Faculty of Technology, Policy and Management, Delft University of Technology), Vassilis Stavrakas (Technoeconomics of Energy Systems laboratory, Department of Industrial Management and Technology, University of Piraeus), Ilias Tsopelas (Technoeconomics of Energy Systems laboratory, Department of Industrial Management and Technology, University of Piraeus), Jenny Lieu (Multi-Actor Systems Department, Delft University of Technology), Anastasia Ioannou (University of Glasgow, School of Engineering), Niall P. Dunphy (School of Engineering and Architecture/ Environmental Research Institute, University College Cork), Georgios Xexakis (Holistic P.C.), Gioia Falcone (University of Glasgow, School of Engineering), Michael Brenner-Fliesser (Joanneum Research Forschungsgesellschaft mbH), Gosia Matowska (Th!nk E), Christina Protopapadaki (Th!nk E) and Alexandros Flamos (Technoeconomics of Energy Systems laboratory, Department of Industrial Management and Technology, University of Piraeus). *Energy citizenship for inclusive decarbonization: Making use of a transdisciplinary framework for creating transformative knowledge.*

Abstract. Achieving the European Union's vision to limit global temperature rise to 1.5℃ based on the Paris Agreement on Climate Change and the Intergovernmental Panel on Climate Change (IPCC) 1.5℃ special report by 2050 dictates the need to transform the paradigm of energy use and the role that citizens can play in decarbonizing the energy system. To this end, structural changes promoting energy services that will prioritize social equality and mobility are of the outmost importance now more than ever. Yet, "which citizens to involve in this process", "when to involve them", and "how to do so fairly and effectively", are questions that still remain unclear to both experts and policymakers. The importance of both the role that citizens, as users, can and will play in the energy transition and the interaction between researchers and users can be witnessed by the emergence of the novel concept of "energy citizenship" in recent years.

Energy citizenship is a concept that describes how the public is increasingly engaging with the energy transition. Yet, the concept itself remains under-theorized with various emerging forms within the energy domain. Misaligned and contested understandings hinder energy citizenship from being a concept that can be easily mobilized for encouraging and enabling systemic transformation by citizens, civil and governmental organizations. We argue in this article that the concept of energy citizenship and its potential for contributing to low carbon transitions should be studied within a research framework that aims to produce transformative knowledge.

In this article, we introduce such a transdisciplinary framework for creating transformative knowledge to not only explore and address questions relevant to the concept of energy citizenship, but also to strengthen and reframe the interaction between science and users. Our framework aims to produce knowledge that can be used to mobilise decarbonization actions for both individuals and collectives, by: (i). integrating different scales of analysis and action - i.e., at individual, collective, and regional/ national/ supranational levels, (ii). reconceptualizing the role of research and researchers, and finally, (iii). striving to be inclusive in a meaningful and innovative way.

The proposed framework is operationalized in the context of the Horizon 2020 project - Energy Citizens for Inclusive Decarbonization (ENCLUDE). For this project, a team of researchers with varying social, geographical and scientific backgrounds has been assembled, as we aim for inclusivity from the ground-up. This framework not only aims to consolidate different scales of analysis and implementation, methodologically, through a mixed-method approach, utilising the full spectrum between qualitative and quantitative methods, but also aims to produce transformative knowledge that creates change and can contribute to defining environments and conditions conducive to collaborative goal-setting and decision-making for decarbonization. Thus, we confront the real world with all its complexities that, certainly, cannot be captured accurately by any bounded conditions of a laboratory or a model.

Elaborating further on the scientific aspect, on the qualitative side we employ during the collection and analysis of data: (i). the modified Delphi method and (ii). Case study analysis through the prisms of the Energy Cultures Framework and the Socio- Ecological Systems Framework. The two theoretical frameworks provide the link between various collective and individual scales to explain energy related behaviour.

Moreover, on the quantitative side (i). a clustering process for decarbonization will deploy data-driven Machine Learning methods to derive clusters of energy citizens alongside (ii). The use of energy systems modeling with the aid of an Agent-Based Model, modeling the diffusion of social innovations, a Demand-Side Model simulating the energy demands of individual households, incorporating an individual's behavior and lifestyle changes, and finally, an Integrated Assessment Model that will be used for a deep-dive assessment of the decarbonization potential and climate implications of social innovations at a national level, in terms of aggregated emissions, key climate impacts and adaptation requirements.

By bringing together not only different method typologies – i.e., qualitative and quantitative, but also methods stemming from different disciplines, ranging from sociology to engineering, in every step of the framework we aim to follow an impact-driven "needs-based research" approach to our objectives, with a strong focus on the end-users and how to address their needs.

Furthermore, the gap between the scientific and societal engagement aspects of this project is bridged by the two key outputs of the framework aiming at co-creating further knowledge – the Energy Citizen Leadership Academy and the Interactive Policy Platform. The goal of co-creation within this framework redefines the way the researchers interact with the users, be it policymakers or energy citizens.

The Energy Citizen Leadership Academy, which aims to spur energy initiatives by allowing practitioners and researchers to share and learn from each other's experiences, demonstrates how the role of research and researchers is reconceptualised. Through this Academy, the goal is for 50 citizens to be trained to become "energy citizenship leaders", and as community leaders will re-establish the program and deliver this collective learning curriculum in their own communities to train more leaders, thus creating a "snowball effect". Of course, this endeavour will be supported from the researchers, who in turn will take on a more active and participatory role in the process.

Additionally, the Interactive Policy Platform will be established and will provide policymakers with useful insights regarding the conditions and the contexts within which energy citizenship can lead to high decarbonization, which will be open access and publicly available. The active involvement of stakeholders in the science-policy-business-citizen learning dialogue process will provide a reality check on the assumptions and approaches, as well as ensure high policy relevance.

Finally, it is also highlighted how striving to be inclusive has shaped the research design, the dissemination of the knowledge produced as a part of ENCLUDE and implementation of the co-production activities connected to the project. For example, the research products of the framework are aimed to be disseminated through interactive and customizable web platforms, emphasizing the need for tailor-made information for reaching a diverse set of users and adapting to their needs and different contexts. All these methods will ensure research results that can be relevant, user-friendly, and useful to stakeholders.

Keywords: Decarbonization, Social movements, Energy citizenship, Deliberative democracy, Sustainability transitions, Transformative social innovations

[80] Jordi Molas-Gallart (INGENIO (CSIC-UPV)) and Richard Woolley (INGENIO (CSIC-UPV)). *Research impact seen from the user side.*

Abstract. This paper emerges from the work of the Oslo Institute for Research on the Impact of Science (OSIRIS). OSIRIS brings together different disciplines to look at the process of research impact and asks: How can we characterise the process through which research makes an impact in society? The paper takes up this question from the perspective of the research evaluation literature. It takes a first step toward trying to develop methodological principles for systematic investigation of the role of research user in the generation of value from research.

The role that scientific activity plays in society is constantly being re-assessed. The public sector, which funds a substantial share of scientific research, must allocate funds across different scientific fields and approaches. These decisions are based, implicitly or explicitly, on an estimate of the value the activity generates and of how such value is generated. Such estimates and the extent to which they should drive scientific work have been a topic of debate since the early 20th Century. After the Second World War, however, a consensus emerged that science was a key contributor to social and economic development and that such contribution justified the investments made in it. Vannevar Bush in his much quoted report "Science – the endless frontier" (Bush 1945) laid out a model in which basic research, carried out mainly in universities and private foundations, freely explored natural phenomena without consideration of the possible economic applications of such work, while industry labs tackled immediate practical objectives.

"As long as scientists are free to pursue the truth wherever it may lead, there will be a flow of new scientific knowledge to those who can apply it to practical problems in Government, in industry or elsewhere." (Bush 1945)

Vannevar Bush's neat sequential interpretation of how fundamental research contributed to economic and social progress and its associated research policy model, has been called into question over the last four decades. First, analysts have shown how scientific practice had diverted from the neat distribution of tasks that Bush had put forward. Scientific practice and the utilisation of research results have been revealed as an altogether messier experience, with feedback loops between research, technological development and innovation. Many concepts and theories have been developed stressing the interactive and complex nature of the relationship between science and innovation. The chain-linked model (Kline 1985, Kline and Rosenberg 1986) drew attention to the feedback loops between design and research. The Triple Helix (Leydesdorff and Etzkowitz 1996) emphasized the fuzzy boundaries between universities, industries and government which each of these institutions being involved in tasks previously assumed to be the exclusive remit of one of the others (thus, for instance, universities will set up firms and firms carry out basic research). Notions like "technology transfer" have fallen out of favour to be replaced by more interactive concepts like "knowledge exchange" (Schmoch 1999). These and other neighbouring concepts (mode two research, transdiciplinarity, problem-orientation, productive interactions, responsible research) are framed within a more systemic view of the role of science and technology, emphasizing interactions among partners and the legal and institutional contexts within which these take place. In short, analysts and policy makers have moved their attention to the linkages between knowledge generation and application, questioning the views that saw scientific research as a world apart with its own rules and practices, that generated knowledge which had then to be transferred to other actors for their "translation" and application.

This evolving understanding of how research results are applied is increasingly informing science and innovation policy rationales but has not trickled down with similar fluidity to the evaluation of their results (Molas-Gallart and Davies 2006) and, more generally, to research impact assessment practices and methods. These continue to be dominated by approaches that take as their starting point an investment in research and the activities and outputs that it has generated. Whether one focuses on the processes of knowledge production and application by tracing forward from the research investment, or tries to estimate the economic returns it has generated, the window this perspective offers is necessarily partial. Tracing forward, for instance, will suffer from a selection bias as it focuses on those cases where traceability can be established from the researchers perspective, instead of instances where the effect has been indirect, with knowledge from research "creeping" over time into application environments (Weiss 1980) without the researchers necessarily being aware of this process.

Research and innovation policy evaluation has also favoured taking the research investment as the point of departure for the analysis. Evaluation efforts are often justified by the large investments that science increasingly requires and an unspoken but latent concern about their potential effect on social and economic welfare. When research investments in a single infrastructure run into the billions of euros, it is understandable that the public institutions authorising such expenditures may not be satisfied by the knowledge that "there is always a chance" that such investment will yield social or economic returns. Yet, the ensuing political need to have evidence of such positive impact prompts evaluation approaches that, once again, have as their starting point the specific research investment. Further, they often focus on economic returns and therefore commercialisation activities and the private capture of the benefits of public research investments. Consequently, not only do research impact assessment methods focus on the results of specific investments but economic (and scientific) impact have received more methodological attention than the contribution of science to the generation of social value (Bozeman and Sarewitz 2011).

There has been, however, broad awareness that the focus on economic returns could only provide a very partial account of the effects of science on society. The work of Bozeman and colleagues on the development of methodologes to identify the "research value" and "public value" of research (Bozeman , Bozeman and Kingsley 1997, Bozeman, Rogers et al. 1999, Bozeman and Sarewitz 2011) constitute one of the most important and influential research agendas in this direction. This approach emphasizes that science policy often pursues objectives other than economic growth, seeking a broader normative consensus on the principles on which public policies are constructed (Bozeman 2007). Public values emerge from this normative consensus on principles, but the way in which all public policies (including science policy) contribute to their accretion is difficult to assess, and even more difficult to measure. The interest in the broader social contributions of research is also reflected in official documents like the Ricci report on the social and environmental impact of European research (European Commission 2005), proposals from influential associations representing the views of research funding and performing organisations (Science Europe 2017) and research evaluation practice (Van Noorden 2015, Evaluation Division for Science 2017).

Broadly, the debate on the social and economic value of research and the autonomy of researchers to be guided by their own scientific curiosity continues in the 21st Century in terms similar to those of the previous hundred years. What is changing is an increasingly nuanced understanding of the relationship between knowledge generation and applications and the role that different social groups have in these processes. The conduct of scientific research is no longer seen as solely the reserve of those with a set of formal academic qualifications, but is opening up to broader citizen communities (Bonney, Shirk et al. 2014), and, similarly, the selection of research priorities is seen as a topic where the participation of communities beyond the performers and funders of research is opening new arenas for public controversy (Wallace and Ràfols 2018). Such "democratic governance of the purposes of research" (Owen, Macnaghten et al. 2012) has gained traction in European research policy and which involves a deeper involvement of scientists in the consideration of the types of impact that their activities may lead to.

As the boundaries between research communities and the users and beneficiaries of research outside academia become blurred (Etzkowitz and Leydesdorff 1997; Funtowicz and Ravetz 1992), increasing their connections and making the relationship between knowledge generation and application more complex, the study of research impact cannot be limited to approaches that, implicitly or explicitly, take the research activity as the starting point of a process that evolves through a sequential set of stages (research, technological development, application, social and economic benefits). In fact, although the image conveyed by the notion of "research impact" is simple and follows this archetype, analysts have proposed more complex views of the processes linking research activities and their effect on society and the economy. They have stressed the multidimensional nature of these processes (Donovan 2011), and see research and their results as one of broad set of factors that contribute to, rather than cause, the generation of relevant changes in the economy and in society (Molas-Gallart, Tang et al. 1999, Mayne 2001, Colinet, Gaunant et al. 2013, Belcher, Davel et al. 2020). The image conveyed by the term "impact" suggests an origination cause (the research) yielding results as of its own momentum. Yet, this is seldom the way in which the benefits from research accrue. To contribute to economic and social changes research results need to have been used at some point, often within complex innovation processes. We can therefore argue that "impact" is fundamentally about the use of research –leading to the commercialisation of new products and services, the implementation of new policy directions, the improvement of healthcare and more. Yet, research users are often missing or have limited roles in the models and narratives employed in impact assessment methodologies. The main rationale for impact assessment remains the identification and measurement of the socio-economic impacts of specific bodies of research rather than to understand how research results are used and how they transform the roles, capabilities, and performance of users.

This paper proposes initial steps toward placing research use and research users at the centre of research impact assessment. We first review the dominant approaches to impact assessment. As part of preparing the paper, we analysed the framing of research users in the key research evaluation literature and incorporated this analysis in what follows. The first review section focuses on the shift from linear and mainly quantitative approaches toward mixed and qualitative approaches, then on to views focusing on the complex ways in which research effects are generated. We refer to those influential approaches that have focused on identifying the interactions and the pathways through which impact occurs and show how process-oriented methods have seldom attended to the role of the research user as a central actor in these processes. The second review section considers the challenges of focusing on the user perspective, particularly tracing back from technological developments and knowledge use as a diffusion process. We highlight the challenges that the research user perspective poses for the design and implementation of impact assessment methodologies. We then propose an initial set of elements for building an approach that can address such challenges and provide an analytical table summarising the main assessment approaches reviewed. From this preceding work we derive a set of simple but systematic methodological principles regarding the identities, roles, and positioning of research users, which configure their contributions to realising value from research and can form the basis of empirical assessments of research impact seen from the user side. We illustrate aspects of our thinking using examples from the OSIRIS project research programme on research impact. In our concluding remarks we discuss the policy implications of our approach and how our methodological principles reframe thinking about research use and research users as both the starting and anchor points of research impact.

Keywords: societal impacts of research, research users, research evaluation review, methodological principles, research impact policy

[81] Sergio Barbosa (Universidad Autónoma de Madrid), Patricio Sáiz (Universidad Autónoma de Madrid) and José Luis Zofio (Erasmus Research Institute of Management (ERIM), Erasmus University Rotterdam, the Netherlands). *The Emergence of Innovation Networks: Patents, Collaboration, and National Innovation Systems in the European Periphery over the Long Term.*

Abstract. Either to compete or to collaborate? These are usually two opposing forces in economic theory and, more specifically, the field of industrial organization, whose trade-off has been studied through the theory of games and economic behavior. In this regard, the effects of collaborating in innovation activities have shown relevant to explain economic development because they encourage strong positive externalities resulting in increased social welfare (Axelrod, 2006; Motta, 2004).

Collaboration networks are drawing increased attention from scholars because nowadays the solution to complex problems requires the integration of different sources of knowledge that favors what several authors call 'recombinant capital' (Endres & Harper, 2020). The way people share and merge ideas, collaborate or compete when finding solutions to scientific or technical problems makes the difference between succeeding or failing. Empirical evidence shows that the intensity and quality of these information flows and collaboration patterns in the past strongly influence the character of national innovation systems (NIS) and economic growth over the long term (Andersson et.al., 2019).

Social Networks Analysis (SNA) is a key tool in social sciences to study collaboration trends among economic agents, as it provides understanding about how agents are connected and how information is shared (Ahuja, 2000; Cantner & Graf, 2006). In this vein SNA methodologies are increasingly used in economics to delve into the role of collaboration dynamics in innovation activities, allowing us to illustrate, analyze, and understand the importance of innovation networks and their topological properties�i.e., density, average path, betweenness centrality, components' size, etc.—in the evolution of the structure of NIS. Specialized literature demonstrates the potentiality of SNA to portray the characteristics of NIS through the above indicators. Part of this literature uses patent data as the most suitable proxy to analyze innovation networks. These studies characterize the networks of co-patentees/co-inventors and relate them with economic, geographical, or sociopolitical variables to conclude the features driving the growth of collaboration (Almeida et al., 2011; Kay et al., 2017). Attributes such as the membership number and the emergence of large components in the networks are key variables in the study of science, technology, and innovation economics (Bianchi et al., 2021).

In this study, we combine in a novel way historical patent data, SNA, and discrete choice regression techniques to study the origins and evolution of the Spanish innovation system. This allows us to offer a long-term perspective of how cooperation emerged and evolved, especially in follower and late-comer countries in the European periphery such as Spain during the late nineteenth and early twentieth centuries. Specifically, we rely on SNA methods to generate a co-patentees' network and analyze its topological properties. We focus the analysis on the dynamics underlying the emergence of the network in terms of the size of the components and the membership of the individuals that conform those components. Membership is a vital aspect because the literature remarks the idea that the larger the components, the higher the flow of information among actors and throughout the entire network (Ter Wal & Boschma, 2009). Thus, our main objective is to analyze and understand how collaborative innovation emerged and how technical information and knowledge spread over the long term.

Data comes from original historical documentation of the Spanish Patent and Trademark Office (OEPM), compiled by our research group through a collaboration agreement (see https://www.ibcnetwork.org/project.php?id=18). We analyze more than 73.000 patent applications registered by residents in Spain from 1878 to 1939. We construct the collaboration networks for two periods: the initial one between 1878 and 1914, i.e., until the First World War (WWI), and the cumulative period between 1878 and 1939 (the end of the Spanish Civil War). Then, we study the transitions associated with the growth in the number of members belonging to components of different magnitudes. For example, the transition of members that start out being isolated in the first period to being connected in the whole period, or those that belong to components with less than three individuals to take part in components of more than three members. Then, we set out to explain why individuals reach a larger membership in the second period while others remain isolated or belonging to small groups. This is equivalent to identifying the factors that triggered collaboration in the form of high connection levels. Consequently, our central focus is to explore and understand the main factors that ease connections among patentees, promoting the evolution of the innovation network.

Thanks to a rich database on the characteristics of each patent (type, duration, assignments, technological sector, etc.) and patentee (profession, gender, geographical location, relative technological specialization and diversification with respect to the national average, etc.) we set up explanatory variables into a linear probability model that test the likelihood of transition. Regarding the relative importance of the explanatory variables, we identify a group of relevant characteristics that stand out from the rest when explaining the emergence of connections and the size of the components. First, variables related to the quality of the invention protected, or the geographical and sectorial dispersion of patentees, are instrumental in triggering collaboration (i.e., are significant in the probability of transition from being isolated to establishing links). Second, variables such as the geographical or sectorial concentration of patentees explain the emergence and development of highly connected (larger) components in the network. On the contrary, institutional weaknesses such as patents of introduction to copy foreign technologies hampered the formation of solid innovation hubs.

Delving into the variables and factors that influenced collaboration sheds light on how innovation networks appear and evolve and, therefore, on the reasons for the divergences among present-day NIS. Particularly, our findings contribute to a better understanding of the historical backwardness of the Spanish innovation system and may be useful to develop policies aimed at fostering social capital regarding R&D&I dynamics. The development of this research agenda will provide a long-term vision of the evolution of cooperation in innovation activities using new methodological techniques (SNA indicators) and help policymakers with recommendations based on NIS and property rights. The historical approach of this study adds a new dimension to studying R&D&I networks. Future research will extend these methods to present-day data, aiming at understanding current situations and problems and be able to propose economic policy solutions. Therefore, we intend to extend the time sample. We also intend to check the robustness of our results using alternative models and estimation methods such as zero-inflated or count data regressions. This will ultimately help us to understand the dynamics of the patent network at the sectoral and regional levels from a long-term perspective.

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Keywords: Patents, Social Network Analysis, National Innovation Systems, Linear Probability, Indicators, Innovation Policy, Long Term, European Periphery

[82] Mika Naumanen (Technical Research Centre of Finland VTT). *Covid-19 pandemic's impacts on innovation collaboration.*

Abstract. Research question

In what way does a company's innovation collaboration profile (breadth, depth, temporality) and receiving national public innovation funding relate on how the Covid-19 pandemic has affected it and its innovation strategy objectives?

Relevance

The Covid-19 pandemic has pushed society toward an unprecedented crisis. In such extraordinary circumstances, the urgency for mitigating the full impact of Covid-19 by reducing its short and longer-term impacts has driven governments to launch widescale and fast-tracked innovation policies. For example, Azoulay & Jones (2020) emphasize that prevailing government attitudes to policymaking indicate that Covid-19 can be beaten quickly by promoting innovation. The impact of Covid-19 to businesses have been studied by Stephany et al. (2022) and Hassan et al. (2020) among others.

Stephany et al. (2022) used data mining approach to study economic consequences of the Covid-19 pandemic by analyzing reports from US companies and developed CoRisk-Index indicator. They defined eight different topical domains (production, supply, travel, demand, finance, aid, remote, vaccine) describing Covid-19 related discussions of companies. studied how to measure and analyze firm level responses to a pandemic shock by analyzing quarterly earnings conference calls of publicly listed companies. They divided discussions into six main topics: supply chain, production and operations, demand, cost, financial and government assistance.

Little is known, how the Covid-19 pandemic has affected companies' innovation activities. Moreover, to innovate companies often need collaborate with many actors from outside their organization. In this paper, we focus on examining the relationship between the Covid-19 pandemic's impact on the company's innovation activities and the nature of its innovation collaboration strategy.

Theoretical framework

Laursen and Salter (2006) conceptualize firms' openness in knowledge searches as being primarily characterized by the breadth and depth of the external knowledge search, where they define breadth as "the number of external sources or search channels that firms rely upon in their innovative activities" and depth as "the extent to which firms draw deeply from the different external sources" (Laursen & Salter, 2006). Collaboration breadth determines the number and diversity of knowledge fields that are available for transfer and internalization, the variety of shared experiences and organizational learning, and the number and ambidexterity of resources. Collaboration depth, indicating the extent and intensity of the interactions between the focal company and its collaboration partners, on the other hand, determines the opportunities for knowledge transfer and learning.

We examine whether there is typical concave (U-shaped) relationship (Kobarg et al., 2019; Laursen & Salter, 2014) between the breadth and depth of the company's innovation collaboration and the level of impact Covid-19 has had on the company's innovation strategy: both companies with no innovation collaboration and companies that are very dependent on external knowledge search may have suffered the most during the Covid-19 pandemic. In other words, resilience to Covid-19 pandemic and the company's strategy to innovation collaboration are likely to go hand in hand. Companies can be more innovative and resilient if they gain from external parties, but this reliance in their knowledge creation makes them more vulnerable to external shocks hindering that collaboration.

Data and methodological approaches

Survey

The survey was conducted between September 29 – October 6, 2021. The target group of the survey were the persons who had applied innovation funding from Business Finland during from January 2018 to June 2021. There were altogether 3898 funding applications from 3002 persons. At the time of the survey, 2836 (95 %) of the given email addresses were valid. A total of 825 responses were received giving a response rate of 27 % of the total sample and 29 % of the valid email addresses. The response rate was quite stable along the four possible funding categories: all the applicant's applications got funding; none got funding; some of the applications received funding, some did not; or the application was withdrawn.

Table 1. Survey sample and response rates.

The questions used in this study focus on the Covid-19 impacts felt by the company. The respondents were asked, using a five step Likert scale, "How has the Covid-19 pandemic affected your company's innovation activities, i.e. research, development and commercialization of a new product or service?" with respect to the following seven statements

• Adequacy of own funding

• Availability of public funding

• Breadth of customer relationships (number)

• Depth of customer relationships (e.g. size of customer purchases, frequency of communication, amount of cooperation)

• Employee job satisfaction and engagement

• Availability of skilled labor

• Relationship with innovation partners

As background variables a combination of the company size, following the EU recommendation 2003/361, and industry grouping was used.

• Knowledge Intensive Business Services (KIBS): NACE classes 62, 63, 69-74, 78

• Manufacturing, NACE classes 10-33

• Others: all other NACE classes

As an example, basic statistics on the adequacy of own funding with respect to company size, industry group and whether it had received Business Finland funding are shown in Figure 1 and Figure 2.

Figure 1. The impact of Covid-19 pandemic to the company's adequacy of own funding for innovation activities with respect to the company size and getting Business Finland funding.

Figure 2 The impact of Covid-19 pandemic to the company's adequacy of own funding for innovation activities with respect to the industry grouping and getting Business Finland funding.

Methodology

Previous studies have frequently measured the depth of external knowledge sourcing as the number of knowledge partners on which the firm deeply draws (Ghisetti et al., 2015; Laursen & Salter, 2014). To operationalize collaboration breadth, we used the number of collaborative activity that the respondent deemed very or extremely important with the partner(s) in innovation activities, i.e. “Another company in the same group”, ”Customer”, ”End-user”, ”Supplier”, ”Consulting and/or software company”, ”Other private company”, ”University”, ”Technical Research Center of Finland VTT”, ”Other research institute”, ”Other public sector actor (e.g. city, regional development company)”.

An interesting element is the introduction of a temporal element of the innovation activity, whether it is serving for a short-term objective or is looking for a more far-fetched advantages – typically in collaboration with universities and research institutes. Accordingly, one of our survey questions dealt with the relevance of the various objectives of company’s innovation cooperation. These objectives include developing the flexibility and efficiency of the company’s processes, knowledge of technological developments, developing the company’s current market, developing wider markets and/or networks and their potential, and participation in public procurement, for example. The respondents were asked also whether the innovation collaboration had created new research, product development or commercialization projects.

Expected results

Besides simple effects, we examine whether our independent variables interact with each other. First results show this seems to be the case with respect to the temporal dimension of the innovation collaboration, for example. This will extend the current literature of innovation breadth and depth with a potential new dimension. We will show how Covid-19 pandemic has affected small, open economy’s companies’ innovation activities, how those impacts have related to the nature of a company’s innovation collaboration and the type of the company (size, industry background, receiving public innovation funding) and the objectives its innovation activities.

Note: it has been challenging to find statistically significant results. Below, I show some preliminary findings.

Impact on innovation activities

On the basis of the question “How has the covid pandemic affected your company's innovation activities, ie research, development and commercialization of a new product or service?”, we can provide either one factor or a three factor model of the impact, the one factor model being a kind of an index of the severity of the impact. The weights for the one factor model would be

• Adequacy of own funding 0,531

• Availability of public funding 0,210

• Breadth of customer relationships (number) 0,761

• Depth of customer relationships (eg size of customer purchases, frequency of communication, amount of cooperation) 0,816

• Employee job satisfaction and engagement 0,450

• Availability of skilled labor 0,207

• Relationship with innovation partners 0,449

One factor model values customer relationships and own funding.

On the three-factor model, the two additional factors indicate that covid pandemic has produced challenges to certain innovation activities. There might have been challenges in own funding and in customer relationships, or the company might have had adequately own and public funds but challenges in all other innovation activity measures.

Table 2. Covid pandemic’s impact on companies’ innovation activities, factor weights on a three-factor model.

In what follows, we present results of the analysis gives for the three-factor model. In essence, the one factor model would produce similar results (following the Factor1 of the three-factor model).

Impact on economic development

We are interested in seeing how the covid pandemic has affected the company financials over the years 2019 – 2021, that is, our dependent variables are the change in the: (1) operating revenue (turnover), (2) number of employees, (3) domestic turnover, and (4) share of the exports in the turnover.

Table 3 summarizes our findings about the relationship between a company’s innovative activities and the impact covid pandemic has had on its economic development. The variable BF_FUNDING depicts whether the company did receive Business Finland financial support or not. The variable INTENSITY measures how often the company is in contact with its most important innovation partner(s). The variable LONG_RANGE shows that the objective of the innovation collaboration is to develop a broader understanding of the development of the business and its technological solutions without (yet) affecting the company's products and services. Finally, the variable HANDS_ON depicts that the innovation cooperation is characterized by involvement in planning and implementation of projects.

Table 3. Innovative activities and the impact covid pandemic has had on a company’s economic development.

In the results above, we have included the intensity variable as a moderator for the three factors that characterize the covid pandemic’s impact on the company’s innovation activities. The results would be the same without the interaction effects, but the interaction intensifies the findings.

Covid pandemic seems to have had a negative effect on those companies whose innovation cooperation involved planning and implementation of projects. The opposite holds true for those companies where the objective for the innovation cooperation has no direct impact on the company's current products and services.

On our covariates, compared to average industries, manufacturing has done better in pandemic and knowledge intensive business services worse. Moreover, smaller companies seem to have suffered less on pandemic than large corporations, which is quite surprising. Have they been less dependent on global value chains?

Conclusions and policy issues

Covid-19 pandemic has affected different types of companies differently, small companies having fewer own resources available for innovation, for example. It is important to get deeper understanding on the Covid-19 pandemic’s impact on companies’ innovation activities, hence, be able to develop policy measures that will remedy those negative effects and secure the basis for future business development.

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Keywords: Covid-19 pandemic, Innovation collaboration, Firm-Level exposure, Public R&D funding

[83] Matthijs Janssen (Utrecht University / Dialogic), Joeri Wesseling (Utrecht University), Jonas Colen Torrens (Eindhoven University of Technology), Matthias Weber (AIT AUSTRIAN INSTITUTE OF TECHNOLOGY) and Caetano Penna (Utrecht University). *Missions as a boundary object in umbrella frameworks: The case of the Dutch Mission-oriented Topsector and Innovation Policy.*

Abstract. 1. Introduction

Mission-oriented innovation policies (MIP) have a prominent place in ongoing debates on innovation policies for addressing societal challenges (Mazzucato, 2018; Larrue, 2021). This debate is generating different understandings of what such policies might look like (Mazzucato et al., 2020; Alves et al., 2021), yet it is typically understood that these policies need to service a clear, ambitious and time-bound societal goal.

Regarding actual missions as the cornerstone of attempts to address societal challenges, one could argue, foregrounds efforts of steering directions and promoting alignment in policies, investments and practices on the ground. While steering is sometimes presented as a state-led and top-down affair, such approach may be unsuitable for wicked societal challenges, which would overwhelm policy capacity and the political willingness to impose clear directions (Wanzenböck et al., 2020). Wicked challenges are societal problems with an uncertain, contested, and complex nature, which require diverse bottom-up experimentation efforts for identifying promising solutions (Hekkert et al., 2020). In such cases, the challenge is to mobilise and unite actors' efforts around a mission without telling them what to do.

To address this challenge, Janssen et al. (2021) have proposed that missions may be regarded as a boundary object (BO), i.e. objects with enough plasticity – interpretive flexibility – to be adaptable to specific contexts yet sufficiently robust to maintain a common identity across these contexts (Star and Griesemer 1989; Star, 2010). This perspective highlights how openness in framing a mission engages different communities, in their own terms, interpretations and interests, while fostering dialogue to develop a more cohesive relationship with a given societal challenge. Communities can engage with the mission in arenas concerned with four distinct aspects, covering strategy, vision, policy instrumentation, and actual search for solutions. Through contestation and negotiation, openness on these aspects can be reduced, which – especially when articulated explicitly – might then also influence interpretations in other arenas.

The BO perspective has significant but underexplored implications for how missions may be used as devices for spurring and coupling activities addressing societal problems. To further explore the analytical and practical applicability of this view, there is a need for more empirical work on how missions operate as boundary objects.

The current paper speaks to a prominent characteristic of policy strategies framed explicitly as missions, the presence of an 'umbrella framework' (JIIP, 2018; Larrue, 2021). Such a framework comprises a set of overarching governance structures and policy instruments that serve to support a number of missions, targeting different societal challenges. Individual missions often rely on additional policy measures and governance processes, especially if they are the responsibility of actors that are not in charge of the umbrella framework. For instance, the German HighTech Strategy, launched by the Federal Ministry of Education and Research (BMBF), includes BMBF's targeted R&D support but also invites other ministries to adapt their policies to the 12 national missions.

It is particularly pertinent to study such frameworks as BOs. An umbrella framework covers goals in different societal domains and must therefore accommodate divergent views on how MIPs can drive change, and through which actions and solution directions this would need to happen. Nevertheless, previous research neglected the interface of a mission framework and the various missions it supports, with little to say about the potential for (and risks of) contestation and negotiation. We explore this interface, regarding missions as BO's, to address the following questions:

1. What subjects provoke disagreements among the communities engaged in the arenas concerning the umbrella framework, strategic missions, and their interface?

2. How do the uniform policy elements in a mission framework relate to differences in how mission strategies and mission goals are understood?

This paper explores, empirically, how missions-as-boundary-objects may help or hinder actors to align their policy and innovation efforts. The analysis centers on the case of the Dutch Mission-oriented Topsector and Innovation Policy and two of its missions. Rather than treating the case as an instance of best practice, we examine the coordination issues related to (mis)alignment to elicit possible policy responses.

2. Theory

Missions are meant to achieve some degree of coordination in research and innovation activities, but also in mobilising the necessary activities in distinct sectors. How this coordination is achieved is a matter of debate. Key propositions regarding missions, as in e.g. Mazzucato's (2018) approach, place too much emphasis on the role setting bold, ambitious goals have. Overemphasising goal setting is problematic, because it a) presumes a lot of consensus, b) is not explicit about how such consensus is achieved.

Janssen et al. (2021) have proposed a boundary object perspective. This approach makes clear that missions coordination has to be achieved in different arenas, which comprise distinct communities. Treating missions as boundary objects allows for unpacking the 'coordination task' of mission in these different arenas, and understand that the process requires a balancing of constructive ambiguity, on the one hand, and moments in which closure is achieved, and boundary objects become less plastic, with more formalised agreements about particular missions.

An aspect of this framework that has not been made explicit yet regards the nestedness of different arenas, and the potential convergence or divergence that arise at the interface between different arenas. Currently, many countries have put forward proposals for establishing umbrella frameworks with which to structure specific societal missions. These frameworks correspond to the outcome of the strategic arenas, the most abstract, where metanarratives about missions and other notions of transformative or challenge-oriented policies are discussed and articulated as governance structures. Meanwhile, the formulation of specific missions can be understood as the primary outcome of the programmatic arena. At these arenas, the thinking goes, debates centre primarily on how to formulate goals that can mobilise different actors, and how to scope the actions that correspond to a mission.

Applying this framework to the analysis of cases questions the idea that an umbrella framework is set in stone before other missions are set up, or that missions formulated in the strategic arena will be automatically aligned with the overarching framework. Instead, the missions-as-boundary-objects perspective highlights the way cooperation without consensus is possible within these different arenas, and how misalignments between arenas is not uncommon, given the complexity of the negotiations between actors at each arena.

3. Methods

To study how different communities engage with mission strategies and goals, we revisit case studied conducted as part of earlier research on the Dutch MTIP and two of its 25 missions – on Circular Economy (CE) and on carbon-neutral Built Environment (BE). The underlying data consists of document research, and around 20 purposively sampled interviews in the period June – October 2020. Interviewees consist of different types of stakeholders involved in the 'delegated' mission governance (i.e. quadruple-helix teams from which supply-oriented and demand-oriented R&D and innovation activities are coordinated)

Interview questions addressed the orchestration and performance of several governance aspects, including exploring problem/solution directions, deciding what to support, and reflexivity on this account. The obtained data was used in an explorative (open) analysis that serves to understand interpretation/negotiation and (mis)alignment around the boundary objects. The analysis pays attention to which communities are engaging in a certain arena, which interpretation of a mission strategy or goal they advance, and (as far as this can already be observed) how the ensuing contestation of different views plays out.

4. Preliminary findings

In the case of the Dutch MTIP and the two investigated missions, communities are found to have divergent views on strategic issues like the objective of having the mission (policy), the type of innovation that should be supported, the dominant force to target (solution supply or demand) and the importance of either boosting variety in novel solutions or supporting synergies by selecting just a few options.

Briefly stated, the MTIP as such is mostly an umbrella framework for driving R&D, while the CE mission is more concerned with actually solving the societal challenge. The BE mission is somewhere in between, as it contains innovation strategies and policies in which the Ministry of the Interior (BZK) leading the mission teams up with the Ministry of Economic Affairs and Climate Policy, as well as purely demand-oriented policy initiatives and legislation by just BZK.

The notion of umbrella framework suggests that missions fall 'under' an all-encompassing canopy. However, if the framework only takes care of the innovation part of solving a challenge (which can get the majority of its momentum from other policies, like sectoral ones), the umbrella is perhaps not always as comprehensive as the metaphor might suggest. If the frameworks aim to use innovation-based missions as a way to activate other policy stakeholders, who might take ownership and mobilize resources, implementing such a strategy is more analogous to building a skeleton architecture, or seeding transformations.

As the MTIP and the two missions were put in place still fairly recently, not much is known about how different communities work out the observed differences in interpretations. Still, it is clear that with the encountered degree of openness, the BO perspective becomes all the more important. It recognizes that plasticity allows stakeholders to contribute to the same goal, without actively collaborating or even agreeing with each other (e.g. on a certain framing). Reasoning from different views, fragmented 'bottom-up' initiatives by different communities can still advance the development and diffusion of innovative solutions, as long as they accept the mission as a valid guidance towards the goal of addressing the focal challenge.

5. Preliminary discussion and conclusions

The downside of working on missions as open concepts is that there are no guarantees that all efforts are fully in line with each other. This creates misalignment risks related to e.g. developing solutions that get stuck in the prototyping stage (no diffusion) or that do not converge towards a dominant design. Reversely, policy might fail by accommodating the upscaling of solutions that are not there yet.

The upside of openness is that it prevents that progress is stifled precisely because actors can not agree on a clear direction. Missions as a common point of reference may invoke uncoordinated yet mutually reinforcing investments, which (especially when supported by accompanying monitoring, evaluation and learning frameworks) ultimately reveal which solutions are most promising, viable, legitimate, etc.

In other words, allowing for openness can be a deliberate strategy to explore the actual preferences from different communities (stretching over industries and citizens) to choose for certain solutions. While ensuring convergence might often be regarded a starting point for targeting policies at wicked challenges, it can thus also be the result of running policies that allow different communities to engage with an open concept.

The above begs the question whether there can be too much openness. One reason for not discarding this possibility is that for very wicked problems there is a lack of common ground that would allow for conflict or learning. If communities adhere to fundamentally different interpretations they might operate independently from each other, and use incompatible criteria for monitoring progress – thereby hampering overall reflexivity on where the mission stands and what is needed to advance it. Such a situation reflects the notion of incommensurability between paradigms; a lack of shared understandings that would allow stakeholders to properly recognize where their views differ. The communities might not confront each other, and all carry on in different directions.

Our study tentatively suggests that when stagnation (in addressing wicked challenges) lurks, it might be better to avoid excessive openness and be as clear as possible on the strategy, the vision, the scope of the instruments etc. This would reduce the spectrum of possible actions and solutions, which could be necessary to spark debates about which paths to follow. Excluding some meanings and views could imply that particular communities are more attracted to the mission as it becomes more specific. Within the refined space of possibilities there can be openness again, until the mission arrives to a point in which clear distinct legitimate solution paths stand out. It remains up for further research to test whether the suggested approach is indeed a recipe for success.

Keywords: innovation policy, governance, societal challenges, policy mix

[84] Indira Yarullina (Friedrich Schiller University Jena). *Structure and dynamics of regional research landscape.*

Abstract. The core proposition of the Triple Helix concept is that universities play an enhanced role in innovation in knowledge-based societies (Etzkowitz and Leydesdorff, 2000). Indeed, the accumulation of knowledge is a key driver of technological change and economic growth (Nelson and Winter, 1982; Giovanni Dosi, 1988). Nowadays universities provide a conducive environment for innovation via education and mobility of human capital, collaboration with firms in which knowledge is transferred, and direct commercialization of knowledge via licensing and academic entrepreneurship (Reddy, 2011). To support this development, policymakers attempt to increase incentives for collaboration with industry. Thus, promoting positive attitude towards more applied research and transfer (Reddy, 2011).

However, empirical research on the embeddedness of actors in the regional knowledge base lacks a comprehensive approach towards the structure and the dynamics of the interaction of academic actors with non-academic actors, especially from the point of academic actors (e.g. universities). Several empirical observations motivate this. First, scholars approach the topic in particular via university-industry co-publishing with the main focus on the broad scientific disciplines, where the collaboration takes place (Abramo et al., 2009; Bloch et al., 2019). Second, the role of universities under knowledge and technology transfer (KTT) is mainly evaluated from the economic perspective (patenting, academic spin-outs) (Trencher et al., 2014b,a). As a result, the medicine, chemistry and biotechnology fields show a high number of collaborations with industry while social sciences are left behind. Therefore, there is a need to extend the traditional assessment of the regional knowledge creation and exchange for knowledge and technology transfer.

To provide means for this more general assessment, I develop a methodology that evaluates the research capabilities of the region to measure and investigate the field-specific contribution of university and non-university actors. Thus identifying the potential ’room’ to intervene and improve the embeddedness of actors in the regional knowledge base system. I apply bibliometric analysis on scientific knowledge produced in the German regions to re-create the structure and dynamics of the regional knowledge base. I define scientific knowledge created in the region as the total number of publications with at least one author from that selected focal region (Bloch et al., 2017). The data is extracted from Dimensions database and it consists of scientific papers with abstracts and authors’ affiliations for the period 2000-2020. Germany consists of several NUTS1 regions and I look at the development of these regions over three periods of time. I apply topic modelling on words and bigrams extracted from the titles and abstracts of the papers to divide the broad disciplines into smaller parts (Asmussen and Møller, 2019). These keywords form broader research topics if they intensively appear together in publications. In the next step, I use the revealed comparative advantage index (Balland and Boschma, 2021; Nesta and Patel, 2005) to measure the specialisation of the region in particular topics and what actors contribute to the creation of these topics. Namely, whether research on a topic is purely published by university and developed only by the researchers from universities or if there is the participation of non-university actors as well. I test the developed methodology on Biological Science papers as most attractive for technology transfer research discipline.

The first findings illustrate that the methodological approach can identify region specialisation in research topics and that non-university actors’ involvement increases over time. It becomes clear that German regions differ in terms of specialization even within one research area. Some regions, e.g. North Rhine-Westphalia and Hamburg, show high diversification and specialise in many topics of Biological Sciences, others focus on some specific areas, thus supporting the need of targeted approach toward regional capabilities, for instance, via Smart Specialisation strategy (Foray et al., 2009).

For a more fine-grained exploration of the knowledge composition of the region, I focus on Thuringia as an example. In the first period (2000-2006), Universities are the main contributors to the knowledge base of the region (38%), in the last period (2014-2020), share of collaborative papers between university and non-university actors increases: within region (22%) and with actors from other region (50%). Significant share of inter-regional collaborations of regional non-university actors (36%) might highlight the mismatch of capabilities of regional actors: namely, regional universities do not or cannot cover the ’needs’ or ’interests’ of regional non-university actors. The same decomposition of knowledge base I apply on each research topic withing Biological sciences to consider the regional specialisation and identify particular research topics - potential targets for Smart Specialisation and KTT policies. When exploring the regional perspective, I estimate the performance of the region in terms of collaboration and specialisation in KTT attractive areas. This approach allows to pinpoint the level of KTT (collaboration) in the region and identifying potential areas for development. For example, increasing the level of collaboration for specialisation areas, where it is possible (areas with high collaboration level) or maybe even considering opening new knowledge domains.

The proposed method allows systematically summarize and estimate research topics within a region. It looks deep into different research subfields and allows comparing them in terms of collaboration with non-academic actors. The paper provides a methodological basis for the potential application of publication data in analysing the regional competencies in the research area and identifying the target areas for KTT and Smart Specialisation Strategy. This research tries to turn the traditional approach toward Universities as ’servants’ of firms and society and explore closely what is actually going on in universities. This is especially relevant for KTT studies that try to explore the obstacles of University-Industry interaction: by exploring the possible mismatch of when regional universities offer and what other actors are doing. Instead of looking to universities to fill the gaps in the regional innovation system policymakers should, use their local research portfolio to encourage new actors (e.g. firms, research organisations) to work with regional universities (Kempton, 2019; Brown, 2016).

Such composition of knowledge specialization of the region can create priorities for Smart Specialization in a region: setting priorities towards some specific research areas (e.g. via funding) and not disperse focus on all actors and activities (Foray and Goenaga, 2013; Balland and Boschma, 2021). This approach by analysing the actors’ contributions is especially relevant for new emerging activities, since new knowledge often appear in basic science (mainly academic papers) and then move to firms. The so-called research trends. In addition, these research results can be used as an interpretation of some failed KTT strategies in regions: mismatch of regional actor’s capabilities.

It is important for policymakers to understand the opportunities that different actors provide, and then decide where it is important to engage firms with universities providing new research directions, and where the university can follow the needs of the firms. Thus match of capacities of regional actors: increase incentives of non-university actors (or establish new non-university actors) to work with existing regional research portfolio and to pick the emerging research trends. Policymakers must consider that changes in faculty research agendas can and sometimes should not be altered overnight.

Keywords: Knowledge space, Technology Transfer, Science-Industry collaboration, Co-publishing, Smart-specialization

[86] Kristin Oxley (University of Oslo). *Grant peer review panels evaluating interdisciplinary research – a stumbling block for effective STI policy for societal challenges?*

Abstract. Helping solve societal challenges through science often requires approaches that cross boundaries between different disciplines, and qualitative and quantitative evidence exists on the positive relationship between interdisciplinary research and societal impact. However, there is evidence that grant peer review disfavours interdisciplinary research. Reviewers tend to favour proposals in their own fields that align with their ways of thinking (Travis and Collins 1991), and quantitative evidence shows that the more interdisciplinary a grant proposal is, the slimmer are its chance of success (Bromham 2016). Studies analysing the effects of different ways of organising peer review find that when the aim is to promote interdisciplinary or other kinds of non-conventional research, the organisational set-up needs to be adjusted to a more risk-taking mode (Langfeldt 2006).

Research questions

The purpose of this study is to explore how interdisciplinary research grant proposals are assessed. More concretely the aim is to answer the following questions:

• How do individual panellists evaluate interdisciplinary research proposals and how

does the organizational set-up of the funding competition affect their assessment?

• How do grant peer review panels collectively evaluate interdisciplinary proposals

and how does the organizational set-up of the funding competition affect their

assessment?

The study takes a pragmatist perspective on evaluation. Emphasizing the situatedness of evaluative practices, it highlights that group dynamics and the organizational characteristic of the funding competition (call requirements, evaluation criteria, panel discussion protocol, etc.) are key to determining the faith of interdisciplinary grant proposals. The study combines insights from the literature on peer review stemming from sociology of science and science policy studies with the literature on group performance and decision making in social psychology.

Data and methods

The study is based on ethnographic observations of grant review panels and interviews with panellists. In studies of grant peer review, observational studies are rare and the few studies that exist have been carried out within a single funding agency only, involving a small number of panels.

The study aims to address these gaps in the literature, including observations of six different funding competitions in four different research funding organisations at national, Nordic and EU-level. The competitions have to varying degrees made adaptations to the review process to accommodate interdisciplinary proposals, making for fertile ground to study how the organizational setting in which review panels are embedded impact the assessments made. The empirical material that the study builds on is unparalleled by any previous studies on the subject, drawing on more than 100 days of observation of more that 100 panels, and interviews with more than 80 panellists.

Preliminary findings

Taken together, the six funding competitions studied point to some common challenges that interdisciplinary grant proposals face:

• Lack of disciplinary match between proposal and evaluator

• Panels fail to appreciate the proposal as a whole

• Interdisciplinary proposals face stricter requirements in terms of language and clarity

• Interdisciplinary proposals face more complex and diverse demands in terms of excellence

• Interdisciplinary proposals face more complex and diverse demands in terms of implementation

These challenges are more pressing the more interdisciplinary a research grant proposal is. Even in competitions specifically set up to select radically interdisciplinary proposals, radical proposals seem to be disadvantaged. One explanation for this seems to be that funders underestimate the challenge of taking panelists out of their "standard" evaluation modus of rewarding traditional forms of excellence. This might be remedied by paying more attention to the orientation and implementation stage of the evaluation process.

According to a functional theory of group decision making, groups normally move through the stages of Orientation – Discussion – Decision – Implementation (ODDI) when making decisions. In the funding competitions observed, nearly all resources are concentrated at the discussion stage. However, when seeking to fund interdisciplinary research, more resources might need to be invested in the orientation stage – in order to take panellist out of their standard evaluation modus - and in the implementation stage – to verify that there was no slide towards the standard evaluation modus in the course of discussions.

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Keywords: Interdisciplinarity, Peer review, Research funding competitions

[87] Marcel Siegler (FH Bielefeld). *Developing a vision as a normative framework for transformative sociotechnical innovation of geriatric care in a real-world laboratory in Bielefeld, Germany.*

Abstract. Real-world labs (RwL) are frequently used experimental settings for co-designing and co-producing social and technological innovations as well as knowledge from the bottom up. The participatory nature of RwL allows meeting unmet needs that the private sector might not consider worth its while. Simultaneously, the niche character of RwL allows accumulating social and technological innovations to engender societal transformation. RwL not only provide the necessary personal and material research infrastructure and knowledge for investigating social innovation practices and innovative technologies. They also follow clear-cut visions that serve as normative trajectories for the general direction of research. Especially in urban, mobility, and energy sustainability research, RwL are used to tackle the persisting problems of our changing society by following visions of a greener future.

In the project TransCareTech (TCT), we want to tap into the visionary potential of RwL as niches for social innovation and utilize them for the socio-technical transformation of care systems. We aim at launching two transformative RwL, one for geriatric care and one for early help, in Bielefeld, Germany, in the next two years. In this context, we are heavily interested in exchanging ideas and suggestions with participants who have already had experience in using RwL as transformative settings within the health care domain.

Currently, we aim to accompany the planning phase of the RwL Geriatric Care with a vision phase. To involve elderly people, their relatives, and professionals at an early stage of development and to seek interested people who want to commit to staying involved for the whole duration of the RwL Geriatric Care, the vision phase is initiated with vision workshops starting in April 2022. The workshops aim to develop a shared vision for good and active aging in Bielefeld from a bottom-up, district-based perspective.

In the vision workshops, different approaches–a more creative and self-reflecting vs. a more group-based one–will be used to encourage elderly people, relatives, and health care providers to share and discuss their dreams, hopes, and imaginaries but also their fears, worries, and concerns of an aging society. In our creative workshop, we want people to dive deep into their utopian visions of a better future. Artistic methods are used to overcome potential cognitive lock-ins of the participants. In our group-based workshop, we are taking a more hands-on approach towards the concrete needs, desires, and worries of the people in Bielefeld. We hope to be able to share and discuss the first version of a shared vision at Eu-SPRI in June 2022.

In addition to a general exchange about our approach and the shared vision, we are particularly interested in discussing how we juxtapose the vision with theoretical insight on persisting problems in the German health care system to articulate and propose a transformation-oriented normative framework for the RwL Geriatric Care. This normative framework is not only supposed to guide the research conducted in the RwL Geriatric Care but also the construction of the RwL Geriatric Care itself. Furthermore, the normative framework serves as a tool for assessing and measuring the research outcome. Our theory-driven approach owes itself to our understanding of health care systems as socio-technical regimes that dynamically emerge from social, professional, economic, and technical interactions between various actors and institutions on one side, and technologies on the other. Consequently, to avoid path-dependencies in researching and developing socio-technical configurations in niches such as the RwL Geriatric Care, the potential for transformative socio-technical innovation must be built into the research infrastructure of the RwL Geriatric Care itself.

Keywords: vision workshop, geriatric care, social innovation, real-world laboratory, sociotechnical transformation

[88] Remi Elzinga (Utrecht University), Matthijs Janssen (Utrecht University / Dialogic), Simona Negro (Utrecht University) and Marko Hekkert (Utrecht University). *Unraveling Directionality: The interrelation between problems and solutions in mission-oriented innovation systems.*

Abstract. Recent years have seen a rising interest for missions as a means to facilitate societal transformations and, thereby, tackle societal challenges. Missions prioritizing an ambitious and measurable societal goal are hypothesized to provide the directionality needed to mobilize and align actors that may contribute to the development and diffusion of solutions. However, actors often do not feel engaged by these missions, or struggle with the question how they can best contribute to the development and diffusion of promising solutions. Moreover, as oftentimes multiple solution are proposed to tackle the mission, contestation among these solutions creates uncertainty for actors to set priorities. Uniting actors around a select set of solutions can be particularly challenging due to conflicting interest, mixed expectations, and a high uncertainty.

The current research aims to investigate the relations and interactions amongst missions and proposed solutions. We chose the case of the Dutch mission of creating a fully circular economy (CE) by the year 2050, focusing on the role of bioplastics in the transition to a circular and fossil-free plastic supply-chain. We make use of the mission-oriented innovation system (MIS) framework and apply so-called Problem-Solution Diagnosis to map the different problem framings that have been proposed, and how they relate to each other. Also, for different possible solutions we examine how they relate to each other, and to the various problems framings. By determining the type of relation (as they can be symbiotic, natural, or competitive), we aim to better understand the dynamics at play and their either limiting or accelerating effect on the transition process.

The data underlying this analysis is obtained from extensive desk research and a series of about 15 semi-structured interviews and several experts' workshops, conducted between summer 2021 and summer 2022.

The research shows that actors in the MIS act upon the ambiguity of the proposed mission by trying to steer problem framings based on their own interests. This process resulted in distinct subgoals of the mission for bioplastics, namely: Being fossil free, preventing plastic pollution of the natural environment, reducing greenhouse gas emissions, and promoting the use of reusable or recyclable materials in order to be circular. Our analyses indicate that solutions for some of the subgoals conflict with other subgoals, and/or with each other. Over the past years, this resulted in strongly polarized actor groups all trapped in discussions in which they do not understand each other, disagree with each other, or both. By creating various problem framings, actors created the room to set their own priorities. These various priorities often mismatch with other stakeholders' opinions or solutions.

For example, claiming bioplastics should counter plastic pollution forces bioplastics to be fully degradable under natural circumstances while maintaining their functional properties. Such demands strictly limit the innovative freedom and dominate the discourse. Biodegradability is at odds with making materials and products more durable and thereby reusable or recyclable. Thus, actors focused on biodegradability have long been in conflict with actors perusing recycling or reusing strategies. Such conflicts could, and probably will, hamper mission progress.

By mapping the interaction amongst and dynamics of multiple missions and corresponding solutions, this research provides input for developing an analytical framework to operationalize the Problem-Solution Diagnosis of the MIS analysis. By providing a structure for mapping different goals, solutions and their interrelations, the framework serves to assist in pinpointing systemic barriers arising from incompatible directionalities advanced by different stakeholders. Pointing out such barriers provides a basis for developing targeted responses and policies that can strengthen the MIS, and thereby accelerate the transition.

Keywords: innovation system, problem-solution space, societal challenges, directionality

[90] Lucio Morettini (IRCRES - CNR) and Massimiliano Tani Bertuol (University of New South Wales, Canberra). *Gender and career progression in academia: European evidence.*

Abstract. Background

Career choices in academia and other research-intensive workplaces, like in the wider labour market, reflect individual expectations about objectives that include career progression (e.g. Lent at al, 1994) conditional to institutional constrains, such as the existence of an initial period of probation (e.g. Faria et al, 2013). Hence, studying career choices ‘holistically’ over a period of time, rather than at a specific point, offers comprehensive insights on their determinants and relative influence. Longitudinal information on the mobility of researchers is however scarce. As a result, many relevant studies offer only cross-sectional or small-sample qualitative evidence.

Notwithstanding this limitation, one consistent observation about the labour market for researchers is its gender imbalance in favour of males, especially at the upper tail of career distribution and in fields related to science and technology (e.g. Torren, 1993; Howe-Walsh et at, 2016). This has been traditionally viewed as a consequence of gender-specific choices about marriage and fertility, risk preferences (e.g. Buser et al, 2014), as well as historical social norms that penalise women’s advancement in the workplace. Yet, the literature documenting such factors over researchers’ career spans is still scant.

Aims

The paper aims to shed light on the factors that affect the career progression of male and female researchers in Europe by identifying positive and negative determinants of the duration (number of years) between successive career stages of more than 10.000 university researchers across Europe surveyed by the MORE (Mobility Survey of the Higher Education Sector) longitudinal database. In doing do, this paper makes two contributions: first, it analyses the determinants of career progression over a long period of time and three career steps. Then, it quantifies the relative significance of established penalising influences of women’s career progression in research, typically related to family formation, vis-à-vis other and novel determinants such as work experience abroad and institutional factors (e.g. proportion of women in the workplace).

Theoretical background

The theoretical model adapts the approach of Faria et al (2013), which represents the dynamic problem of an employer (academia or research organisation) aiming to maximise its reputation, arising from the output of its permanent and probation employees, subject to their labour costs. The maximisation yields the optimal number of probation employees that can be promoted to permanent positions. This condition in turn is rearranged to derive the duration of the probation period, which is a function of individual characteristics (e.g. age, education, but also marriage and fertility decisions, experience abroad, and productivity), and locational and institutional settings.

Data description

MORE provides a unique lens on mobility patterns and career paths, including data related to over 10.000 university researchers across Europe collected with three survey waves. Data has been harmonized to provide consistent classifications of scientific sectors, educational qualifications and career stages. MORE also contains data on international mobility, the characteristics of these experiences (countries of destination, sectors, duration ...) and researchers' position with respect to current and next career steps.

Career stages are defined according to the classification adopted by the European Commission, DG for Research and Innovation, in four levels: (i) up to the point of PhD (first stage), (ii) PhD holders not yet fully independent (second stage), (iii) established researchers that have developed a level of independence (third stage), and (iv) researchers leading their research area (fourth stage).

From the original dataset we selected all the subjects who define themselves as researchers and all the subjects who declare to be at least at second career stage, which we use as benchmark. We excluded respondents that present time inconsistencies such as being promoted to stage 3 prior to being promoted to stage 2 and all those subjects that do not present a complete set of data about their career progression. The working sample contains about 7.170 individuals across 31 European countries. Data includes career development that starts between 1965 and 2016, with 1575 that are in stage 2 in wave 1, 3398 in stage 3 and 2197 in stage 4, respectively. Women represent 40% of the working sample with proportions that decrease from 47% in stage 2 to 30% in stage 4%.

The dependent variable is the duration (years of permanence) of each researcher in a stage, measuring the length of stage 2 and stage 3. Our main explanatory variable is the gender dummy, with women as focus. We include other personal characteristics such as age at the time of stage progression (or when data was collected for those that do not have yet progressed to the next stage), presence of partner and/or children. We include also the duration of any international experience during each stage of career (less than one year, between one and three years, three years or more) and the number of years between being abroad and the survey wave. We restrict the sample to researchers declaring that their international experience was not a permanent relocation. We add territorial control dummies for countries where the researcher currently work. We consider a further institutional variable represented by the female quota of researchers in the workplace, reflecting the hypothesis that countries with a larger percentage of women in academic bodies are more likely to offer women a more favorable environment for their career.

Econometric strategy

To analyze the duration of each phase of the career of women compared to men involves a double point of view: the relationship of individual characteristics and the duration of the career phase is possible only if there is actually a transition towards the subsequent state. As a result, the determinants of career duration in each stage are only observable if a transition to the next career stage has taken place.

To overcome this selection problem we use an 'extended regression model', which allows us to overcome endogenous sample selection with a two-step estimation: first, we model the sample selection affecting the stage transition with respect to characteristics of all subjects, starting with gender. This approach allows us to obtain an estimate of the probability of transition between career stages for women. In the second step we regress the duration in the career stage with respect to observed characteristics using the "extended" sample, as this approach yields the impact of each explicative variable on the duration of each career phase.

The empirical model follows:

$$L_{aict}=\alpha\cdot gender_i+\beta\cdot age_{it}+\beta_2\cdot age^2_{it}+\rho\cdot family_i+\gamma\cdot mobility_{ai}+\delta\cdot academics_{(c\ t-1)}+\varepsilon_{aict}$$

where L represents duration in stage a of subject i in country c at time t; gender is a dummy that indicates if subject i is a woman, age and age2 control for age at the time of transition t; family includes dummies on presence of partner and children; mobility includes variables on international mobility during the stage a (in particular categories of duration of the experience and distance between the mobility and the change of stage); finally academics measure quota of female researchers on total in country c at time t-1.

We use this kind of regression for both transitions from stage 2 to stage 3 and from stage 3 to stage 4. The only difference is that in the first phase of ERM for transition from stage 3 to stage 4 we add a dummy indicating if researchers define themselves as 'civil servants' instead that scholar or public employee, following the indication reported in Benz et al. (2021) where researchers that arrive in top positions through an internal university career tend to feel they are more in of a management role than a research job, and begin to see themselves as such prior to formally reaching the position. We use this dummy to control if this self-reported measure is an indicator of attitude for moving to in stage 4.

Preliminary results

Table 1 shows the results. Column A reports the results relating to the transition from stage 2 to stage 3. The probability of doing this step is 8% lower for women, as shown by the first phase of analysis at the bottom of the table. However, the results relating to the duration of the stage before the promotion show that women reach stage 3 before than their male colleagues: on average women take 9.4 months less than men (-0.78 years). With respect to age, the coefficient of its linear value is slightly higher than 1, while the coefficient for the square of age is negative. These results suggest that the permanence in stage 2 is directly linked to age but that from a certain point onwards with increasing age the experience also increases, which eases the transition to a higher career level. With respect to international mobility, the duration of the experience abroad has a negative coefficient with values close to 1 but the coefficient of the distance of the event with respect to the change of stage is positive, suggesting that the premium associated with foreign experience depreciates quickly: the experience is a positive element that helps promotion but this effect vanishes after a couple of years and the experience becomes statistically no different from zero thereafter. The other variables do not show statistically significant coefficients. This result is interesting for the family-related variables, which are considered primary limiting conditions against the career advancement of women in academia. Here, they play a neutral role.

Column B shows the results for the transition from stage 3 to stage 4. The first step of the analysis shows that women’s career progression to the highest career level is more difficult than for men (-19% probability), but viewing oneself as a civil servant offers an non-zero advantage for career advancement. Compared to the permanence in stage 3, women still have an advantage, with a shorter stay time of about 10.6 months less than men: the effect already observed previously is amplified. Women are less like to move to the next career progression but when they do, they are faster than men. No significant coefficients are found for age, family conditions and international mobility. An exception is represented by the share of women with respect to the total number of researchers, which is negative and significant. This result is consistent with the hypothesis that if women’s presence is more likely in the workplace the conditions for their career progression are eased, making it faster.

The results suggest that women's career progression faces more hurdles than that of comparable men but women who move forward do so faster than their male colleagues, and this outcome is more likely at higher stages of career progression. Among the explanatory variables, two coefficients are particularly interesting: family conditions do not slow down career progressions, and a greater presence of women in academia accelerates the achievement of higher career levels of female researchers.

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Keywords: Gender participation, Gender balance in academy, Research career

[91] Zahar Koretsky (Maastricht University). *Unjust transitions away from coal in Eastern Europe: Preliminary lessons from a monoindustrial Jiu Valley.*

Abstract. Ongoing transitions from environmentally unsustainable towards more environmentally sustainable ways of life are currently lagging behind and need to be accelerated. The urgency creates pressures to bypass democratic processes, which in turn can lead to ethically compromised, or unjust, transitions, creating losers from one of the, typically, less powerful stakeholders: communities and workers. I aim to explore the tension between the urgency for accelerated transitions and the need (of the "losers" in transitions) for just transitions. I aim to study a case of an unjust transition away from coal mining in an attempt to draw lessons for future just transitions.

I will study the case from an often ignored region in transitions studies, Eastern Europe, and focus on the case of the de-industrialised monoindustrial Jiu Valley region in Romania. Jiu Valley's transition away from coal extraction in favour of more innovative solutions was caused by a combination of economic (decreased profitability of regional coal industry since the 1980s) and political (state reforms of the 1990s-2010s) reasons. By 2022, the transition has resulted in massive de-industrialisation and marginalisation of communities and labour unions. This marginalisation has been causing emigration from the region in search for jobs. Such decline contrasts drastically with prior economic affluence and high self-perception in the region's communities.

I will be conducting a longitudinal study focussing on discursive framings of coal and coal industry in key stakeholders on local, regional, national and European levels. From studies of technological and industrial destabilisation, discontinuation and decline we know that discursive framing plays one of the key roles in different stages of transitions. I will explore the mutual influences of the changes in framing of coal and coal industry and the transitions away from coal in Jiu Valley.

The conclusions of this research have not been formulated yet, but certain preliminary findings can already be presented. Based on preliminary research, national government and extranational actors, the IMF and the EU, and their changing discursive framings were key in the processes of transition from state socialism to statism to market liberalisation – processes which had direct impact on Jiu Valley. The EU, in particular, had played a double role: while it had initially posed the closure of the mines as a condition for Romania to join the EU, more recently it has been increasingly important for the Jiu Valley community to revitalise the region, and circumvent the national government while doing so. These revitalisation attempts are being, in turn, aimed at reframing the Jiu Valley form the "valley of tears" to a valley of new opportunities. The case holds potential for lessons not only for policy-making and the role of framing, but also for communities on how to learn to inhabit de-industrialised regions and try to rebuild them discursively and, possibly, economically.

Keywords: coal, framing, just transition, regional revival, Jiu Valley, EU

[93] Ambra Giuliano (Politecnico di Milano School of Management) and Francesco Gerli (Copenhagen Business School). *Navigating Just Transitions: a systematic literature review.*

Abstract. Despite growing academic and practitioner interest, "grand challenges" related to sustainability remain unsolved today (Kohler et al., 2019). Addressing sustainability problems requires an acceleration of the common efforts towards the evolution of socio-technical systems, consisting of actors, institutions, as well as material artefacts and knowledge (Geels, 2004; Markard, 2011; Weber, 2003), which together interact, unleashing innovations within society (Markard et al., 2012). The systems idea emphasizes that many different aspects and actors are interconnected and interdependent on one another, and cannot thus be conceived in a narrow "silo-based" approach when considering transitions.

Transition studies are expanding and gaining momentum over the years, calling for radical shifts, rather than incremental improvements, to tackle grand societal challenges (Elzen, Geels and Green, 2004; Grin et al., 2010). In this context, a number of academics increasingly stress that the sole focus on the "green" attribution of sustainability transitions may risk obfuscating the societal, broadly transformative dimensions behind the transition concept (Hearn et al., 2021). Systemic changes need in fact to consider such transformations as a whole, thus also taking a firmer stance on the broader notions of "justness" and "fairness" to ensure the benefits of green transitions can be distributed equally (Johnson et al., 2020). This is why a truly systemic transition must account for the importance of questions of environmental justice to ensure that policies, plans and programmes guarantee fair and equitable access to resources and technologies (McCauley et al., 2019). Such considerations are so fundamentally needed to ensure that the transition to lower-carbon energy sources does not produce neither perpetuate pre-existing sets of winners and losers: this is an uncomfortably familiar scenario in which the winners are those who benefit from cleaner energy sources, reduced emissions, and employment and innovation opportunities that come with the transition, while the losers are those who bear the costs and lack access to the opportunities (Carley and Konisky, 2020).

Within these boundaries is the concept of the "just transition", which has been receiving increasing attention in the literature to date for its dual commitment to human well-being and environmental sustainability (Swilling, Musango and Wakeford, 2016). The idea of a just transition increasingly features in academic and policy discourse and appeals to the need to ensure that efforts to steer society towards a lower carbon future are underpinned by attention to issues of equality and justice (Newell and Mulvaney, 2013). The just transition as a framework of analysis brings in fact together climate, energy and environmental justice scholarships (Heffron and McCauley, 2018). Within the scholar communities, however, there is significant distortion of what "transition" and "justice" mean, thus creating difficulty around conceiving them under a comprehensive just transition concept. Nevertheless, the discourse permeating just transitions has far-reaching political and policy relevance (see for instance: European Commission: the territorial just transition plans, and International Labour Organization: Guidelines for a just transition towards environmentally sustainable economies and societies for all).

This recalls the urgency for the development of a systematisation of the contributions related to the "just" dimension of sustainability transitions, in order to enable public understanding and public acceptance of the approach of "just transitions" (Heffron and McCauley, 2018).

When navigating the concept of just transitions, policy considerations need to accompany academic discourse, as it is crucial to assess the political trade-offs that will characterise collective attempts to enact and realise a just transition (Newell and Mulvaney, 2013). In fact, "the concept of just transformations makes explicit a need to consider social justice in the process of shifting towards sustainability" (Bennett et al., 2019:1), however there are few to no principles in place for how to effect an energy transition with due attention to social justice in an unequal world (Jasanoff, 2018).

In this paper, we aim at identifying and systematising the major lessons gained from the literature about just transitions. By doing this we aim to identify the communities that so far have explored the topic and to outline relevant linkages between differential literature streams. Thus, this paper offers a systematic literature review of 422 academic publications on just transitions published from 2007 to date.

The systematic review method has been designed in the social sciences as a transparent and rigorous strategy to identify and synthesise high-quality research findings (Petticrew and Roberts, 2006) about a given research issue or subject (Higgins and Green, 2010). The systematic review is seen to be especially beneficial for conveying essential findings from extensive and complicated volumes of research literature. It is governed by a set of distinct principles that enable the understanding of the areas where more research is still needed (Briner and Denyer, 2010).

Even though there have been numerous earlier efforts to trace the boundaries of sustainability transitions literature (among others: Sengers, Wieczorek and Raven, 2019; Chappin and Ligtvoet, 2014; Markard et al., 2012), as well as energy justice literature (van Bommel and Höffken, 2021) and to identify the publications that constitute these fields, none of them focused on the specificities of the just transition and on its significance for policy discourses. As a consequence, in this paper we systematically explore literature stored in Scopus and Web of Science to provide a comprehensive agenda of the current state of the literature.

Through our literature review and bibliometric insights, we also provide a framework offering a detailed description of how the topic of just transitions has evolved over time in the different communities. Suggestions concerning the future direction of research are proposed in the form of research questions that are valuable for both academics, policymakers and practitioners to successfully pursue a systemic transformative path where green and just considerations coexist.

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Keywords: just transitions, sustainability transitions, systematic literature review, bibliometric analysis

[94] Anne Kantel (Fraunhofer Institute for Systems and Innovation Research), Sabine Preuß (Fraunhofer Institute for Systems and Innovation Research) and Maria Stadler (Fraunhofer Institute for Systems and Innovation Research). *Voicing a Diversity of Needs: The role of intermediaries in designing and implementing diverse and inclusive energy transition policies* .

Abstract. As a growing body of literature points out: Just because something is green, it doesn't mean it's just. While public debates and policies are focused on growing Germany's share of renewables in the country's energy mix, issues of justice, diversity, and social inclusion are often simply an afterthought or a nice-to-have add-on in contemporary transition policy design.

This paper builds on and contributes to an emerging scholarly debate arguing that a successful energy transition in Germany does not only need higher shares of renewable energy and innovative energy production and storage technology. It also needs to consider the human side and social aspects including socially just and inclusively designed policy instruments that create space for the active participation of a diverse set of actors in the transition process. The inclusion of diverse (and particularly vulnerable) groups of actors in the energy transition process is both a normative goal and an instrumental strategy as inclusivity is assumed to increase perceptions of legitimacy, policy acceptance and - by extension - rule compliance. While a variety of instruments could potentially increase and address issues of diversity and social inclusion, this paper focuses on the role of energy intermediaries to promote a just and diverse energy transition process.

We define intermediaries as a connection between bottom-up and top-down transition processes. In the case of energy policy, the energy transition, and the participation of citizens, intermediaries present a channel between citizens participation and policy-makers. We define them not necessarily as individual persons but also as communities and initiatives including several individuals. In our understanding, building a communities or initiative on the meso-level strengthens the perceived agency of citizens (bottom-up) but also facilitates the implementation of policies aiming to reduce energy usage and related greenhouse gas emissions by weakening the feeling of a “top-down” approach.

In this paper, we suggest that energy intermediaries will play a crucial role in transitioning to a just and socially inclusive system. Here, the following aspects play a crucial role to allow and provide for a diversity of needs: (1) the diversity of the different intermediaries (e.g., NGOs, sustainable communities and initiatives) as well as (2) the design of governance tools. By applying a case study approach and focusing on the energy and sustainability policy landscape of a German city, this paper seeks to answer the following research questions: How diverse are intermediaries that function as a bottom-up and top-down channel between policy-makers and citizens? How do they promote diversity in the energy transition? And how do national, state, and local policies mobilize or hinder energy intermediaries in the promotion of participatory processes and settings in their communities that accounts for diversity of needs?

We use a critical energy justice framework to study the bi-directional relationships between policies and intermediaries and intermediaries and (energy) citizens. A critical energy justice framework goes beyond the established trifactor of distributional, procedural, and recognition justice by highlighting the importance of power dynamics among policy actors, energy providers, and consumers in situ. It accounts for the contextuality of (policy) practices and discourses, takes intersectionality seriously, and allows us to go beyond the economic-technological language often dominating policy debates around innovation and transition in the energy sector and focus on socio-political dimensions that co-produce and shape both policies and actor behavior.

We approach the research questions by focusing on the role of intermediaries as the bi-directional channel between citizens participation and policies in the city of Darmstadt in the Southwest of Germany. First, we identify important intermediaries for the implementation of energy actions considering policies and citizen engagement. This research step includes conducting a thorough desk-research and document analysis that is supplemented by a total of twelve qualitative interviews with key actors representing policy-makers, energy initiatives/communities, and citizens in the energy and sustainability sector in Darmstadt. A selection of representatives from all three categories will allow us to consider different views around diversity and social inclusion issues in policy design and implementation. The purpose of the interviews is to gain additional information on people's perceptions of justice and inclusion in energy transition policy and gather insights in terms of a diversity of needs of different (particularly vulnerable) groups. The results of the desk-research, document analysis and interviews speak to the first two research questions, i.e. the level of diversity in regard to energy intermediaries and the strategies by which they promote diversity.

The second research steps speak to barriers and opportunities that existing policies provide in regard to issues of diversity and social inclusion. We conduct a qualitative content analysis to examine key energy policies on the national level (Germany), the regional level (the state of Baden-Württemberg) and the local level (the city of Darmstadt) to (a) identify patterns of injustice and social exclusion and/or best practices promoting diversity in existing policies and (b) propose existing as well as potential points of access for intermediaries. These access points should support intermediaries in facilitating (1) to promote just and socially inclusive policy content processes, (2) to increase diverse participation in the energy transition and (3) facilitate policy implementation and compliance.

We find that the diversity of intermediaries leaves space for improvement. Involving all groups in the energy transition seems important to leave no one behind and to reach the goals of the Paris agreement as well as at least six of the 17 SDGs. Yet, appropriate institutional access points to voice diverse needs in the energy transition process need to be improved. Moreover, results of the policy analysis indicate that the categories of diversity, justice, and social inclusion are underrepresented and under-defined across most policy levels in Germany. On the one hand, this opens up space for intermediaries to enter, reshape and co-define debates around these issues, which is particularly conducive for a highly context-dependent diversity of needs approach. Participatory processes and settings need to be adaptable to localized needs and requirements. On the other hand, the lack of rules and guidelines in regard to diversity and inclusion also results in a lack of financial resources and public discourses to hear and make visible the diverse needs of different (and vulnerable) groups. This makes it difficult for intermediaries to find points of access within the transition system to communicate the needs of diverse groups (bottom-up) or implement certain policy-related strategies to promote just and inclusive energy processes and increase participation within their communities (top-down).

This paper seeks to make two main contributions to a growing body of literature questioning existing energy transition policies in Germany in regard to their ability to promote just, diverse, and inclusive transition processes. First, we identify existing points of weakness as well as best-practices in German national, regional and local energy policies to identify institutional access points for promoting diversity and social inclusion in transition processes. Second, we analyze the role of energy intermediaries as potentially important actors in transitioning to a new and just energy system.

Keywords: energy justice, diversity, social inclusion, energy transition policy, intermediaries

[95] Oscar Yandy Romero-Goyeneche (Utrecht University), Enric Vila i de Villasante (Utrecht University), Felber Arroyave (University of California), Gaston Heimeriks (Utrecht University) and Johan Schot (Utrecht University). *Novel approaches for addressing the Sustainable Development Goals at Utrecht University.*

Abstract. 1. Introduction

The UN Sustainable Development Goals (SDGs) present a global agenda addressing social, economic, and environmental challenges in a holistic approach. The development of new knowledge is central to this agenda. Universities thus have a major responsibility to contribute to achieving these goals.

However, knowledge production addressing the SDGs is fundamentally different from knowledge production in other areas in a number of ways. Firstly, addressing the SDGs introduces an element of directionality in research (Cornell et al., 2013; Ramirez et al., 2019a; Sachs et al., 2019). In addition to the fundamental uncertainty inherent to research practices, SDG related research thus requires envisioning sustainable futures and exploratory thinking.

Furthermore, research requires a variety of systemic approaches related to the complexity and uncertainty associated with the SDGs. Integrating multiple bodies of knowledge associated with the 17 SDGs is essential to deploy diverse solutions to social and environmental challenges, as well as visualising disagreements and a diversity of various knowledge claims (Arroyave et al., 2021; Rafols and Meyer, 2010; Stirling, 2007). This brings significant implementation uncertainty and fuzzy conceptual translation issues across the goals (Heimeriks and Balland, 2016).

Moreover, pursuing integrated research and decision-making related to the SDGs fundamentally depends on understanding interactions between them, both negative ("trade-offs") and positive ("co- benefits"), and how these interactions contribute to transformative change (Ramirez et al., 2019b; Schot et al., 2018). The generation, consolidation and growth of such trajectories depends upon existing knowledge blocks from multiple knowledge domains (Boschma et al., 2014; Heimeriks and Leydesdorff, 2012) such as energy, water, politics, history, sustainable food, and environmental health. However, the integration of such diverse knowledge domains implies major challenges and high institutional barriers (Grauwin and Jensen, 2011; Shiffrin and Börner, 2004).

Currently, we lack understanding of the scientific development on SDGs and the transformative opportunities of universities. From an evolutionary perspective, the generation of new SDG related knowledge is facilitated (and constrained) by the opportunities provided by the existing local capabilities in multiple knowledge domains. Moreover, while SDGs present a global agenda, at each location these goals have different implications.

We address the question of how we can measure patterns of growth of SDG related research. Furthermore, can we identify what opportunities and constraints shape the development of SDG related knowledge?

In this paper we study quantitatively and qualitatively the growth and development of SDG research at Utrecht University for the period 2000-2019. We propose an approach to map the emergence of the SDGs research, including single SDGs analysis and interactions across the SDGs (and non-SDG) research communities using a transformative perspective. Additionally, we have interviewed researchers working in knowledge communities that study multiple SDGs and their interactions. The findings inform us about mechanisms for enabling and hindering knowledge production associated with the SDGs.

2. Theory

Recently, a discernible shift from the 'economic' to the 'societal' turn can be observed in university missions (Schot and Steinmueller, 2018). Universities have long experience in contributing to economic competitiveness and university-collaboration, but now increasingly also need to respond to multiple 'wicked' societal challenges and shifting government priorities. Yet, universities are struggling to set up structures to promote transformative change (Stephens, Hernandez, Román, Graham, & Scholz, 2008).

In order to address this transformative challenge, we focus on the ways in which knowledge developments are constrained by path- and place dependency. Knowledge production is path dependent in the sense that existing scientific knowledge provides the building blocks for new knowledge production (Arthur, 2007). Knowledge production is also place dependent; it is differentiated among locations (Boschma et al., 2014). New knowledge developments are dependent on place-specific circumstances that reflect conditions inherited from the previous knowledge production at a location (Martin and Sunley, 2007).

Integrating multiple bodies of knowledge is essential to address complex social and environmental challenges. SDG research thus deals with high levels of implementation uncertainty and fuzzy conceptual definitions of the required transformations across the goals (Heimeriks and Balland, 2016). Therefore the integration of multiple cognitive domains is needed to trigger common solutions and manifest disagreements as well as convergences and shared visions (Arroyave et al., 2021; Rafols and Meyer, 2010; Stirling, 2007).

We analyse whether and how knowledge trajectories that integrate new social and environmental directionalities are intertwined with knowledge trajectories focused on single or multiple sociotechnical systems, and incorporate knowledge trajectories addressing framework conditions such as peace, justice, and partnership (Ramirez et al., 2019. The transformative lens underlines the necessity of developing knowledge trajectories that integrate two and ultimately three types of SDGs.

3. Data and Methods

In order to map the knowledge trajectories and their interaction, a mixed methods approach is applied combining first quantitative data analysis with qualitative data. Scientific publications from the Netherlands were downloaded from Web of Science covering the time span of 2000 to 2020. Publications from Utrecht University were selected and the SDG publications were collected using an automated text search using a thesaurus (Ramirez et al.,) containing 2172 search terms.

A co-bibliography network is constructed to analyse the emergence and existence of scientific knowledge communities at Utrecht University. Using the Louvain algorithm 229 well-defined communities are localised in the Utrecht University network. The communities in the Utrecht University bibliographic network are divided into SDG communities and non-SDG communities. After labelling the publications and grouping them, we introduced the three levels of the SDG publications analysis: Characteristics of SDG research, Relational dynamics of the SDGs (triad analysis), Community dynamics and knowledge circulation

Qualitative research through semi-structured interviews focused on the emergence and enabling conditions of SDG research at Utrecht University. Specifically, the questions covered topics like the emergence and development of the research community; which cognitive, institutional, financial factors fostered (or hampered) the emergence of SDG research, or what mechanisms triggered research that combined different SDGs. Based on an initial analysis of the interviews, first results in the form of statements and questions were formulated and used in the workshop.

4. Results

The annual number of publications for individual SDGs shows that Good Health and Wellbeing (SDG 3) was the most researched SDG in both the Netherlands as a whole and Utrecht University. Both show a steep increase over the past 20 years. Quality Education (SDG 4) is also referred to in a substantial number of publications in both the Netherlands and Utrecht University. The results show that Utrecht University has a relatively high number of publications on Climate Action (SDG 13), as compared to the Netherlands. From 2009 onwards there is a steep increase in publications relating to SDG 13 at Utrecht University; it is clear that researchers here have been building a knowledge trajectory related to climate action over the past 11 years.

The triad census analysis was also applied at community level, where the most frequent triad categories were analysed in each SDG community. The heatmap shows that most communities have a high frequency of triads in the transversal directions (TD) or sociotechnical systems (SD) categories or a combination thereof. However, there are a few communities showing a high frequency of triads which combine SDGs in all three categories (FC-ST-TD).

Whereas this quantitative phase shows us the characteristics of SDG research at Utrecht University and specific communities that focus on certain SDGs, it does not explain how this research happens and what the bottom-up strategies of researchers are in relation to SDG research. In the qualitative phase of this research we focused on the emergence and development of SDG research in these communities. The interviews focus on the how and why of the research in these communities that are deeply concerned with the SDGs.

In our qualitative analyses, we used six different coding categories investigate the ideas and elements regarding SDG research through qualitative interviews. The six categories are as follows: SDG agenda, research motivation, catalyzers for collaboration, barriers for collaboration, university resources, and funding.

In Table 1 the results of the qualitative phase are summarised for each analysis level: the SDG agenda, research motivation and collaboration.

5. Conclusion

Research efforts related to the SDGs have grown rapidly in the period since 2000, covering all SDGs but to a differing degree. This reflects the strategic direction which posits the SDGs as major guiding principles and places them at the heart of the operations and ambitions of the University. Our analyses showed many interactions across SDGs (and non-SDG) research communities. The interactions of Sociotechnical Systems with Transversal Directionalities (such as SDG 13 and SDG 6) are particularly strong, thus providing indications for an ongoing transformation of the research system. However, we identify that less than 2% of the research at Utrecht University combines SDGs from the three categories (socio-technical systems, transversal directionalities, and framework conditions).

Rather than providing a snapshot, these approaches can be used to assess whether a knowledge trajectories changes things in the direction sought by researchers (the direction of change), how much it changes things (the effectiveness) and how quickly change happens which provides insights in the opportunities and constraints for new knowledge developments. Several workshops engaged researchers and other stakeholders in a dialogue to articulate the evolution of research trajectory over time, inviting new perspectives on what research goals and priorities will contribute to transformative change.

The results can support Utrecht University in identifying the thematic orientation of its current research in the context of SDGs and will help to increase the transformative potential of research by adding a reflexive layer to be used for navigation by researchers and decision-makers. The intrinsic interest of researchers in integrating diverse SDGs topics and the current facilities to collaborate at Utrecht University are already having a positive impact. However, Utrecht University may further increase its impact by increasing awareness about the SDGs within the University, generating reflections on SDG research, and employing seed money along with additional mechanisms to nurture and develop knowledge trajectories that integrate diverse SDGs.

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Keywords: Sustainable Development Goals (SDGs), Knowledge trajectories, Transformative change, Scientometric analyses, Mixed methods

[96] Bart Walhout (University of Twente), Kornelia Konrad (University of Twente) and Stefan Kuhlmann (University of Twente). *Making a difference? – Nanotechnology governance, Responsible Innovation and the quest for transformative change.*

Abstract. Recent reflections on 'a decade of Responsible Research and Innovation' give rise to the question how to leverage further efforts to transforming responsibility in research and innovation. For example, last year's special issue of the Journal of Responsible Innovation calls for reinventing Responsible Innovation (van Oudheusden and Shelley-Egan 2021), by adopting orientations like 'slow innovation' (Steen 2021), a genuine 'commitment to care' (Albertson et al. 2021) or challenging 'the dominant technology-market dyad' (Owen, von Schomberg, and Macnaghten 2021). On the other hand, the challenge of inducing such change still remains and will – for better or for worse – have to unfold along the 'legacies of co-creation' (e.g. Robinson, Simone, and Mazzonetto 2021) and challenges of institutional learning (e.g. Stahl et al. 2021) as reported in the same issue. Against this background, we want to take up again the question posed by Owen, von Schomberg, and Macnaghten (2021) how Responsible Innovation can serve as a 'transformative vision for reconfiguring science, innovation and society'.

Over the last years, the challenge of systemic change with respect to Responsible Innovation has been studied and reflected upon by drawing on concepts of institutional and transformative change. These categories of change comprise challenges of organizational learning (Wittrock et al. 2021), (Owen et al. 2021), national networks and contexts (Pansera and Owen 2020; Doezema et al. 2019), as well as institutional provisions (Gerber et al. 2020) or gaps between academic and corporate communities (Jakobsen, Fløysand, and Overton 2019). While all are relevant elements, the overarching challenge resides in linking them to strategies for further navigating the quest for Responsible Innovation. To this end, we discuss in this paper three analytical challenges: 1) establish a long term perspective on what the quest for Responsible Innovation is about, 2) identify which forms transformative change in relation to Responsible Innovation takes and 3) how to pursue such change in concrete and specific domains of action.

First, the quest for responsibility in science and technology, or research and innovation, is not new, nor uniform (cf. Rip 2014; Owen and Pansera 2019; Mody 2016; Owen, von Schomberg, and Macnaghten 2021; Shanley 2021). Already under the heading of Responsible Innovation, there are different traditions, multiple contexts and, accordingly, many articulations of what Responsible Innovation exactly is about. For example, Anticipatory Governance, a vision developed in US science institutions, is considered to enable Responsible Innovation by building capacities for Foresight, Engagement and Integration (Guston 2014). The framework developed by (Owen et al. 2013) for a UK research council aims at practicing forward looking responsibility through Anticipation, Reflexivity, Inclusiveness and Responsiveness. In the offices of the European Commission Responsible Research & Innovation (RRI) is defined as an anticipatory and cooperative activity and translated in the 'six keys' of Engagement, Gender Equality, Science Education, Open Access, Ethics and Governance (European Commission 2014).

All these aims – reflexive capacities, process qualities and issue specific attention – do matter to the idea of promoting Responsible Innovation. Yet each of the related movements struggles with inducing transformative change (Owen and Pansera 2019). This raises the question what kind of transformation is actually strived for and what are the specific challenges of it. Here, the notion of Responsible Innovation and cognate terms like Responsible Development, Responsible Research and Innovation, or Responsible Technology, work as umbrella terms that allow for interpretative flexibility as well as strategic behavior. The challenge for advancing Responsible Innovation we want to address thus is both interpretative and communicative, in constructing a joint thrust that can serve as a frame of reference, while avoiding generating ever more variety with new integrative aims.

The second challenge, about transformation, results from the first. Notwithstanding its ring of radical change, the notion of transformation implies that the new has to grow in and from the old, with all the tensions, interdependencies and incremental change involved in that. Analogous to the challenges of sustainable development, transforming responsibility does not result from just aggregating individual or organizational responsibilities, nor from steering these with grand ideas, new conceptions and institutional structures, but from the dynamic interplay between them. Following (Rip 2014), we therefore conceive of the quest for Responsible Innovation as a social innovation, featuring similar multilevel dynamics as have been theorized for socio-technical change. The quest for Responsible Innovation draws on landscape level ideas about the governance of science, technology and innovation; is being pursued in niche level experiments; and, depending on conditions set by the interrelation between all three levels, may result in regime shift – here being a reconfiguration of responsibility in research and innovation systems.

The third challenge involves how to integrate the orientation to a joint thrust as well as reflexivity about multilevel dynamics in actual, local practices and dynamics of (governing) research and innovation. Apart from Responsible Innovation promotors, actors – i.e. individuals, like engineers, sustainability managers, policy makers, campaigners or board members, as well as the organisations they work in – do not identify with institutionalization of Responsible Innovation as a concept in the first place, but with working towards responsible processes and outcomes in the practices they are concerned with. Hence, what matters in terms of change is not only how responsibility, responsibilities or responsible outcomes are being interpreted, but also how they are enacted in processes of communication, negotiation and evaluation.

These three challenges show that the relation between institutionalization of Responsible Innovation as a concept and its object of transforming responsibility in research and innovation is far from straightforward. Individual or actor responsibilities and responsibility in terms of outcomes and of collective action are not only interrelated but also both subject to interpretation and negotiation. We therefore want to explore how reflexive orientations, system conditions and specific governance challenges can be brought together in pathways towards systemic change. For this purpose we will develop a heuristic that integrates the corresponding levels of analysis in a step-wise approach and explore its value with case study findings from four major efforts of working towards forms of Responsible Innovation in the governance of nanotechnology: addressing uncertainty about safety in risk governance and integration of societal considerations in research governance, comparing efforts in the US and the Netherlands.

A first general lesson is that pathways for transforming responsibility are domain specific. In the nanosafety governance cases actors struggled to overcome lock-in in horizontal interactions, thereby reproducing roles and responsibilities instead of reconfiguring the relation between voluntary and mandatory mechanisms. Here, systemic change concerns organising collective learning and transforming responsibility ascriptions and distributions. Since this involves significant costs, burgeoning complexity and hence uncertainty about what it is all good for, it requires choice in a collective problem. In the research governance cases our analysis showed a different mode of responsibility structuring. In this domain, the challenge of integrating implications research is about mutual learning in how to conciliate the different orientations of promotion and control within the institutional boundaries of an organised actor – large research programs in our case. We show that such learning involves double loop learning about social dimensions and implications as well as about societal embedding.

A second general lesson is that new responsibility conceptions have to take root in existing responsibility distributions. Rather than crafting new responsibilities or institutional structures on top of existing ones, making a difference with Responsible Innovation is about guiding processes of transformation. While the quest for Responsible Innovation itself builds on wider trends in the evolution of social accountability in research and innovation, our contribution aims to further guide these processes of transformation. For example, where anticipation and inclusion are already promoted in many risk governance frameworks, we have highlighted the particular dynamics that arise from the interrelation between them: what is being anticipated depends on who is involved and the other way around. Similarly, fostering integration of societal considerations in research governance already builds on long standing awareness and attempts to anticipate broader impacts. Yet, actual integration as well as mainstreaming crucially rests on pathways for institutional uptake.

What we add to understanding these conditions and dynamics is that transformation is not just about change, but is shaped by interdependencies. This is especially relevant for Responsible Innovation, since ambitions and activities under that label, often introduce agonistic orientations with respect to the practices of research and innovation they target. It then is important to investigate how learning between actors is related to resolving the tensions that arise from the interdependencies at stake. For such learning to become institutional learning, we propose strategies for modulating the relevant accountability mechanisms in place.

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Keywords: Responsible Innovation, Transformative Change, Nanotechnology

[97] Vassilis Galanos (University of Edinburgh). *Why so Few AI Practitioners in AI Policy? Specialist Views on Questions of Control, Regulation, and Participation in Highly Promissory Environments.*

Abstract. Introduction, Relevance, and Policy Issues.

This paper is a documental and empirical reflection about the tentative lack of AI practitioners involved in the AI policy process. In October 2016 three documents published respectively by the United Kingdom, the European Union (EU), and the United States of America. They have all called for close inspection of the ethical and legal implications of AI and robotics, with an emphasis on the protection of human rights from becoming manipulated by robots, AI's relation to legal personhood, and more issues relating to AI-out-of-control scenarios. As Cath et al notice, the three reports have probably been prepared independently from each other, and hence – according to their opinion – highlight the effect of an ongoing resurgence in the field of AI during the last years (Cath et al. 2017: 2). A surprising common finding in comparing the three documents at this early stage of the debate was the minimal consultation of AI specialists in drafting them, while there was evidential influence by prestigious public commentators with little or no expertise in AI, about the potential existential harms of AI (Galanos 2019).

Currently, new policy documents about AI seem to reach a level of maturity, in that more experts are consulted prior to their publication, from the formation of the EU High-Level Expert Group on Artificial Intelligence (2019) and the recent Artificial Intelligence Act (European Commission 2021) to the UK House of Lords' Select Committee on Artificial Intelligence (2018). This is only indicative of a much broader construction of an AI policy landscape. Indeed, while proponents of the Singularity theory would envisage an exponential growth of AI's humanlike capabilities, what actually grew exponentially was the number of AI policy documents after 2017. Canada was the first country to publish a national AI strategy in 2017, followed by 30 countries by December 2020. National strategies are vital, yet covered only a small fraction of various AI-related policy documents which have been commissioned in the second half of the 2010s and early 2020s (a good overview with links to most documents can be found in the AI Index Report 2021; Zhang et al 2021). This urged the international and intergovernmental initiatives such as the Organisation for Economic Co-operation and Development (OECD) to establish institutional tools such as the AI Policy Observatory (Zhang et al 2021: 165), or, in the case of Algorithm Watch, the AI Ethics Guidelines Global Inventory, being a useful search engine, although excluding final legislations (Algorithm Watch 2021). It should be noted that the European Commission's 2021 Act is, globally, the first comprehensive, fully-developed legal framework for regulating AI (with subsequent financial penalties for non-compliance) and it appears to be the fruit of a now crystallised perception that AI, in the form of a family of software and techniques, enters the market and has to be regulated; thus, it separates between four categories of risk: unacceptable, high, low, and minimal (European Commission 2021). Nevertheless, things become fuzzier as to when does AI policy begin, if one takes into account the occasional interchangeability between "AI" and "robotics." Indeed, Boden et al. (2010; we have encountered Boden earlier as one of the principal refreshers of AI's conceptualisation in the 1980s) have published UK's Principles of Robotics: Regulating Robots in the Real World, being, according to co-author Joanna Bryson's website "the first national-level AI ethics policy." More recently, legal scholar Frank Pasquale's book New Laws of Robotics blends the two concepts and aims to "warn policymakers away from framing controversies in AI and robotics as part of a blandly general 'technology policy,' and toward deep engagement with domain experts charged with protecting important values in well-established fields" (Pasquale 2020: 15-16).

AI policy emerged as a novel niche to be explored and relevant papers became published, offering comparative analyses, making suggestions, and identifying gaps. This paper contributes the further emerging field of STS AI policy studies (Winfield & Jirotka 2018; Ulnicane et al 2020; Kerr et al 2020; Dexe and Franke 2020; Stix and Maas 2021) by focusing on the following identified gap. While indeed the AI policy landscape appears to have reached a degree of stabilisation in terms of including AI experts as part of the advisory board, such AI experts, as found in previous work of mine (Galanos, forthcoming), are members of advocacy coalitions serving specific laboratories' interests and cannot advocate about the AI field as a whole, or even at national-level (or international, in the case of EU), currently, there is no focus on the experience of practical AI researchers and their views on AI policy.

Research questions.

More Are AI researchers aware of, interested in, or feel influenced by AI-related regulations? Is the content of their research properly understood by those who regulate it? Does regulation reflect what, according to their knowledge, should be regulated?

Theoretical framework.

The field of AI policy studies is still nascent, and therefore there is plenty of room to introduce new ways of thinking critically about it, based on existing knowledge while reflecting on its unique particularities. This paper contributes to AI policy by critically integrating the following theoretical schemes guiding the subsequent empirical analysis: (a) the Collingridge dilemma, reflecting on the decisions concerning investment and/or regulation of a technology at early or later stages of its development, and Collingridge's emphasis on the need of experts' involvement in governmental advice (which, did not happen in AI regulation's early stages in 2015-7); (b) Collingridge and Reeve's over-critical model, based on the paradox that, in search for better results and scientific objectivity, more venues are opened for variations of "truth" – that being currently true within the growing unmanageability of advocacy coalitions surrounding AI and adjacent fields; (c) Donald MacKenzie's uncertainty trough, contending that those who are closer to production and research know more about potential issues and harms, and hence their uncertainty is quite high; not as high, however, as of those who are very much alienated from production and, in the AI's case, might be the end-users and members of the public with little or no knowledge about technical aspects; the intermediary potential institutional beneficiaries of or contrarians to the technology who still lack the technical expertise are, on the other hand, those who tend to speak with certainty about technologies; in AI's case, these could be policymakers or external commentators and advertisers. In addition to this theoretical toolkit of analysis, such an approach fulfils and contributes to the four main principles of the responsible research and innovation framework (Stigoe et al. 2013): anticipation (in consulting specialists about their views about the future of their domain), reflexivity (in inviting them to reflect on such issues and their relation to policy), inclusion (in terms of democratising AI), and responsiveness (in understanding how specialists respond to novel challenges in of social interaction surrounding their technologies). Lastly, it stems from a larger project focusing on different instantiations of the sociology of expectations (SoE; Van Lente 2006; Konrad et al 2017) field with AI as a case study. While, for the scope of this paper, SoE terminologies are not thoroughly employed, the overall impact of expectational settings found in the results, qualifies a brief acknowledgement of SoE as part of the framework.

Data and methodological approaches.

This paper stems from a 4-year long doctoral research, reporting on interviews with 25 AI specialists between 2017 and 2020, the majority (19) of which being participants at a large collaborative effort in AI and robotics between two major universities in the UK. Out of the six external ones, five have been recommended by interviewees on the basis of respondent referral and one was encountered serendipitously, invited by a mutual personal acquaintance over a friendly meeting. Externals acted as means of comparison with researchers in different universities, based in different cities and countries, or working in different sectors such as public services or industrial development. The analysis has been further informed by primary and secondary assessment of approximately 30 AI-related policy documents, historical documents which informed the research as to the emergence of AI as a field and the early (1955-2010) negotiations the field's establishment which qualifies the question as to what made this round of AI hype worth regulating, and other elements of interaction with AI communities falling within what Nick Seaver recently termed as "scavenging ethnography" (2017).

Results.

The paper, past the above review of the AI policy landscape, theoretical and methodological frameworks, consists of three subsections reporting on AI specialists' views through a case study and two main thematic pillars. It first looks at the concept of the "singularity argument" as a case study which has stirred policy debates at early stages through its hype, and helped the "lock-in" of an AI policy/regulation expectation. The following results, illustrated through interview vignettes, have been extracted and, given space within the final version of the paper, are related back to the theoretical vocabularies.

Problems of Democracy and a Democracy of Problems: AI researchers' awareness of, interest in, and influence by AI regulations

1. AI regulation is difficult as long as the type of AI technology in question is not sufficiently clarified. Conceptual vagueness adds an extra layer of bureaucratic obstacles.

2. AI researchers are aware of AI policy, but they show low levels of interest in being involved, partly because of distrust towards governmental practices and structures, partly because of their prioritising of their own interests.

3. They acknowledge that when experts are involved, they get to respond to questions already irrelevant to "actual" challenges.

4. Policy which does not take sufficient expert advice into account might result in operational problems in everyday research.

5. Moreover, policy has to be adaptable to AI-related technologies' rapid pace of development, while funding for research should include funding for risk mitigation of specific projects' outcomes.

What Should or Not Be Regulated in AI Research? How?

1. Results: The regulator's view on what needs to be regulated is mismatched to the specialist's knowledge on where exactly to constrain. Meanwhile, practitioners' understandings of ethical risks may be constrained by their technical training.

2. There is inherent danger in "throwing the baby with the bathtub water" is too much regulation is imposed, combined with loss of faith to systems which are not convincingly explainable.

3. Related to the theme of regulation of specific technical applications instead of AI, data ownership appears to be a much more pertinent area of regulation. This is tied to the hybridisation of public regulation following private companies' interests who are owners of large datasets and who might advise governments.

4. An item of regulation appears to be the protection of researchers' findings from being transferred into unintended applications by other researchers, companies, or institutions such as the military.

5. A rather pessimistic view is that regulation might be possible and acceptable only after the negative consequences of application are being revealed in full operation.

Conclusions.

It might be safe to suggest that pressing demands for AI regulation are partly after-effects of the singularity hype; this is an important lesson about the role of unsubstantiated hype in crystallising imagined needs of technological regulation. This has generated a series of repercussions apparent in governmental regulatory structures. AI appeared in the eyes of policy threatening enough to be regulated, and although the anti-AI hype has been sufficiently eased and disillusioned by now, there is now a growing AI policy landscape taking different forms, yet lacking standardisation. AI specialists, besides some influential figures, appear to show very low levels of interest in influencing policy, thus, letting outsiders dominating the field. At the same time, such "invasions" cause discomfort, thus, creating a paradox of participation: little willingness to participate paired to the effects of non-participation.

Keywords: Artificial Intelligence, Collingridge Dilemma, Interviews, Science in Policy, Responsible Research and Innovation, Uncertainty Trough

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Multi-stakeholder urban coalitions as platforms for governance processes: Mexico City's Tricolor Coalition Action-Research Case Study.

Abstract.

Application for:

Sub-question: What kinds of organizational structures are emerging to promote and facilitate the application/use of new knowledge to the solution of large-scale societal problems?

Introduction:

Access to water, energy and food have been considered priority sustainable challenges as they are basic needs for the consumption of resources that seriously affects ecosystems (Allouche et al., 2014). Likewise, one of the requirements to develop solutions to decrease sustainable challenges such as this one is participatory governance (General Assembly, 2015).

The governments have been recognized to be the main responsible and capable agents of sustainable transformations as the common but differentiated principle states in the Agenda 2030(General Assembly, 2015). Thus, this would entail that they are the main responsible organizational structures for this participatory governance. However, for the past five years, there has been the emergence of other types of sustainable organizational structures in cities.

This is because cities are the geographies with the greatest diversity of resources (Garland, 2015). Thus, these groups have used this window of opportunity to generate these participatory governance processes (Kabisch et al., 2018). For this reason, in this research we will carry out an action research study with action- research for Mexico City, using the platform of the Tricolor Coalition to involve multiple relevant actors.

Although some processes of this type of governance already exist in cities, they do not always result in the required sustainable transformations (McCormick et al., 2013; Nevens et al., 2013). Therefore, in this research, we will seek to analyze the governance capacities that the actors of the water, energy and food sourcing sectors require to generate sustainable transformations.

Problem definition - Water, energy, and food insecurity :

Sustainable Development is a perspective that has shown the failures of the system in which we currently live (Baker, 2016; United Nations, 2013). It has shown, among other problems, the security risk for access to water, energy, and food resources internationally (General Assembly, 2015), risks that can be perceived in Mexico City (CDMX).

In the first place, these resources are essential for humans. Their related activities contribute to a greater extent to the affectation of ecosystems and to climate change, which in turn generate risks of accessibility of these resources (Steffen et al., 2015). Secondly, there is a risk to energy access because non-renewable resources will be depleted and there is no certainty of how many resources there are of this type, and a sufficient renewable resource alternative has not been found to respond to the growing needs of the population (International Energy Agency - European Commission, 2021; Secretary of Economic Development, 2019). Third, there is a growing risk of water accessibility due to over-exploitation of freshwater water resources that results in a decrease in the quantity and quality of water for drinking, sanitation, and hygiene (Alma Rosa Huerta Vergara & Pedrozo Acuña, 2018; UN-Water, 2020). Fourth, current food production requires high amounts of fresh water and energy resources(Food and Agriculture Organization, 2021). Therefore, the risk to water and energy resources results in food supply chain risks as well. These problems occur worldwide, and with specific characteristics in CDMX.

Despite the above, different actors have proposals for solutions to face the above challenges. However, these actors that work at different scales in these sectors still work in isolation, which generates a lack of agreements to solve these challenges jointly (Allouche et al., 2014; Bellfield, 2015; Bizikova et al., 2013; L. Gutierrez, personal communication, April 13, 2021; SACMEX, 2020). Therefore, this research seeks to analyze what capacities are missing in these governance processes (Hölscher et al., 2019b), to facilitate this type of agreement that leads to the generation of the transformative solutions that are required.

Consequently, this research seeks to find out what are the capacities of the actors developed and required to carry out transformations in the supply chain that can solve the aforementioned problems.

Research question:

Thus, our research question is: What transformative capacities are required to carry out sustainable transitions in the water-energy and food sectors in CDMX?

Research Sub-Questions:

We have four sub-questions to respond to our main research question:

-Which actors carry out transformative capacities within the water-energy and food sectors in CDMX?

-What are the transformative capacities that already exist to jointly carry out sustainable transitions?

-What are the transformative capacities that are still required to carry out sustainable transitions in these three sectors together?

Methodology:

Action-Research Methodology

To co-develop transformative governance policies with Mexico City's water, food, and energy stakeholders, this study will use an action-research case study methodology based on the transformative capacities conceptual framework.

Action research is based on "co-production", which means collaboration between academic and non-academic research partners, including social, private and public sectors, to produce practical and academic knowledge (Darby, 2017) that helps improve practices or "provoke change in specific contexts" (Koshy, 2010). It is an iterative cycle process that requires four actions: a) plan, b) act, c) observe and d) reflect.

These four actions will be carried out to answer the four research questions mentioned above. Thus, these iterative processes will have at least four stages, each responding to a research question. If other items are missing, another stage of this process will be performed if necessary. Furthermore, these iteration processes also hope to develop: more information, more stakeholders, more engagement between stakeholders.

Conceptual framework of transformative capabilities:

The capacity framework was created to analyze transformative governance processes for climate change. Four levels of capabilities have been recognized (Hölscher, Frantzeskaki, McPhearson, et al., 2019a).

● Stewarding capacity: It has been defined as “the abilities of actors to anticipate, protect and recover from risks while exploiting beneficial opportunities for sustainability”.

● Unlocking capacity. It has been defined as “the abilities of actors to recognize and dismantle the structural drivers of unsustainable path dependencies and maladaptation”.

● Transformative capacity. It has been defined as “the abilities of actors to create novelties (to do, think, organize) that contribute to sustainability and resilience and to integrate them into structures, practices and discourses”.

● Orchestrating capacity.- Refers to “the abilities of actors to coordinate governance processes of multiple actors, foster synergies and minimize conflicts between different scales, sectors and times.

With this research approach and theoretical framework, we will follow the following steps and methodologies:

- First Step: Stakeholder mapping - An analysis of actor-networks will be done using the Gephi software. This is to analyze and determine relevant actors and their relationships for decision-making in policies to generate transformative changes in the water-energy-food nexus and the circular economy. The selection of actors will be based on the network-based strategy called nominalist, which consists of choosing actors within the limits of the network (Yang et al., 2017). Likewise, the identification of relevant actors and their relationships will be complemented with documentary analysis and questionnaires.

- Second Step: Documentary analysis - The methodology that Bowen (2009) proposes for documentary analysis is based on identifying text that helps us decide the relevance of the literature. Therefore, an analysis of the scientific, media and public policy publications of the water-energy-food sectors in Mexico City will be carried out to complement the mapping of actors and identify projects and strategies that are being implemented.

- Third Step: Semi-structured interviews - Interviews will be conducted with the main agents of change to learn about and also co-produce with their opinion the capacities that are necessary for CDMX to generate sustainable transitions. The formulation of questions for the semi-structured interviews of this research will be based on the conceptual framework of transformative governance of (Hölscher et al., 2019). The question formulation approach for the operationalization of conceptual frameworks has been used previously by Villamayor-Tomas (2018).

- Fourth Step: A workshop will be held where the characteristics and results of the coalitions are jointly evaluated based on the theoretical framework of sustainable transformative capacities.

Data:

We have already generated a platform where we invite 75 agents interested in transforming sustainable changes from the government, companies, academia, non-governmental organizations, and citizens. We also already have the knowledge of what are the priority issues of these people in these issues, which will facilitate collaborative study with them. This will serve as the initial data to collect and do the analysis to obtain the following data:

● Actors. The main decision-makers of the different social groups in Mexico City on the alternative mechanisms in the water, energy and food supply chains will be included. These are defined as the main providers and consumers of these services.

● Public Policies and Budgets of the Actors. We will seek to know what the strategies and visions of the different agents of transformative change are.

● Current projects. An analysis on current projects that these actors are carrying out will be made to understand what are the possible sustainable actions, and their potential for change.

The above information will then be used to be able to carry out the analysis of transformative capacities following the previously explained theoretical framework.

(Expected) Results

From this action-research work, we expect the following results:

From the first sub-question of "Who are the actors to carry out joint transformative capacities within the water-energy and food sectors in CDMX?", we expect a stakeholder understanding of the main agents of change in CDMX interested in the water-food-energy nexus and with the capacity to make transformational change. The project is at a stage starting to understand the connections and essential relations between sectors and actors.

From the second question. "What are the transformative capacities that already exist to jointly carry out sustainable transitions?", we expect to understand what are the projects and characteristics of the actors that allow for a systems' change.

The third question,"What are the transformative capacities that are still required to carry out sustainable transitions in these three sectors together?" We expect to be able to show possible knowledge and capacity training gaps where capacities can be built in CDMX for sustainability transformation in these sectors.

From this research analysis, we expect to understand how transformative multi-disciplinary stakeholder coalitions can analyze their stakeholder characteristics and activities to propose transformational system transformations in mega-cities such as CDMX.

Moreover, we expect to have takeaways of which are the opportunities and barriers of coalitions to understand the systems and develop co-produced proposals to promote systems transformations.

Conclusions

In conclusion, we expect to understand and learn how can multi-stakeholder coalitions in cities serve to promote the required governance capacities for transformational change. For this, an action-research methodology based on the urban transformative capacities framework will be used. The data that will be collected will use the stakeholder focus groups that we have started to develop in the previous months that include the name and characteristics of the agents of change, their sustainability vision, their policies, (when available and accessible), and activities they are doing.

Policy Issues

- Governance Processes

- Mega-city water-food-energy security challenges

- Multi-stakeholder co-production

Keywords: - Urban Sustainability Transformation, - Urban Governance, - Coalitions, - Water-food-energy security, - Mexico City

[99] Janina Käyhkö (University of Helsinki), Kaisa Korhonen-Kurki (Finnish Environment Institute), Mikael Hilden (Finnish Environment Institute) and Sirkku Juhola (University of Helsinki). *Emerging forms of institutionalising user engagement in science: knowledge co-production in strategic research in Finland.*

Abstract. Transdisciplinarity (TD) is one of the ways to describe the turn in science aiming to tackle complex societal problems using multiple types of knowledge. It refers to research that deals with real-life problems, involves a variety of actors from science and practice to account for the diversity of perspectives, and creates knowledge that is solution-oriented, socially robust, and transferable to both scientific and societal practice (Lang et al. 2012). In such processes, science needs to integrate new ways of knowing into new ways of making decisions. Such integration can be enhanced through processes of knowledge co-production, which can be defined as "processes that iteratively unite ways of knowing and acting — including ideas, norms, practices, and discourses — leading to mutual reinforcement and reciprocal transformation of societal outcomes" (Wyborn et al. 2019). In Finland, the Strategic Research Council (SRC) has since 2015 provided funding for long-term research aimed at finding solutions to major challenges facing Finnish society. This approach goes along with mission-oriented policies that highlight coordinated, intensive and long-term interaction between science and various societal stakeholders.

All SRC-research applications must include active engagement of stakeholders throughout the life cycle of the projects. The specific feature of SRC research is its explicit connection to topics of national level policymaking, which creates a base for engaging public sector officials and other policy actors, including the private sector, in knowledge co-production. This distinguishes the SRC-projects from many other co-production projects that tend to focus on more local-level actions and/or lay knowledge. The SRC-projects deal with issues of governance, and administrative or professional types of knowledge. In this paper, we describe the emergence of knowledge co-production in SRC research in the interface of science and policy, and explore its characteristics. We reflect on how the SRC, as a new organisational structure, contributes to the institutionalisation of transdisciplinary research in Finland.

Our analysis is based on interviews and a survey of 26 SRC funded research projects, which is more than half of all the projects funded to date. The interviews are done with the "end-users" of knowledge and the survey targets the knowledge producers. The interviews will be held in March 2022 with approximately 12 with key stakeholders who have participated in the research projects. The interview questions focus on the impact of the research on decision-making.

The survey questions covered the methods and depth of integration of research and interaction activities as well as background, processes and challenges of the conducted knowledge co-production activities. The results indicate that a majority of projects has joined interaction and research activities to become an integral part of the research approach, while the knowledge co-production displays different "depths" and forms depending on the research topic, among other things. Several challenges were also identified such as ethical concerns and lack of methodological skills. A majority of the respondents considered that they will, also in future projects, use co-production approaches and that applying the approaches had changed their views on the role of research in society. We conclude that the institutionalization of transdiciplinary research through the SRC funding has created a demand for novel research approaches that can support societal decision making in dealing with society's grand challenges. The results do, however, also show the need for diversity in co-production. To ensure innovative development of co-production such diversity is needed within the overall framework of transdisciplinary research.

Keywords: knowledge co-production, science-policy interface, policy development, transdisciplinarity, environmental governance

[103] Vladislav Cadil (Technology Centre CAS), Ondrej Dvoulety (University of Economics and Business Prague) and Tomas Ratinger (Technology Centre CAS). *Research, Development and Innovation Strategies of Enterprises in Business R&D Support Programmes, the Case of the Czech Republic.*

Abstract. Research aims and questions

Czech programmes to support business research and development have very generally formulated targets. Their main objective is to strengthen the knowledge-based competitiveness of enterprises. As a consequence of the generic character of the programmes, there is a high diversity of projects and enterprises supported. Our survey based on questionnaires and interviews with selected beneficiaries carried out as part of the evaluations of the individual national programmes showed considerable differences in the R&D&I strategies of the supported firms. This paper aims to identify specific groups of supported enterprises according to their R&D&I strategies. The paper contributes to the debate on the taxonomy of innovative enterprises based on their R&D&I strategies (Pavitt, 1984, Hollenstein 2018, OECD 2009).

Relevance

When evaluating the business R&D support programmes, the effects (impacts) on firms are usually assessed only by firm-size categories or industries (groups according to their technological/knowledge intensity). However, our previous research (Ratinger et al. 2020) outlined that within each size category or industry there may be very different enterprises in terms of their business and R&D&I strategies. These strategies can significantly influence the range and extent of the scientific (technological), economic and societal effects on the firms as well as regional economies and can help explain why some effects occur and in what timeframe. Knowledge of the firms' R&D&I strategies can allow for appropriate targeting of support tools and maximisation of the desired effects.

Theoretical Framework

The current literature indicates differences in firms' R&D&I strategies and approaches to innovation in general and innovation performance concerning their characteristics, ways of implementing innovation activities, or how firms engage in the economic system (Hollenstein 2018, Roud 2018, Falk (2008) Frenkel et al. (2001) Nunes and Lopes (2015) Fagerberg et al, 2018). Furthermore, the literature shows that the firm typology based on their R&D&I strategies can be studied in different ways (Pavitt, 1984), Evangelista (2000), Sirilli and Evangelista (1998), Arvanitis and Hollenstein (2001), or Hipp and Grupp (2005), Hollenstein (2018) OECD (2009). In these studies, data from specialised surveys on innovation (e.g. CIS) or data from questionnaires and interviews are used to analyse the innovation activity of business entities. However, they are more focused on innovation strategies than on corporate R&D issues or firms' positions in global value chains, which may be particularly important if the economic impact of public R&D expenditure is to be analysed (e.g. Fagerberg et al. 2018). The novelty of our approach rests on the adoption of data on mechanisms of R&D based knowledge creation, dissemination and utilisation and their combination with data on firms' positions in value chains and corporate hierarchies, and innovation activities identified in the above-mentioned literature.

Data and methodological approaches

Latent class analysis based on data from questionnaires was used to create a firm typology. The questionnaires interviewed enterprises that received support from 17 programmes conducted by the Ministry of Industry and Trade, the Ministry of Education, Youth and Sport, the Technology Agency of the Czech Republic and the Ministry of Agriculture in 2008–2020. Questionnaires were sent to 3,715 enterprises; the response rate was 8.43%. The questionnaire consisted of two relatively separate parts. The first part was devoted to identifying the position of the enterprise in the economy (e.g. in the global value chain) and its innovation strategy; the second part focused on the R&D strategy.

Data from the questionnaires were used to set up manifest variables. To create the firm typology, 14 manifest variables from 5 thematic groups were selected - enterprise position (position in the firm hierarchy, in the value chain, enterprise strategy), basic characteristics of the enterprise (size, sector, dominant market), R&D activities (R&D specialisation, sources of R&D knowledge), publicly funded R&D (total expenditure, number of projects, role in the project, motives for participation in the programme) and benefits (importance of product innovation, benefits).

Results

The survey of questionnaire data confirmed the expected importance of selected determinants of innovation activity, such as the importance of firms' position in the value chain, a position in the corporate (group of firms) hierarchy and the company's innovation and market strategy for the realisation of R&D&I activities, especially for participation in R&D support programmes and achieving economic and technological benefits. This result refers to the greater autonomy of firms in terms of their decision-making processes and in terms of operating in value chains, where their higher position and autonomy create a higher potential for upgrading. However, it should be mentioned that these firm characteristics are reflected in firm R&D&I strategies (i.e. including R&D specialisation, R&D expenditure, etc.), as well as their previous R&D&I strategies.

The survey also showed that the traditional division of firms according to size, ownership or industries hides significant differences between R&D&I strategies of firms. These basic firm characteristics are not determinants of firms' R&D&I strategies, although they may, for example, influence the level of R&D expenditure or cooperation with research organisations. The survey revealed that the more important than these characteristics are the firms' positions in value chains.

Last but not least, the survey pointed to the importance of subsidies (grants) for the development of science-industry links. Although research organisations are crucial partners for R&D cooperation, the financing of this cooperation depends on grants to a large extent.

The latent class analysis identified three distinct classes (groups) of firms with specific R&D&I strategies:

- Research and innovation pioneers (33.2% of enterprises);

- Highly innovative SMEs (50.8%);

- Low-innovative firms with a subordinate position in corporate hierarchies and value chains (16 %).

Research and innovation pioneers are independent enterprises without branches or parent companies with branches in the Czech Republic and abroad. In the value chain, these firms occupy the position of a leading firm or first-tier supplier. In terms of R&D&I strategy, these companies bring some completely new solutions to customer needs in a highly competitive market segment. The most significant source of R&D knowledge is in-house R&D, while collaborative R&D with research organisations is less represented. R&D activities focus mainly on long-term strategic R&D, and less on innovation. A key motive for obtaining R&D support is to reduce R&D costs and to carry out R&D on a larger scale. The main benefit is to strengthen competitiveness in foreign markets. Enterprises are mainly of medium and large size and operate mainly in the engineering, professional, scientific and technical services industries. The enterprises focus especially on end customers and foreign markets.

Highly innovative SMEs are notably independent enterprises without branches. The enterprises occupied the position of a leading firm or first-tier supplier within the value chain. In terms of the firm's strategy concerning R&D&I, the two types are equally represented: (i.) the firm brings some completely new solutions to customer needs in a highly competitive market segment, and (ii.) the firm reacts quickly to trends introduced by the technology leaders to keep up with technological developments of competitors. R&D activities are primarily focused on long-term strategic R&D and the development of entirely new products, materials, solutions, and processes, which the enterprises sell to other firms. The main source of R&D knowledge lies in in-house R&D and collaborative R&D with research organisations. The main benefit is to strengthen competitiveness in the foreign or domestic market. Enterprises are mainly active in business and technology services. The primary customers are end customers as well as enterprises that buy products for further processing.

Low-innovative firms with a subordinate position in corporate hierarchies and value chains are mostly SMEs operating mainly in technologically less advanced industries. The representation of the different positions in the value chain is relatively balanced with a predominance of third- and first-tier suppliers. In terms of R&D&I strategy, a strategy focused on maximising productivity or reducing the costs of existing products, mainly by purchasing foreign technology, prevails. R&D support production activities. The main motive for obtaining R&D support is own R&D cost reduction. The benefits lie primarily in achieving the environmental sustainability of production. The companies operate only in the Czech market; the primary customer is a manufacturing company outside the group that buys products for further processing.

Conclusions

The latent class analysis pointed to the great importance of research and innovation pioneers who are crucial subjects not only in business R&D support programmes but in the whole system of business R&D in the Czech Republic. For example, in the R&D support programmes, they represent 25.6-39.2% of the supported enterprises but account for 50.4-72.5% of the programme's costs. This group includes notably industrial enterprises with a long history and, to a lesser extent, transformed research organisations that carry out contract research or provide professional services (testing, diagnostics, etc.).

The latent class analysis also revealed that the group of SMEs is quite diverse. This group includes both innovative small firms, but also firms with a subordinate position in value chains and operating rather in less technology-intensive sectors.

The identification of three distinct groups of beneficiaries raises questions related to the effectiveness of business R&D support and programme evaluations. First of all, the question is whether it is appropriate to support business R&D through generic programmes. As our previous research has shown (Ratinger et al. 2020), this kind of programme tended to promote traditional enterprises operating in traditional industries (mechanical engineering) rather than progressive technologies developed by more flexible SMEs, although national policy documents (e.g. the national RIS3 strategy) and the programmes proclaimed the need to promote KETs and SMEs (surprisingly, this proclamation was not reflected in programmes' targets and project evaluation and selection criteria). This focus may lead to sectoral and technological lock-in, which may pose a major threat to the further economic development of the Czech Republic.

Furthermore, the current evaluation does not distinguish types of companies but assesses the enterprises as homogeneous groups, possibly tracking differences by size categories. However, this evaluation approach blurs differences caused by the different R&D&I strategies of enterprises. As a result, it may lead to misidentification of programme effects and consequent ineffective targeting of follow-up programmes. Therefore, evaluation should distinguish between different enterprise strategies. Programme effects (impacts) should be evaluated separately for each specific group of enterprises. Appropriate evaluation approaches, methods and indicators should be chosen depending on the strategy of enterprises (including R&D&I strategies).

A specific challenge is the evaluation of long-term beneficiaries, where it is difficult to distinguish the effects of individual supported projects.

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Keywords: R&D&I strategy, business R&D support programmes, firm taxonomy

[105] Lars Bengtsson (Lund University) and Charles Edquist (CIRCLE, Lund University). *Functional public procurement for low-carbon innovations in the Swedish municipal sector.*

Abstract. We have initiated a research project with the title above. One of the objectives is to mitigate the severe shortage of systematic empirical data on functional public procurement. We are, therefore, in the process of performing a web-based survey on functional procurement that will be addressed to all 290 Swedish municipalities. We are aware that the specificity and clarity of the conceptual framework used in any questionnaire are of utmost importance for the result of the survey: researchers and survey respondents must relate to the same basic concepts.

Public procurement is when public agencies buy goods and services. Edquist and Zabala-Iturriagagoitia (2012) emphasized public procurement as a relevant and potentially very powerful "mission-oriented policy instrument" aiding in grand societal challenge mitigation. Besides its direct purchasing power, e.g., 17 percent of GDP in Sweden, public procurement has an enormous potential to mitigate problems regarding the environment and climate, i.e., to enhance innovations that will support the transformation to a low-carbon economy.

One challenge with innovation-enhancing public procurement is that public procurement regulations require the procurer to describe, in advance, what they want to procure. As most public procurements concern describing and procuring existing products, there is a clear risk that most public procurement with the intention to enhance innovations, will at best be added diffusion of already existing technologies, such as procurement of electric cars (to replace fossil fuel cars). We call this product procurement, i.e., when existing products to be bought are described in the procurement documents. Only practicing product procurement would limit the potential of innovation-enhancing public procurement to mitigate climate change, at least if we think new technologies and products are necessary to make a real impact.

A way to overcome this challenge is to practice functional procurement, i.e., the procurer specifies problems or functions that the product to be bought shall solve. In the case of functional procurement, the procuring agency specifies what is to be achieved rather than how. In the words of Edler and Georghiou (2007: 960): for the tender process to induce innovation in the marketplace, it is indispensable that it is based on specifying functionalities rather than designs. Functional procurement can lead to new products (innovations) but does not have to. It opens for innovation (Edler and Georghiou 2007; Georghiou et al. 2014).

Despite this transformative potential, in terms of its implementation and the mechanisms for its effective rolling out, functional public procurement both in a general sense and for low-carbon innovations, is still in its infancy (Uyarra et al., 2020). Apart from a handful of published studies and academic articles concerning innovation-enhancing public procurement by organizations in the UK (e.g., Edler, 2013; Edler & Yeow, 2016; Uyarra, 2010, 2016; Uyarra et al., 2014), the empirically-based knowledge is limited.

To mitigate the situation of lacking data on functional public procurement for low-carbon innovations we are performing a survey of all Swedish municipals (290 municipals) to investigate the:

• incidence of functional public procurement in general and for low-carbon innovations,

• governance of public procurement (goals, strategies, policies, local government engagement, interest),

• procurement organization and management (size, specialist competence, use of environmental requirements, use of intermediaries and consultants),

• earlier experiences of functional public procurement in general and for low-carbon innovations,

• five latest cases of functional public procurement.

The aim is to provide an empirical description of the incidence and distribution according to the municipal sector (e.g., buildings, infrastructure, schools, elderly care) of innovation-enhancing public procurement for low-carbon innovations, as well as explore explaining factors (i.e., governance, procurement organization and management, earlier experiences) for the high or low incidence of innovation-enhancing public procurement for low-carbon innovations.

Moreover, we intend to explore a categorization of the cases of innovation-enhancing public procurement for low-carbon innovations into three categories of innovations, inspired by the level of newness (new to the world, industry, and organization), and the difference between functional procurement and product procurement (Edquist and Zabala-Iturriagagoitia, 2020).

The questionnaire will be distributed to the municipal procurement director in March 2022 and the first results will be available from April 2022. Thus, our speed talk will be presenting the survey (including its conceptual framework) and the first results. Important discussion issues will be:

- To what extent is the transformative potential of public procurement used to create a lower carbon footprint?

- Which factors drive or hinder the use of functional procurement in general and in the low-carbon area.

- What are the demands on the organization and management of the public procurement function to functionally procure low carbon innovations?

Keywords: public procurement enhancing innovations, functional procurement, low carbon innovations

[106] Astrid Gläsel (Leibniz Institute of Ecological Urban and Rural Development), Markus Egermann (Leibniz Institute of Ecological Urban and Rural Development) and Magdalena Tanzer (Justus-Liebig-Universität Gießen). *Elucidating the capabilities of international mechanisms to foster procedural just system change - the case of the 2021 UN Food System Summit.*

Abstract. As a global political response to the urgent need of transforming food systems towards sustainability, UN Secretary General António Guterres announced the UN Food Systems Summit (FSS) was to be convened in 2021. The Summit wants to "launch bold new actions, solutions and strategies to deliver progress on all 17 [SDGs], each of which relies on healthier, more sustainable and more equitable food systems" (UN FSS, 2021a). The vision the Summit´s organizers want to spread is described as follows: "The Summit will awaken the world to the fact that we all must work together to transform the way the world produces, consumes and thinks about food." (UN FSS, 2021a). This aspiration, to initiate a process that will finally lead to a global transformation of the currently unsustainable food systems, in terms of the transition theory could be described as the aspiration to create a landscape shift to trigger transformation.

Research on food systems transformation shows that there are different concepts of what makes food systems sustainable. First, the understanding of the sustainability concept is addressed from different points of view regarding problem description of and proposed solutions to unsustainable patterns (Béné et al., 2019). Second, different framings and narratives of food systems are debated, promoting for example a productivist (or extractivist) narrative or emphasizing the regenerative capabilities of food systems that can contribute to both ecological and human wellbeing (Anderson & Rivera-Ferre, 2021; HLPE, 2019). This latter view also stresses distributional issues such as inequality and human rights (Anderson and Rivera-Ferre, 2021: 19). This question – how to address issues such as social justice and human rights in transition processes – has gained increasing attention in the broader field of transformation research (Jenkins et al., 2018; Kaljonen et al., 2021).

With regard to food systems transformation, the active inclusion of marginalized groups beyond industrialized agriculture is key. Indigenous peoples for example possess valuable knowledge on sustainable farming practices. Smallholder farmers are responsible for producing around one third of the food worldwide, but at the same time suffer from poor working conditions that do not enable them to earn a decent living (Anderson and Rivera-Ferre, 2021; Lowder et al., 2021). Since research on justice in transition shows that transformative capacities can be increased by paying attention to and taking into account justice issues in the transition process (Moragues-Faus, 2018), taking a closer look at how justice issues were addressed by the 2021 UN FSS seems promising. Thereby, a special focus is set on the concept of procedural justice as an element of food justice.

The FSS presents itself as a "People's Summit" that invites everyone from everywhere around the world to contribute. While this inclusive approach is a novelty in comparison to prior food summits, the FSS as such has also evoked harsh critique. One of the leading voices was the Civil Society and Indigenous Peoples Mechanism (CSM) in the UN Committee on World Food Security, which represents different civil society groups. The main points of critique as analysed by Canfield et al. (2021) are the selection of leaders and participants, the broad multistakeholder approach blurring human rights as normative basis of the Summit, and the role of strong corporate participation causing conflicts of interest. Furthermore, first ex-post evaluations of the Summit´s process and its advances in initiating steps towards sustainable food systems are reticent or even annihilating (Clapp et al., 2021; Coutinho et al., 2021; Montenegro de Wit & Iles, 2021; van der Ploeg, 2021).

Given the high ambition of the summit to create system change towards sustainable food systems in a participatory and globally just way, the critique on the outcomes of the FSS creates doubts about the capability of such an instrument to deliver it. Hence, the paper investigates the following research questions:

1. How is the procedural justice of the FSS discussed and assessed by actor groups proposing different narratives of sustainable food systems?

2. What are the opportunities and limits of a global governing body like the UN/FAO to foster system change in a procedurally just way?

Thereby, we will examine how procedural justice can contribute to the production of food justice and how procedural structures can hinder or enable the lever of dominant narratives in order to make alternative transition pathways, brought forward by less powerful voices, visible.

The empirical analysis adopts a qualitative case study design drawing on the analysis of official documents, articles and websites as well as expert interviews with representatives from governing bodies and actor groups in the context of the FSS. The article thus contributes to the growing research on just transitions and applies it on food systems from a global political perspective. The case of the FSS offers the chance to investigate discussions and decision-making processes in a multilateral governance context that includes various actor groups such as UN organizations, national governments, producers, consumers, and academia. Therefore, the article creates new insights on how to include issues of justice in the development of transition pathways aiming at sustainable food systems.

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Keywords: food systems transition, just transition, Food Systems Summit, Participatory justice, Food justice

[108] Michael P. Schlaile (University of Hohenheim), Matthias Mueller (University of Hohenheim), Stephanie Lang (University of Hohenheim), Matthijs Janssen (Utrecht University), Iris Wanzenböck (Utrecht University), Kristina Bogner (University of Hohenheim), Michael Schramm (University of Hohenheim) and Andreas Pyka (University of Hohenheim). *From linear policy to tackling wicked problems: A methodological reflection on the implications of the normative turn.*

Abstract. In this paper, we take the normative turn in innovation studies as a starting point for a methodological reflection on the implications of "wickedness" for science, technology, and innovation (STI) policy. More precisely, we expound the following four claims: (1) A "linear" policy approach will fail against the backdrop of wicked problems. (2) mission-oriented innovation policy is in danger of following the same paradigm (or: wicked problems are no moon problems). (3) The most crucial problem with wickedness is not that there is complexity, uncertainty, etc., it is rather not knowing about the wickedness and, thus, inadvertently following inadequate decision heuristics. (4) We need to re-think the knowledge creation process of scientific methods and their interrelationships with STI policy. We build on various strands of STI-policy-relevant literature, including discussions on wicked problems, sensemaking, transformative research, and agent-based simulation, to back up our four claims, before we conclude the paper with implications and suggestions for the way ahead.

Keywords: Agent-based Modeling, Complexity, Uncertainty, Wickedness, Sensemaking, Mission-oriented innovation policy, Transformative Innovation Policy, Dedicated Innovation Systems

[109] Kilian Bizer (Georg-August University of Goettingen), Uwe Cantner (Friedrich Schiller University Jena), Rolf Sternberg (Leibniz University of Hannover) and Jörg Thomä (ifh Göttingen). *How to measure the unknown? A new approach to analyze the DUI mode of innovation in structurally weak regions and related policies.*

Abstract. Most small and medium-sized enterprises (SMEs), unlike large firms, do not innovate or do not innovate exclusively based on the science, technology, innovation (STI) mode, with its strong emphasis on formal processes of in-house R&D to produce explicit and codified knowledge. Rather, they often rely on the doing-using-interacting mode of innovation (DUI), with its focus on informal processes of learning and experience-based know-how which is more in line with their comparative strengths (and weaknesses). The distinction between these two ideal modes is now widely accepted in innovation research. Nevertheless, not in innovation policy: it is still strongly based on the STI mode and thus ignores (or underestimates) the innovation performance of many SMEs, which is not (or only partially) based on R&D, but mostly on the DUI mode.

The STI/DUI concept also has clear spatial implications, because most large firms locate their headquarters and R&D departments in large urban agglomerations, while in non-urban areas the share of SMEs among innovators is relatively high. This circumstance has so far not been sufficiently reflected in innovation policies: they at least implicitly address urban rather than rural or even structurally weak regions. Moreover, recent studies indicate that especially in structurally weak regions, SME innovation activity is strongly shaped by DUI-based learning processes. Policies aiming to reduce regional disparities in terms of innovation should therefore pay attention not only to the STI mode but also to the DUI mode. This fits into a broader body of literature combining the regional innovation systems approach with the STI/DUI concept to focus policy maker's attention on spatially embedded learning processes and region-specific contextual conditions.

This background marks a research gap and a policy deficit, both of which we want to address. First, the indicators recently developed by Alhusen et al. (2021, Research Policy, https://doi.org/10.1016/j.respol.2021.104214) to measure the DUI mode of SMEs remain largely unexploited regarding their practical and region-specific uses. At this point, we aim to contribute to reducing this research gap by measuring DUI innovation activities of SMEs in structurally weak regions. Second, there is still a lack of empirical evidence in favour of an innovation policy to support the DUI mode in structurally weak regions. Hence, based on our empirical data, we aim to conduct policy analyses for the structurally weak regions under consideration to derive policy implications for promoting innovation in SMEs.

We propose therefore, first, a method to empirically capture/measure innovation activity (especially of SMEs) in structurally weak regions. In this context, a special focus is on the DUI mode for aforementioned reasons, even though even SMEs often combine elements of the DUI mode and the STI mode. The 47 indicators proposed by Alhusen et al. (2021) will guide us. The 47 indicators are composed of 19 learning-by-doing and learning-by-internal-interacting indicators, 13 learning-by-using indicators, and 15 learning-by-external-interacting indicators.

By mixing qualitative and quantitative data collection and analysis methods, 12 German counties ("Kreise") are then examined in detail, including two urban and ten rural regions as well as ten explicitly structurally weak and two economically stronger reference regions. This spatial selection takes into account West and East German counties, different types of rurality, and industrial specializations. For each of our study regions, quantitative survey data are collected from companies by means of a standardized questionnaire. They will be used for interregional comparative measurement of DUI innovation activity. Once this part of the empirical study has been successfully implemented, the long-term goal is to integrate these DUI indicators into the existing nationwide indicator system for monitoring the development of regions, which so far uses solely STI indicators to measure innovation. The second pillar of the data collection is qualitative data obtained from 12 to 15 face-to-face interviews per county with entrepreneurs, local economic promoters and intermediaries. The goal is to interpret the quantitative findings in light of region-specific contexts. Innovation policies of different spatial provenance operating in the region are also part of these context factors, without which innovation activities and intensities cannot be explained and understood.

Therefore, secondly, another aim of our approach is to document as completely as possible the role of innovation policy measures in the study regions, also with regard to higher spatial governance levels, such as the respective federal state, the German federal government and the European Union, and to evaluate them with regard to their influence on the DUI innovation activity of SMEs.

Keywords: STI&DUI innovation modes, SMEs, Regional innovation, Regional specificity, Innovation measurement

[110] Ghinwa Moujaes (INGENIO (CSIC - UPV)). *Income Inequality and Economic Complexity in Europe; A Mutually Reinforcing Phenomena.*

Abstract. Introduction

Widening income disparity is increasingly a growing concern for policy makers, politicians and scholars. Growing evidence shows that higher and uncontrolled rates of inequality can fuel economic instability and political tension thus increasing country risk, dampening investment quantities and reducing consumption and growth (Acemoglu et al., 2012; Carvahlo and Rezai, 2014; Cingano, 2014; Kumhof et al., 2015; Rajan, 2011). It is thus necessary to understand the drivers of inequality and how specific policies, mainly intended to achieve growth, can increase or reduce income disparities. The literature is vast with attempts to study the relationship between innovation, knowledge accumulation and inequality. One observable issue in that literature is how knowledge is measured, specifically is the focus on indicators on "quantity". The use of such indicators follows the uncertain assumption that all knowledge has the same value and all knowledge is arbitrarily additive.

These limitations of knowledge proxies highlight the benefits of using approaches of Economic Complexity to capture knowledge accumulation in an economy. In such approaches, knowledge in an economy is a measure of not only the quantity but also the quality of the activities presents in this economy. Measurement occurs by simultaneously leveraging information on the industries the economy specializes in and how ubiquitous (common-place) these industries are around the world. The debate and literature on complexity grew fundamentally based on the works of Hausmann and Rodrik (2005), Hidalgo and Hausmann (2009) and Tachella et al. (2012, 2013). Instead of relying on aggregate levels of data from firm, government, household and national accounts, economic complexity implements network theory and spectral analysis to reduce the dimensionality of the data in methods that conserve more detail than mere aggregates (Balland et al., 2021). Economic complexity was empirically proven to be a good determinant of economic growth (xxx, xxx). Thus, as a concept, it has been influential in policy directions. It argues that policy-makers should concentrate resources and plans towards adequate conditions to diversify local knowledge know-how, and produce a wider range of more complex set of goods and services (Hausmann et al., 2021). The Smart Specialization policy, EU's innovation policy, has been linked to theories of economic complexity due to its vision of funding regions to diversify their industrial portfolio into more related and complex industries compared to their knowledge core (Rigby et al., 2019). As notions of complexity continue to make their way into public policy debate, it becomes essential, for the sake of inclusive growth, to specifically understand but also what type of growth such policies are linked to.

Research Question & Relevance

Recognizing the relevance of economic complexity and inequality in today's public policy debate, this paper studies the relationship between them. The literature on economic complexity and inequality began with Hartmann et al. (2017) who found evidence of a negative relationship between the two phenomena on an international scale. The authors argue that complex productive structures display the a "high-resolution expression" (p.85) of the institutional and educational systems in which they flourish. They conclude that complex products, such as machinery and manufacturing systems, are associated with high levels of economic complexity and low levels of income inequality. On the other hand, simpler products that are at lower levels of the supply chain, such as cocoa beans and animal hair, are associated with low levels of economic complexity and high levels of income inequality. Since that paper, multiple authors have contributed to the literature, by adding new empirical methodologies (Sbardella et al., 2017; Lee & Vu, 2020; Lee & Wang, 2020), or focusing on specific sub regions around the world (Sbardella et al., 2017; Zhu et al., 2020; Morais et al., 2021).

This paper contributes to the literature on the relationship between economic complexity and inequality and to the policy debate on the Smart Specialization Strategies. The main distinctions from the literature are:

The paper measures complexity using patent data. Patents provide a strong estimation to the type of knowledge present in an economy (Griliches, 1990; Jaffe and Trajtenber, 2002). They capture a different part of the innovation eco-system than trade data. Certainly, patents do not capture the entire ecosystem of produced knowledge, but they provide a useful way to focus on technological knowledge to the extent it is transferred into inventions of utility. The detailed information found in patents has widely been used to study the evolution of local knowledge. (Boshcma et al., 2015)

Due to the policy relevance and the context-specific nature of inequality dynamics, the paper analyses the relationship from an EU perspective.

By implementing a 3SLS Systems of Equations methodology, the paper attempts to model the mutually influential effect between income inequality and economic complexity.

Methodology

Following the literature, we expect that education, government spending and globalization make a contribution to the relationship between economic complexity and inequality. Those measures are contextualized in equation (1).

(1) $$Inequality_{i,t}=\beta_0+\beta_1\, Complexity_{i,t}+\beta_2\, R\&D\_Spending_{i,t-1}+\beta_2\, Migration_{i,t-1}+\beta_3\, Foreign\_Employment_{i,t-1}+\beta_4\, Social\_Expenditure_{i,t-1}+\alpha_i+u_t+\varepsilon_{i,t}$$

While equation (1) provides the baseline for the relationship between the two components, the methodology further attempts to capture the two-way dynamic between complexity and income inequality. In order to do that, first a Granger test for Panel Data is implemented to test for the presence of reverse Granger causality between these two variables (Dumitrescu and Hurlin (2012). Once this is established, a systems of simultaneous equations methodology is implemented in order to account for the presence of mutual effects. In the second equation, variables which are arguably components of economic complexity are used as explanatory variables. Those include educational attainment measured through the tertiary attainment of the population, life-long learning proxies to control for continuous training and learning even amongst the labour force, institutional quality of the business market and how conducive it is to innovation captured through the number of days required to open a business, percentage of foreign employment to account for knowledge coming from abroad and the employment rate of the labour market.

(2) $$Complexity_{i,t}=\gamma_0+\gamma_1\, Inequality_{i,t}+\gamma_2\, Educational\_Attainment_{i,t-1}+\gamma_3\, Adult\_Training_{i,t-1}+\gamma_4\, Days\_to\_Open\_Business_{i,t-1}+\gamma_5\, Foreign\_Employment_{i,t-1}+\gamma_5\, Employment\_Rate_{i,t-1}+\alpha_i+u_t+\varepsilon_{i,t}$$

Preliminary Results

Equation (1), implemented through a basic OLS model with lagged measures, finds a negative and significant relationship between complexity and income inequality. The results are negative and significant relationship when calculating complexity using both a four-year or a five-year moving average, and when we control for the specific years of 2008, 2009 and 2010. The results are also robust when we include a dummy variable to control for the EU-15 countries, countries which have a GDP higher than 50% of the EU average and countries whose manufacturing industry contributes to more than 50% of gross value added compared to the EU average. To quantify the results and on average across the models we apply, a one-standard deviation increase in complexity decreases our GINI coefficient by 1.78 units. The negative relationship is in-line with the findings presented by Hartmann et al. (2017), Sbardella et al. (2017) and the OLS analysis of Lee & Vu (2020). This confirms that the negative relationship holds true even when using patent data to measure complexity and also when focusing purely on the European context.

Despite using lagged-variables in our analysis, the methodology does not capture causality. Indeed, for countries to become more complex in the first place, the regional innovation ecosystem needs to be conducive to such types of innovation. It is widely acknowledged in this literature that the institutional ecosystem needs to co-evolve with the knowledge structure (Hartmann et al., 2017; Sbardella et al., 2017). This could imply that more equal societies are themselves correlated with higher levels of economic complexity. Vast literature on the consequences of inequality can motivate this theory by explaining how inequality can hamper economic growth, social trust and mobility and skill development (Nel, 2006; Stiglitz, 2012; Corak, 2013). Through this mechanism, inequality hampers innovation and thus reduces economic complexity.

Empirically, this reverse causality is evident when we implement a Granger Causality test, adapted for Panel Data (Dumitrescu and Hurlin, 2012), on our GINI variable and Complexity Variable. The results confirm that complexity Granger cause inequality, and also inequality Granger cause complexity. This motivates our implementation of a 3SLS model which will be implemented and discussed in future drafts of this paper.

Discussion

The paper contributes to the specific literature on the relationship between economic complexity and inequality and the general literature on knowledge accumulation, diversity and specialization. From a policy perspective, this paper will present additional insight to the argument that innovation policies that motivate regions to become more economically complex, are also conducive to higher levels of inclusive growth and more equally shared prosperity. Nonetheless, the role of human capital, skill formation and accumulation and training should not be underestimated here. Otherwise, the capacity of a nation to achieve higher levels of economic complexity is limited and so is its capacity to translate higher levels of economic complexity into lower levels of income inequality.

Keywords: Income Inequality, Knowledge, Diversity, Complexity, Smart Specialization

[111] Manuel Pereira-Puga (Institute of Public Goods and Policies (IPP), Spanish National Research Council (CSIC)) and Luis Sanz-Menéndez (CSIC Institute of Public Goods and Policies (IPP)). *Research centres funding schemes as instruments for university change: Their policy and institutional barriers .*

Abstract. 1. Introduction

Governments influence scientists' activities and practices as well as scientific organisations. One of the main ways in which governments promote change in universities is through funding models and instruments. Over the last four decades many Governments have implemented specific funding instruments addressing University Research Institutes and Centres (URICs) and, more recently, those schemes have drift to “centres of excellence”.

Research has been conducted on issues such as to what extent the grants allocated contribute to improving their scientific output. However, little research has been conducted on how research centres funding schemes, as policy instruments, promote organizational changes that can lead to a significant improvement of the research carried out at the university. And, more importantly, on the institutional and policy barriers to achieving this goal. From transformative research organizations we know that there are various conditions for the success of URICs: autonomy in the scientific decisions, including human resources policies, and coordination of internal research agendas, usually based on a strong scientific leadership, are among the most relevant ones.

That is why this article addresses the following research question: What institutional and policy barriers make it difficult for new URICs to achieve autonomy in decision-making and coordination of research agendas? To answer this question, we address the centres of excellence scheme for URICs implemented by the regional government of Galicia (Spain) in 2016.

The paper is organised as follows: section two is devoted to the theoretical framework and analytical approach of the research, section three explains the main characteristics of the case study, section four gives details of the methodology employed in the research, section five explains the main results and, finally, section six includes the main conclusions of the study.

2. Theoretical framework

The analytical approach builds on the framework provided by the historical institutionalism and its classification of the different types of institutional or policy change (see for example Mahoney & Thelen, 2015; Thelen, 2003).

As the article focuses on organizational and institutional autonomy, we use the notion of organisational governance, that implies the existence of various stakeholder groups, as well as rules, behaviours and interaction between them within the context of a scientific organisation (Luo et al., 2019). Additionally, to deal with relationships among academic actors, we use the concept of academic authority and their two sources, the academic community and the hierarchy within the organisation (Cruz-Castro & Sanz-Menéndez, 2018, p. 137).

3. The case study

Spain is a highly decentralised country. Competences on higher education funding and supervision were transferred to the regional governments (Autonomous Communities) several decades ago. R&D and innovation competencies are shared. Galicia has had multi-year funding plans (4 years) for the Galicia university system in place since 1990; a new one (2022-2025) has been just agreed between the Government and the 3 public universities and it has been included in the Regional Government budget Annual Act in December 2021. It provides with an overall amount of university funding.

In addition, the regional government of Galicia (Xunta de Galicia) has been developing a policy mix of competitive research funding instruments for supporting the activities of university researchers. These instruments are aimed at different targets: individual researchers, research groups, and research centres. As part of its policy mix, the Galician government designed and implemented a funding instrument aimed at promoting research centres based in the Galician universities.

The Galician centres of excellence scheme provides research centres with recurrent funding for periods of 4 years (2016-2019 in its first call), which can be extended after external evaluations. The functioning of the programme is similar to the rest of the excellence initiatives identified at the international level (see OECD, 2014). The government of Galicia opened a competitive call. Universities submitted applications from their research centres. These applications were evaluated by a panel of independent experts, affiliated with institutions outside Galicia. The selected centres were accredited and received initial funding for an extendable period of 4 years. After two years, the centres underwent a mid-term evaluation. The centres were also subject to a final evaluation at the end of the fourth year. Currently, all centres selected in 2016 continue to receive funding. The programme has an external advisory board composed of leading scientists who advise the Galician government on the improvement of the programme.

4. Data and methodological approaches

In order to study this centres of excellence scheme a qualitative methodological approach was used. It was based on semi-structured interviews with key informants and documentary analysis of legal texts and reports with information of the accredited centres. Fieldwork was carried out in all the centres funded by the programme, i.e. data were obtained not from a subset of accredited centres but from all of them.

5. Results

5.1. Policy inconsistencies

Science policy instruments seek to solve problems in the science system or to improve specific aspects of it. Sometimes, an instrument intended to be effective to address a particular problem may be inconsistent with another existing instruments, generating adverse effects. Quite recently calls have been made in favour of the consideration of policy mixes (Flanagan et al., 2011) and the policy coherence (May et al., 2005, 2006) in the portfolio of interventions. The case study demonstrates that centres of excellence schemes can be negatively affected by other competitive funding instruments implemented at the same governmental level. Additionally, there may be conflicts or mismatched between instruments implemented by different levels of government.

5.2. Institutional barriers

The creation of new research structures (centres) within larger and more complex structures (universities) can lead to clashes. The case study focused on conflicts around human resources policy, and the consequences of the distribution of competencies, for the feasibility of the centre long term project. The interviews with the scientific directors and the focus groups with scientists identify potential constraints for the operation of the centres within the traditional structures of a university concerning recruitment and access to tenure.

6. Conclusions

Previous research has focused on highly relevant matters, such as identifying the mechanisms by which capacity building generates epistemic effects (see Hellström et al., 2018) or quantifying the effects of the excellence grants on the centres' production and growth dynamics (see Langfeldt et al., 2015). This article has attempted to shed light on an issue that is still in the shadows. We have sought to improve our knowledge of how Governments try to promote and incentivise institutional changes within host universities as well as on the institutional and policy barriers to change.

We conclude that the transformative effects of public science policies are mediated and sometimes mitigated by multiple factors and mechanisms. Indeed, this case study shows that centres of excellence schemes do have a transformative capacity for universities, although this capacity is limited (and the effects take time) by the regional scientific ecosystem, the university governance model, the actors belonging to the university system (policy-makers, university managers, scientist…), and the programme's inconsistencies with other public policy instruments implemented at the same or at other level of government. Centres of excellence schemes can make a decisive contribution to the transformation of universities, but there needs to be a strong policy mix coherence, between the programme and other science funding instruments, and a commitment to the centres from the host universities and the main actors in the regional science system.

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Keywords: Centres of excellence., Funding instruments., Organizational autonomy., Authority sharing.

[112] Toon Meelen (Utrecht University). *Political economy scenarios for the housing-energy-mobility nexus .*

Abstract. In addition to climate change problems, concerns over affordability of housing, energy and mobility have emerged. An increasing number of authors argues for just sustainability transitions, which address both environmental concerns and social equity. In this literature, a 'three tenet' normative analytical framework is often applied that considers multiple forms of in(justices) in relation to sustainability transitions (Williams & Doyon, 2019). This has led to rich assessments of the justice dimension of actually occurring sustainability transitions, including the mapping of various injustices. However, the mechanisms by which (in)justices come about during transitions have received considerably less attention. In this study, we argue that political economy structures are highly important for social outcomes of transitions, because they influence the ownership structures and power relations of technologies. We hence take up the call to engage more with different variations of capitalism and their influence on transition outcomes (Feola, 2019). In this regard, we see 'transformative' innovation policies, as well as their targets, as embedded in broader political economy structures. Hence, the justice dimension of transformative innovation policy should be assessed in its political economy context.

The study considers a sustainability transition in the nexus of housing, mobility and energy. New technologies such as domestic energy generation (e.g. solar panels), electric vehicles and vehicle-to-grid technologies increasingly connect these domains. The emergence of a nexus of these previously disconnected domains also risks bringing about non-linear effects in the accumulation of power and inequalities. For example, one company can become an integrated provider for the now-related services of housing, energy and mobility, which increases its power vis a vis consumers.

The main argument of the paper holds that political economy structures influence social justice outcomes of transitions in the housing-energy-mobility nexus via ownership structures. Two political economy scenarios are discussed: continuing neoliberalism as well as a revived social democracy. The former refers to a market-dominated form of capitalism, whereas the latter entails a form of stakeholder capitalism in which the state takes a prominent role. The two types of political economies influence the mix of ownership structures (rental, co-ownership, private ownership and public ownership) in the housing-energy-mobility nexus. In turn, the mix of ownership structures affects the outcome of sustainability transitions in terms of distributional, procedural and recognition justice.

Empirically, the study starts by mapping current ownership structures for the domains of housing energy and mobility separately. It does so for the Netherlands, which is a frontrunner in terms of technological innovation in these domains. Examples are identified across domains: For rental (privately rented homes, leased solar panels, leased cars), for individual ownership (home ownership, solar panel ownership, car/electric bike ownership), for co-ownership (housing co-operatives, solar co-operatives, car-sharing co-operatives) and for public ownership (Public housing, municipal energy companies, public transport electric bikes). We then proceed by describing emerging examples of ownership structures that connect the domains of housing mobility and energy. These include public housing organizations providing shared cars, as well as privately rented homes which include solar panels.

Starting from this analysis, scenarios are developed for the development of the mix of ownership structures in the housing-energy-mobility nexus for Western Europe for the period till 2040. These scenarios take into account different transformative innovation policies as well as technological developments in the housing-energy-mobility nexus. A Delphi approach is taken, and experts are surveyed as to develop the scenarios. The scenarios are assessed in terms of distributional, procedural and recognition justice. All in all, this leads to recommendations for including justice concerns in transformative innovation policies, taking into account the broader political economy context in which transitions take place.

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Keywords: Just Transitions, Political Economy, Justice, Transformative Innovation Policy, Mission-oriented Innovation Policy

[113] Jochen Markard (ETH Zürich; ZHAW), Peter Wells (Cardiff University), Xiao-Shan Yap (Eawag; Utrecht University) and Harro van Lente (Maastricht University). *Unsustainable developments: Exploring a blind spot for transitions research through SUVs and space tourism.*

Abstract. In recent years, sustainability transitions research has gained quite some prominence in the literature on innovation studies and beyond (EEA, 2019; Köhler et al., 2019; Markard et al., 2012). At the core of the field are fundamental transformations in socio-technical systems around energy, transport, agri-food or water. So far, scholars have explored two main strategies for improving sustainability issues: i) supporting innovations such as renewable energy technologies that perform better on specific sustainability dimensions than established practices and ii) fostering the decline and phase-out of unsustainable practices such as using fossil fuels (Markard and Rosenbloom, 2020; Rosenbloom and Rinscheid, 2020). Both strategies are typically complemented by a variety of public policies, including innovation policies (Smith et al., 2010) and phase-out policies (Rinscheid et al., 2021).

While both approaches are important from a sustainability perspective, they are not sufficient. In fact, as we focus on developments for the better, there is a risk that we miss those that make things worse (Antal et al., 2020; Markard et al., 2021). This paper argues, that in order to address grand sustainability challenges in a comprehensive way, transitions research also has to explore unsustainable developments. In fact, there is a large, uncharted terrain of unsustainable innovations, practices and structures, whose emergence and persistence can fruitfully be addressed by transitions research. Examples include established unsustainable practices such as fast food, fast fashion, high frequency product cycles, planned obsolescence, fracking, tar sands, urban sprawl, SUVs or cruise ship tourism as well as emerging fields and practices such as fast furniture, flying cars, deep-sea mining, asteroid mining or space tourism that have the potential to exacerbate sustainability issues.

To be sure, the point is not that there are unsustainable practices but that they continue to expand and multiply, even in parallel with sustainability innovations. The key challenge for sustainability transition studies is that unsustainable developments counteract and potentially even dwarf the current efforts to innovate and transition toward sustainability. Take electric vehicles. They are a classic example of an innovation currently in the focus of research as they may contribute to a transition toward low-carbon transport (Henderson, 2020; Kotilainen et al., 2019). At the same time, however, automobility at large is shifting towards sports utility vehicles (SUVs), which consume more materials in production, more energy in use, require more space and are more dangerous than smaller cars (Taylor, 2020). Also, urban sprawl continues almost unabated, increasing the overall demand for transport. These transformations happen in plain sight but do not seem to get sufficient attention. Ironically, the transition towards electric vehicles (and the attention it receives) might even help to obscure the above developments for the worse.

The aim of this paper is to define the terrain of unsustainable developments, to show how transitions research can contribute, and to provide navigational tools. But what does it mean to study unsustainable developments, and where to start? A first step is to reflect on what, in principle, can be said to be unsustainable; here we present a typology. A second step is to detail what exploring unsustainability means for the agenda of transition studies; here we present two illustrative cases: one that is already established (SUVs) and one that is emerging (Space tourism). In these examples we focus on climate change as a central sustainability challenge, allowing that there are many more sustainability issues at play (e.g., air pollution, safety, land use, inequality; modern slavery).

Sports utility vehicles (SUVs) are characterized by high fuel consumption. They have diffused widely in many markets, thereby not only replacing more efficient conventional vehicles but also counteracting the positive climate effects associated with electric vehicles. The SUV example is about a carbon-intensive socio-technical system, which has been under pressure for decades to reduce its emissions and climate impact. However, it has not only continued on an unsustainable trajectory but even spawned a transition that exacerbates the carbon footprint. This points to deeply entrenched regime structures and strong path-dependencies. One element of the regime includes firms which cling to established business models and use their close ties into policy to prevent effective climate policies (Skeete, 2017; Wells et al., 2013). Other elements include a car centric culture, strong dependence on automobility and unsustainable user practices (Mattioli et al., 2020; Wells and Xenias, 2015).

Space tourism is a prospective market in the early stages of development. Space flights and rocket launches generate high and particularly harmful greenhouse gas emissions in the stratosphere (Spector et al., 2017; Yap and Truffer, 2021). Space tourism is of particular interest as it might contribute to a significant shift in consumer aspirations and needs, similar to the advent of air travel in the middle of the last century. Space tourism is a case, where regime structures are still in flux and there are many uncertainties with regard to future pathways. It has been launched as a novel realm of experience and commercial activity, instead of an extension within an established market. Nonetheless, it is likely that the negative climate impacts of space tourism will be enormous if the transition materializes as envisioned by its proponents. The case is highly policy relevant as there is still an opportunity to intervene before major lock-ins have emerged.

This paper points to a research agenda on ‘unsustainable developments’ that has not received much attention in transition studies so far. The topic has profound implications for policy and research. With regard to the former, sustainability transition policies have to tackle at least three interrelated targets: i) supporting more sustainable innovations and practices, ii) accelerating the decline of established unsustainable systems and technologies, and iii) guiding and constraining unsustainable innovations before they create additional problems on top of the existing ones. While the first two are commonly addressed by innovation studies and transitions research (Kivimaa and Kern, 2016; Markard and Rosenbloom, 2020; Rosenbloom et al., 2020), the latter has received only scant attention so far. Here, we might be able to develop and inform precautionary transition policies, which can take effect before unsustainable socio-technical systems become institutionalized. That way, transition research would avoid the ‘firefighting’ approach that sets in when things have already gone awry. Further engaging with environmental governance studies may be fruitful to tackle this challenge, given that these literatures adopt a more anticipatory perspective towards emerging unsustainable trends (Biermann and Kim, 2020; Gupta et al., 2020).

With regard to research implications, insights from transition studies can be fruitfully mobilized for studying unsustainable developments. For example, transition studies highlight the systemic nature of innovation and transition processes. One of the key issues is that (unsustainable) innovations are all the more difficult to change the more they become intertwined with complementary business models, economic interests, infrastructures, consumer practices, needs, etc. (Rosenbloom, 2020a). Studying unsustainable developments will also enrich established frameworks and advance conceptual repertoires. For example, the simultaneous upsurge of both SUVs and electric vehicles and their interrelations will deepen our understanding of transition pathways (Geels et al., 2016; Rosenbloom, 2017), while studies on the emerging space industries will strengthen the emerging research agenda on multi-system interaction (Andersen and Markard, 2020; Rosenbloom, 2020b), larger paradigm shifts (Mathews, 2013; Perez, 2013) or deep transitions (Schot and Kanger, 2018).

To conclude, it is necessary to better acknowledge and analyze unsustainable developments, and how they interact with ongoing transition processes. It is high time to address the associated challenges both in terms of policymaking and research.

Keywords: unsustainable development, transition, SUV, space tourism, multi-system

[114] Susana Borrás (Copenhagen Business School), Stine Haakonsson (Copenhagen Business School), Christian Hendriksen (Copenhagen Business School), Trine Pallesen (Copenhagen Business School), René Taudal Poulsen (Copenhagen Business School) and Lucas Somavilla (University College London).
Conceptualizing the Roles and Capacity of Public Organizations in the Governance of Sustainability Transitions. A Literature Review.

Abstract. Sustainability transitions are complex because they involve many and diverse actors and stakeholders in processes that require creating market and institutional contexts for public and private investments, adapting standards and safety regulations, fostering the creation of new knowledge, etc. Public actors like municipalities, local port authorities, national regulatory agencies, publicly controlled utilities, etc. are key players in those processes. These public actors might take different roles in the governance of sustainability transitions, acting as entrepreneurs (Mazzucato 2014); acting as intermediaries (Kivimaa et al. 2019); and/or acting as lead-users, gatekeepers, mitigators, etc. (Borrás and Edler 2020).

Given the centrality of public actors in sustainability transitions, there is a growing view that their capacities are paramount in such processes.

The innovation literature has recently paid attention to the governance and policy mixes of innovation policy initiatives towards solving grand challenges, here including the grand challenge of climate change mitigation (Kuhlmann and Rip 2018) (Weber and Rohracher 2012) (Rogge and Reichardt 2016). This literature has made a typology of public innovation and mission-oriented agencies, and inspired by research in business studies on firms' dynamic capabilities, has started to consider as well issues of their dynamic capabilities in mission and directional innovation (Breznitz et al. 2018) (Kattel and Mazzucato 2018).

Likewise, the literature on governance and public administration has increasingly payed attention to the problem-solving capacity of the modern state (Lodge and Wegrich 2014). Particular attention has received the problem-solving capacity related to the grand challenges associated to environmental sustainability, as a particular form of 'wicked problem' for collective problem solving (Termeer et al. 2016) (Head 2018). For its part, the sustainability transitions literature is increasingly focusing on intermediaries and change agency in processes of sustainability transitions (Köhler et al. 2019) (Kivimaa et al. 2019) (Geels 2020). Likewise, this literature has also been recently looking at questions about policy and governance capacity at a systemic level, particularly at urban level (Castan Broto et al. 2019) (Hölscher and Frantzeskaki 2020).

Taken together, this growing body of literature has used the notions 'capacity' or 'capability' in a diverse manner. Most notions refer to systemic features, or the overall capacity of a (urban, governance) system to adapt and change; others refer to state-led policy capacities; while others refer to intra- and inter-organizational dynamics in such processes. At the core of these studies is the willingness to identify core elements in such complex and demanding processes focusing on action-oriented capacities for such transformation.

This paper is interested in the intersection between the action perspective in the governance of socio-technical systems' change directed towards sustainability challenges, and the capacity of actors for initiating/guiding/conducting transformative action. In particular, we pay attention to public actors, in the understanding that they are highly relevant agents of change for such transformative processes. The non-profit, general-interest 'raison-d'être' of public actors (different than for-profit private actors) puts public actors a particularly relevant position for fostering transformative processes.

This article has two overall purposes. Firstly, it aims to review the various strands of literature mentioned above in order to identify key conceptual developments in this field. More specifically, this paper looks carefully into the way in which the literature has dealt conceptually with notions about 'capacity' and 'capability' when studying public actors' in the governance for sustainability transitions. The goal is to identify common conceptual trends, detect conceptual inconsistencies, and ultimately find untapped possibilities in this body of literature. Secondly, building from that, this paper aims at moving the research agenda a step further by developing a novel conceptual framework to study the capacity of public actors in the governance of sustainability transitions focusing on the various roles that these actors might perform, and focusing as well on the way in which capacity is developed and utilized when unfolding those roles.

With this purpose in mind, this paper addresses the following research questions: What are the various conceptual approaches in studies focusing on public actors' capacities in sustainability transitions? In what specific contexts are those studies analyzing the capacity of public actors? What are the various types or elements of capacities identified in those studies and how are they conceptually interrelated? And, last but not least, how can we conceptualize the roles and capacities of public actors in the governance of sustainability transitions, and what specific lines can be developed for advancing a research agenda on this crucial topic?

The next section after the introduction explains the methodological approach and data used in this literature review. There are various types of literature reviews according to their methods (Grant and Booth 2009) and/or their overall aims (Gough et al. 2012). We focus on the conceptual aspects of the literature, and follow Paré et al, in their understanding that a theoretical review "(…) goes beyond merely assembling and describing past work. The primary contribution and value of this type of review lies in its ability to develop novel conceptualizations or extend current ones by identifying and highlighting knowledge gaps between what we know and what we need to know." (Paré et al. 2015) P .188. As such, this type of review focuses on the conceptual aspects of previous literature in order "to provide a context for identifying, describing, and transforming into a higher order of theoretical structure and various concepts, constructs or relationships". P. 188. The overall objective is to identify gaps, showing the 'thinness' in the crossing-fields that deal with the topic under study, in our case, the capacity of public actors in sustainability transitions.

In practical terms we have followed the various steps which are informed by the literature on reviews (Petticrew and Roberts 2008). Therefore, after defining the overall goals of this review article, formulating its concrete research questions, agreeing on a specific protocol, and consulting with external experts, the review was undertaken according to four steps.

We searched two major scientific bibliographic databases (the Web of Science and Scopus) using the same search terms and script. We identified 1640 papers, and removed 466 duplicates. We screened 1174 papers by reading their abstracts, and considered 915 irrelevant. Of the remaining 188 papers, we took the next step of reading the whole text, and excluded 99 as were out of scope. Hence, we selected 89 papers for full.

We created a specific template for coding different items, and undertook a careful review of the selected papers based on that template. The items are: the types of public actors studied in the literature; the different roles or functions of public actors in sustainability processes as defined/described in the paper; the different terminologies and approaches about 'capacity' and/or 'capability'; the specific empirical cases of sustainable transitions, processes of systemic change analyzed; the specific levels of capacities (policy, governance, organizational, individual capacities); and the specific types of capacities (analytical, regulatory, coordination, operational, etc.). This paper analyzes the literature following this coding, and reflects about these findings in order to identify conceptual trends, inconsistencies, and/or untapped opportunities.

This paper follows generally a policy and governance studies' approach that defines capacities as "the set of skills and resources necessary to perform policy functions". (Wu et al. 2018) p. 3. Hence, capacity can be understood as the specific combination of resources (as knowledge, budget, legitimacy, etc.) and of skills (as the abilities or competences to make use in specific ways of those resources). Our approach is interested in the organizational level of public actors (not the systemic level of policy/governance systems, or the individual-person level of public employees). This organizational level is particularly related to the literature on public administration and governance. Recent studies are for example looking into the municipalities' capacities for sustainable and climate policies in cities (Bettini et al. 2015; Salvador and Sancho 2021); looking into social entrepreneurship as mode of building institutional capacities in organizations (George and Reed 2016), or exploring what general capacities are needed for accelerating sustainability transitions in specific intervention points (Rogge and Song 2021).

This paper takes a step further, and builds a conceptual framework from the untapped opportunities. In particular we offer an insight based on various types of organizational resources, various types of organizational (cap)abilities as skills, and various roles performed by the public organizations in processes of sustainable transitions. We engage in a discussion with the literature about intermediation, focusing in particular on issues about the degrees of transformative agency. A core tenet in our understanding is that the higher the transformative nature and ambition of these roles, the more capacity (resources and abilities) these public organizations would need.

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Keywords: Transformative innovation, Organizational capacity, Sustainability, Governance, Green innovation

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Sustainability and Resilience through Transformative Innovation Policy, at National And Regional Level.

Abstract. The European Green Deal (EGD), introduced in December 2019 as Europe's Growth and Development plan, calls for innovative policies that will address the challenges related to the Green and Digital transformations required for the transition to Sustainability. Consistently, the 17 UN Sustainable Development Goals (SDGs) give Innovation a central role. Especially SDG is about building resilient infrastructure, promoting inclusive and sustainable industrialization, and fostering innovation. In this paper, the Research and Innovation gaps both at the country and European level will be identified, and appropriate Transformative innovation policies will be proposed, along with possible financial pathways to support the Green and Digital Transformations for Sustainable and Resilient societies. This will be based on existing work regarding the interdependence of innovation policy and the SDGs to address increasingly urgent societal challenges, and an established methodology for mapping the 17 SDGs, with the European Green Deal and the European Commission's Country-specific recommendations.

Keywords: Innovation Policy, Sustainability, Resilience, Sustainable Development Goals, Machine Learning

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Stability and change in academic engagement: Collaborative PhD projects in biomedical engineering at Chalmers University of Technology 1948-2018.

Abstract. Introduction

Much of the literature in economics and the economics of science has focused upon commercialization of university research through market-based mechanisms of patents and start-up companies (see for example, Ambos et al 2008; Lockett and Wright 2005; Bozeman et al 2013; Wright et al 2004). Based on an extensive literature review of the diverse literature on university-industry interactions, Perkmann et al (2013) proposed a new concept, that of “academic engagement with industry”. This concept stresses the importance of knowledge networks between university and industry—visible through various mechanisms such as co-authorship, consultancy, university-industry centers and more—in contrast to the commercialization of research in the narrow sense of patents and start-up companies. Drawing on a longitudinal mixed-methods study of collaborative PhD projects in biomedical engineering over seventy years at one university, we explore the evolution of academic engagement to improve our understanding of the sources of its stability and change.

Theoretical framework

An important topic within evolutionary economics is the co-evolution of technology, markets, and institutions over time and space, which in turn, impacts technical change, innovation and economic growth (Nelson and Winter 1982; McKelvey 1996; Murmann et al 2003). Even if the tendency is to analyze broad macro-level processes involving the generation of novelty, retention and selection, these broad changes are linked to actions of organizations and individuals through concepts such as routines and capabilities (Nelson et al 2018; Teece et al 1997). However, not all changes are possible within a given context leading to path-dependency. This path-dependency of change may depend upon underlying cognitive paradigms shared within a community (Dosi 1982), an industry or a shared technological regime (Malerba and Orsenigo 1997), or regional networks and social structures (Boschma and Martin 2010). Thus, co-evolutionary processes are characterized by both stability and change.

In this paper we refer to academic engagement as "knowledge-related collaboration by academic researchers with non-academic organisations." (Perkman et al 2013, p. 424). Thus, we are interested in the stability and change of such collaborations as they evolve through actions of organizations and individuals, within a broader path-dependent co-evolution of technology, markets and institutions in a given context.

Research design and methodology

In this paper we study the evolution of biomedical engineering at the Chalmers University of Technology in Gothenburg, Sweden (Chalmers) in the period 1948-2018 with a focus on how faculty collaborated with a local university hospital, Sahlgrenska University Hospital (Sahlgrenska), through PhD projects.

The analysis is based on interviews, archival data, and bibliographic data. First, we have done semi-structured interviews with researchers at Chalmers and the Sahlgrenska. Second, we have analyzed extensive archival data stored in the archives of Chalmers. Thirdly, we have collected bibliographic data from publication databases (Web of Science and PubMed). Finally, we have identified and collected data on all PhD theses produced within biomedical engineering at Chalmers during the selected time period.

Findings and conclusions

Our findings show that collaborative PhD projects are guided by formal organizational structures and routines that evolve in response to individual initiative and external changes. Important changes include technological change, new incentives by funding organizations (e.g. funding for university centers), new regulation of research on humans and animals, new professors, and so forth. Furthermore, the medical applications and problems also change in time. However, at a general level, we observe long-term trajectories for some topics that do reproduce themselves (but in slightly different ways) and despite that individual professors come and go.

In particular, we have identified two different sets of organizational routines concerning how the university collaborate with hospitals through PhD projects. The first set of routines guide how students and their supervisors collaborate directly with hospitals. The routines involve different types of activities that evolve—in a path dependent way—in response to external changes, new professors, and the structures that are specifically created to promote medical innovation. These activities include the design and implementation of medical devices, verification activities in the lab, validation through the clinical use, the use of the devices for clinical research, writing of joint research papers, etc.

The second set of routines guide how students and researchers collaborate indirectly with hospitals through firms. This set emerged in the 1990s and has become more prominent in recent years. In the beginning these routines were primarily concerned with the commercialization of research results that had been achieved through PhD projects, but in the last ten years they are invoked already during PhD studies with students finishing an industrial PhD degree.

Based on our finding we conclude that many factors incite change in the evolution of academic engagement, but organizational routines are the main source of its stability.

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Keywords: academic engagement, biomedical engineering, stability and change, organizational routines

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Science diaspora collaboration with home country: empirical evidence on factors that facilitate and hamper collaboration.

Abstract. Introduction

This study presents findings from an analysis of factors determining collaboration between science diaspora and home country innovation system actors. We rely on systems of innovation conceptual framework and argue that science diaspora, although distant, can be an important actor in the particular innovation system. Previous research has established that science diaspora and home country innovation system actors can engage in cooperation benefiting home country development. There is also some evidence factors determining science diaspora's engagement in collaboration. However, it is limited to selected geographies, and the findings are mixed. Therefore, we take a holistic approach to understanding the various factors hindering and enabling collaboration and aim to answer the research question – what factors determine science diaspora collaboration with actors of the home country innovation system? We study this for the science diaspora of Latvia – a country suffering from large volumes of brain drain. We conducted a survey of Latvian science diaspora across the globe and ran four focus group discussions with members of the Latvian science diaspora. We find a mix of individual, organisational and system level factors that determine collaboration between science diaspora and home country innovation system actors and discuss implications for a policy aiming to apply diaspora option.

Theoretical foundation, relevance and research question

We rely on systems of innovation framework as a central theoretical foundation to justify the relevance of analysing science diaspora collaboration with the home country. Systems of innovation framework acknowledge that various actors and their actions are part of the system of innovation (Lundvall et al, 2010). Systems of innovation emphasise the role and interaction between private firms, scientific institutions, government actors, and wider society and their role in innovation development. Science diaspora, although distant, is one of these actors and a source of new knowledge in the systems of innovation. Previous studies have found that collaboration with science diaspora can be one of the policy options to mitigate the adverse effects of brain drain (Meyer and Brown, 1999; Jöns et al 2015; Davenport 2004). Diaspora option implies remote mobilisation of the science diaspora (Meyer and Brown, 1999). It holds on the premise that diaspora scientists are not likely to return to the country of origin but are a significant source of intellectual capital that can still benefit the country of origin (Davenport 2004). Engagement with science diaspora and its contribution to home country development can be viewed as one of the activities that systems of innovation scholars describe (e.g., Edquist 2017) as activities that influence the development of knowledge and innovation in the systems of innovation.

Previous research has established that science diaspora and home country innovation system actors can establish various forms of cooperation. Studies point to the interest in collaboration (Tejada et al, 2013). Ciumasu (2010) found that most surveyed Romanian diaspora scientists are interested in co-working with Romanian scientists. Others report diaspora scientists collaborating with scientists, policymakers, and other professionals in their home countries (Larner 2015; Jöns et al 2015). Tejada (2012) reported that scientists from Colombia, India, and South Africa living in Switzerland built networks that organised activities benefiting respective countries of origin (Tejada, 2012). Collaboration with science diaspora can support policy or research system reforms and overall capacity building (Tejada et al, 2013) and start joint projects with home country scientists (Saxenian, 2006).

In several countries, governments have developed collaboration with their science diasporas. In 1990-ies members of the Colombian science diaspora established the Caldas Network of Colombia, which works to support scientists in Colombia (Kuznetsov, 2006). In Lithuania, policymakers facilitate cooperation with science diaspora (Gudelis and Klimavičiute, 2016). Armenian policymakers have tried to connect with the science diaspora by organising joint events for the members of the science diaspora and home country scientists interested in participating in the Horizon 2020 programme (National Information Point of Armenia, 2017). Recently, engagement of science diaspora is at the centre of government efforts to promote innovation-led growth (UNECE, 2021). In Greece, the Ministry of Economy and Development initiated the operation of the 'Knowledge and Partnership Bridges' - an interactive networking platform designed to provide a registry of highly skilled Greeks abroad and providing regular information on funding opportunities in Greece (Labrianidis et al, 2019). The Hellenic Foundation for Research and Innovation in Greece uses the registry to engage the Greek science diaspora in remote reviews of applications for research programmes (Mahieu et al, 2022).

Belonging to the science diaspora does not automatically mean willingness to engage with the home country. Researchers have pointed to the universality of science where national belonging is not the main factor guiding decisions about collaborators and partners (Jöns et al, 2015; Gaillard et al, 2015). Yet, studies also point to emotional ties and an element of solidarity (Gaillard et al 2015; Leung, 2015; Tejada, 2012).

There is also some evidence on factors determining science diaspora's engagement in collaboration. For instance, Tejada's study from 2012 (Tejada, 2012) examines conditions for science diaspora contribution from a distance, including factors such as a sense of belonging. However, it is limited to selected geographies (science diaspora of Colombia, India, South Africa living in Switzerland). The findings are mixed for different countries analysed. Welch and Hao (2015) analysed the engagement with the science diaspora of China and Israel, focusing on policy action and exploring some factors that hamper collaboration, particularly how lack of merit-based decisions in home country discourage collaboration.

We conduct a systemic exploration of factors determining collaboration to understand the role of government and policy. This study examines factors that determine science diaspora collaboration with actors of the home country innovation system. We examine these factors for scientists of Latvian descent and their collaboration with innovation system actors in Latvia. Latvia has experienced outmigration in ways that threaten the national innovation system. Yet, this mobility also presents opportunities for leveraging the global scientific networks of Latvian scientists. This study aims to answer the following research question – what factors determine science diaspora collaboration with actors of the home country innovation system? The study will inform research and innovation policymaking in countries suffering from brain drain about what enables and hinders the collaboration with science diaspora.

Building on existing evidence and policy response in various countries, we hypothesise and explore in our study a range of factors, grouped into four groups, potentially hindering and enabling collaboration.The novelty of this study is taking a holistic approach to understanding the various factors hindering and enabling collaboration.

Data and methodological approaches

The methodological approach relies on a triangulation of data sources and qualitative and quantitative data analysis methods. We conducted a consultation of Latvian science diaspora to gather the data. First, we conducted a survey of Latvian science diaspora across the globe. The survey of Latvian diaspora scientists explored the motivation for collaboration and factors determining the collaboration. Relying on multiple pre-existing data sources and further snowballing, we sent the survey to 824 Latvian diaspora scientists across the globe. 187 diaspora scientists responded to the survey.

To gather an in-depth understanding of the determinants of collaboration, we conducted four focus group discussions with 19 members of the Latvian science diaspora equally representing STEM and social science and arts subjects. Latvian science diaspora members residing in the USA, Austria, United Kingdom, Finland, Switzerland, Germany, and Sweden participated in the focus group discussions.

We use Principal Component Analysis to reveal the groups of factors facilitating and hindering cooperation between scientists in Latvia and abroad.

Results, conclusions and policy issues

The study found that a mix of factors hypothesised based on previous evidence and policy action are relevant for determining science diaspora collaboration with home country innovation system players. The key factors are availability and exchange of information, funding for collaboration, peculiarities of the home country academic environment, and individual attitudes.

We conclude that systemic and organisational level mechanisms need to be developed and sustained to promote more intensive collaboration between the science diaspora. Policy implications are manifold. Some factors that determine the collaboration point to stimulating policy initiatives. These can be relatively low resource incentives that appear to push collaboration significantly. For example, the availability of information on R&D topics, collaboration needs, funding opportunities is a prerequisite for initiating collaboration. Seed funding to initiate collaboration, conduct short-term visits, also motivates collaboration. Other factors determining collaboration reveal a need for much larger and systemic policy changes. The existence of transparent and merit-based promotion procedures, good research management practices, openness to internationalisation need to be addressed on the systemic and organisational level as the lack of these prohibit collaboration. Finally, individual attitudes towards collaboration with home country innovation system actors also matter and cannot be directly addressed by policy action. However, our findings indicate that provided there is are systemic and organisational level frameworks to support scientific initiatives, individual attitudes are likely to promote and not hinder the engagement of science diaspora in collaboration with actors of the innovation system in Latvia.

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Keywords: science diaspora, research and innovation policy, collaboration with science diaspora

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Abstract. Abstract:

A new understanding of innovation has been identified in scientific and political discourse as social innovation. Recent research suggests that social innovation can be new forms of governance Therefore, new methodologies for including society in policy development and science are crucial. Innovation policy is a key field for the EU, international institutions, policy makers and researchers. Research in Europe shows beneficial links between science-driven science and the innovation system, where the

national innovation system and local capabilities interact with each other combiningpolicy driven by scientific research. This paper pursues two main objectives, the study of social innovation ecosystems, and the regional innovation policy in the metropolitan area of Zapopan. This paper will be based on two case studies relevant for the regional incubation. The selection of these programme is based on research and innovation policy in incubation models, which have been active for at least five years.

Introduction

Innovation policy is a key field for the EU, international institutions such as the OECD and member countries, policy makers, but also researchers (OECD, 2016; OECD, 2019). Research in Europe shows beneficial links between science-driven science and the innovation system (Isaksen and Nilson, 2013), where the national innovation system and local capabilities interact with each other combining policy driven by scientific research. Mexico as a country in the global south has focused in recent decades on fostering innovation to boost social and economic development (OECD, 2019). In addition, it has invested in new governance of science, through funding for higher education institutions and research, but also in developing infrastructure for innovative companies and start-ups (OECD, 2013:54) for incubation and transfer of research.

Together with innovation policy, a new understanding of innovation has been identified in scientific and political discourse as social innovation in the last decades. Social innovations are seen as new forms of organisation or new social institutions (Zapf, 1989). Social innovation can also be understood as new social practices (Howaldt et al., 2010, Howaldt et al, 2015; Hochgerner, 2011), new institutions, new social relations, new processes or new networks of institutions that solve societal challenges (Maldonado Mariscal, 2017:39). Recent research suggests that social innovation can be new forms of governance (Schröder and Krüger, 2019; Galego et al, 2021). Therefore, new methodologies for including society in policy development and science are crucial. In this sense, co-creation practices provide key tools to develop and experiment with new forms of interaction (Eckhardt, Kaletka, Krüger, Maldonado-Mariscal, Schulz, 2021:3) between different societal actors. Social innovation in Europe has become a relevant topic to address current social challenges. In the European Union (EU), this topic shows a strong interest and commitment to bring together different actors and nations. Despite the EU's efforts to implement the concept of social innovation at the European level, the development of institutional capacity is progressing slowly (Hubert, 2018: 214). However, there is a general quest to develop evidence-based policies, measure social impact and fund social innovation (BEPA; 2014:24). In Germany, for example, the recent publication of a concept paper on social innovation in 2021 by the Federal Ministry of Education and Research (BMBF) reveals a growing perspective on social innovation in the federal government. This paper aims at promoting social innovation with interdepartmental cooperation for understanding and developing instruments to promote social innovation in the country (BMBF, 2021). One perspective of social innovation research suggests analysing the local ecosystem for social innovation to understand a broader perspective of innovation and the actors fostering social innovations at the local level (OECD, 2021). But also to explore the potential and framework conditions of a specific area.

This paper pursues two main objectives. One, to study an ecosystem of social innovation at the local level in a city of 1.4 million inhabitants in Mexico with a high number of universities, incubators and innovation culture. Second, to analyse the regional innovation policy in the metropolitan area of Zapopan and to better understand regional development in a country of the global south. The main objectives are described below.

Objectives

1) To study the local social innovation ecosystem of incubation models in a municipality in Mexico.

2) To study the historical development of innovation policy in the last ten years (2021-2011) in the municipality of Zapopan with a focus on two regional incubation case studies.

3) To provide theory-based policy recommendations for regional development.

Methods

This research will identify policy shifts in incubation models at the regional level over the last ten years. A more in-depth stage pursues identifying experts and conducting interviews with experts of each sector of the innovation ecosystem, such as, universities, government, civil society and companies. For this research, I will make use of the multi-stakeholder approach (Kazepov, 2017) in order to identify the multiple levels of interaction between actors and its governance arrangements.

This paper will be based on two case studies relevant for the regional incubation. Two regional incubation models identify are the case of Zapopan Challenge (Reto Zapopan), the case of Neuron (Neurona), and Mass Challenge Mexico. The selection of these programme is based on research and innovation policy in incubation models, which have been active for at least five years.

This research will identify policy changes in incubation models at the regional level over the last ten years. A more in-depth stage pursues the identification of experts and conducting interviews with experts from each sector of the innovation ecosystem, e.g. universities, government, civil society and business. For this research, I will make use of the multi-stakeholder approach (Kazepov, 2017) in order to identify the multiple levels of interaction between actors and their governance arrangements.

This work will be based on two case studies relevant to regional incubation. Some regional incubation models already identified in the region are the Zapopan Challenge (Reto Zapopan), the Neurone (Neurona), and Mass Challenge Mexico. The selection of the case studies is based on research and innovation policy in incubation models, which have been active for at least five years.

Background and Discussion

This paper will build on the theoretical debate on social innovation and regional policy innovation in the global south, starting from the transformation of regional innovation policies.

The specific case of Zapopan Challenge is a programme to accelerate new businesses aimed at young students and recent graduates from higher education institutions in the municipality of Zapopan, which through a competition seeks to identify the most promising entrepreneurs in the municipality to support them with the development of their projects in the shortest possible time, through funding, advice and linkages, for technological development, environmental protection and the promotion of social responsibility in the municipality of Zapopan (Reto Zapopan Executive Project, 2011). This programme was developed in 2011 and implemented from 2012 in the municipality of Zapopan. This programme was born after a local diagnosis of marginalisation and social problems in the municipality in 2011 and as a result of international cooperation and exchange of sustainable city policy innovation in Boston Massachusetts with a team of interdisciplinary researchers.This programme reflects the problem-oriented policy design approach, identified as policy-mix, to develop policy instruments ad hoc to local needs and with a systemic character (Borrás and Edquist, 2013).

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Keywords: Social Innovation Ecosystem, Innovation Policy, Mexico, Regional Innovation

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Abstract. INTRODUCTION

Current policy discourse is increasingly attending to the need for research to address the "Grand Societal Challenges" (Cagnin, Amanatidou and Keenan, 2012) that we are facing. The recognition that addressing these challenges will often require profound systemic change has led to research and innovation policy strategies that explicitly seek such change. These transformative policies emphasize the interactions between demand and supply of research and innovation and the need to articulate shared future visions towards which these policies are oriented. The ambitious and complex character of this approach has in turn led to policy formulations that are experimental in nature and seek to unlock the interactions between new policy experimentation and socio-technical system change (Schot and Steinmueller 2019).

In the world of policymaking, research and innovation policies targeted at societal grand challenges rather than purely economic growth have been argued to be a new type of policy (Borras and Edler 2020, Schot and Steinmueller 2019). Such "Transformative Policies" contribute to facilitating innovation and socio-economic impact in a particular direction towards a desirable transformative change (Weber and Rohracher 2012, Linder, Daimer et al. 2016, Biegelbauer and Weber 2018, Mazzucato 2018, Borras and Edler 2020).

However, the extent to which specific localized experiments, or wider policy interventions can contribute towards systemic change poses a difficult analytical and evaluative challenge. With transformation goals being postulated by a number research funding programmes, including Horizon Europe (Robinson, Mazzonetto and Simone 2021), there is a growing need to develop support tools and approaches that can aid in the characterization, analysis and understanding of how research can contribute to the transformative change envisioned in grand societal challenges and missions.

Although many of the Transformative Policy proposals that are currently being discussed focus on innovation activities, we argue that research activities must also be included in the debate on transformative change. The complex nature of grand societal challenges requires that new and diverse knowledge is continuously produced to fuel and drive solutions. Moreover, many of the potential solutions may be at very early stages of development, where knowledge about the pathways linking knowledge production and the implementation of applied solutions are highly uncertain. Thus, the world of research has to be well linked to the discourse on transformative change (Joly et al. 2019).

MISSION-ORIENTED TURN IN RPOs and RFOs

As part of the mission-oriented "turn", funding programmes such as the latest European Commission Framework Programme (Horizon Europe) have put societal "Missions" at the centre of the 88 Billion Euro programme. Similarly, national funding agencies such as the French ANR (Agence nationale de la recherche) are experimenting with mission-oriented research funding programmes, for example, the Cultiver et Protéger Autrement programme which places at its heart, the ambitious objective fo funding and facilitating research to contribute to achieving a Zero-Pesticide future.

In this context, funding organisations have to design research and innovation programmes that (a) deliver excellent research and innovation and (b) contribute to mission objectives. Since, the eventual mission contributions mostly occur much later than the end of the funded activities, programme managers have to increasingly (i) engage in anticipation of the future evolution of the results of the R&I programme to be able to ascertain their contribution to mission objectives and, (ii) engage with a variety of stakeholders, many of whom will be responsible for developing, scaling up and generalising the products of the funded programme. To do so, research and funding programme managers, as well as researchers performing the actual R&D, need to develop capacities to create this intelligence, interpret it and incorporate it into real-time steering of the research programme and research activities.

In addition to these challenges, funding agencies such as the ANR and European Commission, are challenged to steer research and innovation activities “on-the-ground” via funding calls , be complementary to other funding programmes and activities nationally and beyond, and align with broader policy orientations around the targeted mission area.

THE CONTEXT OF THE PAPER

In the context described above, this paper describes an ongoing mission-oriented research programme that focuses on providing “transformative” research that can contribute to a specific societal mission. The ongoing (2020 – 2026) ‘Cultiver et Protéger Autrement ‘Growing and protecting crops differently’ Priority Research Programme in France, has been designed to contribute to the mission of ‘Zero chemical pesticides in agriculture by 2040’ and participate in solving the societal challenge linked to the sustainability of food security. This mission represents a clear and ambitious objective for society. It sets out a clear, measurable direction and a timeframe for action.

However, the pathways to achieving this mission are uncertain. To meet the ambition for 2040, the PPR programme has financed ten research activities (2 million Euros each) that are realistic and are a clear break from existing solutions. Radical innovations are foreseen to emerge from multiple experiments, based on transdisciplinary, trans-sectoral and multi-actor approaches, tested in secure environments before being generalised for the whole of society. These processes are non-linear, complex and subject to strong uncertainties. Indeed, developing sustainable agriculture and healthy diets by eliminating chemical pesticides requires profound changes to existing agricultural systems. These transformations require modifications to the systems of production, consumption and innovation, accompanied by changes to regulations, food habits, standards and infrastructure, and the creation of new markets.

AN ANTICIPATORY, REFLEXIVE, INCLUSIVE AND RESPONSIVE APPROACH TO STEERING RESEARCH?

As part of this programme, both at the individual project level (the 10 projects) and at the programme management level, a responsible research and innovation approach (RRI) has been developed, and tailored in situ, to anticipate on pathways to impact (both contributions to the mission aim and other impacts) and to use this approach to reflexively steer both individual projects and the overall programme.

The combination of anticipating on potential impacts of research and feeding these insights into broadening research activities is not new, it has been at the heart of the earliest discussions on responsible research and innovation (Robinson 2009, von Schomberg 2013, Stilgoe et al. 2013, Lindner, Goos et al. 2016, Shelley-Egan et al. 2018). What IS new, is the integration of a clear societal objective into the RRI approach (the societal “Mission”) and its combination with real-time steering at multiple-levels of research governance - the project level, the funding programme level and at high-level policy (Barré et al. 2013, Robinson, Schoen et al. 2021).

Focusing on arming each of the 10 projects with tools to anticipate (a) the innovation journey of each project outcome and (b) the impacts generated during this journey, the approach (called ASIRPA Real Time), captures the four core characteristics of RRI outlined in Stilgoe et al 2013:

* ANTICIPATORY: because it anticipates how the future will unfold in terms of prospective innovation pathways, the impacts that are generated and the socio-technical changes that are desirable and undesirable,

* REFLEXIVE: It unpicks the dynamics of the co-evolution of science, technology and society at the micro-level of specific innovation journeys and at the meso and macro-level through the impact generation processes envisioned,

* INCLUSIVE: whilst being located firmly in the world of research, the approach includes stakes and stakeholders beyond the realm of research into the anticipatory process

* RESPONSIVE: The approach is an iterative process (repeated every 12-18 months) to provide intelligence to steer research directions in real-time, preparing the ground for desirable impact generation from the projects, whilst enabling the possibility to mitigate undesirable effects.

CONTRIBUTION

The paper will present insights gained from the first 18 months of applying (and co-evolving) the approach within the Zero-pesticide mission-oriented research programme.

This paper directly contributes to the two core questions of the session:

1. What is the relationship between the concepts of transformative innovation policy and RRI: Our paper shows how research performing organisations, as part of mission-oriented funding programmes, are wrestling with the combination of RRI and Transformative Policies in real-time "on the ground".

2. How are transformative innovation policy and RRI institutionalised in structures, processes and practices of research funding and research performing organisations? The paper shows how an already institutionalised tool, based on historical impact assessment as a means of evaluating past programmes, has been further developed and applied so as to (a) bridge transformative policy and RRI, and (b) how it has being embedded in ongoing research practices.

We propose that the ASIRPA RT approach, combining RRI with Transformative Policy underneath the banner of "implementing Missions on the ground", is of direct interest to the session aims. While the approach is currently being demonstrated and integrated in France, we argue that the experiences currently being gained in this real-time steering approach is opening space for a renewal of RRI-like approaches, recognised in recent debates on the future of RRI (Van Oudheusden and Shelly-Egan 2021, Robinson, Mazzonetto and Simone 2021, Owen et al 2021).

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Abstract.

1.Introduction

During the last decade, public procurement of innovation (PPI) has increasingly been considered as one of the key instruments fostering innovation, responding to grand societal challenges and enabling structural change (e.g. Edquist and Zabala-Iturriagagoitia, 2012; Uyarra et al., 2020). In this line, the European Commission (2012) recognized PPI as one of the tools to implement smart specialization strategies. However, several barriers, such as lack of coordination of PPI, have resulted in a lower-than-expected uptake of this practice (Uyarra et al., 2020).

The role of places' distinctive strengths is a key determinant of innovation-driven regional development. These development paths are in turn the result of co-evolutionary regional development processes, which calls for greater attention to "the evolution of the institutional environment and the role of agency in that evolution" (Uyarra et al., 2017: 560). Grillitsch and Sotarauta (2020) argue that both history and futures, e.g. in the form of experiences and expectations and related actions of relevant actors in the present, contribute to the development of regional development paths. Three types of agency, i.e. innovative entrepreneurship, institutional entrepreneurship and place-based leadership, are the main drivers of regional structural change. The interplay of multiple actors representing the three types of agency is vital for this development (Grillitsch and Sotarauta, 2020).

While the literature widely recognizes public procurement as an innovation policy tool, there are still gaps in the role of place and scale in these discussions (Uyarra et al., 2020; Uyarra and Flanagan, 2021). This article responds to this gap in the context of the Tampere region in Finland. Finland is an interesting context for these explorations as the Government has recognized PPI as a strategic policy tool aiming for ten percent of all procurements to foster innovation (Government of Finland, 2019). Moreover, the recently launched 'Ecosystem agreements' between the state and 16 university cities recognize PPI as one of the key means to foster innovation in the regions (Ministry of Economic Affairs and Employment of Finland, 2021). Tampere region, which is one of the most successful regions in the country, has a well-established maturity to utilize PPI to correspond to its strategic aims.

In line, this article asks:

RQ: How can public procurement of innovation contribute to creating regional development paths and how can different actors representing different types of agency foster this development?

2. Case description, data and methods

The article responds to the research question by scrutinizing the selected regional development path in Tampere and the role of public procurement of innovation in developing this path. The selected path, i.e. 'Digital health solutions', is recognised as one of the strategic focus areas in the 'Ecosystem agreement' between the state and Tampere region. The general objective of the agreement is to foster the development of innovation ecosystems by strengthening key competences, intensifying cooperation within networks, and by increasing effectiveness. The 'Digital health solution' ecosystem is a research-, development and a testbed platform for almost a hundred companies in the region, and the total worth of the ecosystem 1050 million euros and 11 000 workplaces (Ministry of Economic Affairs and Employment of Finland, 2021).

The article explores the role of different actors in fostering the past and future developments of 'Digital health solution' path. Moreover, the article investigates the expectations and related actions of different actors to foster the use of the PPI within the ecosystem by conducting 13 expert interviews with relevant actors. The interviewees represent different organizations positioned in the region, and working for advancing the development and implementation of new (digital) health solutions producing new business opportunities and improved public services (Table 1). The interviewees represent 1) place-based leadership in Tampere region referring to public bodies that are in a position of decision making; 2) institutional entrepreneurship referring e.g. to development companies of public bodies or research institution; 3) innovative entrepreneurship referring to private companies developing new products, services or processes (Grillitsch and Sotarauta, 2020).

Table 1. List of interviewees.

Position of interviewee Type of agency

1. Representative from the city of Tampere, social and health care services Place-based leadership

2. Representative from the city of Tampere, social and health care services Place-based leadership

3. Representative from the Council of Tampere Region Place-based leadership

4. Representative from the city of Tampere, IT department Place-based leadership/institutional entrepreneurship

5. Representative from the city of Tampere, IT department Place-based leadership/institutional entrepreneurship

6. Representative from the city of Tampere, IT department Place-based leadership/institutional entrepreneurship

7. Representative from TAYS Kehitysyhtiö (the Development company of the university hospital and three Healtcare districts) Institutional entrepreneurship

8. Representative from Business Tampere (the economic development agency of the Tampere region) Institutional entrepreneurship

9. Representative from the University of Tampere Institutional entrepreneurship

10. Representative from Healt-Hub Tampere Innovative entrepreneurship

11. Representative from a small start-up company Innovative entrepreneurship

12. Representative from a small start-up company Innovative entrepreneurship

13. Representative from a small start-up company Innovative entrepreneurship

14. Representative from an established large-size company Innovative entrepreneurship

The interviews were semi-structure thematic interviews (e.g. Schmidt, 2004) meaning that we designed the interview themes in advance but we encouraged new themes to emerge into the discussions. The original themes were 1) the emergence of and the future expectations for the digital health solutions development path in Tampere; 2) the role of PPI in the developing innovations in the region; 3) the roles of different actors in developing innovative health solutions; 4) networks, knowledge spreading and interaction between the different actors; 5) scaling of new solutions from test-bed experiments to PPI. The method to analyse the data was qualitative content analysis to classify the foundings of the conducted interviews (Hsieh & Shannon 2005; Mayring 2004). The classification utilized the original interview themes but new themes emerged during the analysis.

3. Preliminary results: The role of PPI in improving public services and creating business opportunities for the field of innovative health solutions

We explored in the interviews different roles of actors in developing innovative health solutions in Tampere and the role of public procurement of innovation in the development. Different actors clearly had different initiatives and goals for developing innovative health solutions: Public-sector representatives argued to be in a position to develop better public services (by innovative health solutions) for instance in terms of improving effectiveness or producing end-user benefits. Development initiatives are implemented and aligned with the organization goals. However, development requires open and innovation minded experts and managers who acknowledge the importance of new solutions. Cooperation with private sector and researchers was seen important and the interviewees argued that developing innovative heath solutions in cooperation with companies has a long tradition in Tampere. For instance, developing digital solutions requires cooperation with the private sector if there are no in-house resources (e.g. coders) in the organization. In practice, public procurement is usually connected to cooperation with the companies although the size, timeline and complexity of the procurement changes according to the development project in hand. Pre-commercial procurements (PCP) that are typical in the experiment phase are needed to assess whether there is a proper need for the solution (e.g. among the end-users or experts working with the end-users) or whether the solution requires more development.

As public sector is the key organizer of the healthcare services in Tampere (as in Finland in general), public sector is also one of the key customers for innovative health solutions developed by companies. Public procurement bidding competition is in practice a necessary gateway to the markets for those companies developing solutions directed for public sector and aiming to sell services or products that exceed the national threshold values (referring to procurement legislation). Interviews with the intermediate organizations (that operate in a close collaboration with the companies to support and create business opportunities in the region) showed that there is a need to emphasize the demand-side, i.e. the needs of the public organizations. Without a clear need, the solutions will not be procured and the solutions not commercialized (for public markets). In line with this, there is a clear need among the private sector (especially start-ups) to understand in an early phase of innovation development the nature of public procurement practices (when public sector organizations form the market for the solution).

Some interviewees argued that there are challenges in moving from pre-commercial experiments to public procurement (of innovation), especially if innovation partnership procedure (that include development and deployment phases) is not used e.g. due to its heaviness. Even though the procurement legislation was acknowledged to secure open competition, the transformation from experiment to commercial phase was seen somehow problematic in terms of continuity when the experiment is successful and there would be benefits to continue with the original developer of the solution. The bidding phase should be sensitive in releasing the appropriate amount of knowledge of the experiment phase solution. It was suggested that already the experiment phase could better acknowledge procurement planning e.g. in terms of designing the need description and considering procurement requirements. Openness was seen as a solution. If the needs are clearly communicated with the market in an early phase, and already the experiment phase is openly communicated and bidded for, there is a fair opportunity for all companies to participate from the beginning to the development. In line with this, it is important to negotiate IPR issues in an early phase.

The interviewees emphasized the importance of collaboration between the different actors in the region in order to utilize public procurement of innovation as a tool in developing the innovation (eco)system of innovative health solutions. The interviewees argued that the major structural change in transferring the health care services from municipalities and health care districts to new wellbeing services counties (at the beginning of the year 2023) is a good point to improve the leadership that acknowledges and recognizes the role of public procurement of innovation as a tool to develop innovative health care solutions. Some of the interviewees suggested that the county could take coordinative role in increasing the knowledge of cooperation opportunities and PPI procedures, and developing new means of cooperation between the different actors working for the innovative health care solutions and for supporting industrial and business opportunities in the region.

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Keywords: public procurement, innovation, regional development paths, agency

[122] Dominique Guellec (High Council for the Evaluation of Research and Higher Education (HCERES)), Paresa Markianidou (Technopolis Group Belgium), Lena Tsipouri (OPIX) and Joseba Sanmartín (Spanish Foundation for Science and Technology (FECYT)). *The IntelComp Platform: A Policy Intelligence Tool for Transformative STI Policies.*

Abstract. THE ENHANCED ROLE OF DIGITAL TOOLS IN THE CONTEXT OF CHANGING STI POLICIES

As STI policies evolve toward more directionality for sustainability and societal transformation, it is a continuous challenge for policymakers to:

1) select the type of evidence needed to support transformative STI policy, e.g., granular information about social needs (health, environment, etc.), scientific and technological trends, and the socio-economic impact of policies.

2) identify suitable sources of data, where that type of evidence can be drawn from, and

3) effectively use tools to analyze and visualize that data, generating knowledge for specific tasks in the policy cycle.

It is believed that new sources and forms of data, and alternative digital tools, such as machine learning, semantic analysis and big data visualisation, provide more granular, timely and accurate information for transformative STI policies. The IntelComp project is an example of these efforts to build digital tools for transformative STI policies.

THE INTELCOMP PROJECT

IntelComp is a Horizon 2020 Innovation Action to build a digital platform for STI policy. With a 4 million euros budget from January 2021 to December 2023, the project involves a multidisciplinary team of 13 partners from academia, the private sector and Public Administrations responsible of STI policy. This policy intelligence platform is based on two existing platforms for STI policy: Corpus Viewer and Data4Impact.

THE INTELCOMP PLATFORM

The IntelComp platform will be able to analyze large volumes of unstructured textual data in a High Performance Computing environment, located at the Barcelona Supercomputing Center. Traditional and new sources of (mostly open) data (e.g. CORDIS or the OpenAIRE Research Graph) will be exploited using natural language processing pipelines, a machine translation system, automatic classifiers, topic modelling or graph analysis.

These services will be integrated into the four tools of the platform that aim to provide knowledge, policy relevant analysis and evidence for transformative STI policies:

• The Interactive Model Trainer. It may help academic experts in specific domains (e.g. artificial intelligence, blue economy or cancer) to validate the results of the different services, optimizing them, and to design the datasets, topic models and classifiers available in the other three IntelComp tools.

• The STI Viewer. It may assist Public Administrations and policymakers in the agenda setting and monitoring stages of the policy cycle, by mapping scientific and technological fields, and by linking funding to outputs, outcomes and impacts.

• The Evaluation Workbench. It may assist call for funding managers in analyzing the state of the art related to a given proposal for funding, or in detecting similar proposals or grants.

• The STI Policy Participation Portal. It may assist all relevant stakeholders of STI policy (academia, industry and citizens) to co-create STI policies, synthesising public inputs and connecting scientific topics and technological fields with social needs.

The project will enrich the European Open Science Catalogue (EOSC) with new and reusable analytical services for Public Administrations: a suite of natural language processing/machine learning services for the analysis of STI-relevant information. IntelComp services will apply standards for interoperability with EOSC.

THE TESTING OF THE INTELCOMP PLATFORM

Though the IntelComp platform is a generic and domain independent solution, it will be tested on STI policies in three specific domains: artificial intelligence, climate change/sustainable blue growth and health/cancer. Three use cases have already been identified: the Spanish National Strategy on Artificial Intelligence, the Sustainable Euro-Asian Seas Initiative coordinated by Greece and the research on cancer of the Science and Technology Observatory in France.

THE SOCIAL DIMENSION OF THE INTELCOMP PLATFORM

The IntelComp project adopts a Living Labs methodology involving Public Administrations and stakeholders:

(i) to co-design and co-create IntelComp services and tools, jointly revising user requirements and improving the developed services and tools in an iterative manner (agile methodology) to make the results easy to use and actionable to the users; and

(ii) to validate the resulting platform through the co-creation of STI policies in the three domains.

CONCLUSION

The IntelComp project and platform is an example of the provision and use of knowledge bases and policy intelligence tools to inform system-level transformative STI policy. It may facilitate international learning on the development of policy intelligence tools, in particular at the OECD and the JRC.

Keywords: Digital Tools, Policy Intelligence, Machine Learning, Semantic Analysis

[123] Susanne Giesecke (Austrian Institute of Technology) and Dana Wasserbacher (Austrian Institute of Technology). *Future Roadmaps of Consumption in the EU.*

Abstract. Research Questions

How will EU priorities such as the Green Deal and the Digital Agenda affect consumer behaviour in the post Covid19 era? This was the central focus of a study commissioned by the European Commission.

The Foresight project "Impact of COVID-19 on European consumer behaviour", developed alternative scenarios, visions and roadmaps anticipating future challenges for consumer policy and assessed likely impacts on private consumption in the EU by possible future systemic disruptions and major economic shocks. The work was conducted by the Foresight on Demand (FoD) Consortium who's investigations also included the relation of consumer behaviour, rights, and markets to the Green Deal, the Digital Agenda and the role of the New Consumer Agenda.

Methodology

In a first step, the project team collected and analysed literature and data sources in a Horizon Scanning and Scoping activity in order to identify possible influencing factors, trends and drivers for the post-COVID-19 world. The second step was committed to the development of two sets of scenarios, organised around two scenario workshops with experts and stakeholders to gain different perspectives on post-COVID-19 developments. The third step foresaw the use of the scenarios to analyse possible gaps in consumer policy and to identify potential emerging challenges for consumer rights and protection. The link between the scenarios and consequences for future consumer policy contained the formulation of four visions that depicted preferable situations and goals as to what consumer policy, consumer empowerment and consumer protection in 2030+ (and mid-term in 2025) should look like. The visions were based on preferable and unpreferable aspects from a set of scenarios developed in a previous step of the project. As a next step, a dedicated stakeholder workshop helped to develop roadmaps on how to reach the visions. As a result of this interactive exercise, a range of milestones and barriers were identified, presenting crucial aspects for future consumer policy. The FOD Team consolidated these milestones and barriers to seven policy issues to lay the ground for a further discussion of policy implications of EU consumer protection policy and consumer empowerment. The paper summarises the different steps with special focus on the roadmaps and possible policy issues, and includes the work and contributions of stakeholders, of European Commission (EC) representatives and of the FOD team.

Empirical Results

In more detail, the team and the stakeholders developed four roadmaps from the perspective of the consumer to pursue the following visions:

1. Empowered to buy 'responsibly' by accessing 'responsible' data

2. I am sharing, renting & repairing

3. I can choose to live in a digital bubble

4. I can safely co-create and test new products and services and new business models

After a consolidation exercise clustering the aspects brought in from the discussion groups, 34 milestones and barriers emerged as significant issues for future policies on consumer protection and empowerment. The results of the stakeholder workshop and of the roadmapping exercise were then fed into the next phase of the Foresight project, the identification of policy implications and online stakeholder dialogues. In the following, we summarise the policy issues:

- EU wide packaging labels

EU wide packaging labels is a complex policy issue that involves several policy instruments and activities. The issue as such comprises policy actions at EU level on key 'sustainable/green' information requirements and a unified definition of a "composite footprint": making "green empowerment" possible. All relevant information for the consumer who wants to take a responsible decision on what to purchase sustainably should be available for each product (and service) at any time.

- Making data and information comparable and accessible

Related to the policy issue above is the barrier free access to all relevant product information from the consumer perspective. The combination of the label information with a "solid database" could provide all information about the origin, production, supply chain, impact etc. of a product regarding product sustainability and other indicators and make these indicators comparable.

- Ensuring product sustainability

With the EU policy objectives within the twin transition, drawing on digitalisation and the Green Deal, it will be important to guarantee the sustainability of products in the EU that comply with the sustainability principles related to the environment, economy and ethical principles. There is some serious concern among experts that the objective of digitalisation is challenging especially the environmental sustainability. This policy issue connects to the one on labelling and the one on accessible product information. At the same time, it goes a step further by embodying certain societal and ethical values in the product. They could also be part of legal minimum requirements.

- Boosting the culture of co-creation

Boosting the culture of co-creation across the EU is currently a primarily local effort that is characterised by the diversity of existing approaches and activities. In order to bring clarity into the muddle of concurrent approaches, a first, easy-to-implement step could be to carry out a comprehensive mapping exercise. The mapping of current EU-wide activities and efforts to implement co-creative processes in the field of consumption would provide helpful information on the state of affairs in the short-term. When considering a mapping exercise, the question of who will take action and how to ensure willingness to participate, already render the matter more complex.

- Personalisation & privacy

After the era of mass production, many companies took a different turn and introduced customized products and services. This trend toward customization is now very common and goes hand in hand with personalisation of products for the user. However, along with increasing digitalisation and collection of personal data about every consumer, privatisation is not always to the benefit of the end user. At the same time, we as users we want products and services to meet our very personal needs. Some might even be unique, applying to just one single person. In order to keep the costs within a margin, companies use automated data collection and interpretation about their customers. This brings a lot of privacy issues to the fore and is of concern for many consumer organisations and policy makers as well as developers and producers. They wonder: How to keep the balance?

- Simplify complexity of digital information and coordination requirements

Despite many efforts from the policy level to reduce complexity and increase data security and user-friendliness of the internet, platforms and applications, for example with the EU's data protection law GDPR, the complexity of new digital technologies and solutions for users and organisations is constantly increasing. Data protection is a pillar of citizen's empowerment and the EU's approach to the digital transition. The demand for more power to the user is still an unmet goal. Consumer organisations are worried that the collection of information and the purchases over the internet are affecting the consumer's choices in a manipulative way. The collection of user data by companies and organisations has to be made more transparent and the consumer should be able to choose what to share and what not. As a solution, Artificial Intelligence tools could be used to reduce complexity, e.g. by monitoring data generation, sharing and using, or by generating settings in line with user preferences without giving agreeing to cumbersome and annoying statements of consent. From the consumer perspective, convenience and ease of use should be priorities of internet use and not the extra burden of coordination. One of the convenience features for consumers could be to easily opt out of sharing their data.

- Multi-level coordination

Multi-level coordination is a cross-cutting issue affection all other policy issues discussed in this chapter. It addresses the challenge to coordinate the pressing policy issues on future consumer protection not only between the different DG and other authorities at EU level but also with and between respective authorities at MS level, at federal and regional level. In different Member States (MS) we find different administrative bodies dealing with consumer related issues. Not all have the same competencies. In centralist states we often find a central agency as a contact point but in federalist countries there might be one for every administrative sub-unit at federal or even regional level. As consumer rights are not condensed in one jurisdiction because they are a cross-cutting issue themselves, administrative bodies from different jurisdictions such as energy departments, law departments, transport departments, education departments etc. might be relevant if changes toward more consumer protection at EU and MS level are to be implemented.

Conclusions

The policy issues are to be understood as inputs to the debate and need to be further developed and filtered into suitable policy instruments to ultimately achieve the objectives formulated in the Commission's plans set out in the current New Consumer Agenda. Only with further enrichment through the multi-stakeholder discussion can the policy issues become implications and make contributions to the formulation of policy instruments. Whether these policy instruments are directives, awareness raising activities, information platforms, initiation and support of stakeholder networks, capacity building activities, funding for research and innovation, or any other or a combination of some of these, will be topics for further discussion between the various EU actors and the stakeholders.

The strong involvement of stakeholders and experts in the development of the policy options implies that there is a certain degree of consensus across the different stakeholder groups about policy priorities related to the impacts of the COVID-19 pandemic on the future of consumption in the EU. For some of the policy options, first actions have already started in 2022, for others long-termed actions are required.

A main finding of the study is that despite the challenges posed to consumers by the pandemic, the trend towards sustainable consumption seems to be continuing, even if not all people can yet afford it financially or have access to the information and products they need to do so. Thus, despite the pandemic, the EC can continue to pursue its twin transition goal without running the risk of leaving out certain consumer groups.

Keywords: Consumer policy, Green Deal, Digitalisation, Foresight, Visions, Roadmap, Covid19 pandemic

[124] Franz Barjak (University of Applied Sciences and Arts Northwestern Switzerland). *Student-mediated knowledge exchange: reviewing the literature on an unjustly neglected form of interaction between higher education and business.*

Abstract. Background and research questions

Knowledge exchange between academic organisations (universities, research organisations) and non-academic organizations draws on the widely accepted insights that universities are important institutional actors in innovation systems (Edquist, 2005; Mowery & Sampat, 2005) and knowledge hubs for innovation (Youtie & Shapira, 2008). The academic work on knowledge exchange has concentrated on two groups of institutionalised and contract-based mechanisms, knowledge commercialization (via patenting, licensing, spin-off formation) (Phan & Siegel, 2006, Rothaermel et al., 2007) and academic engagement (via research and consulting) (Perkmann et al., 2013, 2021).

Non-institutionalised mechanisms of knowledge exchange, such as joint theses with companies, employing graduates, participation in university training activities, start-ups founded by students and recent graduates are as common as the institutionalised mechanisms (Schartinger et al., 2001, D'Este & Patel, 2007), but they are more heterogeneous, in part difficult to measure and more complex to manage (Geuna & Muscio, 2009). Several of these mechanisms are linked to the teaching function of universities and involve students not only as another group of stakeholders, but as the carriers of the knowledge and skills that are exchanged. The current paper conducts a review of the literature and synthesizes the evidence on student-mediated knowledge transfers.

Individual mechanisms of such student-mediated knowledge exchange have been analysed extensively, above all collaborative theses (Borrell-Damian et al., 2010; Thune, 2009; Thune & Børing, 2015) and student entrepreneurship (Colombo & Piva, 2020; Wright & Mustar, 2019). However, overall, the conceptualization, operationalisation, and understanding of the antecedents of student-mediated knowledge exchange are lacking. Ignoring student-mediated knowledge exchange might have serious negative effects: it might create the impression that it is less important than other transfer types, inducing scientists to disregard it and choose mechanisms which are less suitable for transferring a particular technology or knowledge item or exchanging knowledge with a particular type of partner (Arundel & Es-Sadki, 2021; Hayter, Rasmussen, & Rooksby, 2020). It might induce policy makers at different levels (in universities, regional or national science and education departments) to focus policies on what is being measured, thus cumulating the negative incentives (Arundel & Es-Sadki, 2021). Last but not least, the transfer activities of certain organisations, e.g., those with a teaching focus (Sánchez-Barrioluengo, 2014), might remain less visible affecting their reputation among their stakeholders and making them less attractive as transfer partners, places for work and studies, leading to the underuse of precious resources of knowledge and competencies.

The paper therefore synthesizes the literature with a focus on four questions:

1. How can student-mediated knowledge exchange be distinguished from other types of knowledge exchange?

2. What types of student-mediated knowledge exchange have been described in the literature?

3. What are the benefits of student-mediated knowledge exchange for companies, students, and universities?

4. How can student-mediated knowledge exchange be measured?

It is concerned with a clarification and discussion of this construct and differentiation from related constructs in the field of knowledge exchange/transfer and university-industry collaboration. “Contrasting, specifying, and (re)structuring existing theoretical constructs” is described by Post et al. (2020, p. 361) as one of seven possible contributions of review articles to theory-building and operationalisation. The paper first distinguishes student-mediated knowledge exchange from knowledge commercialization and academic engagement. Then it suggests four types of student-mediated knowledge exchange and presents costs and benefits on two types of student-mediated knowledge exchange which are under the control of universities. It discusses measures for these knowledge exchange mechanisms and illustrates them with data from 18 Swiss higher education institutions. The paper ends with a few short conclusions.

Methods

The paper conducts a narrative literature review and draws on literature from the fields of university-industry collaboration, third mission of universities, technology transfer, academic entrepreneurship, academic engagement, project-based learning and others that includes students and graduates as carriers of knowledge. It presents results on selected mechanisms of student-mediated knowledge exchange from a survey of the institutes of 18 Swiss higher education institutions.

Results

Student-mediated knowledge exchange differs in many regards from academic engagement and commercialization. Students are the key output of universities’ teaching activities, and they embody knowledge and transmit it to their employers, sponsors of theses, hosts of internships, or companies that they themselves found after graduation. It must be conceded that the economic value of student-mediated knowledge exchange tends to be indirect and more challenging to assess than for technology transfer or academic engagement, as licence, research or consulting contracts usually come with a price tag (Perkmann et al., 2015) which is rarely the case for transfers involving students. The motivational set is different for student-mediated knowledge exchange: raising students’ employability and contributing to the third mission of the university are key, while research-related motivations are absent (Orazbayeva et al., 2020). Whenever student-mediated knowledge exchange includes the movement of students between the university and the company, even if only temporarily as in student mobility and lifelong learning, it facilitates the transmission of tacit knowledge to companies (Thune, 2009).

Student-mediated knowledge exchange can be differentiated a) according to who governs the process – either the university or the students/graduates – and b) by the type of knowledge transferred (codified or tacit).

Measuring student-mediated knowledge exchange is a first step to benchmarking organizations, understanding and explaining its antecedents, and assessing the impact on students, companies, and universities in a reliable and valid manner. The paper provides an overview of the indicators that have been suggested and used for university-controlled student-mediated knowledge exchanges. Indicators have been suggested and data collections been implemented predominantly at the level of universities and through faculty surveys. Individual studies have also been done with firms and students. This overview is not yet comprehensive, but it shows that there is a general lack of data collections that assess student-mediated knowledge exchange with companies in a comparable (across organizations, disciplines, countries) and comprehensive manner.

The paper then discusses the benefits and costs for the three involved parties, students, firms and universities, as they have been presented in the literature. Due to limited space, it will focus on student-mediated knowledge exchange under the control of the university only.

First conclusions (to be developed)

Student-mediated knowledge exchange is a widely spread mechanism of knowledge exchange that is still insufficiently conceptualized and understood. It is an important mechanism for many universities: a minority of universities are research universities and educating qualified graduates is the primary task of many HEI across Europe. For instance, in the UK the Russel Group of research-intensive universities consists only of 24 universities or 13% of all 184 universities or colleges that can award bachelor's degrees (https://www.gov.uk/check-university-award-degree/recognised-bodies). In the two-tiered German system 203 out of 420 HEI (48%) are universities of applied sciences (https://www.hochschulkompass.de/hochschulen/hochschulsuche.html). They teach up to master's level, do not offer PhD degrees and engage in (applied) research and development only in selected fields. Like teaching-oriented universities in other countries they often struggle to demonstrate their contribution to knowledge exchange. Focusing on students as knowledge carriers may help them to develop strategic measures with which they can increase their social and economic impact. Even though they can and should do knowledge exchange via research (as research universities educate students), they should obtain better results, if they use their specific strengths for knowledge exchange.

Student-mediated knowledge exchange lacks an established set of measures and multi-disciplinary and internationally coordinated data collections across higher education institutions which would be necessary to assess and compare its antecedents and success factors across different dimensions. Universities wanting to use student-mediated knowledge exchange are therefore at a disadvantage when it comes to assessing the impact of their measures, benchmarking, and improving their approaches.

Previous research on student-mediated knowledge exchange has often been conducted from the perspective of higher education teaching and learning and has therefore placed a strong focus on the effects on students. The effects on companies and universities are a lot less clear and mainly come from individual surveys or case studies. Further studies are necessary to strengthen student-mediated knowledge exchange, help universities to develop and manage it strategically and convert it into an equally accepted mechanism of sharing their knowledge with the economy and society.

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Keywords: Knowledge transfer, Knowledge exchange, Students, Teaching-oriented universities, Industrial doctorates, Student entrepreneurship

[126] Carolina Resende Haddad (Chalmers University of Technology) and Anna Bergek (Chalmers University of Technology). *Rethinking additionality for transformative innovation policy.*

Abstract. The emerging transformative innovation policy (TIP) paradigm (cf. Diercks et al., 2019; Schot and Steinmueller, 2018) shifts the agenda for innovation towards "a range of situated sociotechnical transitions" (Steward, 2012, p. 331). This poses new demands on policy evaluation, not least when it comes to establishing causality, i.e. determining whether the observed change or outcome are due to a policy intervention, to another cause, or coincidental (Davidson, 2000). Indeed, there is a widespread understanding that attributing causality is difficult when it comes to complex policy interventions (Cummings, 2006; Hind, 2010; White, 2010). A traditional evaluation approach to attributing causality is by comparing the additional effects of a policy intervention (i.e. additionality) to the counterfactual, i.e. what would have happened in the absence of the intervention (Bartle and Morris, 2010). In the case of TIP, however, factors such as uncertainty and the long duration of transformative processes make it problematic to determine the effects of a particular policy (Amanatidou et al., 2014; Edler and Fagerberg, 2017). Among other aspects, spill-overs and other systemic effects confuse the input-output logic and make it difficult to define a counterfactual (Janssen, 2019).

Despite these challenges, it is essential for evaluators to find ways to infer causality and assess the effects of programmes (Davidson, 2000; Hind, 2010), since this is still a need in policy practice (Bartle and Morris, 2010; Molas-Gallart and Davies, 2006). This does not mean that evaluations for policy learning are non-important, but rather points towards the need of abandoning the dichotomy "evaluation for learning versus for accountability" on behalf of complementary approaches (Magro and Wilson, 2019). The argument of this extended abstract is that in order to achieve this we need a new conceptualization of additionality, which explores alternative ways to establishing causality and the counterfactual.

Additionality has been differentiated in three types in the innovation policy literature: input, output and behavioural additionality (Georghiou and Clarysse, 2006). The first two are associated with a neoclassical innovation policy and market failure rationale (Georghiou and Clarysse, 2006). They are based on a successionist view of causality, where observed differences between the target of a policy intervention and a control group are assumed to be due to the policy in question (Hind, 2010). Typically, input and output additionalities can be combined into a cost-efficiency assessment or a cost-benefit analysis (Georghiou and Clarysse, 2006). Behavioural additionality (BA), in turn, is "the hallmark of the evolutionary/structuralist perspective on innovation policy" (Gök and Edler, 2012, p. 309) and focuses on changes in how firms organize and manage innovation processes as well as on more indirect policy effects, such as learning (Clarysse et al., 2009). Initially, the concept of behavioural additionality focused on assessing changes in how firms organize and manage R&D (or innovation processes more broadly) (Clarysse et al., 2009), e.g. in terms of different scale, scope, timing or collaboration partners. Later, the concept was expanded into an ambition to capture the indirect effects of policy, in particular in terms of the learning that takes place in firms because of public support (Clarysse et al., 2009), which can result in new attitudes, skills and capabilities (Georghiou and Clarysse, 2006). As such, BA evaluation should, in theory, encompass a range of behavioural aspects, e.g. knowledge acquisition and collaboration (cf. Georghiou and Clarysse, 2006). In practice, however, these multiple aspects are rarely captured. Instead, evaluators still use traditional experimental and quasi-experimental approaches, which hinders the whole potential of BA (Gök and Edler, 2012).

What is needed, then, is to find new methodological approaches that are able to address the multi-faceted complexity of behavioural additionality (Gök and Edler, 2012). In this way, previous research has shown that approaches that are grounded in generative causality, such as theory-based approaches – e.g., theory of change (ToC) and realist evaluation – contribution analysis (CA), and process tracing could be used for this purpose (Befani and Mayne, 2014; Hind, 2010; Mayne, 2001). These approaches are alternatives to the counterfactual approach and focus on complex interventions where defining counterfactuals is not possible nor practical (Befani and Mayne, 2014). For example, Hind (2010) suggests using additionality in conjunction with theory-based evaluation to look at the contribution of a policy intervention to producing outcomes. In this case, the evaluator, together with policymakers, first hypothesize what the counterfactual could have been and then looks for different pieces of evidence that suggest additionality during the process of evaluation. Alternatively, Befani and Mayne (2014) argue that a policy intervention is one among a set of factors affecting the generation of outcomes. As such, it works as a "contributory cause" to the outcome and work as part of a "causal package" the is composed by multiple factors that bring about change. Consequently, it is not possible to demonstrate definitively the contribution of an intervention to the outcome (Mayne, 2001). Instead, the evaluator can look for evidence that reduce uncertainties regarding the programme's contribution and, as a result, come to conclusions that approach an attributable impact. Befani and Mayne (2014) suggest, thus, applying CA together with the principles and tests from process tracing to strengthen the conclusions about causal inference and, hence, about the impact of a programme. While a more detailed discussion of these approaches is beyond the scope of this extended abstract, they show that, rather than proving attribution definitively, one looks at different pieces of evidence to strengthen the attribution claim, i.e., by analysing the contribution of a policy intervention to the generation of outcomes (attribution through contribution).

While BA already includes a wide range of aspects to assess, recent discussions in the TIP literature indicate that what evaluators should be looking for goes beyond the comprehension of input, output and behavioural additionality. The type of additionality we are looking at is one that reflect the “phenomenological characteristics” of sociotechnical transitions, which are complex, multi-dimensional, long-term, and involve transformations of systems, actors and institutions (Geels, 2021; Köhler et al., 2019). While the capacity of sociotechnical transition frameworks to explain causal mechanisms have been a topic of criticism in the literature (cf. Sorrell, 2018; Svensson and Nikoleris, 2018), recent frameworks have shed light on this direction. Most notably, De Oliveira et al. (2020) refine the technological innovation system (TIS) framework to improve its analytical capacity to explain systemic malfunctioning and their implications, using a mechanism-based approach, e.g., process tracing. Additionally, Geels (2021) discusses causal mechanisms underlying sociotechnical transition frameworks, such as TIS, multi-level perspective (MLP), and strategic niche management (SNM). The author argues that TIS can explain many mechanisms and processes related to the emergence of new technologies, while the MLP and SNM can explain niche and regime level processes needed for a transition to unfold (cf. also Markard et al., 2015; Markard and Truffer, 2008). According to Geels (2021, p. 18), the explanatory capacity of such frameworks do not ask for single deductive approaches, but rather for those that “accommodate complex causalities and conceptualise temporal unfolding, theories of longitudinal transformation processes”. This is in line, for example, with approaches grounded in generative causality.

To sum up, we have argued that there is a need for a new view on additionality targeting TIP evaluation, which goes beyond the comprehension of input, output, and behavioural additionality and draws on generative approaches to evaluation. We have also argued that some recent views on how sociotechnical transition frameworks can explain causality are also in line with such generative approaches. These are a useful starting point for the further development of a new type of additionality for transformative change. Table 1 sheds some light on the potential building blocks of such a concept. This extended abstract works as a call to further develop this idea and potentially take the next step in TIP evaluation.

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Abstract. 1. Background

Globalisation, the new technologies, the effects of climate change, the transition to a circular, carbon-neutral economy, the loss of natural capital, and, more recently, the COVID-19 pandemic, are globally impacting our way of living. Although big costs are associated with a successful attainment of all those challenges, the potential opportunities brought about are enormous. At the European level, the Commission aims at accelerating the green transition in the 2021-2027 period by implementing the Green Deal [1] and by allocating funds in the cohesion policy framework and the Horizon Europe programme [2] to mobilise European research and innovation ecosystems towards the tackling of outstanding Societal Challenges. Many of these challenges are established by the UN 2030 Agenda and formalised within the 17 Sustainable Development Goals (hereafter, SDGs) [3]. It is now clear that reaching these goals requires changes in the forms of cooperation between governments, companies, academia, and other societal stakeholders, new ways of combining knowledge from diverse disciplines, and new tools for evaluating the impact of public policy and research and innovation (R&I) [4].

In this context, research and innovation strategies for smart specialisation (hereafter, RIS3) [5] are becoming extraordinarily important. RIS3 strategies are dynamic agendas for economic and social transformation based on research and innovation and articulated through opportunities discovery processes. The Catalan RIS3 (RIS3CAT [6]) specialisation was defined, from the start, through an open and progressive process of concretion: stakeholders within the research and Catalan innovation ecosystem themselves, by means of their decisions, define the sub-areas of specialisation in which Catalonia has competitive advantages and a good position in Europe. This approach is in line with that of the European Commission: RIS3 strategies should prevent top-down policies from restricting stakeholders and themes; they should facilitate the generation and consolidation of emerging activities and stakeholders.

Today, these discovery processes may be greatly helped by taking advantage of the wider transformative trends in the fields of Open Government and Open Science [7], which are making data potentially relevant for the public good increasingly available in open and usable formats [8]. Data on research and innovation activities is made available by a series of initiatives: the availability of this data is helpful for the identification of R&D niches and key actors within territorial R&I ecosystems that might be embarked in those transformative processes. At the same time, the exploitability of this data is exponentially increasing thanks to the disruptions brought about by the wider accessibility to data science [9].

Within the framework of monitoring the RIS3CAT [10], a line of work has been established to explore the potential of integrated open data, semantic analysis and data visualisation with the aim of developing methodological proposals for monitoring smart specialisation. This experiment, which tackled the challenges linked with the definition of indicators for monitoring emerging areas, territorial patterns of specialisation and collaboration dynamics between different stakeholders and areas of knowledge, led to the development of the RIS3-MCAT interactive platform [11], whose conceptualisation, development framework and use are presented in this paper.

2. Relevance

The RIS3-MCAT platform [4] is an open government, artificial intelligence, data visualisation project that integrates, interrelates and makes interoperable open data from R&I financed by Horizon 2020 and the European Regional Development Fund (ERDF) in Catalonia. In a nutshell, the platform analyses the contribution of European funds to the sectoral, technological and thematic specialisation of the Catalan R&I system and to the SDGs in Catalonia. But, in a much deeper level, RIS3-MCAT aims at:

- understanding the impact of European funds on the specialisation of the R&I ecosystem of Catalonia, in terms of both sectoral and technological specialisation and the detection of emerging activities;

- identifying opportunities to maximise the collective impact of R&I in Catalonia, based on synergies and the coordination of efforts;

- providing new evidence that facilitates decision-making by stakeholders in the R&I ecosystem of Catalonia, promoting new dynamics of collaboration and inspiring new public policies;

- raising the profile of Catalan public and private actors that participate in R&I European networks;

- understanding the contribution of European funds to innovative responses to societal challenges (SDGs).

To achieve so, possible indicators and methodologies have been tested within RIS3CAT to assess how they respond to the needs of smart specialisation monitoring.

3. Paper aims and research questions

The work carried out in the context of RIS3-MCAT aimed at answering the following questions:

1) How to move from collective awareness to collective transformative action, and how can smart specialisation strategies help?

2) What kind of data and indicators can help policymakers and other actors better understand the dynamics of sociotechnical systems to address more effectively those challenges that really matter?

3) What kind of data and indicators can support policies and actions to accelerate transitions?

4) How can we use available technologies and knowledge to design the new monitoring systems that public policies so urgently need?

5) How can EU funds contribute to accelerate transition towards sustainability in Catalonia?

The aim of this paper is to explain the methodologies and the approach followed to tackle the above questions within the framework of RIS3CAT and while developing the RIS3-MCAT platform, specifically.

4. Theoretical framework, data and methodological approaches

One of the major challenges to RIS3CAT in the 2021-2027 period is that of articulating the collaboration of stakeholders in the research and innovation system to ensure that R&D&I contributes to meeting societal challenges that are closely linked to the SDGs, within the framework of the shared agendas for sustainability and social change [12]. Identifying the stakeholders and projects in Catalonia that contribute to the SDGs is key to implementing these shared agendas. In the development of RIS3-MCAT, this identification was performed on top of data relative to projects funded by the European Horizon 2020 programme and projects funded by RIS3CAT calls for proposals and programmes. The methodologies and indicators developed in the context of the current project could however be applied to open data from other sources and be declined for the case of other regions.

[Figure 1]

In the context of RIS3CAT, two types of strategic needs were to be covered, that could be defined as “top-down” or “bottom-up”. The “top-down” needs were linked with cases where a deeper understanding of the regional dynamics within a specific research area defined a priori was needed, while the “bottom-up” approaches were aimed at getting an emergent picture of the thematics tackled within a specific research community (either geographically or disciplinary bounded).

In the context of RIS3-MCAT, several data science techniques have been applied to address the above needs.

5. Results

At the time of writing, the RIS3-MCAT Platform includes 4,031 projects (with a total value of 2.674MEUR) developed by a total of 1,356 organisations from Catalonia and 12,786 external partners: by July 2021, it had been viewed by more than 3,500 users in 66 countries. The principal channels for visualising the data on the Platform are a network of organisations and information modules. The Platform also offers the possibility of downloading the data viewed on a CSV file and of making queries about all the data included using SPARQL. The data has been classified into the sectoral domains of the RIS3CAT strategy, as well as per their potential relevance towards 16 out of the 17 SDGs. Additionally, thematic modules have been developed for the cases of Circular Bioeconomy, Artificial Intelligence, Sea Plastics Reduction, Health and healthcare, and Women’s health [13].

The participative methodology devised for defining the boundaries of the thematic modules, the visual specifics of the platform as well as for the validation of the classifications is a result per se. For instance, to define the perimeter of the field of interest of women's health, work was conducted with experts in health policies, with university researchers and health workers. In the perimeter of circular bioeconomy, a series of workshops with experts and stakeholders have been organised to improve the perimeter of the automatic classification, and to draw interpretations and insights from the benchmarking analysis with other European regional ecosystems.

6. Conclusions and policy issues

Open data and artificial intelligence offer new ways of addressing strategic and operational demands in research and innovation policy, as, when properly used to support a deeper reflection, they allow for [4]:

- Identification and mobilisation of actors

- Evidence-based, collective, definition of challenges and opportunities

- Priority-setting and resource allocation

- Collaboration (inter-institutional, inter-regional)

- Monitoring and evaluation

But to fully benefit from these opportunities, openness, collaboration and replicability are essential. In this same direction, to continue advancing in the creation and use of open data standards and platforms, and to continue exploring policy frameworks, datasets and data science techniques that help connect R&I actors and activities with transformative results and impacts in the real word (health, economy, environment, etc.), are fundamental.

However, the RIS3-MCAT experience shows that all this is not enough to monitor how innovation is contributing to sustainability transitions or to the SDGs. For that, we need:

- To build new data sets that incorporate citizens' expectations, informal networks, communities of practices, social innovation.

- To develop monitoring systems able to measure transformative outcomes.

- To build monitoring systems focused on optimising dynamic efficiency (not allocative efficiency) and able to identify tipping points in the system (where a relative modest input in technology, infrastructure, legislation, or social practices leads to a disproportionately large outcome)

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Keywords: open data, science and technology policy, natural language processing, data visualisation, smart specialisation strategies

[129] Bart Hollants (Ministry of Defense, Utrecht University), Maryse Chappin (Utrecht University), Matthijs Janssen (Utrecht University) and Ellen Moors (Utrecht University). *Dual use innovation: a systematic literature review and research agenda.*

Abstract. Introduction:

With the deterioration of geopolitical relations worldwide, the changing role of the US in European safety and in NATO and the rise of new military tensions on NATOs eastern border, a renewed focus on military development and the strengthening of Europe’s military can be found in most EU-member states (MINDEFNL, 2018). However, military budgets and innovation capacities of European partners (in NATO, as part of GDP) have declined of the past decades (Jakobsen, 2018), while civilian oriented industries have become highly innovative (Mowery, 2012; Lynn, 2014). Therefore, civilian innovation is expected to play an increasingly important role in the future of military innovation, in particular by means of dual use innovations (Verbruggen, 2019, Montgomery, 2020).

In policy and scientific literature, the term “dual use” refers to items (knowledge, technologies and artefacts) that can be used both in military and in civilian settings (Forge, 2010; EC, 2022). A major part of the academic debate is devoted to avoiding or controlling the dangerous or harmful effects caused by the offensive use of such items, related to dealing some kind of damage to nature, humans or societies (Mehlich, 2018). Weaponization is a clear example of this harmful aspect of dual use items, highlighting the risks of malevolent offensive use by state or non-state actors, for example in space technology (Pražák, 2021).

However, dual use technology can also refer to military-use technologies that are used in a non-harmful way or setting, such as found in humanitarian, commercial business or entertainment settings, with associated benefits for society (Mendoza et al., 2021). Much like in the scholarly debate on the societal relevance of space technology (e.g. Robinson & Mazzucato, 2019), there is a body of academic work that studies economic impact of military R&D and innovation (Molas-Gallart, 1997; Caviggioli et al., 2022). Moreover, there also indications that some military technologies are helpful when addressing societal challenges related to e.g. sustainability (Mendoza et al., 2021). Due to the vast attention for offensive capacity of dual use items, which has contributed to critical thinking on risks associated with dual use items, not much is known about the origins, nature and potential of dual use innovations that have no or less offensive capacity and harmful effects. Furthermore, new and previously unaccounted for dual use opportunities (or risks, for that matter) may arise as innovation progresses and novel applications of items are discovered (Volpe, 2019). In some cases, the boundaries between civil and military technologies are dynamic and fuzzy, and their military use is determined by different actors than their development (Malsch, 2012).

This research aims to develop a broader conceptual understanding of dual use innovation, acknowledging the non-offensive side of military activities. By means of a systematic literature review, the concept of dual use innovation is refined. We use both core dual use characteristics: specificity and offensive capacity to position the identified literature. This provides insight into factors that hamper or enable spread of technologies from civilian to military settings and vice versa, and on how such dynamics can be influenced by innovation system actors.

Theoretical framework:

Dual use as a concept in innovation research was originally introduced to highlight both the intended and unintended military use of civilian technologies, often qualifying the military use of such technologies as harmful or unfavorable (Stowsky, 1996). This interpretation, of civilian technology with potentially harmful use, sparked debate about ethical and institutional dilemmas related to regulating or avoiding these harmful effects (Miller, 2007). Dual use items and technologies have been the target of regulations like export controls, ethics committees, custody protocols and other institutional tools (NSABB, 2007; EC, 2022). However, military technologies also move into civilian settings (Forge, 2010) and the transfer of technologies between civilian and military settings can also have favourable outcomes and need not only be focused on developing offensive capacity (Volpe, 2019; Mendoza et al., 2021). Therefore, unravelling the concept of dual use is necessary, taking into account variety in both offensive capacity and the transfer of technology between settings itself.

The first component of dual use technologies therefore is the fact that such items cross the civilian-military boundary and can be used in (or be made suitable for) both civilian and military settings (Forge, 2010). Civilian settings here being settings focused on civilian use, outside of military operations and state conflicts. Military settings are military operations and settings associated with such operations and state conflicts. Both civilian and military settings have their own sets of actors, institutions, infrastructure and interactions, and therefore could be seen as distinct and differing innovation systems.

As different technologies also have different characteristics, such as use, knowledge base, barriers for use and even innovation systems, their specificity to either civilian or the military settings also differs. For example, nuclear weapons technology is highly specific, with little civilian uses, while a combustion engine can easily be used in military operational settings as well and is therefore less specific to the civilian setting. Taking into account that technologies are in constant development and their specificity can therefore change over time, we should define technological specificity as a dynamic characteristic that describes the effort required to allow for dual use application (in different settings) of the item.

Additionally, the dual use of technologies has varying consequences, often framed as harmful or measured by the damage done to humans, nature or societies (Mehlich, 2018), but also as favorable to societies and economies (Mendoza et al., 2021). Furthermore, the outcome of use of technology is heavily influenced by the intent of the user and the setting in which it is used. (e.g. the use of nitrates as fertilizer has less harmful outcomes than the use of the same nitrates to create explosives, and said explosives can also be used in the mining industry instead of in warfare (Forge, 2010).) To understand and map these differences in outcome of dual use, offensive capacity can be defined as the extent to which an item can be used to cause deliberate harm by any actor. At one end of this scale one can find technologies that can be weaponized, while at the other end we find items in healthcare or more beneficial settings, e.g. items that have a low offensive capacity.

These two core dimensions of dual use innovation can be combined resulting in a 2-by-2 a matrix. This creates a conceptual space that opens up research on how technologies develop in different degrees of specificity and offensive capacity, which risks are associated with such technologies and how considerations and practices differ in this conceptual space. Civilian and military markets can be plotted in this conceptual space, their boundaries explored and opportunities to align dual use technology development with societal challenges in both the military and civilian settings can be understood better if the two core dimensions are defined and refined.

Methods and expected results:

In order to conceptualize the current research on dual use innovation and refine the concept of dual use innovation, a systematic literature review has been conducted.

We used Web of Science for the search, conducted on October 25th, 2021, using search terms focusing on dual use innovation: “Dual use” innovate* (211 hits), “Dual use” R&D (56 hits), “Dual use” “Research and development” (82 hits). The terms “multiple use” technology (199 hits) and “multi-use” technology (123 hits) were also included, but yielded no additional articles. The search only included English articles, with no time restrictions.

Only articles related to the use of technology or the purpose of technological development or the use of outcomes of research in both civilian and military contexts were included in the corpus. Articles focusing on dual use in other contexts, such as biological pathways or raw resources were excluded, as were strictly technical descriptions of technology. Articles using the term “dual use” describing multiple practical uses or dual functionality of a technology in the same setting were excluded, as were multiple uses of non-technological items such as health systems or insurance.

The inclusion and exclusion of articles in the corpus has been determined on the basis of this titles and abstracts, and by a reading of the introduction and conclusion if no clear verdict could be reached based on the abstract itself. These steps resulted in a final corpus of 115 unique articles for further analysis.

Each article of the corpus will be fully read to identify definitions of dual use innovation and to identify its position on the conceptual model discussed in the previous section, mapping them on the four quadrants. From this mapping of articles on the proposed conceptual model, specific characteristics of the quadrants will be defined.

The quadrants will be characterized by means of an inductive thematic analysis of the articles, focusing on dual use strategies and outcomes of dual use innovations. Characteristics of each of the four quadrants such as the types of articles and the objects of study, and descriptive variables; keywords, research areas, technological fields will also be discussed and used to refine the results.

Using the results, the conceptual model will be refined and factors that hamper or enable the spread of technologies from civilian to military settings and vice versa will be discussed, and directions for further research will be outlined.

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Keywords: Dual use, Military innovation, Civilian military integration

[130] Douglas Robinson (CNRS, LISIS - the Laboratory for Interdisciplinary studies of Science, Innovation and Society), Mireille Matt (INRAE, LISIS - the Laboratory for Interdisciplinary studies of Science, Innovation and Society) and Matthias Weber (Center for Innovation Systems & Policy, Austrian Institute of Technology). *Strategic Intelligence for mission-oriented STI policy making: are new requirements and new capacities needed?*

Abstract. THE TURN TOWARDS MISSIONS AND GRAND CHALLENGES

Grand challenges, be they Sustainable Development Goals or Grand Societal Challenges, capture societal needs that are currently unmet and often require international and multisector solutions (Cagnin, Amanatidou and Keenan, 2012). The need for European research to address major societal challenges was proposed in the Green Paper on the European Research Area adopted by the Commission in April 2007 (Commission of the European Communities, 2007). During the preparation of the Horizon Europe framework programme, a decision was taken to go one step further in this direction with the design of "missions". The Lamy Report proposed a mission-oriented, impact-focused approach to address global challenges (Lamy, 2017).

Whereas societal challenges may be considered as the broader social problem aim or benefit that is being sought (e.g. fighting climate change), missions represent a more narrowly defined set of activities that are supposed to deliver a verifiable result on a planned timescale that can be used to measure progress in overcoming the societal challenge. STI policies targeted at societal grand challenges rather than purely economic growth have been argued to be a new type of policy (Borras and Edler 2020, Schot and Steinmueller 2019). Such "Transformative Policies" contribute to facilitating innovation and socio-economic impact in a particular direction towards a desirable transformative change (Weber and Rohracher 2012, Linder, Daimer et al. 2016, , Mazzucato 2018, Robinson and Mazzucato 2019, Borras and Edler 2020).

WHAT DOES THIS "TURN" MEAN FOR STI POLICY?

For STI policy, the techno-centric perspective of supporting and governing the emergence of new technology-enhanced value chains has been the predominant frame, however, missions involve transformations of whole socio-technical systems such as agriculture, food production and distribution, energy production and distribution, mobility, health etc. This means a broader range of knowledge is needed based not only on the science of technology areas around which the policies are being framed, but also incorporating non-STI insights and intelligence.

Goal-oriented policies, such as missions, extend the time-horizon for science and technology towards mid and long-term futures where societal challenges are overcome. Thus, STI policies increasingly have to incorporate a variety of future visions into the very heart of the policies (inscribed in the very notion of Mission).

Moreover, with the rapid pace of new technologies, coupled with urgency of many grand challenges, STI policy is challenged to be agile and adaptive -

Thus, STI Policy making is challenged (a) to incorporate knowledge traditionally outside of its remit, (b) to deal with the uncertainty of new and emerging technologies whilst steering towards missions or challenges located much further beyond the timeframe of policy cycles, (c) to actively coordinate with other policy areas to facilitate STI contributions to missions, and (d) do so in an agile way, steering in near-real-time.

NEW REQUIRMENTS FOR STRATEGIC INTELLIGENCE PRODUCTION/COLLECTION AND USE:

To be able to define robust STI policy in spite of these four challenges, there is a need for what Kuhlmann and others have labelled Strategic Intelligence - a set of sources of information and tools employed to produce useful insight in the actual or potential costs and effects of public or private policy and management (Kuhlmann 2003, Kuhlmann et al. 1999, Cagnin et al. 2008, Robinson et al; 2021). In its original form, strategic Intelligence can take various forms and examples are Monitoring, Technology Assessment, Technology Foresight and Evaluation.

What is clear from the situation and challenges described above, is that there is a need for (a) diverse sets of strategic intelligence, sourced from (and/or co-created with) a diverse range of stakeholders in an ecosystem of intelligence, and a need for capacity building for gathering and using the strategic intelligence.

CONTRIBUTION

This paper will provide a reflection on the increasing demand, and new requirements, for, strategic policy intelligence amidst the double pressures of (a) the normative turn towards societal missions and challenges and (b) the pressures for (and ambivalences of) rapid policy making due to the pace of technical change and the variety of crises that require urgency. The authors will provide some illustrations of how these new demands are being met, drawing on a number of examples and case “vignettes” to illustrate how in various countries and contexts, these new requirements are being addressed.

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Keywords: Strategic Intelligence, Missions, STI Policy, Challenge-driven policies, Foresight, Technology Assessment, Evaluation, Trends, Engagement

[131] Tineke Kleinhout-Vliek (Utrecht University), Wouter Boon (Utrecht University), Rob Hagendijk (Utrecht University), Jarno Hoekman (Utrecht University) and Ellen Moors (Utrecht University).
Legitimising Dutch Social Pharmaceutical Innovation.

Abstract. Thousands of patients, including many children, are diagnosed with a rare disease every year. For a substantial number of these rare diseases, there is, as yet, no treatment in sight (Schieppati et al., 2008). The lack of treatments for rare diseases, in particular, indicates market failure as low patient numbers make it difficult to recoup investments, which, in turn, leads to high prices, which are often considered unaffordable (Côté & Keating, 2012), threatening accessibility and healthcare systems' sustainability worldwide (Moors et al., 2014). Getting market approval for new products is also problematic as classical standards for clinical trials cannot be met given the low number of patients (Heemstra et al., 2008).

The 1983 Orphan Drugs Act (USA) and the 1999 EU Directive on Orphan Medicinal Products attempted to address this market failure. They offer economic incentives and scientific advice to developers of medicines for rare diseases and less stringent admission criteria for clinical data. They may also grant 'orphan drug designations' for approved and marketed drugs, granting the pharmaceutical company exclusive marketing rights (e.g., Boon & Moors, 2008). These policies have been successful in the sense that the development of orphan drugs has considerably increased over the last decades (Brabers et al., 2011). Nevertheless, the success is limited and slow, particularly in light of the total number of people with conditions that qualify as 'rare' and for which there is little or nothing to substantially and effectively address their needs.

Actors attempt to address or bypass problems with rare disease R&D and accessibility in novel ways (Coppens et al., 2020). We note that much of this activity classifies as social innovation, defined as: "a combination of ideas, objects and/or actions that changes social relations and involves new ways of doing, thinking and/or organising" (Avelino et al., 2019). Working from this definition, we hold that social innovations in the rare disease field share two characteristics. First, these social innovations aim at particular societal missions, such as redressing vulnerabilities in terms of unmet medical needs (Murray et al., 2010). Second, these social innovations feature novel, alternative partnerships between stakeholders. Stakeholders may include civil society and patient organisations, private companies, and governments or other public institutions. The role of the last actor type is critical due to the highly regulated character of the field (Caulier-Grice et al., 2012).

Innovators need to create and sustain legitimacy to secure social innovations' lasting success. Legitimising is a diverse, stratified activity: it may be both implicit or explicit, it varies across levels and publics, and it may take the shape of different modalities or regimes (Suddaby et al., 2017). We see two primary reasons why legitimacy is fundamental in social innovation. First, alternative collaborations are potentially disruptive to existing configurations, requiring legitimacy construction to allow space for the alternative (Fougère et al. 2017; Verleye et al., 2019; Weber and Rohracher, 2012). Second, to gain legitimacy, actors must "construe an innovation as consonant with and linked to the existing widely accepted cultural framework of beliefs, values and norms" (Suddaby et al., 2017). For social innovation, such a shared belief system dovetails with and frames the envisioned societal mission. Legitimacy construction is thus a primary mode of social innovation: it mobilises stakeholders into novel partnerships around the shared societal mission in question.

In gaining legitimacy for social innovation, actors form partnerships with some but not with others. In this process, they assign positions to selves and others, not just as 'in or out' but as occupying particular roles. Jasanoff (2012) describes how governmental actors shift from a neutral and detached to a more normative and engaged position. Shaw et al. (2014) investigated think tanks and their highly effective positioning as 'independent'. The question remains how other and self-positionings are made consonant with shared belief systems. This paper analyses how actors in 'social pharmaceutical innovation' (SPIN) partnerships seek to legitimise their project by (re) positioning themselves and others and formulating an envisioned societal mission. Comparing two cases will yield insight into the actors' interaction within the initiative's setting and their engagement with the wider Dutch rare disease field.

We have chosen to study two Dutch social pharmaceutical innovation (SPIN) initiatives (novel partnerships seeking to secure patients' access to medicine) with similar stakeholders. Specifically, they feature the Dutch Health Care Institute and hospital-based principal investigators engaging with pharmaceutical companies and patient representatives. The Dutch National Health Care Institute (Zorginstituut Nederland, in this text: the Institute) is the Dutch Health Technology Assessment body and is, as such, responsible for advising the Minister of Health on the contents of the Dutch collective health insurance: the basic benefits package. The Minister is then responsible for the final decision based on this advice. The basic benefits package is obligatory for all Dutch citizens, who can then take out insurance with the health care insurer of their choice. We explore this role in case 1, eculizumab for aHUS patients. In 2016, clinicians at the Radboud University Nijmegen had drafted a new research initiative, CUREiHUS, to establish whether a 'restrictive treatment regimen' would be feasible for Dutch aHUS patients. The Institute decided to fund the medicine used for this research through the benefits package. The Institute is also involved in the field in myriad other ways, from horizon scanning for expensive medicines in the pipeline to setting quality standards and measuring instruments and granting subsidies as explored in case 2. In 2020, University Medical Center Groningen, University of Groningen, received a "monster subsidy" of 30 million euros from the Institute for research on the 'in house' production of Chimeric antigen receptor (CAR) T cells. The project compares the 'in house' generated CAR T cells with CAR T cells produced by the incumbent pharmaceutical company.

In these cases, we see four actor types taking and assigning positions. First, the positioning of the Institute in the Dutch pharmaceutical innovation field is crucial. They attempt to reposition themselves from "losers" who are "critiqued" for taking a long time to arrive at advised decisions to those who challenge the pharmaceutical industry's pricing by "sticking their neck out" in both cases. They do so by seeking out the media. They are at the same time fully aware that there is no legal basis (yet) – they are highly dependent on cooperation between other stakeholders. Second, in both cases, the hospital-based researchers position themselves and are positioned by others as in partnership with the Institute. In one case, this happens through a subsidy and, in the other, through a positive advised decision. The collaboration started, in both cases, with significant efforts from the hospital-based researchers who had something specific to gain (a prestigious subsidy and continued access to eculizumab, respectively).

Third, the positioning of the industry is at a distance. Pharmaceutical company employees do stress the importance of conversation, which also hospital-based researchers noted as potentially meaningful. At the same time, the pharmaceutical company refused to comment outright in case 1, and in case 2, they refused to comment on the case's specifics. Both companies also were considered less than cooperative by other actors in the field. Fourth and finally, the way patients position themselves and are positioned by others varies most significantly across the two cases. For the CAR T cell therapy case, their position is that of recipients but potentially critical of the goings-on. In the eculizumab case, the patients serve as cooperation examples. They acted as partners throughout the eculizumab decision process at the Institute, but also afterwards.

Based on these positionings, we identify the following shared belief systems. First, as described in the introduction, the pricing of medicines is a hot topic, and the system's failure is made evident (cf. Weber and Rohracher, 2012). Importantly, we found that uncertainty was crucial in enabling the two treatments to reach patients. Due to the relatively low number of patients with a rare disease, considerable uncertainty in effectiveness data is standard in the rare disease field. For the pharmaceutical company submitting their clinical trial data, this generally poses a problem. However, our data highlight that, for doctors, it provides an opportunity to work on such research protocols, finding novel ways to meet unmet needs, albeit temporarily. The promise of lessening the uncertainty then legitimises both research activities, and being part of ongoing research was the institutionalised circumstance under which these drugs could reach these patients.

The second overarching belief is that patients should be engaged. In both wider health care practice and social innovation, patients are seen as central, both actively taking and being given more responsibility. Likewise, in pharmaceutical innovation, involving patients is considered a critical success factor (Douglas et al., 2015). As such, the active and initiative-taking, but also cooperative and, to a certain extent, yielding patient is a crucial position when legitimising activities in health care innovation and further afield. To what extent are alternative positions obscured and what happens to those patients who exhibit some of these less legitimate characteristics? Further research would do well to engage with these topics.

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Keywords: Social Innovation, Medicine, Rare diseases, Legitimacy, Positioning

[132] Joeri Wesseling (Copernicus Institute of Sustainable Development). *A comparative analysis of Mission-Oriented Innovation Systems: sustainable aviation, preventive health and traffic safety.*

Abstract. Mission-oriented innovation policy is gained increasing attention as a novel policy approach to overcome societal challenges (Janssen et al., 2021; Kattel and Mazzucato, 2018). Since existing socio-technical and innovation systems approaches are not suitable for assessing these types of policies (Janssen et al., 2022), Hekkert et al (2020) have introduced the perspective of Mission-oriented Innovation Systems (MIS).

A MIS can be defined as "a temporary semi-coherent configuration of different innovation system structures that affect the development and diffusion of solutions to a mission that is defined and governed by a mission arena of different stakeholders" (Wesseling and Meijerhof, 2021, p.1). Mission solutions involve technologically and socially innovative solutions, as well as the destabilization of harmful technologies and practices (Elzinga et al., 2022; Hekkert et al., 2020). The concept of a mission arena refers to actors that are engaged in the highly political and often heavily contested process of mission governance; we describe this governance process as mobilizing, directing and aligning existing innovation system structures into a semi-coherent ensemble that aims to pursue the mission (Wesseling and Meijerhof, 2021) – see table 1 for an overview of mission arena tasks.

Table 1, Mission arena tasks, building on Wesseling & Meijerhof (2020)

Setting up the mission arena [1] is the process in which the mission governance structure is decided. This includes the question 'Who is in?'; 'How to develop networks that enable effective mobilization and redirection of existing innovation systems structures?'; 'What governance structures to employ?'. There are different perspectives and approaches to mission governance, as there are to transition governance (Stirling, 2008; Vo� & Kemp, 2006).

Formulating the mission [2] refers to the prioritization of societal problems and translating them into an ambitious and actionable mission that provides direction to the overall MIS.

Mobilizing the MIS components [3] via mission governance actions requires an overall mission agenda or action plan that includes not only the activities that existing innovation system structures need to pursue, but also the governance actions that incentivize and enable these structures to undertake such activities. We refer to 'mission governance actions' as all the measures by which the mission arena aims to mobilize and align the MIS components to improve the MIS performance. They include mission-oriented innovation policy instruments implemented by governmental organizations, as well as measures to mobilize system components, implemented by other arena stakeholders.

Continued, reflexive mission governance [4] is required throughout the duration of the mission. This involves ensuring that mission progress is monitored and evaluated; reflecting on how the translation of different interacting solutions into solution pathways is coordinated; ensuring that the mission is reformulated and the MIS redirected if it no longer captures the most relevant societal problems; and ensuring that mission governance actions are adapted or existing institutions changed if the solution pathways developed are evaluated as inadequate in relation to the mission goal.

This MIS perspective has recently been developed into a tool to formatively evaluate mission governance actions (Wesseling and Meijerhof, 2021). However, application of the MIS approach remains limited to a handful of cases and more empirical studies to explore the usefulness of the approach are needed. Particularly comparative MIS case studies can help create insights into generalizable patterns of MIS structures or dynamic developments.

For this purpose, this paper applies the MIS approach to three cases of Dutch missions; one on clean aviation, one on reducing the burden of disease, and one on road safety. For each mission, we address the research question 'Do the mission arena's governance actions adequately target the systemic barriers in the respective MIS?'.

Based on a database comprising 77 interviews with experts including all actors of the innovation system (i.e. governments, research institutes, industry associations, intermediaries, firms along the value chain, investors, consumer representative organizations and other interest groups), numerous documents and ad hoc databases (e.g. on innovation projects), we analyzed the different steps of the MIS approach as defined by Wesseling & Meijerhof (2020). Disclaimer: further analysis is still ongoing; this abstract is therefore work in progress.

In the first step, the problem-solution diagnosis, we explore the different societal problems and wants that the mission relates to and amongst which it needs to make a prioritization. We find that particularly for the sustainable aviation and health missions, the mission goals do not properly reflect the actual rationale behind the missions, which is to profit from overcoming societal challenges. This is the explicit policy rationale of the ministry of economic affairs and climate that initiated a policy program of 25 missions across different sectors. Missions, like the Health I mission, that fall under this program have an explicit profit-orientation that is not always reflected in the mission statement. The mission for sustainable aviation does not fall under this broader mission program, but shows a similar profit-oriented outlook (so called 'green growth') that results from the internationally cost-competitiveness of the sector as well as its institutionalized growth paradigm. This mission-oriented innovation policy outlook of 'profiting from/while overcoming societal challenges' seems at odds with the feasibility of the transformative missions, as all three cases show that the missions require a broad scope of both technological and social solutions that are not all profitable – particularly not the transformative and the behavioral solutions. The case of traffic safety shows that one way of overcoming this issue is that the societal problems become so legitimized that a solution-scope defined by profitability becomes unethical – as is the case for traffic safety which has, to some extent, moved beyond the for-profit paradigm (Craens et al., 2022).

When comparing the solution diagnosis, we find that sustainable aviation has a manageable set of solutions that range from technological to social. Traffic safety has a much broader range of different types of solutions, and the health mission has the broadest and most diffuse set of solutions. This is likely the result of the number of sectoral-interfaces that touch upon the mission. Aviation is relatively isolated, while the preventive health mission is affected by civilians' lifestyle and living environment, which are affected by many sectors other than health, like infrastructure, construction, food, education, and mobility and which drastically increases the scope of influential factors and therefore, mission solutions. This increasing solution-complexity makes for more wicked missions (Wanzenböck et al., 2020) and is more demanding of the governance capacities of the mission arena.

In the second MIS analytical step, the structural analysis, we compare the different mission arenas for each case, and the overall MIS structures (i.e. including those actors that do not govern the mission, but support the mission via the development and diffusion of mission solutions). The mission arenas of the three cases have in common that they are similar in size, comprising a large group of 34-63 committed organizations, including mostly governments, knowledge institutes, intermediaries and industry associations. Sustained involvement of firms and NGOs differed per arena, while citizens and institutional investors were often not involved . Some arenas are government-dominated, with a directional/dirigiste role, such as the RSSP traffic safety arena and the health mission. Government directs and facilitates in the aviation sector, and government is more passive in the voluntary, sector-initiated TSC traffic safety mission arena. This TSC arena is the only arena that emerged bottom-up, because of increasing traffic casualties, via a network initiated by a dinner party. It successfully lobbied for traffic safety to be included in the Dutch Coalition Agreement and secured €500 million funding for the top-down, government-led RSSP arena. The aviation arena was initiated by the infrastructure ministry to meet the Paris Agreement, and the health arena by the economic affairs ministry as part of its mission program. Hence each arena was initiated by broader institutional developments (decreasing traffic safety; global warming and the institutional void left by the Paris agreement and its nationally determined contributions; challenge-led mission approaches for profit potential applied to improve preventive care) that created windows of opportunity to develop top-down governance structures.

The third analytical MIS step is the functional analysis, which studies the key transformation activities that are needed to make the mission a success. These activities involve both the creation of the new, as well as the phase-out of the old (e.g. polluting practices). Table 2 gives an overview of these activities. Our comparison shows different developmental patterns. We The main common denominator lies in the fact that for all cases, entrepreneurial activities, resources mobilization, and particularly knowledge development are functioning well for technological innovations, but the story is quite different for social innovation. Social design processes (SF2) needed for social innovation as well as for the societal embedding of technical innovations in fragmented systems are struggling for funding and cannot secure upscaling support. We also find that across missions there is sufficient support for creating the new, but a neglect of the phase-out of the old.

SF1: Entrepreneurial activities. Experiments with solutions (or clusters of solutions) to enable learning; entering markets for new solutions; engaging in business model innovations to foster the diffusion of solutions.

SF2: Knowledge development. Learning by searching and by 'doing', resulting in development and better understanding of new technical and social knowledge on problems and solutions, through R&D, social research and behavioral science research.

SF3: Knowledge diffusion. Stakeholder meetings, conferences, governance structures, public consultations, mission progress reports and other forms of disseminating technical and social knowledge for the mission's solutions and societal problems.

SF4: Providing directionality. Besides pre-existing institutional structures in the context of the mission arena, the mission arena is central to providing direction and mobilizing support from the existing innovation system structures that comprise the overall MIS.

4A: Problem directionality. The direction provided to stakeholders' societal problem conceptions and the level of priority they give it.

4B: Solution-directionality. The direction given, both by existing system structures and the mission arena, to the search for new and further development of existing technological and social solutions, as well as the coordination efforts needed to identify, select, and exploit synergetic sets of solutions to the mission.

4C: Reflexive governance. Reflexive deliberation, monitoring, anticipation, evaluation and impact assessment procedures; these provide the analytical and forward-looking basis for redirecting the system's problem framing and search for solutions based on lessons learned and changing context. Reflexive governance can be seen as second-order directionality, and it can be initiated by the mission arena or by critical outsiders.

SF5: Market formation and destabilization. Creating a niche market and upscaling support for technical and social solutions; phasing out or destabilizing markets for practices and technologies harmful to the mission.

SF6: Resources (re)allocation. Mobilization of human, financial and material resources to enable all other system functions.

SF7: Creation and withdrawal of legitimacy. Creating legitimacy for prioritizing (a) the problem and (b) the development and diffusion of the solutions, at the cost of harmful practices and technologies.

The fourth analysis step is the MIS barrier analysis, in which we compare the barriers that inhibit the system from functioning better. This step is currently still under researched, but the most profound trend we see across cases is the exclusive focus of MIP on technological and profitable innovations. This strongly inhibits the social innovations that are crucial to meeting the missions.

The fifth step is the ex-ante evaluation of mission governance actions, which is done by assessing to what extend the mission arena's governance actions are tackling the MIS barriers. Our main recommendation that results from this step, is that the three missions overlook social innovation and the phase-out of the old. The feasibly govern mission progress, these areas need to be tapped into. This requires a balance between 'supporting mission solutions for profit' and 'supporting mission solutions to effectively meet the mission'.

Keywords: mission, innovation system, phase-out, social innovation

[133] Matti Pihlajamaa (VTT Technical Research Centre of Finland) and Anton Sigfrids (VTT Technical Research Centre of Finland). *Public Procurement and Social Innovation: Creating an experimental space for institutional change in Tampere, Finland.*

Abstract. 1.Introduction

Transformative innovation policies emphasize the role of innovation policy in advancing sustainability transitions (Schot & Steinmuller, 2018). Demand-side policies, such as public procurement, promote sustainability transitions by articulating societal challenges as market demand and incentivizing companies to develop solutions to mitigate them (Boon & Edler, 2018; Edquist & Zabala-Iturriagagoitia, 2012; Uyarra et al., 2020). Many of the grand societal challenges of our time cannot be solved with cutting-edge technologies and instead rely on social innovation, i.e., new social practices and organization forms (van der Have & Rubalcaba, 2016). However, less attention has been paid to how innovation policy may support social innovation (Pel et al., 2020).

Moving from traditional procurement to procuring social innovations is expected to require institutional change at the levels of norms, practices, and structures (Lawrence & Suddaby, 2006; DiMaggio & Powell, 1983; Phillips et al., 2014). Public procurers need to acknowledge innovation, social problems, and non-technical solutions as strategic procurement priorities and adopt practices that support them (Uyarra et al., 2020; Pelkonen & Valovirta, 2015). Companies face the challenge of balancing between profit-maximization and creating social value (Mair et al., 2015). Furthermore, public organizations, companies, and NGOs may need to adopt new roles and collaboration forms (Yan et al., 2018; van der Have & Rubalcaba, 2016). Each actor group is guided and constrained by their distinct institutional logics, which determine their goals, and interaction and operating patterns (Zietsma et al., 2017). From an innovation policy perspective, it becomes interesting whether public procurement may help create "experimental spaces", protected from clashing institutional logics, where social innovations may emerge (Zietsma & Lawrence, 2010). While a few studies have mentioned the relevance of public procurement for social innovation (e.g., Gerghiou, 2018; Uyarra et al., 2019), the relationship between public procurement and social innovation is poorly understood.

This study aims to answer how public procurement may generate innovation and welfare outcomes. We conduct a case study of how the city of Tampere, Finland procures a "Wellbeing Centre", comprising various social and health care services, to improve the welfare of citizens in a district with complex social problems.

2. Public procurement and social innovation

To promote social innovation, we propose that public procurement benefits from integrating three elements: innovation-friendliness, directionality, and cross-sectoral collaboration.

2.1 Innovation-friendliness

Solving social problems requires innovative approaches (Nicholls et al., 2015). Traditionally, public procurement focuses on minimizing costs ignoring innovation (Constantino et al., 2012). Procured products and services tend to be specified detailedly, forcing companies to propose well-known existing solutions (Edquist & Zabala-Iturriagagoitia, 2020). In innovation-friendly public procurement, a public organization sets incentives to encourage innovative solutions (Uyarra & Flanagan, 2010). Hence, innovation-friendliness is needed if public procurement aims to induce social innovation.

2.2 Directionality

Innovative solutions to social problems are not developed if innovation systems suffer from directionality failures (Weber & Rohracher, 2012). When public procurement is used as a transformative innovation policy instrument, its role is to redirect the current priorities regarding innovation towards chosen policy goals (Uyarra et al., 2020). This requires policy-led demand articulation where social problems are translated into priorities and actions (Boon & Edler, 2018). Procurers may, for example, implement sustainability-related requirements or award criteria that favour solutions that address social issues (Sönnichsen & Clement, 2020).

2.3 Cross-sectoral collaboration

Social innovation aims for complex socio-technical change, which requires new combinations of capabilities and resources (Phillips et al., 2014). Consequently, cross-sectoral collaboration is essential in facilitating the emergence and diffusion of social innovations (Domanski et al., 2019; van der Have & Rubalcaba, 2016). Public-private partnerships (PPPs) and similar arrangements help actors leverage multiple capability sets and explore new institutional logics supporting social innovation (Clarke & Crane, 2018; Aschhoff & Vogel, 2019; Bryson et al., 2006).

3.Methodology

We adopted an exploratory single case study research design (Siggelkow, 2007). We identified a suitable public procurement case based on it prioritising social innovation and including intensive cross-sectoral collaboration. The case is about launching a “welfare centre” in the district of Tesoma in the city of Tampere, Finland. The welfare centre houses a wide variety of social and health care services and other public services, including a health clinic, a maternity clinic, a dental clinic, a youth centre, a library, and a café. It is run by the city, a private medical care provider, and a social work NGO. The project was implemented using a project alliance PPP model, originated in the construction sector (Clifton & Duffield, 2006). The case is globally among the first to use the project alliance model in the health care sector. We conducted 17 interviews with key actors in all organisations in 2019–2022 and collected ample document material. For analysis, we adopted the “CIMO-logic” (Denyer et al., 2008), involving the following elements: a problematic context (C), initiating a certain intervention (I) to produce, through specified mechanisms (M), intended outcomes (O). We distinguished these elements from the material and established causal connections between them.

4.Results

4.1 Context

The project had two primary motivating factors. First, the Tesoma district had severe development needs. The district suffered from multiple problems ranging from health challenges to employment and social challenges. Consequently, the city launched a development project to co-create an understanding of local development needs with the citizens. Second, the City of Tampere held strategic objectives for promoting innovation in service production. However, as a development director stated, they “felt frustration with the city’s ability to innovate”. The city sought novel approaches and identified the project alliance model.

4.2 Intervention

The procurement process included a year-long development phase where the implementation of three important elements was negotiated between the city and the service provider.

Directionality. The project was strongly directed by policy objectives of improving citizens’ welfare, the cost-effectiveness of public services, and service innovation and customer-centricity. Long-term impact goals were operationalized into a measurement framework. A significant effort was put into finding indicators and data sources for measuring goals such as the wellbeing of children in primary school. It was agreed that succeeding in reaching the determined goals would affect the service provider’s compensation: the company would receive a bonus for high performance and be sanctioned for not reaching the goals.

Cross-sectoral collaboration. A driving principle for the project was to combine the capabilities of public and private sector actors. During the development phase, a social care NGO was added to the partnership as a subcontractor of the private service provider. According to a city director, “the public, private and third sectors all have different operating logic. Working together will create a fertile ground for finding novel solutions”. To achieve this, the welfare centre was based on a joint organization: all actors share the same spaces, and significant decisions are negotiated until a consensus is reached. A joint cost target was set for the project. If the budget were underspent, the saved funds would be shared by all parties. Similarly, overspending would harm all.

Innovation-friendliness. Innovativeness was communicated as a project goal from the very start. When selecting the supplier, much attention was paid to evaluating potential partners’ innovative capabilities. Unlike in many outsourcing projects, where the forms of service provision are specified in detail, ample room was left for the parties to choose the most effective ways of providing the agreed services. This was supported by the year-long development phase and agile decision-making procedures in the implementation phase. The contract period was long and it was expected to guide the actors to innovate beyond low-hanging short-term improvements.

4.3 Mechanisms

In the implementation phase, the project configuration challenged the existing institutional logics of the involved actors. First, there were strong incentives for achieving verifiable welfare results with reasonable costs. Challenges arising from divergent interests, which plague many service contracts, were avoided using outcome-based compensation and shared risk and reward sharing. Having monetary incentives for reaching qualitative project goals harnessed the private sector profit-maximization logic to serve policy goals. Second, the project's values and priorities (innovativeness, collaboration, and customer) were strongly emphasized in internal communications. Third, the model ensured ample room for innovation. Structures that limit innovation in standard service operations, such as detailed service specifications, bureaucratic decision-making, and short contract periods, were absent, creating opportunities to innovate. Fourth, structures facilitated collaboration, redefining existing boundaries and supporting the emergence of a shared identity. These included physical proximity, frequent interactions, roles as equal partners, and shared management.

From these premises, we identified emerging practices that facilitate social innovation. Resource allocation for development work differed significantly from both the city's other internal service provision and the private service provider's other contracts. The combination of monetary incentives, explicit values and priorities, and innovation-enabling structures motivated investments into innovation in multiple ways: all organizations benefit from innovative outcomes given that they improve welfare or efficiency, innovation was considered a legitimate effort within the centre, and the environment was supportive of creative activities. Consequently, significant resources were allocated to development work.

Interorganizational learning was supported by close integration between the actors and emphasising collaboration as a value. The city learned of new digital tools, management systems, and compensation models from the service provider. The company, in turn, benefits from the opportunity to combine various data sets, which help gain a more comprehensive picture of the citizens' needs. A low threshold of interacting across organizations was considered helpful in solving daily problems.

Seeking synergies in service provision was also enabled by the structures and values promoting interorganizational collaboration. The multi-sectoral welfare centre was considered capable of fulfilling customer needs more holistically. The involved NGO, which ran a community café and organized various events, had a critical role in service coordination. The NGO was an approachable actor with an in-depth understanding of local needs. The café was often the first customer contact point where they were directed to other services. Also, other actors guided customers towards different social and health care services and public events.

Finally, the centre increased the actors' attention to long-term welfare goals. By communicating the value of citizens' sustainable wellbeing, the work's rationale shifted from reactive (curing illness) to proactive (maintaining health). This was supported by data collected for the compensation model. These priorities and their progress become a part of meetings agendas and discussions, resulting in new insights into customer needs. Furthermore, attention to the issues led to more comprehensive analyses of the customer base, developing new customer segmentation methods, and targeted recruitments to meet identified needs.

4.4 Outcomes

After the first four-year implementation contract period, the welfare centre shows promising outcomes. Collaborative development efforts have resulted in several innovations, some more typical service innovations (e.g. remote 'digital clinic', semi-automatical medical reports, software robot for anticoagulant dispensing), others more social in nature (e.g. an "exercise prescription", collaboration with employment and growth services). Most welfare goals have been reached, and the costs have remained below the target level.

5.Discussion

Our results reveal how the city responded to local social problems by a combination of three procurement elements (directionality, cross-sectoral collaboration, innovation-friendliness) and how they triggered mechanisms that generate social innovation outcomes. Drawing from the institutional theory, we consider different actor's prevailing rigid institutional logics to hinder social innovation (Phillips et al., 2014; Lawrence & Suddaby, 2006). Our study illustrates how public procurement may be used to create an experimental space, where the actors may detach from their institutional logics to experiment with new practices (Zietsma & Lawrence, 2010; Cartel et al., 2019). We track how procurement elements realize in a specific project environment that disrupts the preexisting "scripts" that actors follow (Scott, 2014), and reinforce new priorities, values, and boundaries. We observe how the novel environment gives rise to practices that direct actors towards social innovation and report promising early outcomes from the project. Our study elaborates the nature of public procurement as a transformative innovation policy instrument (Uyarra et al., 2020; Schot & Steinmuller 2018) by providing a detailed micro-level understanding of its potential in facilitating social innovation.

Keywords: Public procurement of innovation, Social innovation, Health care, Demand-side innovation policy, Challenge-led policy, Transformative innovation policy

[134] Matti Pihlajamaa (VTT Technical Research Centre of Finland) and Ville Valovirta (VTT Technical Research Centre of Finland). *Innovation Contests, Demand Articulation, and Mission-oriented Innovation Policy: the case of Helsinki Energy Challenge.*

Abstract. Abstract

While public procurement of innovation is deemed to have the potential to advance mission-oriented innovation policy goals, there is a discrepancy between broad supranational missions and public procurers' locally embedded needs. This study focuses on innovation contests as a form of public procurement and investigates their potential for articulating demand for a localised version of a broad mission. We conduct a longitudinal case study of Helsinki Energy Challenge, where the city of Helsinki, Finland sought solutions to decarbonising the city's heating system, promising a million-euro reward to the winners. We pay attention to operationalising the challenge, attracting participants globally, the role of interactions between the organisers and the contestants during the process, and the impacts of the contest on the Helsinki region and the broader supranational mission. We find that the city enforced spatial and temporal boundary conditions to guide contestants towards solutions that matched the city's local needs. We further observe challenges arising from the open-ended scope of the search for solutions. The competition outcomes speak for innovation contests' potential for facilitating demand articulation and promoting mission-oriented policies.

1. Mission-orientation in innovation policy

New forms of innovation policy, such as mission-oriented (Mazzucato, 2018) and transformative (Schot & Steinmueller, 2018) innovation policies, emphasise solving societal challenges as a key rationale for public interventions. In this context, demand-side policies, such as public procurement of innovation (PPI), are considered a promising means to direct businesses' innovation processes towards more socially desirable goals and create markets for socially and environmentally sustainable solutions (Edquist & Zabala-Iturriagagoitia, 2012; Uyarra et al., 2020; Wesseling & Edquist, 2018).

Mission-orientation and the targeted "grand challenges", such as the United Nations' Sustainable Development Goals, are broadly defined at a supranational level (Wanzenböck & Frenken, 2020). Consequently, they are extremely broad and difficult to address as a whole with concrete policy interventions (Edquist & Zabala-Iturriagagoitia, 2012). To make missions accessible, narrower partial problems need to be specified based on them. A large share of PPI is implemented by regional and local governments. To guide public procurement, missions must be articulated at the regional level, acknowledging the local economic and institutional context. If this process of demand articulation is disregarded, missions are at risk of being perceived as fuzzy and confusing with little practical relevance (Brown, 2020). Therefore, it becomes of interest how mission-oriented policies can be operationalised in regional PPI.

2. Innovation contests and demand articulation

Innovation contests can be used as a particular form of PPI that we propose to have potential as a tool for articulating local needs to broad audiences of potential solution developers. While innovation contests have been used for hundreds of years (Scotchmer, 2004), innovation policy literature has paid little attention to them (Liotard & Revest, 2018). Their basic structure is that an organisation announces a challenge to be solved, determines the associated reward, and proceeds to invite contributions from multiple participants (Adamczyk et al., 2012). Previous studies have identified the design of an innovation contest to be a multifaceted task, where the organisers need to provide a carefully defined problem statement, decide on the rules, guidelines, selection criteria, and awards, and motivate potential participants to join (Liotard & Revest, 2018; Pihlajamaa & Merisalo, 2021). Therefore, setting up a mission-oriented innovation contest necessitates that a broader mission is translated into a narrower problem that the contestants are invited to solve. In addition, a key outcome of a contest may be new perspectives to local problems arising from interactions between the organiser and the contestants (Pihlajamaa & Merisalo, 2021), enabling better demand articulation in future procurements.

3. Case description and methods

In this study, we explore how innovation contests may improve the demand articulation of mission-oriented policies. We pay attention to the process of designing and running an innovation contest and aim to understand how it may benefit the articulation of a broad mission to fit a regional context. We thus respond to the call for research on how broad challenges are contextualised locally and how mission-oriented innovation policy can be implemented at the regional level (Wanzenböck & Frenken, 2020).

We adopt a single case approach to gain a comprehensive understanding of the preparation of an innovation contest. It allows rich data collection from multiple informants and a sufficiently deep focus depth (Eisenhardt & Graebner, 2007). We examine Helsinki Energy Challenge, where the city of Helsinki, Finland sought solutions to the problem of decarbonising the city's heating system using as little biomass as possible, promising a million-euro reward to the winner(s). This narrower locally embedded problem was related to the broader mission of achieving the city's ambitious carbon neutrality targets by 2035 while, at the same time, contributing to promotion of low-carbon economy. The more specific mission of carbon-neutral heating can be characterised as a problem-led mission (Wanzenböck et al., 2020) as it is widely recognised and agreed on as the biggest single problem on the city's transformation towards carbon neutrality. However, there were divergent views and visions of which solutions would be feasible to meet the targets. The contest also aimed to identify solutions that other cities around the world could use. Due to the large scale of the contest, its strong mission orientation, and the city's motivation to scale up the local solutions to other regions, we consider it a particularly information-rich case (Patton, 2014).

We studied the contest longitudinally, starting our investigation in 2019, when it was still under preparation, and following its execution from the launch in February 2020 to its end in March 2021, also paying attention to the aftermath and outcomes. We used multiple data sources, including organiser, stakeholder, and finalist contestant interviews (n=22), a survey to contestants (n=58), materials from an online platform, participation in events and workshops, public documents and news articles, and regular meetings with the city's project manager responsible for the contest.

4. Preliminary findings

Adopting a broader mission as a starting point, the competition articulated a localised version of the challenge to a global group of innovators, guiding innovation processes towards regional needs for sustainable solutions. In our analysis, we paid attention to the process of operationalising the challenge, the contest's design, the role of interactions between the organisers and the contestants during the process, and the impacts of the contest on the Helsinki region and the broader supranational mission.

Overall, we find that the contest increased the city's ability to articulate its future demand more concretely. The contest functioned as an interaction arena, where the city gained a better understanding of potential solutions for its local problem. The contestants learned about the procurer's priorities and constraints, helping them align their solutions with actual needs.

We find that the spatial and temporal boundary conditions established by the organisers were key mechanisms for guiding the innovators towards solutions that matched the city's local needs. The organisers emphasised the spatial boundary conditions in extensive informational materials and interactions with the contestants. Their goal was to convey an understanding of the city-specific instance of the broader issue of carbon-neutral heating. To develop a successful proposal, the contestants were required to adapt their idea to fit the city's existing heating system, and learn about issues such as the design and costs of the current district heating system and regulations related to the energy sector and land use. Temporal boundary conditions were addressed by defining a strict deadline for the solutions' implementation. The city is committed to running down its current coal-based heating production by 2029 as per the Finnish Government's decision to ban the energy use of coal. The tight schedule determined the sought solutions' maturity: technologies with too low maturity cannot be realistically implemented in the determined schedule, whereas existing conventional solutions may be ineffective in solving the challenge. These boundaries defined the solution space within which the contestants had room to innovate with demarcated boundaries operating as functional requirements for the procurement.

A major decision in the contest's design was to avoid restricting the proposed solutions' scope. As there was a significant divergence in different stakeholders' views of potential solutions (Wanzenböck et al., 2020), it was decided not to restrict the proposals to specific technologies. Even non-technological solutions were encouraged. However, this strong problem-focus of the contest led to challenges in communicating the city's needs to the participants and comparing the proposals with each other in the evaluation phase.

Interestingly, despite the contest being strongly embedded in Helsinki's local context and its district heating system's peculiarities, the participants found the experience contributing to improved ability to meet other regional actors' and potential clients' requirements. This provides preliminary support for the notion that mission-oriented policies may advance via locally-oriented experimentations solutions that are then diffused to global audiences (Wanzenböck & Frenken, 2020). It also provides further evidence of locally embedded needs articulation process taking place between users and technology providers, creating knowledge spillovers beyond the geographical context (Liotard & Revest, 2018). This observation was amplified by the contest's high international visibility, resulting in a large number of overseas teams participating in the contest, thus opening up diverse channels for knowledge diffusion.

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Keywords: Innovation contest, Demand articulation, Public procurement of innovation, Mission-oriented innovation policy, District heating

[135] Mireille Matt (INRAE), Douglas K.R. Robinson (CNRS) and Renée van Dis (INRAE). *Steering research towards a pesticide free agriculture: a nested evaluation approach.*

Abstract. 1 Introduction

Current policy discourse supports the idea that there is a need for research to address SDGs. The European H2020 research framework program was built on this premise, with 45% of the budget dedicated to Grand Challenges. In Horizon Europe, five Missions will be implemented in 2021 to solve challenges such as fighting cancer, adapting to climate change, protecting our oceans, living in greener cities and ensuring soil health and food. This trend is also visible at the level of member states. These Mission-Oriented Policies (MOIP) (Robinson and Mazzucato, 2019; Larrue, 2021) or Transformative Innovation Policies (Schot and Steinmueller, 2018) are implemented to develop radical innovative solutions to contribute to reach SDGs.

However, the extent to which the research results supported by these policy interventions can contribute towards societal challenges poses a difficult analytical and evaluative challenge. Transformative Research programs have to understand whether they are achieving their aims. Do the supported research results generate desirable impacts? How to analyze and evaluate the efficacy of those policies?

This paper is developed in the French context where, in 2019, the government launched a multi-year research program with the mission of contributing to a 'pesticide-free agriculture by 2040'. Being the most ambitious research program focusing on pesticide reduction in Europe to-date, the program includes 10 projects (each of the order of 3 million Euros), funded over 6 years to conduct research that will: focus on zero use of pesticides; identify new methods and solutions; contribute to radical innovations to transform agricultural and agri-food systems.

The aim of this paper is to show how a real-time impact assessment method (ASIRPAReal-Time), applied simultaneously at the project and the program level, can help to promote research that could contribute to reach SDGs. We contend that this nested approach constitutes a promising solution for Mission-Oriented research programs to orientate and steer activities towards desired directions.

2 ASIRPAReal Time: a nested real-time impact assessment

In this paper, we use the ASIRPAreal-time approach (Joly, Matt and Robinson, 2019) to collect data and observe the importance of having a nested approach when steering research. It is a nested and integrated approach based on impact pathways developed at the level of the program and the projects that enable to steer novelty towards desired societal impacts. According to the multi-level policy process (Barré et al., 2013), the program level translates the objectives stated by the mission (orientation layer) into interventions (experimentations, funding, R&I performers, selection criteria…) and the project level produces knowledge through R&I activities, networking and infrastructures. Monitoring programs should enable to articulate the priorities of the program (the mission) with the R&I activities conducted within projects. The challenges of the program manager is to manage a portfolio of projects and work on their possible synergies, to interact with the relevant policy-mix (Rogge and Reichardt, 2016) and to embed (Sengers, Turnheim and Berkhout, 2020) and anchor (Elzen, van Mierlo and Leeuwis, 2012) novelty produced by the portfolio of projects to foster and support transformations. For instance, the program could induce and foster a change in regulation that would otherwise block the adoption of novelties generated by a set of projects. Programs should be able to show that they facilitate the generation of impacts through their ability to foster the generalization of successful R&I activities. At the project level, principal investigators together with the partners and relevant stakeholders will have to define a collective vision of the expected transformations and impacts, the projects aim to contribute to. Their aim is to steer the projects towards these desired goals, by building an appropriate network of actors and anticipating blocking factors and bifurcations on their pathways to impacts. This will enable project leaders to develop strategies for achieving the different envisaged steps.

Monitoring is integrated in the policy process and provides strategic intelligence to program and project managers. Its aim is to help managers designing, strategizing and implementing activities that are coherent with the program and project objectives (directionality, societal transformations and impacts). Managers at different levels of the policy making and implementation should develop appropriate monitoring competences and capabilities.

ASIRPAreal-time is also based on the following principles:

- It is an iterative, adaptive and reflexive approach: assessment is made ex ante to anticipate future events and build a first impact pathway and real-time, i.e. on a recurrent basis with the aim to trigger learning and look at how intermediate results may lead to reconsider the initial impact pathway;

- It uses a principle of parsimony of information: because of the radical uncertainty related to the research process, collecting detailed information on all the possible outcomes and impacts is neither possible nor useful. The approach has to clearly define which information is necessary to build the impact pathway at each different stage

- A principle of flexibility and agility in the decision-making helps to fully take advantage of learning effects and information growth. ASIRPA real-time approach has to be associated with a governance process that allows flexibility and responsiveness.

- It is an anticipatory approach, based on endogenous futures thinking. The anticipatory exercise starts from the present and expands into the future. There are path dependencies at play but also rooms for path creation and divergence. ASIRPA Real Time helps producing a first representation of the impact pathway with anticipated expected transformations, productive configuration of actors, critical points, role of intermediaries. However, in the meantime, it is necessary to take into account explicitly that the transformation targets may move and that some causal relations identified may be challenged. We use the concept of “rational myth” (Meyer and Rowan, 1977) to take into account this important cognitive characteristic: the need to draw on the current vision (transformation target, causal chains), to consider it as true, while being aware that this is a convention that may be challenged by the production of new knowledge.

3 Contribution

The contribution of this paper is to show the advantages (and difficulties) of conducting a real-time impact assessment at the level of the projects and at the level of the program to promote research relevant to societal challenges. We will share the lessons learnt during the evaluation experimentations conducted in the context of the French Priority Research Program “a pesticide-free agriculture by 2040”. We observed and accompanied through workshops the 10 funded projects in their process of developing their impact pathway and the corresponding narrative. These impact pathways provide a rich set of information on how projects envisage their contribution to desired transformations. The role of the program manager is twofold: (i) to manage projects as a portfolio to work on the possible synergies between the projects and (ii) to coordinate with the external context to anchor the research results. We will show how the program impact pathway built stepwise and based on the experiences and needs of the projects will enable the program manager to build the necessary strategic intelligence to steer research towards a chemical-free agriculture. In particular we will share the lessons learnt during a program level workshop which aim was to understand the common needs and challenges of the projects to guide program activities.

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Keywords: steering research, Real-time assessment, Project and program assessment, Mission-oriented program

[136] Jan Fagerberg (TIK). *Mobilizing innovation policy in the pursuit of net-zero emissions.*

Abstract. Mobilizing innovation policy in the pursuit of net-zero emissions

Climate change, mainly caused by emission of climate gases from burning of fossil fuels, is probably the most important challenge facing humankind today (Stern 2015), and to avoid the most negative environmental, social and economic consequences that climate change entails, net emission of climate gases has to be reduced to zero by mid-century (IPCC 2018). A broad range of policy-actors world-wide, including the European Union, has already committed to this goal. However, transforming the society and economy to a state that is consistent with the net-zero objective is a very demanding task. For example, to succeed in this endeavour, fossil fuels - which currently provide 80 % of global energy - will have to be phased out and substituted with renewable energy in energy-production as well as in energy-using sectors (Goodall 2020). Extensive change, i.e., innovation, in the way energy is provided, distributed and used across all parts of society will be required (IEA 2021). Moreover, these changes will have to happen much faster than in e.g., earlier energy transitions (Wilson 2012, Fouquet 2016, Smil 2016).

An important question, to be addressed in this paper, is how policy – particularly innovation policy - can contribute to mobilize innovation for this purpose (Mowery et al 2010, Fagerberg et al 2016, Fagerberg 2018). A commonly held view is that to success in innovation is primarily requires devoting sufficient resources to R&D. However, more than a century of scholarly work on this topic within the fields of innovation studies and evolutionary economics has demonstrated that the issue is more complex than that (Kline and Rosenberg 1986, Fagerberg et al 2004). Arguably, for policy to be effective in its aims, a more holistic perspective, taking into account a broader range of factors, instruments and actors, will be required (Fagerberg 2017, Edler and Fagerberg 2017, Borras and Edquist 2019). We discuss the implications of these lessons for our topic in more detail in section 1 of the paper.

Innovation is problem-solving in practice. But innovation does not only solve problems, it also creates opportunities. This holds not only for business but for policy makers as well.

Hence, while clever policy-making may influence innovation processes in a beneficial manner, successful innovation may also positively influence the possibility for policy to succeed in its aims, i.e., a virtuous interaction between policy-making and innovation dynamics along the path towards net-zero emissions. We consider this possibility, related to the notion of “technological revolutions” (Freeman and Perez 1986, Perez 2002, 2016), in section 2 of the paper. It is shown that a green technological revolution, centred on production and use of renewable energy, is (greatly helped by policy) already well underway, and it is argued that this creates very important opportunities for policy makers in their attempts to support and speed up the transition to net-zero.

When innovation policy started to become popular among policy makers around the turn of the century, it was primarily the potential economic effects that attracted their interest (Fagerberg 2017, Borras and Edquist 2019). Nevertheless, since innovation is about solving problems, it can also be mobilized to tackle challenges that are more specific. In fact, there is a long tradition for doing so, particularly in the US (Mowery 2011, Mazzucato 2013). Recently, such so-called mission-oriented innovation policies have received renewed attention (Mazzucato 2017, 2018) as ways to tackle important challenges facing humankind (and hence also policy makers), including the climate challenge (Mazzucato 2021). Section 3 of the paper consider the relevance of this and other recent policy approaches (Steward 2012, Schot and Steinmueller 2018) for the path towards net-zero. It is argued that there is a long way from engineering specific innovation-projects, even very daring ones such as bringing a man to the moon, to transforming the global economy to a state consistent with net-zero emissions. In fact, the scale and complexity of the challenge is unprecedented (Mowery et al. 2010). Arguably, what will be needed is simultaneous (and relatively rapid) change in a whole range of technologies, sectors, and ways of life, that is, so-called “system innovation” (OECD 2015), for which new, bold policies (Geels 2014), e.g., “system innovation policies” (OECD 2015), may be required. Moreover, what seems evident is that such new, bolder policies will make the need for effective coordination (extending to important non-governmental actors) of innovation policy even more pressing (Braun 2008, Weber and Rohracher 2012, Edler and Fagerberg 2017, Fagerberg and Hutschenreiter 2020).

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(selected figures in separate file)

Keywords: Global green shift, Energy transition, Net-zero emissions, Climate change, Innovation policy, Policy coordination, Missions

[137] Tuukka Mäkitie (SINTEF), Jens Hanson (SINTEF), Sigrid Damman (SINTEF) and Mari Wardeberg (SINTEF). *On the role of digital innovation in energy transitions.*

Abstract. Introduction

Digital technologies have only recently emerged as a topic in sustainability transitions research (Andersen et al., 2021, Sareen and Haarstad, 2021). There have been expectations that digital technologies may contribute to sustainability transitions (Perez, 2015), especially among policymakers and industry. For instance, an EU Ministerial Declaration stated that "smart use of clean digital technologies can serve as a key enabler for climate action, environmental sustainability, and reaching the UN Sustainable Development Goals" (European Commission, 2021). However, how, and to what extent, such promises can be realized needs further scrutiny, particularly since the emerging empirical analysis presents a more sober picture. For instance in key Norwegian industries, digital technologies have until now been used mostly to increase efficiency in industrial processes (Mäkitie et al., 2020), which in itself is inadequate to achieve ambitious targets like those of the Paris Agreement. Digital technologies can also have outright negative sustainability effects. For instance, diffusing cryptocurrencies and other blockchain technologies create vast energy needs and thus emissions (Stoll et al., 2019). Uptake of digital technologies may also entrench existing social inequalities (Klerkx and Rose, 2020, Sareen, 2021). There is thus a need for more nuanced analyses and elaboration on the role of digital technologies in sustainability transitions.

In this conceptual paper we seek to further explore and unbox how digital innovation may contribute to sustainability transitions, understood as fundamental transformation of socio-technical systems towards more sustainable patterns of production and consumption (Markard et al., 2012). We reviewed existing literature on digital technologies in sustainability transition. Moreover, we drew upon insights and earlier work from two Norwegian research centres, on sustainable energy transition strategies (FME NTRANS) and innovation policy for industrial transformation, sustainability and digitalization (INTRANSIT). Further empirical material will be collected.

We propose a framework for understanding the types of digital innovations in the context of environmental innovations and how they may enable socio-technical systems change towards sustainability. We ask: How may digital innovation enable radical environmental innovation in the context of sustainability transitions? Building on innovation and sustainability transition studies we conceptualise different interactions between digital and environmental innovation and use empirical examples to illustrate. We thus aim to contribute to policymaking and research on sustainability transitions regarding the role that digital innovation may have in sustainability transitions, and how synergies between them may be fostered.

Perspectives on digital innovation in sustainability transitions

We define digital technologies as electronic systems, devices, tools and resources that generate, store and process data (Nordic Council of Ministers, 2021), and understand digitalization as "transformation of socio-technical structures that were previously mediated by non-digital artifacts or relationships into ones that are mediated by digitized artifacts and relationships. Digitalization goes beyond a mere technical process of encoding diverse types of analogue information in digital format (i.e., “digitization”) and involves organizing new socio-technical structures with digitized artifacts as well as the changes in artifacts themselves" (Yoo et al., 2010: 6). In other words, while digital technologies could be understood as their own socio-technical systems, we are more interested in how they may reconfigure other socio-technical systems and the interactions between them.

To conceptualize the impact that innovations have for socio-technical systems, we differentiate between incremental and radical innovations. An incremental innovation enhances the performance and value of existing key technologies. Incremental innovation therefore does not destroy or make current technological knowledge and competences obsolete, but rather solves problems and eliminates flaws in the design of current technologies and makes them more attractive, thus raising barriers for alternative solutions to outcompete the current technologies (Abernathy and Clark, 1985). Incremental innovations thus largely maintain the existing structures and processes of socio-technical systems (e.g. mobility, energy and food systems), i.e. in terms of actor relationships, production and distribution systems, markets and user practices, power relations, institutions and infrastructures (Geels, 2005). A radical innovation, on the other hand, disrupts the pattens of production and consumption in sectors and may make existing technologies obsolete. The "creative destruction" of radical innovations thus raise the need for new knowledge and competences and may lead to the formation of new industries and actors (Schumpeter, 1943). In other words, rather than optimizing current technologies, radical innovations normally leads to a new set of technologies and practices (Abernathy and Clark, 1985). Over time, this may lead to reconfiguration or changes in the key patterns and processes of socio-technical systems. Radical innovations thus may imply a much more substantiated change in, and between, socio-technical systems, and help to contribute to more fundamental transitions towards new (sustainable) patterns of production and consumption. Such fundamental changes in e.g. the socio-technical systems around energy, food and mobility are needed in order to meet urgent societal needs such as the Paris Agreement and Sustainable Development Goals (Markard et al., 2020).

When evaluating the potential role of digital technologies in sustainability transitions, we thus argue that it is relevant to differentiate between incremental and radical environmental and digital innovations as different modes of innovation with different potential impacts for socio-technical systems, and thus for sustainability transitions. We differentiate between the modes of innovations. Radical digital innovations in themselves are unlikely to lead to sufficiently fast and wide decarbonization, nor do incremental environmental and digital innovations. However, for instance the diffusion of radical environmental technologies, such as renewable energy technologies and electric vehicles etc., may benefit from digital innovation. Moreover, novel digital technologies may support further optimization of environmental technologies, and be crucial for their integration in a future renewable energy system. We thus propose that while environmental innovations involved in sustainability transition may develop further without major digital innovation, digital technologies may play a crucial role as enablers, for instance by contributing to system integration, thereby opening alternative pathways for sustainability transitions.

We suggest to conceptualise two exemplary types of socio-technical systems change enabled by digital innovations : (1) incremental digital innovation that leads to changes within socio-technical systems, but essentially leaves them intact and where digital technologies are used as an "add-on solution", and (2) radical digital innovations that in addition to substantial changes within systems by changing the internal organization and interactions between the elements of the system, also entail reconfigurations between socio-technical systems, and thus hold the potential for wider change across the systems of production, distribution and consumption.

Preliminary empirical illustrations

We illustrate the role of incremental and radical digital innovation in low-carbon transitions in the socio-technical systems related to shipping and energy (see Figure 3). We suggest that the combination of radical digital innovation with radical environmental innovation has most relevance for sustainability transitions. For example, autonomous zero-carbon vessels enable opportunities for increased modal shift from land to sea, thus reducing climate gas emissions and improving e.g. health and safety in and near major roads, and opens new pathways to decarbonize transport. Moreover, they enable more optimal and effective routing, coordination and energy use. Meanwhile, however, automation may reduce or change employment, making part of seafaring competences obsolete, thus potentially leading to lay-offs or retraining needs. Moreover, automation can also bring great emission reduction opportunities in ports. Alone, automation in cargo-handling can contribute to higher efficiency, lower costs and decreased time used in port. When combined with electrification and automated equipment power by electricity or battery, the port can reduce its emissions significantly (ITF, 2021).

In the energy sector, digital platforms and software enable decentralized (renewable) energy solutions for smaller communities, contributing local communities to supply their own energy needs, thus empowering communities as energy prosumers, i.e. community energy. Such communities with decentralized power supply and create an alternative for centralized (renewable) energy production, distribution and use, controlled by large incumbent utilities or energy companies. Moreover, blockchains used in energy also have great potential and can change the way energy is traded, sold and used. Blockchains could assist in challenges related to decentralized energy systems, enable consumer-oriented energy trading, microgrids and facilitate easier transactions between energy generator and consumers (Andoni et al., 2019).

Preliminary conclusions

Our preliminary analysis suggests that digital technologies can have an intermediary role – facilitating and enabling novel practices and uses of novel environmental technologies and thus enabling changes within and between socio-technical systems. Analysis of processes and synergies between radical digital and environmental innovations are thus important future research topic in the study of sustainability transitions. Moreover, we note that while digitalization in itself is unlikely to lead to fundamental sustainability transitions (e.g. decarbonization), radical digital innovation may enable new uses of radical environmental technology, creating novel power relations and lead to institutional change, thus opening more alternative paths for decarbonization. However, while such synergies may lead to social and economic sustainability impacts, new actors constellations, redistribution of power and new competence and skill needs may also have adverse sustainability effects.

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Keywords: Digital innovation, Energy transition, Incremental innovation, Radical innovation

[138] Robert Hassink (Kiel University), Michaela Trippl (University of Vienna) and Han Chu (Kiel University). *Smart Specialization: Mastering the Shift from S3 to S4.*

Abstract.

Smart specialization conceptually means "the capacity of an economic system (a region for example) to generate new specialities through the discovery of new domains of opportunity and the local concentration and agglomeration of resources and competences in these domains" (Foray, 2015, 1). On this basis, the European Commission has supported the design and implementation of smart specialization strategies, aiming at developing the endogenous innovation and diversification potential in regions. Over the past few years, smart specialization strategies have been playing a key role in European regional innovation policy, although their uptake and successful implementation has been found to vary widely across different types of regions (see, for instance, Trippl et al., 2020a). Smart specialization emerged due to thoughts developed by the Knowledge for Growth Expert Group on how to explain and reduce the productivity gap between the USA and the EU. The group identified two main weaknesses in Europe: national-level fragmentation of public research systems and the duplication of knowledge bases, as many regions focus on the same high-tech industries (Foray 2015, 10, 11). The rationale of smart specialization is to build on existing industrial structures in regions and to transform them with the help of new but related explorative research and innovation activities (Foray 2015, 11). The latter should have the potential to transform existing regional economic structures. That is to say, smart specialization is not about more of the same, but more about R&D and innovation that could potentially lead to new industrial activities both in emerging and established sectors. The strategy development is defined as a policy process that should lead to the selection and prioritization of domains (fields or areas) in which entrepreneurs play a key role as they are supposed to discover the appropriate domains for the future. In a similar vein, Foray (2015, 2) states that well-timed and targeted governmental intervention is key in this process as it is supposed to select the most promising new activities, which should lead to spillovers and structural changes in the regional economy. It is not only about having an important industry in a regional economy (such as alpine industry in a tourism region), but about smart diversification with the help of general-purpose or key enabling technologies, so that existing industries become more competitive (e.g., ICT application in the alpine industry) (Foray 2015).

Smart specialization strategies aiming at making regional industries more competitive were introduced as an ex-ante conditionality for receiving support from European Structural and Investment Funds for the 2014–2020 funding period (S3), without a strong directionality (Hassink and Gong, 2019). However, in the next funding period (2021–2027), there will be a stronger focus on "the green [and inclusive] dimension of Smart Specialisation ... in line with the European Green Deal" (Landabaso, 2020; without page number). The latter has also been discussed as a shift from S3 to S4, namely smart specialization strategies for sustainable and inclusive growth (McCann and Soete, 2020).

This shift can be understood as being part of a broader discussion about challenge-oriented policies, which are referred to as, among others, challenge-driven innovation policy (Coenen et al., 2015), mission-oriented policy (Mazzucato, 2018), and transformative innovation policy (Schot and Steinmueller, 2018). They 1) are geared towards transforming (unsustainable) socio-technical and socio-economic systems, and 2) involve different actors, organizations and ministries, and hence policy fields. Participatory governance forms and engagement of a variety of actors in policy processes have been given much emphasis by scholars (Schot and Steinmueller, 2018). This emerging approach is supposed to be more bottom-up, decentralized and focusing on experimentation and learning among a broader group of actors, including niche actors. What is more, the orientation on place-based needs and problems in prioritization processes - instead of solely focusing on pre-existing knowledge assets and capabilities as emphasized in conventional approaches - is said to enhance the opportunities of less-favoured regions which are often poorly equipped with knowledge assets (Flanagan et al. 2022). However, there is still debate about the extent to which regions are embracing such challenge-oriented development norms (Coenen et al., 2015; Tödtling and Trippl, 2018; Tödtling et al., 2021; Wanzenböck and Frenken, 2020; Uyarra et al., 2019; Hassink et al., 2021; Bugge et al., 2021; Rohe and Mattes, 2022), and related smart specialization (Foray, 2015) and green path development (Trippl et al. 2020b).

Against this background, this paper has two aims. First, we aim at analyzing the literature on smart specialization from both a S3 and S4 perspective. We will first conduct a theme mapping and direct citation networks of the outputs using a bibliometrics based on Bibexcel and Histcite in order to provide a systematic overview of the available literature on smart specialization and how they have evolved. The study demonstrate how smart specialization moves from a theoretical concept to a spatial policy and found that the current papers have mainly been studied from the perspective of governments, companies and other stakeholders such as universities and civil society. In a next step, we will review the key papers on the transition from S3 to S4 with manual reading. Secondly, we aim at discussing and proposing transformations necessary in innovation systems facilitating a shift from S3 to S4. We advocate a systemic perspective and examine in what ways S4 could benefit from building up challenge-oriented innovation systems (CoRIS). We explicate why CoRIS could provide a fertile ground and asset base for S4 to thrive and we cast light on necessary transformations in regional innovation systems that could facilitate a shift from S3 to S4. Overall, our paper will not only provide a research agenda aiming at facilitating the shift from S3 to S4, it will also provide policy recommendations to master this shift for policy-makers and intermediaries at several spatial levels.

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Keywords: smart specialization, sustainable and inclusive growth, challenge-oriented innovation systems

[139] Sampriti Mahanty (University of Manchester), Mayra Morales Tirado (University of Manchester) and Oishee Kundu (Cardiff University). *The impact of research funding on Early Career Researchers: 'hold on' or 'get out'?*

Abstract. The production of scientific knowledge seems to be a far cry from 'blue skies' research. For instance, the intrinsic value of scientific knowledge has been eclipsed by the quantification of science and value for money principles. Additionally, the funding landscape for scientific endeavours has become increasingly complex with various funding sources - private for-profit and non-profit organisations which are increasing their presence, even as public sources of research funding to universities have been shrinking. Different funding institutions are likely to have their interests and these may not be perfectly aligned to Mertonian principles of communism, universalism, disinterestedness, or organized scepticism (Merton, 1957). Research funding bodies can steer research agendas (Luengo-Fernandez, Leal and Gray, 2012) and the subjects or topics pursued (Kundu and Matthews, 2019).

Moreover, funding is more competitive than ever, drawing on performance-based proxies and the evident use of research outputs (Langfeldt et al., 2020). This has resulted in behavioural changes at all levels of the research system. Studies have looked at those changes at the macro-level, i.e. universities structures, training programmes, hiring practices, performance assessment (Slaughter and Leslie, 1997), and have started to explore the effects of individual researchers and disciplines (Lam, 2010, 2011). However, despite the relevance of this transformation for the future generation of scientists, its implications on doctoral students and early career researchers (ECRs) have not been studied. The motivations to pursue a scientific career and research agendas of ECRs can be more easily steered by funding regimes to a particular direction since funding availability has a palpable influence on the scientist's research choices. Examples that support this assumption are the objectification of doctoral training and the lengthy transition from ECR to tenure. Thus, the practical realities of ECRs seem to draw ever more away from the Mertonian ideals of scientific careers (Boden et al., 2004; Nedeva and Boden, 2006).

Scholars have framed this changing order of knowledge production in various ways such as Mode 2 knowledge production, double, triple, and the quadruple helix of innovation systems (Leydesdorff, 2012), academic capitalism (Slaughter and Leslie, 2001), mission-oriented innovation systems (Hekkert et al., 2020). Such contemporary framings of knowledge production direct attention towards the researchers' reflexivity in their choice of which research direction, concept, method or approach they undertake (Hessels and van Lente, 2008; Laudel, 2017). Within this backdrop of changing nature of science systems, our research aims to explore the richly variegated motivations of researchers in pursuing a particular research direction and understand to what extent their choices are defined by 'academic freedom'.

The topic is important because the choice of research direction by ECRs is consequential for both themselves and the future of science (Foster, Rzhetsky and Evans, 2015). We intend to focus on PhDs/ECR (within 5 years of PhD completion) for our empirical work for three reasons. Firstly, ECRs are considered relative outsiders to the scientific establishment (Farnham et al., 2017) and are strongly subjected to pressures of publishing and establishing themselves as academics to stand a chance of securing their next research contract (Balaban, Wróblewska and Benneworth, 2019). Secondly, researchers at the early stages of their careers can be more agile in modifying their research topics since they are still in the process of building their research portfolios. Thirdly, this article is like a personal essay, based upon observations and reflections of the authors who are ECRs themselves. To this end, the research question that we aim to address are:

• What are the motivations of ECRs in engaging in a particular direction of research?

• Do these motivations signify the academic/intellectual freedom of ECRs?

• How does funding influence the selection of topics for research?

This order of questioning allows accounting for the social dimensions related to scientific progress (Kitcher, 1998; Wray, 2002). These topics related to the politics of science can offer a deeper understanding of the driving factors of scientific work on economic, social and technological problems (Whitley, 2000; Fortunato et al., 2018). Our research seeks to contribute to the discussion on the nature of research funding policies and their impact on the future of science.

We are yet to decide on our methodological strategy to address the research questions. The project is in its early stages and we are particularly keen to present our proposal to the audience at EU-SPRI given it is one of the most important forums for such a discussion. The feedback will help us refine our directions of inquiry and research strategy further.

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Keywords: politics of science, research funding, research motivation, ECRs

[140] Pablo D'Este (Universitat Politècnica de València) and Oscar Llopis (University of Valencia).
Prosocial motivation and academic engagement: the contingent role of networking skills.

Abstract. 1. INTRODUCTION AND RESEARCH TOPIC

Recent research on academic entrepreneurship and knowledge transfer has increasingly focused on the role of pro-social motivations – the desire to benefit other people – as an influential driver of scientists’ engagement with non-academic actors (e.g.: Atta-Owusu and Fitjar, 2021; Iorio et al., 2017; Orazbayeva and Plewa, 2020). In the context of scientists’ knowledge transfer, the increasing interest in prosocial motivations responds to a call for a better understanding of the micro-mechanisms that underlie academic engagement (Balven et al., 2018; Perkmann et al., 2021). This study aims to expand current research on prosocial motivations on three critical aspects. First, the extent to which prosocial motivations represents a stronger (or weaker) driver for scientists’ engagement in knowledge transfer, compared to intrinsic and extrinsic motivational factors. Second, by exploring the contingency factors that moderate the prosocial motivations – academic engagement relationship. Third, by considering the type of partners involved in these relationships. There are many different types of social actors that are relevant for academic engagement, including industry, public administration and civil society (Ramos-Vielba et al., 2016; van de Burgwal et al., 2019), but much of the literature has focused on university – industry interactions.

The above questions are addressed through a large scale survey of almost 10,000 Spanish researchers, affiliated to different types of institutions and multiple disciplines (including physical sciences, engineering, life sciences and humanities and social sciences).

2. BACKGROUND AND HYPOTHESES

Organizational psychology scholars have pointed out the connection between individuals' prosocial motivations and a willingness to go above and beyond their call of duty (McNeely and Meglino, 1994), perform extra-role behaviours and exhibit greater work productivity and work- group performance (Grant, 2008). When individuals perceive that their work exerts a positive impact in others, they consistently show greater levels of commitment and dedication to their job requirements (Grant and Sumanth, 2009; Thompson and Bunderson, 2003). Moreover, prosocial motivations stimulate feelings of task significance and social worth associated with the undertaking of job requirements (Grant, 2007). In the academic context, prosocial motivations are increasingly viewed as relevant individual-level antecedents to scientists' engagement in interactions with non-academic actors (Lam, 2011; Waldman et al., 2021).

2.1 Extrinsic, intrinsic and prosocial motivations

We largely draw on self-determination theory (SDT) to characterise different types of individual motivational processes (Gagné and Deci, 2005; Ryan and Connell, 1989; Ryan and Deci, 2000). . SDT has identified distinct types of motivation. . Intrinsic motivations correspond to decisions to expend efforts in activities done for their inherent interest and enjoyment (Deci and Ryan, 2000). Extrinsic motivations refer to the performance of an activity in order to attain some separable outcome (Ryan and Deci, 2000). . Prosocial motivation is a category distinct from intrinsic and extrinsic motivations, which concerns behaviours driven by the desire to benefit others. Psychologists have argued that prosocial and intrinsic motivations involve different reasons for expending effort: (i) the degree of self-regulation and (ii) goal directedness. This suggests that the three motivations can be understood as essentially distinct, although not necessarily independent or self-excluding.

2.2 Prosocial motivation and academic engagement

The engagement of scientists in knowledge transfer activities is part of the central missions of universities and public research organisations. Evidence suggests, however, that scientists differ in the extent and intensity to which they engage with non-academic actors. Scientists have different tastes for science (Roach and Sauermann, 2010) and different role identities (Jain et al., 2009). This raises the possibility that motivational processes are critical to explain why certain scientists are more likely than others to engage in knowledge transfer and research-related interactions with non-academic actors.

Scientists with other-focused outcome goals may be more likely to engage in knowledge transfer activities (Lam, 2011). Iorio et al. (2017) and Atta-Owsu and Fitjar (2021) show a positive and significant association between prosocial motivations and engagement in diverse knowledge transfer mechanisms. However, scientists may be extrinsically, intrinsically or prosocially motivated to different degrees in their pursuit of research activities. An intrinsic interest in an activity does not rule out the salience of extrinsic or prosocial motivations (Lam, 2011: 1357). We argue that scientific prosocial motivation is likely to be more strongly associated with greater intensity in academic engagement, as compared to intrinsic and extrinsic motivations.

2.3 The boundary conditions of prosocial motivation

The literature on knowledge transfer and academic entrepreneurship has largely overlooked a contingency perspective with regards to the influence of scientific motivations. We propose the existence of a synergistic interaction of prosocial motivation and networking skills to predict the degree of intensity in knowledge transfer activities. The underlying claim is that networking skills facilitates the creation of effective channels of communication to share tacit knowledge and sensitive information, and favours the formation of trusting relationships among partners with different perspectives, interests and priorities. Thus, we suggest that networking skills toward connecting others moderate the relationship between prosocial motivation and knowledge transfer.

2.4 Prosocial motivation and type of non-academic partner

Extant research on academic engagement has largely focused on university and industry interactions, while often neglecting attention to other types of actors, such as public administration or the civil society (Ramos-Vielba et al., 2016; van de Burgwal et al., 2019)..

We further investigate the extent to which prosocial motivations influence the type of partner in external engagement. That is, whether prosocially motivated scientists have a 'natural' preference for a particular type of non-academic partner when participating in external engagement. Drawing on the literature on value congruence and person-organization fit (Meglino et al., 1989), we posit that when values and goals of the non-academic partner are congruent with those of scientists, the likelihood of establishing interactions is higher. Accordingly, we expect that high prosocially motivated scientists will be more likely to engage with civil society organisations and the public sector, compared to industry and for-profit organisations.

3. SETTING, DATA AND SAMPLE

Our data is drawn from a large-scale project contextualised in the Spanish public research system. The population of interest is research-active faculty in the Spanish public research system, in all fields of science. We considered all scientists with a Spanish institutional affiliation who had published at least one scientific article indexed in the WoS database during the period 2012-2014. We received 11,992 valid responses, which means a response rate of 21%. The population covers all fields of science including engineering and physical sciences (STEM), biology and medicine (BIOMED) and social sciences and humanities (SSH).

The data were collected using a web-based questionnaire developed on the basis of a focused literature review. The questionnaire was administered electronically between June and July 2016. Respondents received a personalized link to the online survey.

4. PRELIMINARY RESULTS

Our preliminary findings show that respondents display significant levels of heterogeneity with regards to their type of motivations towards scientific activity. Intrinsic motivation seems to be the dominant form of motivation: 58% of the respondents indicated this form of motivation to be ‘quite important’ or ‘very important’. We also see that 53% of respondents reported that ‘prosocial motivation’ was either ‘quite important’ or ‘very important’, and this proportion is reduced to 37% for extrinsic motivation. Moreover, 58% of our respondents reported to have some degree of interaction with non-academic partners. Of this percentage, 20% engage with civil society organizations, such as NGOs, 38% engaged with large firms or SMEs, and 26% reported engagement with government partners.

Preliminary analysis (using OLS and Negative Binomial regressions) suggest that prosocial is positively and significantly related to the frequency in their interactions with non-academic actors. The magnitude of this relationship is comparatively greater than for intrinsic motivation and extrinsic motivation. We also observe that networking skills strengthens the positive connection between prosocial motivation and interaction with non-academic partners. However, Finally, our preliminary findings do not support that prosocial motivation is more aligned with engagement with civil society partners. Instead, we find that prosocial motivation is positively and similarly related to interactions with all types of non-academic actors.

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Keywords: prosocial motivation, university-industry interaction, academic engagement, networking skills

[142] Maria Åkerman (VTT Technical Research Centre of Finland), Hanna Saari (VTT Technical Research Centre of Finland) and Regina Sipos (TU Berlin). *Reshaping RRI keys to embrace grassroots innovations: focus on community empowerment.*

Abstract. Recent research has shown the potential of grassroots innovations and maker communities to shape socially relevant, problem-driven innovations. To ensure that these citizen-driven innovation processes ultimately lead to more sustainable and inclusive outcomes, there is a need to increase and support the reflexivity and responsibility of key grassroots innovation actors, including communities active in makerspaces and fablabs. Currently the concept of Responsible Research and Innovation (RRI), which is originally developed for the purposes of institutionalised research and innovation funding and performing organisations fails to address the particularities of these kinds of citizen-driven processes taking place outside research organizations. As the sites of frugal and grassroots innovations are diverse ranging from social collectives to informal enterprises, also the understanding of dynamics of innovations and their social embeddedness needs to be revised and enriched with context specific knowledge to make the concept of RRI meaningful for these communities.

To address the need to support responsible citizen- and community-driven innovations , the EU funded Critical Making project has co-created a Critical Making Responsibility Framework to better understand how social responsibility can be understood, practiced, and evaluated at the level of grassroots innovations. The Critical Making Responsibility Framework draws from the existing conceptualisations of RRI capacities, including anticipation, reflexivity, inclusion and responsiveness (Tassone et al. 2018) and reinterprets them with an in-depth substance understanding of social embeddedness of maker-driven grassroots innovations provided by grassroots innovation movement (GIM) studies (Smith et al. 201). The GIM framework guides researchers to focus on the context, framings, pathways and spaces and strategies shaping the development of grassroots innovation communities. The core of the Critical Making Responsibility framework is to put the analytical, retrospective four-dimensional GIM framework into dialogue with the forward looking and reflexive RRI capacities approach.

This presentation introduces the Critical Making Responsibility framework and presents the experiences related to its participatory development and application while evaluating different types of responsibility interventions in maker spaces. Based on these learnings, we will also introduce and justify a suggestion to include community empowerment as a novel RRI key when evaluating grassroots innovations. Our preliminary results indicate, in line with the existing research on grass roots innovations, that a functioning community with committed members is one of the most important corner stones of grassroots innovation movements, and therefore projects working with these communities should also take community empowerment seriously. Empowered grass-roots communities have a feeling of capability when it comes to creating changes in the society and they hold the keys to maintaining their functionality in the long term. These kinds of community empowerment aspects are not covered by the existing RRI monitoring and indicator frameworks.

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Keywords: Grassroots innovations, Maker movement, RRI capacity, Responsibility framework, Community empowerment

[143] Mariane Santos Françoso (State University of Campinas), Ron Boschma (Utrecht University) and Nicholas Vonortas (The George Washington University). *Regional diversification in Brazil: patterns and policy prospects.*

Abstract. Introduction

This paper has two objectives. First, we investigate the relative importance of relatedness and complexity on regional diversification in an emerging country. Based on two datasets on patents and sectors, we examine technological and industrial diversification in Brazil. Second, there is little known about diversification opportunities in different types of regions in the Global South. Brazil is an interesting case because spatial inequality is high: the country is home to regions with characteristics similar to those of developed countries as well as regions looking similar to those of underdeveloped countries. Taking Brazil as a case, we investigate how regional diversification processes occur in an emerging economy context and how distinct regions may develop different patterns of diversification under the same national conditions.

A large body of literature has investigated the possibilities of countries in the Global South to catch-up (Keun, 2012; Petralia et al., 2017). Huge policy efforts are made to engage regions in new and more sophisticated activities that may leverage value capture. However, many regions fail to do so. Failure to catch-up is often attributed to local factors, such as a lack of absorptive capacity, a weak research and educational infrastructure, or poor institutions. Scholars in evolutionary and complexity thinking (Boschma, 2017; Hidalgo et al., 2018; Keun, 2012) argue that economic diversification is a path-dependent process, in which regions tend to diversify into sectors, jobs, products and technologies related to their local capabilities. The rationale behind it is that related activities demand similar capabilities that are more easy and less costly to combine. Studies have demonstrated that related diversification in regions is indeed the most common pattern. Almost all of these studies have been conducted on the Global North (Essletzbichler, 2015; Neffke et al., 2011; Rigby, 2015). Few studies on regional diversification exist on the Global South (Alonso & Martín, 2019; Galetti et al., 2021).

Hidalgo and Hausmann (2009) argued it is crucial for countries to diversify into complex activities and to enhance the complexity of their economies. They found that economic complexity is positively correlated with country GDP. This is because complex activities represent sophisticated knowledge and require a wide diversity of capabilities that need to be combined. The less available these capabilities and knowledge are, the more exclusive will be the products those countries are able to produce. This exclusivity gives them an advantage over others, as they produce something not widely available while having capabilities that are not easy to transfer across space.

What is more, there is still little understanding of the nature of diversification in distinct types of regions (Boschma, 2017). Studies tend to suggest that diversification opportunities can vary across different types of regions (Pinheiro et al., 2022; Xiao et al., 2018). This is expected to be especially true in countries in the Global South where regional inequalities are more pronounced. However, little research has been done on this topic with a particular focus on regions in the Global South.

Data and methodological approach

To investigate diversification opportunities of all Brazilian regions, we used two datasets: patents and sectoral data. Sectoral data were put together from the Annual Social Security Information Report (RAIS) compiled by the Labour Secretary in the Ministry of Economy. We gathered data on 87 two-digit NACE sectors (Statistical Classification of Economic Activities in the European Community) and on the number of companies in each sector in 137 functional meso-regions of Brazil following the spatial classification of IBGE (Brazilian Institute of Geography and Statistics) during the period 2006-2019. Regarding data on patents, we resorted to Orbit Intelligence, and used the same period.

The next step was to calculate relatedness and complexity. To control for any variations, we followed Balland et al. (2019) and divided the data into three non-overlapping periods: 2006-2010, 2011-2015 and 2016-2019. The EconGeo R package (Balland, 2017) was used to calculate both relatedness and complexity for each of the three time periods in each of our 137 regions. Following many works on regional diversification, we use a linear probability model (LPM), in which the dependent variable is 1 if the region r enters the sector/technology i in the period, and 0 otherwise. Entering means acquiring comparative advantage in a sector/technology in which the region was not specialized in the previous period.

Our main variables of interest are relatedness density and complexity. Complexity is sector- and technology-specific. Moreover, we control for some region-specific features including: population density; GDP per capita; variety of sectors/technologies in the region; and the size of sector/technology (Balland et al., 2019). All independent variables are lagged by one period. We include region and time fixed-effects and, as errors are correlated, we clustered errors at the region and sector/technology levels.

We have run different estimations. First, we estimated the full sample for both technologies and sectors. Second, we split our sample in two (the 50% most and the 50% least complex regions) in order to see how the diversification process occurs in regions with different complexity levels.

To further assess how diversification opportunities differ between types of regions, we classified the 137 Brazilian meso-regions into three groups: central, intermediate and peripheral regions. To make this classification, we used the average data from the period 2006 to 2019 for the following variables: agriculture, industry and services GDP, the share of the population with tertiary education, population density, GDP per capita, applied patents per million inhabitants (based on our patents database) and average regional complexity. Next, we conducted a cluster analysis.

We make use of the framework of Balland et al. (2019) to identify diversification opportunities of each region in terms of relatedness and complexity. For illustrative purposes, we took a representative example of each of the three types of regions.

Results

Relatedness density has a positive and statistically significant effect on the probability of a region to develop a new specialization: the greater the relatedness density of a region in a given sector/technology, the higher the probability of this region to develop a specialization in this sector/technology in the next period. Complexity represents a negative and statistically significant effect, suggesting that the probability of a region to develop a new specialization is smaller the greater the sector/technology's complexity. This is as expected, as complex capabilities are more difficult to develop (Balland et al., 2019).

High and low complexity regions are positively impacted by relatedness density. However, the findings suggest that the most and the least complex regions are subject to different patterns of diversification in terms of complexity. The likelihood of the most complex regions to develop new specializations is positively impacted by complexity. This is not true for the least complex regions, as complexity shows a negative and statistically significant effect. This result indicates that the most complex regions in Brazil have more diverse and exclusive capabilities, which enhances their ability to develop new complex activities with greater potential economic benefits. Less complex regions are more likely to enter less complex sectors.

The diversification opportunities of regions look very different. Central regions have the best opportunities to diversify in complex sectors. Peripheral regions have diversification opportunities only in low-complexity sectors. Central regions also show more opportunities to develop new complex technologies than intermediate regions where most opportunities are in low-complex activities. The capabilities of peripheral regions leave them with little opportunities to develop new technologies.

Conclusion and policy implications

We found that sectors and technologies requiring similar capabilities to those available in the regional portfolio are more likely to enter the region. Broadly speaking, we found that complexity is negatively correlated with regional diversification: the higher the complexity of a sector or a technology, the lower the probability that it will enter a region. This reflects the fact that complex activities are more difficult to develop (Balland et al. 2019). In high-complexity regions, however, the opposite is true: complexity now turns into a positive effect for both sectoral and technological diversification. These results seem to be in line with recent studies at the national (Hartmann et al. 2021; Pinheiro et al. 2021) and regional scale (Pinheiro et al. 2022) that argued that low complexity economies are more likely to enter low complexity products, as they are more related to them, while more complex economies are more likely to diversify towards complex products. Our study also demonstrated that the diversification opportunities of regions look very different.

These findings have policy implications. Much debate on regional diversification opportunities has centered around Smart Specialization policies in Europe. Hartmann et al. (2021) argued that emerging economies that adopted smart policies in the past, such as South Korea and Singapore, were the ones that managed to move up to more complex activities. The justification for adopting such policies in emerging economies, according to Hartmann et al. (2021), is the fact that these countries are more related to low-complex products, however, at the same time, they have the basic skills to produce more complex and high-value-added activities. Our study shows such policy should be made region-specific, as local capabilities provide opportunities but also set limits to what can be achieved by Smart Specialization policies to diversify into low or complex activities.

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Keywords: regional diversification, relatedness, complexity, emerging economies, Brazil

[144] Milene Tessarin (Utrecht University), Jefferson Galetti (Whitaker Institute for Innovation and Societal Change, National University of Ireland) and Paulo Morceiro (South African Research Chair in Industrial Development (SARChI-ID), University of Johannesburg). *The influence of innovative skills on the innovative activity of a developing country: an analysis of unequal regions.*

Abstract. Studies have identified the relationship between relatedness and technological change essentially for developed countries and using patent data (Balland et al., 2019; Castaldi; Frenken; Los, 2015; Rigby, 2015). Relatedness elucidates in a simplified way that changes in the structure - be it productive or technological - are related to pre-existing conditions, which can define its future development. Therefore, it allows us to show with empirical evidence that path-dependence matters, both to promote and to hinder development paths. These studies show assessments for well-developed regions that have a sufficiently large knowledge base and technological inputs. However, they offer a limited analysis possibilities for peripheral regions, with low knowledge density (which makes spillovers and information exchange difficult), lack of diversification of industrial structure, and lack of organizations and actors to sustain the innovation systems.

As far as we know, we have not found studies that address technological relatedness for developing countries. This difference is relevant because it is widely recognized that the innovative process of developing countries is different from that of advanced countries (OECD, 2005), which demands an approach oriented to their challenges (Mazzucato, 2018). According to the Oslo Manual (OECD, 2005), innovation in developing countries occurs via diffusion, incremental and organizational changes, in addition to being in particular environments with deficient physical infrastructure, institutional fragility, and immature innovation systems. In addition, developing countries have intense regional inequalities; for one hand, few regions concentrate productive and technological development; on the other hand, the rest of the country retains productive activities that promote little local dynamism. Thus, public policies in these countries must be distinct from those designed for advanced countries (Chang; Andreoni, 2020).

To contribute to this literature, we propose to assess the effect of relatedness on innovation considering an indicator different from the traditionally adopted by the literature focused on advanced countries - which uses patents. We intend to contribute with a properly measure to capture innovative activities carried out in regions far from the technological frontier. With this proxy of innovative activity we will also calculate the relatedness between innovative occupations to analyze the influence of innovative occupations and the innovative activity. As a second contribution, besides to include developing regions in this lively debate on technological relatedness, we also propose evaluating Brazilian micro-regions. We will promote a disaggregated regional view of a country that has many regional inequalities, in terms of GDP, technological development, infrastructure and skilled workers.

Brazil has a relatively diversified productive structure, being one of the five developing countries that are part of the UNIDO list of 15 leading countries in manufacturing added value. It is a large country in terms of territory (137 mesoregions) and present significant regional income and populations disparities. According to the National Innovation Survey (PINTEC), about a third of the companies are innovative and they mainly carry out process innovations and product improvements and acquire machines and equipment to contribute to the innovative activity. Therefore, besides the difference between developed countries, we will also pay attention on the intraregional disparities.

Our objective will be to assess whether there is a positive association between innovative-skill relatedness and innovative activities in different regional contexts. This means that the innovative capacities (measured by innovative-skills relatedness) accumulated in period t are influencing innovative performance in the future period. We want to understand whether unequal regions – for example, in terms of development (or income level), with different innovation systems (from the most structured to the weakest), and with distinctive technological structure – present marked differences in the role relatedness over innovative activity. We intend to obtain robust results that shed light on innovation policies in unequal regions in developing countries.

We propose a proxy for innovative activity based on labor. We will use a restricted group of professionals called POTec (technical-scientific staff) that are related to innovative activities following a study done by researchers from the Brazilian Government Institute of Applied Economic Research (Araújo; Cavalcante; Alves, 2009). According to these authors, POTec occupations had a correlation of more than 90% with business R&D and 60% of innovative activity for Brazilian innovative companies. Therefore, we will use POTec occupations by industry and region as a proxy for innovative activity.

Additionally, to capture the proximity between occupations we will occupations that share innovative skills. In this way we intend to capture a broader group of professionals – in addition to POTec occupations – who also develop incremental innovations in the assembly lines, promote operational adjustments or adaptations in projects, characteristic of regions with immature innovation systems. Following the literature (Acemoglu; Autor, 2010; Autor; Dorn, 2013; Bacolod; Blum; Strange, 2009), we selected skills that refer to requirements that contribute to developing innovative activities in regions with immature innovation systems. We selected six skills that directly contribute to developing innovation, and then, we transformed it into an index of innovative skills through a Principal Component Analysis (PCA). We only choose occupations with above-average innovative skills to calculate the relatedness.

In the next step we followed the procedures indicated by Hidalgo et al. (2007) Fist we calculate the Balassa index to find the specialization in occupations with innovative skills. Second, we calculate the relatedness measure to identify which industries are close in terms of innovative occupations. Third, we computed the relatedness density to regionalize the presence of innovative occupations by industry. In the end, our model is the following:

$$Innov_{(r,i,t+1)} = \alpha + \beta_1 \, ISRD_{(r,i,t)} + \beta_2 \, CI_{(r,i,t)} + \beta_3 \, Size_{(r,i,t)} + \beta_4 \, Wage_{(r,,i,t)} + \beta_5 \, Emp_{(r,i,t)} + \theta_{(r,,i,t)} + \psi_{(r,i,t)} + \varepsilon_{(r,i,t)}$$

Where: innovative activity in an industry i and region r at time t+1 ($Innov_{(r,i,t+1)}$); innovative skill-relatedness density ($ISRD_{(r,i,t)}$), Complexity Index by regions and industry ($CI_{(r,i,t)}$), average wage ($Wage_{(i,r,t)}$), size of firms ($Size_{(i,r,t)}$), total employment ($Emp_{(i,r,t)}$), and dummy variables to control for region-time ($\theta_{(r,t)}$), and industry-time ($\psi_{(i,t)}$) fixed effects. Following previous empirical studies (Boschma, Minondo, and Navarro 2013, Boschma, Balland, and Kogler 2015; Xiao, Boschma, and Andersson 2018), we estimated the relationship of ISRD with innovative activity using a two-way fixed-effects.

Our hypotheses involve national level (1) and regional inequalities (2-4):

(1) Innovative-skill relatedness density is positively associated with the development of innovative activity in a region in the future;

(2) The association of relatedness with innovative activity in the future will be lower in less developed regions than in more advanced ones;

(3) The likelihood of relatedness to influence the innovative activities is higher in innovative leaders' regions than in weak innovative regions;

(4) The greater the technological intensity in a region, the greater the association of relatedness with innovative activity in the future.

The results show that, as expected, the innovative-skills relatedness density has a positive and significant coefficient in the current innovative activities in a region. This finding is consistent with other studies. This indicates that regions with related industries in terms of innovative skills are more likely to absorb spillovers, internalize knowledge, and engage in new efforts for innovation.

To further investigate regional differentiation, we organized the regions by two different characteristics: development level and innovative potential. And for the industrial aggregation, we organized 581 industries into four OECD technological groups.

First, we divided Brazil into two regions by development level: North and South. South has a relatively more mature innovation system than North, concentrates most of the production, workers, and is more diversified. The results also state that the ISRD is associated with greater innovative activity in both regions, but with a 40% higher coefficient in the South. North region, on the other hand, has a smaller association, we understood that the weak scientific and technological infrastructure make it difficult to develop innovative efforts.

Second, to investigate regions by the innovative potential we aggregated them into four groups: leaders; followers; moderate; and weak innovative regions - from the most to the least innovative. The ISRD is positive and significant for all regions, but in the most innovative the coefficient is bigger than in the moderate and weak regions. We know that innovation depends on the intensity and variety of knowledge sources available in a region and also the quality of regional innovation systems. Leading regions have a diversified knowledge structure, which allows cross-fertilization of ideas and the addition of new information that results in innovation. On the other hand, in weak regions, there is low technological diversity and few attractive for high-skilled workers, building a barrier to advance to other stages of the innovation system.

Third, we aggregate industries by technological groups using the new OECD classification, considering medium-low, medium and medium-high and high technological groups. The results did not confirm our hypothesis (4). The highest ISRD coefficient correspond to the medium-low and the medium-high tech groups. In its turn, the coefficient for high tech group is low, which we understand may be due to this group not doing much innovation in Brazil. However, despite not validating our hypothesis, this result is consistent with the Brazilian production structure, which is intensive in medium-high and medium-low technological groups.

We understand that this article can contribute in three ways: first, by presenting a way to measure innovative relatedness in the context of a country far from the technological frontier. Second, when assessing in detail the effect of innovative skills relatedness on the innovative potential of unequal regions. Third, for providing conditions for elaborating public policies aimed explicitly at reducing gaps of innovative potential among regions in developing countries.

Our results reinforce that it is necessary to know the local productive structure to understand how to stimulate innovative activity in less advanced regions. And also, the main concern is about lagged regions, with fewer innovative potential, they will remain behind if they don't create technological capabilities. And a question remains: how to overcome this stage? How regions can overcome path dependence towards better innovative performance? These are research questions that we will investigate in further projects.

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Keywords: worker kills, relatedness, unequal regions, regional innovation system, innovation policy, evolutionary economic geography

[146] Susan van der Veen (TU Delft), Lotte Asveld (TU Delft), Cedric Heijdens (TU Delft) and Patricia Osseweijer (TU Delft). *Designing inclusive bio-based value chains: Involving local stakeholders through capability sensitive design.*

Abstract. Biomass from agricultural residues is increasingly used as a source to replace fossil-based energy and materials, like fuels and chemicals. Research and innovations on new conversion technologies and new bio-based resources is happening at a fast pace. As a consequence, many new bio-based value chains will be set up, linking actors in different contexts, with different needs, knowledge and skills. Innovations such as advanced biofuels have the potential to contribute to climate goals and create opportunities for local socio-economic development. At the same time, it also creates new risks and uncertainties. Research on global value chains and biofuel projects has shown that the risks and benefits of global value chains are not always distributed fairly (Balkema and Pols, 2015; Selfa et al., 2015). Especially stakeholders at the beginning of global value chains, such as small-scale farmers, are in a more vulnerable position. While they play a vital role in bio-based value chains, the role of biomass producers is often underrepresented in the development of new value chains and in strategies for making these more sustainable. Biomass producers have valuable knowledge about farming practices, local challenges and needs. Leaving out their perspectives can result in a failed project, when biomass producers appear to be unwilling to cooperate, or lack the capabilities to fully participate in a bio-based value chain. It can even create unintended negative impact in the context where biomass is produced (Balkema and Pols, 2015). This highlights the need for inclusive innovation, where new goods and services are developed for and by a broad range of stakeholders, including those in a more marginalized position (Grobbelaar and Van de Merwe, 2016). This paper addresses the question: How can bio-based value chains be designed and developed in an inclusive and sustainable way?

There is a growing interest in inclusive innovation, both in academic and policy circles (Heeks and Foster, 2014). Research on inclusive innovation focused mainly on descriptive research, portraying examples of inclusive innovation. There is a need for an analytical approach to guide and understand the development of inclusive innovation (Heeks and Foster, 2014; Grobbelaar and Van der Merwe, 2016). This paper contributes to this knowledge gap by applying Capability Sensitive Design to a specific case study on opportunities for new bio-based value chains from olive oil residues in Jaén, Spain. We claim that a focus on capabilities of local stakeholders is useful in the context of inclusive, bio-based innovations. It looks at increasing the opportunities of local stakeholders, takes into account local factors that enable or limit the expansion of these opportunities and provides a framework for translating this information into concrete design requirements.

This paper presents findings from a case study on the olive oil sector in Jaén, Spain. In the province of Jaén, the cultivation of olives is the most important economic activity and is dominated by small-scale farmers who cultivate olives in a traditional way. Every year, millions of tons of field and processing residues are produced as a result of olive oil production. Currently, these residues are mismanaged or underutilized. Pruning residues are burned or left in the field and processing residues are used inefficiently, causing environmental pollution and nuisance. The case study looked into how new value chains could be set up from these residues in an inclusive manner. In a period of six weeks, in-depth information is gathered based on 40 qualitative, semi-structured interviews with relevant stakeholders, such as olive farmers, cooperatives, farmers unions, governments, researchers and technology providers. In addition, field observations were done and a scenario workshop was organized, where all stakeholders were brought together to co-design the most desirable scenario.

As an analytical framework, this paper uses the lens of Capability Sensitive Design, a combination of Value Sensitive Design (Friedman, 1996) and the Capability Approach. The Capability Approach is a normative approach to human welfare that concentrates on the actual capability of people to achieve their well-being (Sen, 1999). A capability is defined as what people are effectively able to be and do, for example being healthy or being educated. Instead of focusing on expanding utility or resources, the Capability Approach looks at how these resources can enable people to engage in meaningful and fulfilling activities (Oosterlaken, 2009). This is relevant in the context of design because it accounts for human diversity, both in what is understood as valuable and in the factors (personal, social, environmental) that influence the ability of stakeholders to convert resources into opportunities (conversion factors) (Oosterlaken, 2009; Jacobs, 2020). It provides a lens through which we can examine what opportunities the new bio-based value chain could bring to local stakeholders, and how the design of a new value chain could be adapted accordingly.

The case study provided insights into which capabilities were most valued by local stakeholders and how they were interpreted. These included both capabilities that were important to preserve, such as self-determination, and capabilities that were desired to change, such as receiving a more stable income and improving mental health by reducing uncertainties. Second, information on the local personal, social and environmental conversion factors that enable or limit the expansion of these capabilities was gathered. For example, the olive sector in Jaén is a traditional sector, where plots are passed from generation to generation, together with the knowledge on how to cultivate olives and manage the plots. Farmers do things certain ways, because they have always done it like that and it has been successful so far. Openness to change or to make new investments is low (social conversion factor), and new projects should make it very clear and tangible to farmers in what way it would affect them and how it would benefit them. In addition, the sector is dominated by a generation of farmers of over 50 years old and the younger generation is less interested in working in the sector due to unstable employment opportunities. The younger farmers that are involved in the sector are involved in a different way than the older generation. Where the older generation goes to the field every day, the younger people only go a few days and work in a more efficient way. Or they start their own service companies, where they don't own land themselves, but provide services to farmers that own plots but not work themselves on the field. This indicates that the younger generation could be involved in a different way in the value chain than the older generation (personal conversion factor). Lastly, environmental factors such as the present infrastructure and landscape determine to a large extent what opportunities the new value chain could bring to local stakeholders (environmental conversion factor). Andalusia is a water scarce region and only a minority of farmers has irrigation. New value chains should not require additional water and ideally help closing the loop and use water more efficiently. Additionally, there are mountainous areas with hills with over 20% steepness. It is very difficult to enter these plots with machines to collect pruning rests. This restricts the areas suitable for the collection of pruning biomass.

The information on the valued capabilities and local conversion factors was used to formulate context-specific design criteria. These criteria related to important choices to be made in early stages of development, such as the division of responsibilities along the chain, type of benefits to be generated and logistics around the collection of biomass. Insights from this case study provide useful information about how new bio-based value chains could be set up in an inclusive way. By taking the valued capabilities and conversion factors of local stakeholders central in the design process, local stakeholders are included in the goal, process and outcomes of the new bio-based value chain. A focus on capabilities and conversion factors make inclusion more concrete and the design can be adapted and account for the local needs, limits and opportunities.

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Keywords: Capability sensitive design, Inclusive innovation, Bio-based value chains, Smallholders

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A toolkit for inclusive innovation workshops: Enabling co-creation in multiple-stakeholder settings.

Abstract. Since the European Union (EU) has introduced Responsible Research and Innovation (RRI) as a crosscutting issue in its Framework Programmes, the topic has gained in popularity among academic scholars, business practitioners and policy makers. Through the inclusion of diverse stakeholders in a participatory approach, RRI aligns the values of science with ethical acceptability and societal desirability (Von Schomberg 2013). A central strategy of RRI is public engagement, encompassing multi-actor exchange and co-creation (European Commission, 2020;). However, there have been calls for a more 'practical RRI' and for the development of effective tools and collaborative approaches for specific innovation contexts to grow the understanding of RRI in theory and practice (Kuzma & Roberts, 2018; Schuijff & Dijkstra, 2020). In order to address this gap, this research provides both, practical tools and the scientific underpinning to facilitate the implementation of a concrete RRI solution.

When it comes to innovation processes, popular facilitation techniques are workshops. While there is a vast amount of research on general workshop tools, only few publications in academia have addressed the issue of conducting workshops for people with blindness or visual impairment (BVI). Furthermore, to enable the creation of accessible products, the process should include all three stakeholder groups (BVI and sighted people) to ensure that their needs are met adequately. This research equips workshop facilitators with tools and guidelines to push for the implementation of RRI practices in inclusive innovation processes and simultaneously addresses the user needs defined in the European Accessibility Act (Directive 2019/882, 2019).

The aim of this research is to develop a toolkit, which is grounded on the principles of RRI and easy to implement. Building on collected data from the EU project Living Innovation, stakeholders from business and science have co-developed a pilot-toolkit to improve innovation process accessibility. Some of the tools have already been tested in a pilot workshop, where participants have co-created a technological radio device with the Siemens Accessibility Competence Center. The pilot-toolkit is separated in two sequenced sections, the first one addressing preparations before the workshop and the second one providing hands on tools to facilitate the co-creation process within the workshop. In order to investigate the research question How can co-creation be facilitated in innovation workshops including both participants with visual impairment and sighted participants? the pilot-toolkit is applied in a series of workshops with mixed group settings involving multiple stakeholders to test and co-develop the tools. Over the next six months, five innovation workshops for developing accessible products will be conducted. The attendee selection will always include multiple stakeholders, ranging from product users, technological experts, business stakeholders and scientists. In order to assess the effectiveness of the toolkit, different evaluation methods will be applied. Before and after the workshop the participating stakeholders will respond to a questionnaire aiming to assess their perspectives on the workshop design, technological outcome, individual (dis-)contentment, societal contribution. The questionnaire is designed for a mixed methods approach and includes additional open-ended questions, in order to identify additional points for improvement. After the completion of three workshops, the design of the workshop will be adjusted based on the results of the questionnaire analysis. By also taking an observational approach, additional process related data will be collected through the analysis of videos, photos and recordings. In depths interviews will be conducted with representatives of different involved stakeholders after completion of the entire workshop series. The expected findings will contribute to the facilitation of RRI in practice, add to the scientific discourse and provide normative recommendations for governance and policy.

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Keywords: responsible research and innovation (RRI), innovation workshops, toolkit, co-creation, people with visual impairment, people with blindness, inclusion, collaboration

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Abstract. Introduction

Data from the Web of Science reveal that Brazil and the Netherlands are very close regarding their indexed scientific output (Clarivate, 2022). In the 2017–2021 period, Brazil ranked 13th among the top-producing countries in the database, publishing a total of 289.562 papers and reviews. With 241.863 publications, The Netherlands followed in 14th place. Despite the proximity in absolute numbers, there are significant differences between the countries when results are observed from a relative perspective. For instance, while the Netherlands has a population of around 17.6 million (CBS, 2021), Brazil has already exceeded 213 million people (IBGE, 2021). That means the Latin American country produced 136 publications per 100.000 population, ten times less than the European counterpart, at 1374 publications.

Another relevant distinction between the scientific production of the two countries is evident from the analysis of impact indicators. For example, considering the percentage of publications of each country among the upper 10% percentile of the citation distribution in the same fields (PP top 10%), Brazil performs below the average of the database, at 7,7% of the expected 10% value. The observed impact is significantly higher for The Netherlands, as 17,3% of the country's publications are in the top 10% (see Bornmann, 2014).

The differences in impact and relative productivity may suggest a higher level of efficiency exists in the Dutch science system, which has attracted the attention of Brazilian researchers, policymakers, and funding organisations. In line with the views on research governance and the role of evaluation presented by Molas-Gallart (2012), Brazil seeks inspiration in the long-standing and stable Dutch evaluation system, which has been recognized as a key factor in the country's quality assurance (Drooge et al., 2013, p. 17).

While it is important for a country to investigate international experiences to improve its own practices, it is also necessary to cautiously reflect on potential learnings. On the one hand, Brazil already has one of the most sophisticated performance-based evaluation systems in the world, so any potential changes should consider what has already been achieved (Faljoni-Alario et al., 2018, p. 5). On the other hand, science systems can be as distinct as the social-economic circumstances, established governance, and cultural realities of each country. Potential disparities should be considered when trying to replicate any strategy that has been successful elsewhere.

This work investigates the main differences and similarities in the research evaluation conducted in Brazil and The Netherlands. From the analysis of policy and guiding documents, connected legislation, and related literature, we compare the design of the science system in each country, examining their impact on the adopted evaluation models. For that, we adapt established comparison frameworks and focus the analyses on influential aspects for each system, such as the links between evaluation and funding, or the consequential effect the results can have on researchers' behaviour. Finally, we conclude by highlighting inspiring methods and approaches from each evaluation system, so that those lessons could lead to positive change for both countries.

Methodology

According to Galleron et al. (2017), different typologies of research evaluation systems have been proposed over time, but none of the existing frameworks was applicable for comparing multiple national systems, especially if disciplinary differences were to be considered. A suitable alternative has been investigated by a workgroup within the European Network for Research Evaluation in the Social Sciences and Humanities (ENRESSH), resulting in the design of a new comparison framework and accompanying codebook. This paper derives from that broader research project, which has supported analyses of national evaluation systems from 23 European countries, plus Brazil and South Africa (Ochsner, 2020).

Reproducing the effort behind the Brazilian report produced for ENRESSH by Brasil and Trevisol (2022), this study begins with an extensive analysis of the practices and regulatory framework of the Dutch evaluation system. From the investigation of the Strategy Evaluation Protocol (SEP) active in the country (VSNU, KNAW, & NWO, 2020), as well as its previous iterations and related legislation, the study proceeds to apply an expanded version of the ENRESSH analytical categories to compare the national evaluation models in Brazil and the Netherlands.

For each of the 19 categories in the comparison framework, the experiences from each country are contrasted, identifying distinctions and similarities either recorded in policy documents and connected legislation, or emerging from an extensive literature review conducted on national evaluations and evaluation impact, including the works by Leeuw and Furubo (2008), Molas-Gallart (2012, 2014), Ochsner et al. (2020), Verhine and Freitas (2012), and others. As a result, we find not only the inspiration sought by Brazil, but we also identify pertinent lessons for The Netherlands.

Results

The Dutch and Brazilian evaluation systems were developed from very different conceptions of assessment, university autonomy, and governance of higher education, science, and technology. Regulatory frameworks and improvements over time have institutionalized unique systems, which seem to shape very distinct research cultures that may contribute to the previously mentioned impact differences.

From the Brazilian side, the evaluation system was implemented in the 1970s and continues to evolve as a top-down, centralized model executed by a federal government organization: the Brazilian Agency for Support and Evaluation of Graduate Education (CAPES). The country’s graduate system is the result of a state policy that made the university the house of science in Brazil, mainly within master’s and doctoral courses. Evaluation guidelines, criteria, and procedures are, therefore, largely influenced by desired educational results. Additionally, CAPES accumulates the evaluation responsibility with two additional roles: regulating the graduate system and being the leading funding agency in the country. The combination of tasks and the strong links between evaluation results and funding makes the assessment model predominantly normative, standardized, and performance-based. Furthermore, the process seeks accountability through comparisons between graduate programs, leading to a high incidence of quantitative methods in the analyses, despite the ever-present participation of peer-review committees in the process (Brasil, 2020; CFE, 1965; Verhine, 2008).

The Netherlands was the first country to institutionalise an evaluation system in Europe. In 1982, the Dutch model started being shaped as a bottom-up and decentralized process. While leading academic and scientific organizations in the country (VSNU, NWO, KNAW) design guiding policies, execution is based on the principle of autonomy and institutional planning. The research unit is the main unit of assessment, and those usually include PhD programs. Self-evaluation is the backbone of the system, contributing to a predominantly internal, formative, contextual, and qualitative assessment. Thus, units are evaluated based on their mission, aims, and strategies, in a self-knowledge practice not designed for external control, state regulation or accountability. Furthermore, results are not used to calculate the distribution of financial resources between institutions and research units, as there is a clear separation between assessment and financing (Drooge et al., 2013; VSNU et al., 2020).

The results from the broad analysis of each country are presented in detail in the full paper.

Source: Brasil and Trevisol (2022) and VSNU et al. (2020).

Discussion and Conclusions

One of the central conclusions of the present work comes from the distinct relationship between evaluation and funding in Brazil and The Netherlands. Performance-based funding systems not only influence researchers’ way of working but also limit the design of the evaluation model that can be implemented (Hicks, 2012). In Brazil, the high-stakes evaluation model impacts funding and even the accreditation of the units assessed, which is not renewed in case of poor performance. Trust is an issue, and assessment is seen as an audit procedure, making reliance on quantitative indicators very high (Ràfols et al., 2016). That means the Dutch formative evaluation, based on self-assessment practices, would face significant obstacles to work in Brazil without a reorientation of evaluation goals. Furthermore, even the periodicity of evaluation is impacted by the connection between assessment results and funding, as longer cycles represent fewer opportunities for the Brazilian graduate programs to get better results and the additional resources that derive from the achievement.

At the same time, the Brazilian high-stakes evaluation system has also led to a series of positive developments that could inspire the evolution of the Dutch model, or the tools in existence to support it. For instance, Brazil has developed very advanced Current Research Information Systems (CRIS) designed to support evaluation with bibliometric and scientometric data (Siqueira, 2019). Data is collected from graduate programs, higher education institutions, funding agencies and more, being open to the public and for research purposes (CAPES, 2021). A centralized effort to collect, validate, clean, and generate comparable evaluation data for the whole research system could support the self-assessment of Dutch research units in very positive ways.

A series of additional analyses are included in the full paper, making it clear that the peculiarities of each evaluation system are strongly rooted in the core decisions behind each of those systems. No analytical category in the comparative study can be interpreted in isolation as each of them have dependencies and consequences, creating an interconnected mesh that can't be simply unmade.

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Keywords: national evaluation systems, research evaluation, policy design, evaluation instruments, funding policies

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Dynamics of mission-oriented innovation policy assemblages: transformative potential or old wine in new bottles?

Abstract. Introduction

Mission-oriented innovation policies (MOIP) are gaining popularity across national contexts to support transformation of specific socio-technical systems. One major challenge in MOIP and the core interest of this paper is the organization of mission directionality in the search for solutions to societal problems, where mission directionality refers to the 'shared vision and direction-guiding design and implementation of policy interventions towards a desired transformative change' (Miedzinski, Mazzucato, and Ekins 2019, 11). In MOIP, the incorporation of directionality in missions is considered key to drive and coordinate innovation activities of diverse stakeholders towards collective benefits (Janssen 2019; Schlaile et al. 2017; Mazzucato 2016). One aspect underpinning the organization of mission directionality is the notion of ambidexterity (literally meaning two-handed), in which existing strengths in the innovation system continue to be exploited and new opportunities are tried out at the same time (Rathenau Institute 2020; Kattel and Mazzucato 2018) also in view of issues of 'phase-out' of incumbent systems (Kivimaa and Kern, 2016). To ensure the level of democracy in missions (Rathenau Institute 2020), this means balancing incumbent interests with newcomer interests. MOIP thus likely involves dimensions and struggles of power between diverse power agents than can affect how missions unfold (in terms of formulation, selection/prioritization, and enactment), align with their contexts of implementation and develop transition capacity. Yet, there is still little empirical evidence on the processes of how missions come into existence and how those processes influence their enactment, so the goal of this paper is to gain insights in how strategic choices around mission directionality are made and by whom. We are particularly interested to examine how ambidexterity influences mission formulation and enactment, and what this (potentially) implies for transformative innovation governance.

Theoretical lens

As the literature on missions has denoted mission policy making as a messy process (Wanzenböck et al. 2020), we introduce the concept of policy assemblage thinking, which recognizes the non-linearity and evolving process of policy construction (Savage 2020; Mccann and Ward 2012; Fox and Alldred 2020). Rather than seeing policies as a static 'end' product of the policy process, policy assemblage thinking approaches policies as a relational construct, subject to power, politics and agency during policy making and implementation (Savage 2020). Established in posthuman ontology, policy assemblage thinking recognizes the agency of non-humans elements in policy constructs, such as policy visions, narratives, policy documents, policy instruments and more (Mccann and Ward 2012), and how the interaction between these non-human elements with human elements produce a policy directionality towards a strategic end. As we want to understand how the ambidextrous organization of missions loops back on mission directionality, policy assemblage thinking enables us to unravel what actors (incumbent human and non-human networks and newcomer human and non-human networks) make up the mission assemblage throughout subsequent mission policy making phases and how these actors are situated in old and new networks. A drawback in policy assemblage thinking is that is provides little methodological guidance in how to empirically study how and when elements come together and how they evolve. We therefore integrate assemblage thinking with mission-orientation policy stages as introduced by (Larrue 2019).

Case study and findings

As a case study, we use the recently implemented circular agriculture mission in the Netherlands, which is part of the renewed Dutch Mission-oriented Topsector innovation policy. We studied the policy assemblage of the circular agriculture mission during three important stages of Dutch mission policy: mission strategy articulation, mission agenda setting and mission programming. The mission circular agriculture became assembled in this phase as part of new Dutch Mission-oriented policy in 2018, which replaced existing Top sector enterprise policy. Implemented in 2011, the Dutch Top sector enterprise policy was designed to improve the match between knowledge demands of innovative industries/sectors and the activities of research institutes, preferably while solving societal challenges (Janssen et al. 2020). Over the course of 2011, firms and research institutes had the opportunity to unite themselves in so-called 'Topteams', of which nine Topteams were finally selected to become a Topsector (like Agrifood, Life Sciences and Health, High-Tech Systems and Materials). Every two years, the Topteams made agreements with the authorities and social organizations around desired innovation activities, which crystallized in knowledge and innovation agendas (KIAs). These agendas formed the basis for a contract signed by 'triple helix parties' (i.e. government, research and enterprises – see (Lundberg 2013; Etzkowitz and Zhou 2006; Scalia et al. 2018) in which they committed themselves to the agendas.

Findings reveal how the policy assemblage was dominated by incumbents and existing innovation policy networks throughout the three stages. This resulted in mission vagueness, power conflicts, loss of legitimacy across stakeholder worlds, and lack of oversight on mission directionalities. These findings indicate that when we make governments responsible to direct missions without building in reflexive mechanism on the policy process, missions risk to become formulated in 'one-size fits-all approaches' (Wanzenböck et al. 2020). Secondly, when an ambidextrous approach is used to organize mission policy without significantly changing existing 'legacy effects' of the incumbent system in terms of institutional, cognitive and political path dependencies on MOIP, missions potentially end up being captured by powerful incumbent networks (Diercks 2019; Diercks, Larsen, and Steward 2019). This risks for missions to turn into 'accelerator' missions, organized top-down and focused on technological/scientific solutions, instead of transformative missions, organized top-down bottom-up aimed at systemic change (Polt 2019; Wittmayer and Schäpke 2014).

Discussion

A theoretical implication of the findings for literatures on MOIP is that mission directionality is a relational construct that is continuously in flux, so while missions give direction, this is constantly negotiated and not a fixed goal. We need more empirical studies that engage with the operationalization of mission directionality as paradox: how support steering missions on the one hand by the entrepreneurial state while stimulating mission plurality on the other hand by including diverse stakeholders and experimentation. This requires insights in power dynamics between newcomer and incumbent networks when nations adopt and enact mission oriented innovation policies.

To engage with these theoretical implications, we propose for MOIP scholarship to move beyond studies that aim to identify the right policy frameworks for MOIP and put faith in rational design and coordination (Wittmann et al. 2020; Mazzucato, Kattel, and Ryan-Collins 2020; Wanzenböck et al. 2020; Miedzinski, Mazzucato, and Ekins 2019). Instead, a better understanding is needed of how learning and adaptation takes place when nations adopt MOIP, and how this relates to agency (human and non-human) and power. This involves to take the normative dimension with regard to innovation systems and sustainability goals seriously and to critically follow up how missions are constructed by particular actors (human and non-human) and their normative underpinnings, and how this affects mission directionality as it unfolds.

Practically, mission oriented innovation policy may need to be governed by an independent governance structure that is capable to coordinate directionality and manage ambidexterity in missions, and engages with processes of reflexive governance and policy learning.

Conclusion

To conclude, the paper shows that the organization of mission policy as new approach to innovation policy in a national context is a messy process, and does not automatically translate in mission solutions and policy change. Using policy assemblage as conceptual lens, we found how mission directionality is not only a matter of bringing together opposing voices and complex trade-offs, but is also subject to agency dynamics during mission-policymaking. Without acknowledging the role of agency and politics and without tracing how actors organize themselves around missions, our case shows how this risks for missions is to become captured by industries, universities and policymakers that represent the ‘old’ innovation regime. In this way, the experimental capacity of missions is narrowed down right away to the power of incumbents. Other types of actors that shape missions ‘from the bottom up’, such as industries, farmer representatives, social organizations, and start-ups seem to be underrepresented in mission agenda setting. We argue that insufficient attention towards actor and politics during innovation processes risks for path dependencies of the existing innovation system to be kept in place. Therefore, an evolutionary understanding the role of agency and power dynamics during mission policymaking and how this loops back on mission directionality matters. It also indicates a stronger need for awareness of the pros and cons of the ambidextrous organization of missions: how use incumbents to exploit existing networks while including newcomers at the same time to explore new avenues of innovation.

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Keywords: circular agriculture, mission-oriented innovation, policy assemblages, directionality, transition policy mixes

[150] Thomas Zacharewicz (University of Seville), Noemí Pulido Pavón (University of Seville) and Benedetto Lepori (Università della Svizzera italiana). *Funding modes and university research performance. A Data Envelopment Analysis.*

Abstract. Introduction

Over the last decades, the use of research funding mechanisms based on a competitive allocation of resources have expanded across countries. In line with New Public Management approaches first developed in the 1980s, this evolution from a mainly non-competitive block funding systems towards the development of competitive funding incentives has mainly been motivated by the search for efficiency gains (Boden et al., 2004; Whitley 2011; Whitley 2007). More precisely, this orientation builds on the assumption that fostering competitive allocation mechanisms can lead to improvements in research performance by facilitating a more efficient use of the funding resources, by selecting the best research groups or incentivizing specific research themes (Geuna 2001; Braun 2003; Zacharewicz et al. 2019).

Generally, funding research policy frameworks differentiate between institutional funding, which is traditionally non-competitive, and competitive project funding. Institutional funding is defined as 'the total of national budgets in a given country, attributed to a research performing organisation (university or Public Research Organisation), with no direct selection of R&D project or programmes and for which money the organisation has more or less freedom to define the research activities to be performed' (Van Steen 2012). As opposed to it, project funding refers to 'the total of national budgets in a given country, attributed to a group or an individual to perform an R&D activity limited in scope, budget and time, normally on the basis of the submission of a project proposal describing the research activities to be done' (Van Steen 2012).

To date, evidence regarding the positive impact of competitive research funding on research performance is both mixed and limited. While the levels of competitiveness are expected to impact positively on scientific production (Aghion et al, 2007, 2008, 2010; Auranen & Nieminen, 2010; OECD, 2002), recent papers highlight that more competition would have no impact or correlate negatively with research efficiency (e.g. Auranen & Nieminen, 2010; Sandström & Van den Besselaar, 2018). In addition, most analysis of funding modes and research performance focus on data collected at national level, while the impact of national research funding modes on the distribution of funding and research performance at university level remains largely unexplored.

Therefore, the present study aims to analyze the extent to which the amount and structure of funding allocation mechanisms at national level influence funding modes at university level and whether these have in turn an impact on research performance. To do so, we will rely on a multilevel analysis based on data from 10 EU countries (Austria, Belgium, Czech Republic, Germany, Ireland, the Netherlands, Portugal and Slovakia) and Switzerland and corresponding to 148 universities between 2016 and 2018.

By deepening existing analysis of the impact of funding modes on research performance through the integration of university level perspectives, the present study aims to provide a precise understanding of good practices and possible adverse effects of the use of different research funding mechanisms for designing public policies.

Research questions

This paper aims to provide a multilevel analysis to identify the impact of funding amounts and funding allocation mechanisms at national level on funding amounts, funding allocation mechanisms and research performance at university level. Through its multilevel perspective, this study extends previous analysis of the impact of funding modes on research performance and aims to provide further granularity in the understanding of how resource allocation influences research production.

Method

This project builds on three main types of variables and datasources.

Output variable. Research performance will be measured through the percentage of academic papers situated within the top 10% highly cited papers as a proxy of academic quality. This choice is justified by the fact that this subset of total publication output is generally considered as the one representing breakthrough knowledge (Waltman et al., 2012) and as such is a more valuable proxy of academic performance the absolute quantity of publications. These data were retrieved from the database built by the Leiden University Centre for Science and Technology Studies (CWTS). Data are disaggregated by university for the year 2018.

Independent variables. Two types of independent variables are considered. We first relied on research funding data at national level and used Eurostat government budget allocation for R&D (GBARD). These data are disaggregated by total amount of funding for R&D, institutional funding and project funding. Secondly, we relied on funding data at university level by differentiating between the total revenues of universities, core funding and third party funding. Core funding is considered as a proxy for institutional funding and third party funding as a proxy for project funding. These data are retrieved from the European Tertiary Education Register (ETER) database.

The time reference in the observation of the variables is 2016 for the independent variables and 2018 for the dependent variables. This choice is motivated by the following considerations. First, the choice to focus for the observation of independent variables on one year (2016) instead of conducting a panel analysis is motivated by the high stability of the share of institutional and project funding in the total amount of national GBARD over the last decade, for which we would not expect important variations of results between the cross-sectional method adopted and a panel analysis. Second, the ETER database provides data for the year 2011 and 2016 at university level, for which we chose to focus on 2016 as the most recent data available. Finally, we opted to observe the effect of funding allocation on publication output for 2018, with a two-year delay between data related to inputs and data related to outputs as a shorter period could be considered too short to observe an impact and three years too long (Crespi & Geuna, 2008).

The matching of Eurostat for funding allocation at national level, ETER database for university-level funding and CWTS database for publication outputs leaves data available for 10 countries (Austria, Belgium, Czech Republic, Germany, Ireland, the Netherlands, Portugal, Slovakia and Switzerland) and 420 universities. Out of these, we observed that many universities show very low levels of publications (e.g. applied universities, art or music higher education institutions, etc) and that their research performance is generally insensitive to budget levels and funding mechanisms. In order to focus our analysis on research intensive universities, we opted to select universities with a publication record of over 100 scientific articles (in fractional counting) in 2018. This leaves 148 institutions across the 10 countries considered.

Results

The three variables considered at national level -GBARD, institutional funding and project funding- show very low and non-significant correlation levels both with university level funding variables - university total revenues, core budget and third-party funding – and with academic performance variables. In turn, university level funding variables show very high correlation levels across each other and have a strong and significant effect on the total number of publications (P10) and on the percentage of academic papers situated within the top 10% highly cited papers (PP10). No significant differences appear between funding modes (core or third-party funding) and academic performance.

[Insert Table 3]

When observed at national level, different patterns emerge. For all countries considered, university level funding variables are highly and significantly correlated with numbers of publications at university level. No significant difference regarding these correlation levels is observed across university total revenues, core budget or third-party funding. Differently, Switzerland and Germany are the only countries for which university level funding variables are significantly correlated with PP10 variables. For all other countries, correlations are non-significant. The reasons underlying these differences need to be further explored. No significant differences in correlation levels with PP10 is observed across university total revenues, core budget or third-party funding (see Table 3).

The three variables of GBARD, institutional funding and project funding were not included in the correlation analysis presented above as they are constant at national level. Further multilevel analysis will aim to test for country variables and random intercepts.

Discussion

The preliminary analysis presented above offers a first insight regarding existing relationship between national level funding variables, university level funding variables and university level performance indicators. In this regard, four main observations may be provided. First, the three university level funding variables are always strongly and significantly correlated with number of publications at university level. Second, except in the cases of Germany and Switzerland, they are not correlated with most cited publications. These differences and the reasons why Germany and Switzerland follow a different pattern than other countries should be further explored. Thirdly, there seems to be little or no difference in the effect of core funding and third party funding on publication performance. These results are in line with previous literature and would confirm that competition would have no impact on research efficiency (e.g. Auranen & Nieminen, 2010; Himanen et al., 2009; Sandström & Van den Besselaar, 2018). Finally, possible effects of national level funding variables could not be observed through correlations in the specific countries considered as these variables are constant at national level. Our data represent a hierarchical structure such that university level data are nested within countries. Accordingly, to evaluate our hypotheses, we will deepen the preliminary analysis conducted here through mixed model regressions.

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Keywords: Research funding, Academic performance, Competitive funding

[153] Anabela Santos (European Commission, Joint Research Centre), Javier Barbero (European Commission, Joint Research Centre), Olga Diukanova (European Commission, Joint Research Centre), Simone Salotti (European Commission, Joint Research Centre) and Dimitrios Pontikakis (European Commission, Joint Research Centre). *On the road to a 'Competitive Environmental Sustainability': How can European funds support regions in the transition?*

Abstract. The Covid-19 outbreak drastically affected the European Union (EU) economies, leading to a contraction of the GDP in 2020 even higher than that of the 2008/2009 economic crisis. Mobility restrictions, lockdown, confinement, and other government measures to stop disease spread, affected everyday life and work, and generated changes in consumers' behaviour and preferences. The pandemic accelerated the adoption of digital technologies by companies and households in time of physical distancing. More conscious of the climate change effect in human health, consumers seem also to be more determinate to adopt eco-friendly solutions for everyday life.

The pandemic hit the world when the EU was preparing to adopt specific measures to fight climate change effects, thanks to the European Green Deal (COM/2019/640 final). The EU recovery, supported by the NextGenerationEU, is also expected to be greener and more digital, in line with the goal of the new EU growth strategy to achieve a climate-neutral economy by 2050.

New market trends and needs associated to the green transition, which already started before the pandemic and accelerated during the Covid-19 crisis, change the way in which the factors of production are used, and make employment and other resources shift across sectors. These industrial transitions are hard to achieve for certain regions: barriers to investment activities, gaps in large infrastructure, lack of business innovation and unavailability of people with the right skills, are all factors which may impede a smooth transition towards a competitive and greener economy. Furthermore, these macro-economic conditions make some regions less attractive to foreign investors. Consequently, the regions struggling with these long-term challenges are at risk of industrial decline, significant job losses in some sectors, and outflows of workers.

It appears important to achieve an understanding of how macro-economic conditions, innovation, and European policies such as the regional structural funds have supported and influenced changes in employment across different sectors in the EU regions over the last decades. This would constitute not only a scientific advancement, but it would also bear a certain relevance for supporting the design of policies instruments to enhance the green transition.

Therefore, the paper proposes:

i) a new indicator able to measure transition to a competitive and sustainable economy constructed using sectoral employment data;

ii) and an analysis to identify the determinants of such transition.

Our study innovates on the existing literature in several ways. First, most of the existing contributions have focused on productivity when studying industrial transitions across sectors (usually using highly aggregated ones like agriculture, industry and services - see, among others, Duernecker et al., 2017; McMillan et al., 2014; Herrendorf et al., 2014; and Dabla-Norris et al., 2013). Our indicator uses two dimensions to measure the extent of economic transition: one based on productivity to account for competitiveness, and a second one based on greenhouse gas emissions to account for the green/sustainability dimension.

Second, the vast majority of the existing evidence is based on country-level data, while in our analysis we use both country-level and regional (NUTS 2) data. Third, we focus on the role of public policies and innovation in supporting the transition towards a greener and competitive economy, a dimension which has been overlooked so far due to the fact that the literature has mostly (but not only - see for instance Martins, 2019) focused on secular shifts across macro-sectors, rather than medium-term changes as we do in our paper.

Our Regional Competitive Sustainable (RCS) indicator, expressed in NUTS 2-level, measures changes in the ratio between the employment in economic activities (NACE 2-digits) that have registered simultaneously a growth of their productivity level and a reduction of greenhouse gas emissions (grams per euro) over the total employment in the region. Both dimensions have the same weight in the indicator. To build this indicator, we use region-activity data from “Regional Structural Business Statistics” and country-activity data from “Air emissions account” (EUROSTAT). Productivity level is proxied by wages and salaries per employee, since information on gross value added or other output measures are not available with a high degree of granularity at NUTS 2 level and NACE 2-digits. Monetary values are transformed in constant price, using GDP deflator (base 2015).

The RCS indicator is used as dependent variable of a Spatial Durbin Model to capture direct and indirect (spillover) effects of set of explanatory variables, which include the EU funds and macroeconomic conditions (e.g. capital accumulation, technological progress, R&D expenditures and quality of human capital). We use a spatial econometric model, because changes in labour market structure in region i could be influenced by what is happening in nearby regions j. The database covers the period 2008-2018 and the 282 regions of the EU27 + UK.

The expected outcome of this study is first a mapping at NUTS 2 level about the speed of the transition to a competitive sustainability and the degree (measured by employment share) of this transition. Secondly, the econometric model will show us which macro-economic factors are able to influence direct or indirectly the transitions and if the EU funds were effective in supporting the transition.

An initial inspection of the newly constructed indicator reveals that the share of employment in economic activities moving to a competitive sustainable economy (more productive and green) has increased between 2008 and 2018. Even if the process is not linear, a positive growth trend could be observed in the long-term. Poland, Czech Republic and Sweden registered the higher average change in the share of employment, whereas, Denmark, Spain and Portugal the lowest.

Preliminary econometric results suggest that competitive sustainable transition is associated with the capital stock and the past performance of the regions. Structural funds also appear to be positively correlated with transition. However, such relationship seems to be only significant in more developed regions. These findings can also suggest that a supportive regional eco-system is also needed in lagging regions in addition to EU funds. The size and direction of other regional covariates such as human capital and government quality remain to be investigated.

The EU regions, as well as other territories over the World, are faced with two big challenges for the next coming years, the Covid-19 pandemic recovery and the transition to a climate neutral economy by 2050. Under the programming period 2021-2027, the EU has mobilized €750 billion to support the EU recovery, in addition to the €1,074 billion of the EU’s Multiannual Financial Framework (MFF) for 2021-2027. Faced to the unprecedented huge amount of money available for EU Member States, the results of our study can be particularly useful for policymakers to better understand what can enhance the transitions and in which circumstances public support is the most effective. In addition, this research is also of interest for academia, because it contributes to the literature on the determinants of sectoral shifts over time. Indeed, our indicator combines two dimensions (competitiveness and sustainability) to capture the quality of the transitions, instead of simply assessing the quantity of people moving from one sector to another, as most of the researches are focusing on.

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Keywords: Green transition, Public support, European regions

[154] Sumit Kumar (Indo US Science and Technology Forum). *Energy Transitions and Artificial Intelligence in Global South (India): An analysis using patent data .*

Abstract. Research Problem

The agenda of the 2030 Sustainable Development Goals set up by the United Nation is to promote sustained and inclusive economic growth. The United Nations has emphasised that Science, Technology, and Innovation (STI) are key in driving this economic growth within the ecological boundaries of the earth (United Nations Conference on Trade and Development, 2019).

However, STI is seen as an 'elite' concept and often closed, self-regulated, disciplined with its own agenda and therefore is detached in addressing the societal needs and become non-inclusive (Sutz & Tomasini, 2013). The STI policies during the 1960s focused on economic growth by increasing the means of production, competitiveness among economies including mission programmes in defence, space, and transport (United Nations Conference on Trade and Development, 2019). These policies were linear and inspired by the science push model however over the years these policies are no longer linear since they have become more complex (OECD, 2018).

Patents have been used by scholars for several decades to measure innovations (Archibugi & Pianta, 1996) although there are also criticisms to this approach. Multilateral institutions like World Intellectual Property Organisation (WIPO) also use patent data as one of the variables to measure innovations and rank the countries (WIPO, 2019).

Artificial Intelligence (AI) is often seen as the key driver for the 4th Industrial Revolution (Chalmers, MacKenzie, & Carter, 2021). While on one hand AI is seen as the key driver to promote economic growth, on the other hand it can also impact societal challenges, governance system and environment for social good (Goralski & Tan, 2020). Potential of AI can be harnessed to accelerate the energy transition to decarbonise the global energy systems.

India is an interesting case to examine the role of AI in accelerating the energy transition in the country for several key reasons. At the COP26 Summit held in Glasgow, India has pledged to reduce the carbon intensity of the nation's economy by 45% by 2030 and net-zero carbon emission by 2070. As one of the largest economies in the Global South, it has committed to spend around 1000 million USD in the next five years on emerging technologies like AI, Internet of Things, quantum computing among others (Department of Science and Technology, 2020).

Research questions

Key research questions

1. To what extend are the patents filed in the field of AI in the Indian jurisdiction linked with green technologies?

2. In what way does the national and international policies impact the directionality to the technological innovation in the field of AI related to green technologies?

Research methodology

The methodology which I will be using in my research has been borrowed from the Steering Research and Innovations for Global Goals (STRINGS) project.

Quantitative method

- The quantitative method will focus on identifying the AI related patents linked with SDG 7. This can be done by conducting a keyword search of patents on the Dimensions patent database from 2010 onwards.

- The next step would be to identify the top terms (bi-gram and n-gram) using text analysis and topic modelling on the title and abstract of the patent data identified using keyword (STRINGS project) search. Analysis of this data will give us the following information

o Frequency of keywords with low carbon technologies like solar, wind, biomass among others has changed over the years (Target SDG 7.1).

o Frequency of keywords linked with conservation of energy (Target SDG 7.2)

o Frequency of keywords linked with energy generation and consumption (Target SDG 7.3)

- Further analysis will provide information on the countries and firms which have been filling these patents in the Indian jurisdiction and how the frequency of these patents has changed over the years.

- Quantitative tools like R programming, VOSviewer and Gephi will be used for data analysis and visualisation.

Qualitative method

- Analysing the national and international policies (like Paris Agreement, UNFCC framework etc.) related to these low carbon technologies and assess if there is any correlation with the number of patents in AI related to green technologies which have been filed during that time period.

- Analysing the international policies (by OECD, QUAD etc.) on AI in which India has played a key role and whether these policies have any role in filling of the patents in AI related to green technologies.

Keywords: Energy Transitions, Artificial Intelligence, Global South

[155] Agata Lambrechts (Università della Svizzera italiana), Marco Cavallaro (Università della Svizzera italiana) and Benedetto Lepori (Università della Svizzera italiana). *Collaborative Preference: Mechanisms of Alliance Formation across the European Universities Initiative.*

Abstract. Introduction

Within the organisational studies, a rich literature is available on inter-firm alliance formation (e.g. Ahuja et al., 2009; Kim & Higgins, 2017). While considerable attention has also been given to inter-organisational arrangements, including alliances within the higher education (HE) research field, the focus here has been on the considerations for entering the alliances (Musselin, 2018), understanding the differences between types of inter-organisational arrangements (Brankovic, 2018), and establishing the standards of good practice for such associations, partnerships and networks (Matross Helms, 2015). Fewer attempts have been made thus far to describe and explain the mechanisms and dynamics of the formation of alliances between higher education institutions (HEIs).

In this study, we address this gap by focusing specifically on the formation of European University alliances (EUA) - international inter-organisational arrangements between HEIs within the framework of the European University Initiative (EUI). The scheme encourages creation of bottom-up networks with broadly defined boundaries: partner institutions must hold a valid Erasmus Charter for Higher Education and be located in either an EU Member State or third country associated to Erasmus+, thus constructing, at least in theory, a large potential tie pool of all types of higher education institutions within a broad geographic area.

Theoretical mechanisms for tie formation

Borrowing a perspective from sociology and management literature, we identify three core observable theoretical mechanisms for tie formation among the actors that comprise the alliances: complementarities and/or similarities and/or pre-existing network ties.

1. Complementarities

Rooted in the resource-based view of organisations lies the belief that organisations come together to exchange resources and complementary capabilities (Kim & Higgins, 2017) in order to gain market advantage either through vertical integration across the production value chain or to forge alliances to gain a stronger competitive position in markets (see also Stensaker (2018) on university alliances). To achieve complementarity and create greater value, organisations must find partners that are somewhat different from their own.

Developing cooperation in education and research is the key goal of the EUI. Therefore, we first expect alliances to include preferentially HEIs active in the same subject areas and/or in similar activities (such as postgraduate education), and complementary assets that allow developing novel products/services, such as interdisciplinary curricula or research activities. Second, we expect that the complementarity argument plays a core role in how individual alliances have been formed, selected and are implemented.

2. Similarities

Perhaps the most commonly cited mechanism of ties formation, is the mechanism of attribute-based homophily, that is, the tendency for alliances to be formed by organisations that share or are similar in terms of some attributes (Siciliano et al., 2021). Such attributes can include reputation and status (Podolny, 1994; cf Collette & Philippe, 2014), values or attributes such as size, age, geography and social environment, or the demographics of clients served. A connected, but somewhat specific concept is that of structural homophily - alliances tend to be formed by institutions occupying similar network positions (Ahuja et al., 2004).

The literature on HEIs highlighted similar levels of research reputation as a core dimension of similarity explaining the formation of HEI networks, including associations (Brankovic, 2018; Zapp et al., 2021), respectively, of HEIs research cooperation (Lepori et al., 2013). However, the European University Initiative is focused on a broader set of cooperation rationales both in research and–primarily–in education. Therefore, we might expect that also other dimensions of similarity come to the forefront, such as disciplinary identity ('arts' universities or business schools) or geography.

3. Pre-existing network ties

Much research also suggests that organisations are more likely to form alliances with actors with whom they already have ties, organisations they trust and with whom they share a history of a rich exchange of information (Gulati & Gargiulo, 1999).

As for university alliances, we, therefore, expect that alliances are preferentially formed between universities already having ties, such as research collaborations or being part of the same groups or associations of universities (Zapp et al., 2021); in the European context, we also expect that alliances are formed preferentially between HEIs already cooperating within the European Framework Programmes (Paier & Scherngell, 2011) or the Erasmus+ programme (Fumasoli & Rossi, 2021).

We note, that the tendencies to seek out partners who are different but similar and searching among previous connections all at the same time is not uncommon (Kim & Higgins, 2017).

Methods

To test the importance of these mechanisms in the formation of European University Alliances, we adopted a mixed-method design, using both quantitative and qualitative approaches (Schoonenboom & Johnson, 2017).

As a first step, we compare quantitatively the characteristics of HEIs participating to EUAs with the characteristics of the whole population of HEIs delivering at least a bachelor degree in European countries as provided by the European Tertiary Education Register. In that respect, we test whether HEIs participating to EUAs are systematically different in terms of core attributes with respect to the whole HEI population, such as organisational size, which is determined by the full-time equivalent (FTE) number of academic staff, publication and education intensity, incoming Erasmus+ students and subject specialisation which is measured through the share of ISCED 5-7 students enrolled in STEM disciplines.

As a second step, we analyse qualitatively how individual EUAs presented the motives for cooperating in order to identify arguments related to complementarities and joint product vs arguments related to similarity and/or previous collaboration. To this aim, we have created an inventory of the various public texts which act as communicative tools used by the alliances to define not only strategy and future visions but also the basis for the partnership, expressing what the alliance partner institutions themselves consider as the basis for their compatibility.

As a third step, we analyse individual EUAs in terms of the similarity of attributes of participating HEIs as compared with similarity in the overall HEI population in ETER. We test whether EUAs have been preferentially formed among HEIs previously collaborating by using data on European Framework Programme collaborations from CORDIS' publicly available datasets and the exchange of Erasmus+ students (Gadár et al., 2020). Both datasets cover the years 2014 until 2020. This allows a more fine-grained understanding of the motives during the formation of alliances, for example, contrasting the importance of the research vs the educational dimension.

Preliminary results

We present preliminary results focusing on the quantitative comparison of institutional attributes. We observe that HEIs participating in EUAs have overall substantially more resources in terms of academic staff (Figure 1a), receive more students through Erasmus+ (1b) and have a higher publication intensity (1c). HEIs with a higher education intensity are less likely to be part of a EUA (1d). We have not found any particular tendency with regard to HEIs' STEM orientation (1e).

Table 1 overleaf gives an overview of common geographical and institutional characteristics within EUAs and of their thematic focus. In some EUAs, HEIs share common geographical characteristics, such as their location in coastal regions (CONEXUS), city-universities (EC2U), rural and mountain regions (UNITA), and their proximity to the sea (SEA-EU). Others are composed of a specific type of HEI, such as Universities of Technology (ATHENA, ENHANCE, EUT, UNITE!), reform universities (ERUA) and young universities (YUFE). Some EUAs, including ECIUn, Eurotech and YUFE originate from pre-existing alliances.

Most EUAs do not have a specific thematic focus and offer a cross-disciplinary range of education opportunities. Others focus on specific themes and disciplines, such as arts (EU4ART), brain research (NeurotechEU), or engineering (EELISA, EUT).

Figure 2 illustrates the network ties within EUAs in terms of collaborations in the eighth European Framework Programme Horizon 2020 and of the intensity of student exchanges within Erasmus+. We find that HEIs in 1EUROPE, ENHANCE and UNITE! have the highest intensity of cooperation within their respective EUAs in both programmes. Other EUAs such as EuroTeQ and NeuroTech, which are focused on engineering and brain research respectively, have substantially more network ties in Horizon 2020 than in Erasmus+. EUAs focused on social sciences such as ENGAGE.EU and CIVICA have more network ties in Erasmus+ than in Horizon 2020. Other EUAs, notably focused on arts (EU4ART, FILMEU) or centred around geographical properties (CONEXUS, E3UDRES2), have weak ties in both programmes. Being built upon existing alliances is also not necessarily correlated with multiple pre-existing network ties. UNITE!, which originates from the Consortium Linking Universities of Science and Technology for Education and Research (CLUSTER), has strong ties in both Horizon 2020 and Erasmus+, while the Aurora Alliance, which stems from the Aurora network, has average to low network ties.

Discussion and Conclusions

Our preliminary findings suggest that all of the three mechanisms can be detected in the examined dataset. Alliances are indeed formed around complementarities and joining forces for common activities. Given the broad framework of cooperation, similarity/homophily appears along different dimensions such as subject specialisation, geographical position and general institutional characteristics. Finally, our results suggest that alliances have been largely formed between HEIs with pre-existing ties, either on the research side (EU-FPs) or on the educational side (Erasmus+ programme).

We expect our full analysis to highlight the relative importance of the three mechanisms, which appear to be operating simultaneously, and the extent to which the institutional framework of the EUI mobilised them. Therefore our results will have important implications for our understanding of inter-organisational cooperation within the HE sector. Moreover, they might also contribute to understanding how specific choices in the design of the EUA initiative at the European level contribute to reshaping European HE.

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Keywords: university alliances, European University Initiative, alliance formation, complementarity, similarity, network ties

[156] Koen Beumer (Utrecht University). *Inclusive innovation and distributive justice: crop genome editing for smallholder farmers.*

Abstract. In recent years, inclusion has emerged a prominent theme in science, technology, and innovation (STI) policy, both as a topic on itself (e.g. Heeks et al. 2014) and as part of broader discussions on justice, equity, diversity and inclusion (JEDI). While STI policies increasingly incorporate inclusion as an objective, little is known about the way inclusion is made operational in the research and development (R&D) that these policies seek to influence. We contribute to this debate by integrating frameworks of inclusive innovation with normative theories of distributive justice. This allows us to assess the impacts of inclusive STI policies from different normative perspectives on inclusion.

We will apply this framework to assess inclusion in research projects on crop genome editing that seek to include the needs and concerns of smallholder farmers in the global South. This is an interesting case because recent advances in genome editing technologies like CRISPR, ZFN and TALEN are said to offer unique opportunities to improve food security among smallholder farmers in the global South, for example by creating crops that are drought-resistant or more nutritious. Compared to older generations of biotechnology, genome editing technologies are relatively cheap and easy to use and can thus more readily be used by research institutes and companies with fewer resources, including those in the global South. This lowers the barriers to using biotechnology for the improvement of crops that are commercially less interesting, like orphan crops that are predominantly grown by smallholder farmers in the global South. Indeed, recent review papers show genome editing technologies have already been applied to a variety of tropical crops like rice and yam, and to orphan crops like cassava and sorghum (Haque et al. 2018; Venezia and Krainer 2021). Genome editing therefor has great potential for promoting inclusive innovation.

At the same time, it also seems clear that inclusion of smallholder needs and concerns will not occur automatically. In the past, similar promises have been made for genetically modified (GM) crops and much of those promises remain unrealized (Jansen & Gupta 2009). GM crops have not been widely adopted by smallholder farmers in the global South (Fischer et al. 2015) and in several regions that were initially regarded as success stories for smallholder adoption of GM crops - like Burkina Faso and the Makhathini flats in South Africa - farmers have since renounced the use of GM crops (Gouse et al. 2008; Dowd-Uribe & Schnurr 2016; Beumer & Swart 2021).

Moreover, it is notoriously difficult to identify smallholder' demand for seed (Almekinders et al. 2019) and improved varieties often fail to reach smallholder farmers, despite the best of intentions (Spielman and Smale 2017). We thus cannot take for granted that researchers know to what ends genome editing can best be used to benefit smallholder farmers. In this context, various schools of thought have emphasized the importance of involving stakeholders at an early stage of technological development (Bijker 2010; Owen et al. 2012; Beumer, 2021). Yet we know very little about whether and how smallholder farmers are currently included in attempts to use genome editing for their benefit.

We would like to address this research gap by investigating how inclusion is conceptualized and practiced in genome editing projects that explicitly seek to include smallholder farmers. In doing so, our empirical contribution will be to test claims by the likes of Bill Gates that genome editing is already "accelerating research that could enable (...) farmers in the developing world to grow crops (...) that are more productive, more nutritious, and hardier" (2018). Whereas these claims have been circulated widely and such calls for inclusion have been incorporated in STI policies, their success in achieving inclusion is unclear as of yet. This contribution is informed by literature in the sociology of expectations that calls for critically assessing the promissory narratives on emerging technologies (Nordmann and Rip 2009; Lucivero et al. 2011).

Our theoretical contribution is to integrate inclusive innovation with theories of distributive justice. We will first assess how inclusive genome editing projects are by drawing on the ladder of inclusive innovation (Heeks et al. 2014). This framework distinguishes six levels at which inclusion can occur, as is further explained in the theory section. For example, an innovation at step 1 is inclusive in terms of intent, such as a product designed to meet the needs of the poor; an innovation at step 3 actually has a positive impact on the poor; and at step 5 innovations make socioeconomic, institutional, or organizational structures of production more inclusive. This framework thereby offers a broad perspective on the various ways in which inclusion can occur.

The inclusive innovation framework offers little in understanding the contested nature of inclusion, however (Levidow & Papaioannou, 2018). For example, different actors may disagree over what exactly are the needs of marginalized communities (step 1) or what constitutes a positive impact (step 3). We therefore seek to integrate the ladder of inclusive innovation with distributive justice theories. Specifically, we will draw on the work of Cozzens (2010) and Smallman and Beumer (under review) who distinguish three distributive justice approaches: pro-poor, fairness, and equalizing. By classifying inclusion measures of research projects both in the inclusive innovation ladder and the distributive justice approaches, we can assess research projects from different normative perspectives on inclusion. This allows us to understand how practices of inclusion in genome editing project may be judged as inclusive from the perspective of one normative viewpoint, but not from another. This helps to better identify what inclusion measures are (not) taken and how inclusion could be achieved.

We have applied this framework to genome editing research projects that seek to include the needs and concerns of smallholder farmers. We used two criteria for selecting projects: the projects focus on crops that are specifically relevant for smallholder farmers, and the projects include smallholder benefits as one of their objectives. These crops were identified based on the CGIAR list of 'crops to end hunger', the list of orphan crops by the African Orphan Crops Consortium, and the list of cash crops covered in the Sustainable Smallholder Agribusiness program. In total, we found 30 research projects around the world. We approached members of all 30 projects for an interview. We conducted 23 interviews with 24 interviewees of 18 different projects. We mostly interviewed project leaders, as they have the best overview of the project's activities and structure.

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Keywords: Inclusive innovation, Distributive justice, Genome editing, CRISPR, Smallholder farmers

[157] Hugo Confraria (UECE/REM, ISEG, Universidade de Lisboa, Portugal), Tommaso Ciarli (UNU-MERIT) and Ed Noyons (Leiden University). *Analysing the research priorities of countries towards societal challenges.*

Abstract. In recent years there is an increasing demand for science and research funding to be better aligned with societal challenges (Ciarli and Ràfols, 2019; Sarewitz and Pielke Jr., 2007). This shift has emerged since there is an increasing call for research funders and evaluation systems to prioritise concrete and pressing problems in society at large, alongside "scientific excellence" per se (Hicks et al., 2015). However, the capacity of science to meet societal challenges remains poorly studied and understood.

In this paper, based on the notion that research capabilities are needed to address SDG challenges, our core assumption is that a misalignment between a country's research priorities and its SDG challenges may reduce the efficacy of global investments in research to address sustainable development. We develop a new method to identify research that is related to an SDG by examining research areas in WoS with a higher share of publications that contain text that is related to SDG policy outlets. Then, we use the SDG indicators to create a new score to assess the performance of countries in SDGs in relation to the top performers

We operationalise the concept of "alignment" at three different levels: global, country and SDG. First, at the global level we compare the global production of SDG-related research in different country income groups in relation to their SDG challenges; second, at the country level, we compare to what extent the research was done by the authors of specific countries is related to their country's major SDG challenges and; third, at the SDG-country level, we use multiple regression analysis (OLS) to assess if the correlations previously identified hold when controlling for other factors, and to understand how changes in SDG challenges dynamically influence SDG research priorities. We ask three main research questions in our econometric part:

RQ1: Are countries that score worst in a certain SDG specialized in research related to that SDG?

RQ2: Do countries that score worst in a certain SDG tend to change their specialization towards research related to that SDG?

RQ3: Is a change in SDG scores associated with a change in SDG research specialisation?

At the global level, as expected, we find that, while the vast majority of SDG challenges are worse in low and lower-middle income countries, only a small fraction of SDG-related research takes place in those regions. This suggests that a major source of misalignment between research priorities and SDG challenges in the world is related to the vast inequalities that exist in research capabilities and funding across countries. Research users in lower income countries need to rely on research done elsewhere, which may be less relevant to their contexts.

At the country level (Figure 2), we created a methodology and visualizations that allow countries to have a better understanding (and more productive discussions with relevant stakeholders) of the research being prioritized, the capabilities created in the country, and the factors that might have led to the absence of research in areas related to their main SDG challenges. Our findings indicate that this kind of mapping might be particularly relevant for countries that have greater societal challenges (low and middle-income countries), since the higher variation of results helps to identify specific misalignments.

At the SDG level (Table 1), our findings indicate a positive relation between SDG challenges and SDG research prioritisation by country in some SDGs, including SDG1 (No Poverty), SDG2 (Zero Hunger), SDG6 (Clean Water and Sanitation) and SDG9 (Industry, Infrastructure and Innovation). This indicates a certain degree of alignment between research priorities and SDG challenges across countries in these SDG areas. These are encouraging findings since they imply that countries with serious challenges in these SDGs are indeed specialized (and becoming specialized) in research related to them, which can enable the application of scientific knowledge on issues that are relevant to these countries. As for SDG3 (Health Well-being), SDG7 (Affordable Clean Energy) and SDG10 (Reducing Inequalities), we also found a positive alignment pattern between SDG challenges and SDG research priorities, however when controlling for other factors we found that these patterns seem to be more related to historical patterns of research specialization (and potential international research funding patterns) than to research priorities chosen based on the challenges themselves.

We instead found a negative or inconclusive relationship between research prioritization and SDG challenges for all other SDGs. In SDG12 (Responsible Consumption and Production), for example, the countries that have the most unsustainable consumption/production patterns are usually high-income countries that are not specialised (or becoming specialised) in research related to these themes. This is a severe misalignment since the countries producing more waste are expected to prioritise research related sustainable use/management of resources and recycling processes which would enable them to create solutions to these unsustainable consumption/production patterns.

By analysing (mis) alignments between the global production of research and the societal challenges related to the SDGs targets/indicators, we hope to help national policymakers and international donors in two crucial ways. First by providing examples about how certain countries are prioritising research areas (creating research capabilities) that are related (or not) to their main SDG challenges, second to provide a global understanding about how misalignments between research priorities and SDG challenges might be worst in certain SDGs than others. By analysing whether countries' research priorities align with their greatest SDG challenges, we are able to provide guidance that can help rebalance research priorities towards generating research capabilities to address countries' major challenges.

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Keywords: Research priorities, Sustainable Development Goals, Science Policy, Bibliometrics, Societal Challenges

[158] Henriette Ruhrmann (Technical University Berlin / University College London). *Science-policy engagement as behaviour - how quantitative modelling can inform new organisational structures in the research system to promote engagement.*

Abstract. Background and Relevance

New challenges create new collective responsibilities; mission-oriented policies call upon the research system to inform political action in increasingly complex and interdependent transformation processes (Mazzucato, 2018a, 2018b; Schot & Steinmueller, 2018). The complex issues societies need to address today demand a new quality of engagement between research and democratic policymaking.

Whether around the climate, public health, or negotiating the opportunities and threats of technological innovation—creating effective, efficient, and equitable policy frameworks requires informed political debates. In navigating the topography of change, policymakers hold responsibility to aggregate, articulate, and represent societal interests and values in light of scientific evidence. Researchers must engage with policymakers in a way that allows co-development of a shared knowledge base to inform both political action and the direction of future research.

Under these circumstances, researchers face new expectations to become effective interlocutors for policymakers as part of their academic role. The science system and its research institutions, conversely, must create institutional structures to support their researchers in engaging with policymakers. Specifically, researchers need the science system and their institutions to recognise policy engagement as career-relevant and provide engagement opportunities and dedicated resources. Importantly, researchers need to learn to tailor their communication to new users and negotiate their role as experts in contested policy processes.

At present, institutional support for researcher-policymaker engagement remains relatively rare. In the UK, a pioneer for policy engagement support, various support mechanisms have been piloted and iteratively developed over the past decade. The momentum for policy engagement support is mainly credited to the normative turn towards engaged research institutions and the emphasis the UK's Research Excellence Framework for funding places on "research impact". Many other countries, including Germany, remain further behind with much fewer institutional support mechanisms for policy engagement and less diversity in their formats (Oliver et al., 2021).

To date, practitioner experience is the main foundation for the development of support mechanisms. While practitioner experience is valuable in its own right, there is little research evidence underpinning practice and linking interventions to impact in policy processes for evaluation purposes remains difficult (Oliver et al., 2021). Therefore, research evidence on the potential of different interventions to facilitate researcher-policymaker engagement is urgently needed to guide organisational change and capacity-building processes across the science system.

Knowledge Gap

The current state of knowledge on systematic support for science-policy engagement is insufficient. This study aims to shed light on the intersection of three current academic blind spots around science-policy engagement. First, methodologically, the focus of science-policy engagement research remains on case studies with (to my knowledge) no applications of theory-based quantitative modelling. Second, we are missing a translation of available qualitative evidence and quantitative modelling into practice-oriented guidance for capacity-building to support researcher-policymaker engagement.

Third, academic research on the specific context of legislatures in the broader field of science-policy engagement is scarce (Akerlof et al., 2019). In the interplay of democratic institutions, legislatures are uniquely positioned to represent the diversity of constituents' interests, act as a forum of debate on controversial issues, and scrutinise government action. Therefore, establishing an evidence base on the particular context of researcher-legislator engagement is critical, and this study will focus specifically on the role of legislators.

Research Questions

This mixed-method study focuses on the following research questions: (A) How, when, where, and why do researchers and policymakers/legislators engage? (B) How can we model and explain researcher-policymaker/legislator engagement? Which behavioural determinants are positively and negatively associated with engagement? And (C) what can we learn about the promise of different engagement support mechanisms from qualitative evidence and quantitative modelling?

Theoretical Framework

The study adopts an interdisciplinary approach linking science and policy studies with behavioural science. Understanding researcher-policymaker/legislator engagement as behaviour, the study leverages behavioural science theory to explain and model engagement behaviour, as well as to propose tailored behaviour change interventions to promote engagement.

Specifically, the COM-B model developed by Michie et al. (2011) structures the inquiry. The COM-B model posits that any (B)ehaviour is determined by (C)apability, (O)pportunity, and (M)otivation. Each determinant can be operationalised within the COM-B model framework for a specific target behaviour. The unique advantage of the COM-B model among behavioural science models is that it systematically links the framework domains (C, O, M) to specific types of behaviour change interventions. In the context of this study, this feature allows using the qualitative and quantitative analysis of researcher-policymaker/legislator engagement behaviour based on the COM-B model to derive actionable practitioner guidance for research organisations seeking to support engagement.

Data and Methods

Situated in Germany, the interdisciplinary empirical research design combines two methodological approaches. First, I conducted a qualitative interview study around a data-rich case study with high within-case variation: the deployment of facial recognition technology in public spaces in Germany (~ 30 interviews with researchers, legislators, and intermediaries) (A). I collected the data in semi-structured, 30-60-minute interviews. I employed a two-step qualitative data analysis process with an initial deductive assignment of primary codes based on the COM-B model and a secondary inductive derivation of inductive sub-codes following Mayring (2000) and Hsieh and Shannon (2005).

Second, I am collecting data in a two-fold quantitative survey based on the COM-B model (~1.000 researchers + ~150 legislators from federal and state parliaments) (B). The goal of the survey studies is to quantitatively test the external validity of hypotheses developed in the interview study (A) for larger samples of researchers and legislators. The survey design operationalises the COM-B model based on insights from the interview study and academic literature. It leverages or adapts validates item batteries from the literature wherever possible.

For the dependent variable in the researcher survey, researchers' engagement with policy, I adapted the established Academic Engagement Index (Tartari et al., 2014) for policy engagement. However, validated item batteries specific to policymakers as knowledge users were scarce. Therefore, I conducted an expert open card sort exercise with 16 experts on knowledge exchange to validate the item battery developed for the survey.

Following the data collection in April 2022, I will confirm whether the item batteries capture the underlying constructs employing a confirmatory factor analysis. The survey data will be analysed using hierarchical multiple regression using ordinary least squares estimation.

(Expected) Results

The paper presentation will include findings from both studies. The interview study (A) revealed through which engagement activities researchers and legislators interact and with which frequency, what motivates them, and the impact of their environment and social influences. I also identified several distinctive patterns in researcher and legislator engagement behaviour that serve as a basis to formulate hypotheses. Their external validity will be tested in the survey studies.

Among other findings on researcher behaviour, evidence from the interview study supports the hypothesis that researchers with institutional support engage more intensively with legislators and tend to perceive their community as more approving of their engagement. Based on the interview study findings, I developed a Sankey chart aggregating researchers' core motivations for policy engagement, the support received from their organisations, and the type of interaction they engage in (see Figure 1 in additional materials).

For legislators, the interview study's findings demonstrate that legislators adapt their engagement strategies to their limited time. This time crunch often prohibits engagement with researchers, whose communication is not tailored to their needs. Moreover, legislators tend to favour the field in which they are academically trained. Overall, they voice an unambiguous demand for more researcher-engagement as a whole and particularly more consideration for their needs as knowledge users.

The survey studies (B, April 2022) will test multiple hypotheses formulated based on the interview study and academic literature on researcher-policymaker/legislator engagement. It will compare the relative effect sizes of capability, opportunity, and motivation in driving engagement.

Understanding the interplay of these three determinants allows designing evidence-based behaviour change interventions. Chief among these interventions are institutional support mechanisms for researchers engaging with policymakers/legislators. Ideally, such interventions or support mechanisms should target the most salient determinants of engagement behaviour to optimise their effectiveness.

Conclusions and Policy Issues

As research organisations acknowledge their new responsibility as interlocutors in societal transformation processes and mission-oriented policy making, they must adapt their institutional capacity to the new challenge. They must create new organisational structures to support their researchers in integrating policy engagement with established expectations for excellence in research and teaching.

Preliminary results from the interview study (A) show that institutional support is positively associated with strong researcher-policymaker/legislator engagement. The behavioural model for researcher-policymaker/legislator engagement developed in the pilot study (A) and the survey studies (B) yield new insights into which determinants most strongly affect engagement behaviour. These findings allow me to assess which types of behaviour change interventions or support mechanisms are best suited to promote engagement.

Based on the findings, I plan to inform the process of capacity-building in the research system to support researcher engagement. By translating these findings into actionable guidance for research organisations, I hope to contribute to more strategic, evidence-based capacity building of organisational structures to support engagement between research and policymaking.

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Keywords: mission-oriented policy, science for policy, science-policy engagement, science advice, legislative science advice, policy impact support, policy engagement support, organisational change, capacity building, emerging organisational structures

[159] Luise Schlindwein (TNO) and Carlos Montalvo (TNO). *Accounting for heterogenous behaviors within transformative policy-making: the case of Energy Citizenship.*

Abstract. Extended Abstract

Recently, the engagement of citizens in design and implementation of policies is seen as a cornerstone of increased legitimacy and effectiveness in government policy (EU COM, 2019). It is argued that citizens play an important role in transitions and should be conceptualized as "important stakeholders in the innovation process shaping new routines and enacting system change" (Schot, Kanger, & Verborg, 2016, p.1). Similarly, the engagement of citizens is found to be a critical factor to achieve a clean and effective energy transition (Campos & Marin-Gonzalez, 2020). The inclusion of citizens into energy-related decision-making processes influences community response and uptake to decarbonization solutions, especially when the energy transition reveals existing inequalities and steps that must be taken to overcome them (Sovacool et al., 2020). Specifically it has been argued, that to achieve a fair, inclusive and just energy transition, suitable policies, good collaborations between stakeholders, realistic business models, and citizens who play an active role are required (Van Wees et al., 2021). In line with that, recently the term energy citizenship has emerged and has been found to be a useful concept that encapsulates a new definition of consumers. Within the concept of energy citizenship, the public is conceived as active rather than passive stakeholders in the evolution of the energy system (Devine-Wright, 2004; 2007). Citizens are not perceived as merely users of energy technologies and innovation, but participants in the energy system in a more comprehensive way (Devine-Wright, 2004). However, for policy interventions to be effective in promoting citizen engagement, a better understanding of energy citizenship and the emergence of active participation is needed before providing recommendations for policy design. We argue that our literature review on (behavioral) insights related to energy citizenship and the ecosystem of change is the key to improve the design of policies and policy interventions towards a fair, inclusive and just energy transition.

First, the paper offers a literature review on the understanding of the concepts energy and citizenship separately, while giving insight into the many meanings of energy, the difference between centralized and decentralized energy systems as well as different notions of citizenship. Examples of these notions of citizenship are performative citizenship or environmental citizenship, which are both about the active participation of citizens. The key feature of performative citizenship is enacting and claiming rights, while environmental citizenship is about taking responsibility for one's interaction with the environment. In line with that, a literature review on the definition and emergence of energy citizenship is provided. Based on that, an overview of levels of energy citizenship emergence in terms of engagement is given. By doing so, we propose that energy citizenship is contingent on the level of engagement that people might have (or not have) in actions supporting the energy transition.

These actions are defined in characteristic energy-related behaviors (e.g., investments, consumption, storage, pursuing efficiency, using specific technologies and practices, etc.), which are all relevant in an energy transition ecosystem. These behaviors, again, manifest differently across the different types of energy citizens. In the paper, we establish six types of energy citizen based on their involvement in the energy system, without suggesting a clear distinction between them. These six types are either individuals (i.e., consumers, prosumers and prosumagers, participants in protests and movements, and policymakers) or collective entities (i.e., energy communities and business entities). We further argue that each type of energy citizen mentioned above, has different rationales and contextual determinants that affect their engagement in the energy transition, but do not account for each type of energy citizen. This produces a large set of potential factors determining (i.e., driving, enabling or inhibiting) the engagement of energy citizens and therefore the emergence of energy citizenship. In other words, the paper gives not only an overview of the different types of energy citizens and their energy-related behaviors, but also gives insight into what drives or inhibits those behaviors and their engagement in the energy system. Finally, in order to cluster and summarize the determinants that were found in the literature for each type of energy citizen, we distinguish between cognitive, normative, instrumental, emotional, and socio-demographic determinants.This choice is based on human decision-making and behavioral research dating back to the early works of Simon (1955) as well as influential models of decision making and behavior (Ajzen, 1985; Ajzen & Madden, 1986) and more recent research in innovation adoption and innovations of new technologies (Montalvo, 2003; 2006).

In conclusion, by means of an extensive literature review, we give answer to the following questions: ”What is energy citizenship?”, “Who are and who are not energy citizens?”, “How does an energy citizen behave?” and ”Which factors determine the emergence of energy citizenship?”. By answering these questions a better understanding of energy citizenship and the stakeholders involved is reached. The review also indicates that by accounting for heterogenous behaviors new insights can be brought into the analysis and design of transformative policies aiming for a just, fair and inclusive change within socio-technical systems. The literature review of barriers and drivers conducted here support the argument of Steg et al. (2021), that current policy instruments aiming to create behavioral additionality lack sufficient support from behavioral sciences. Bringing the behavioral dimension into policy interventions could improve the effectiveness of policy frameworks to induce actions in all types of energy citizens that support a just energy transition.

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Keywords: energy citizenship, energy citizenship emergence, energy policy, energy transition, just transition, behavior, collective behavior, sustainable behavior, behavioral change, transformative innovation, transformative policies, innovation

[161] Carlos Cuevas-Garcia (Technical University of Munich) and Lukas Fuchs (Eindhoven University of Technology). *The Public Value of Innovation in the Inspection and Maintenance Sector: The Case of Pre-commercial Procurement of Robots.*

Abstract. This paper articulates an assessment framework building on the notion of public value to examine two pre-commercial procurement projects aimed at developing sewer inspection robots.

Research questions

How can we use public value to assess "assemblages" of innovative technology and policy instruments to produce improvements in the infrastructure inspection and maintenance sector?

How do pre-commercial procurement approaches to the production of inspection and maintenance robots differ? What are their strengths and weaknesses in the areas of public sector capabilities and partnerships with industry?

What is the role and what are the limits of pre-commercial and public procurement of innovation in successful innovation policy?

Relevance

Governments and industrial actors around the world are investing substantial resources to accelerate the inspection, maintenance and repair activities of large infrastructural assets. In this context, robotics has emerged as a promising technology. Improvements through inspection and maintenance robots serve at least four goals. First, they mitigate the societal and environmental risks produced by infrastructures in bad state. Second, they improve the health and safety of maintenance workers. Third, they decrease the use of resources like water and energy, as well as the emission of CO2 and other pollutants. Fourth, reducing maintenance costs implies a reduction in service costs. This may be directly translatable to improved or cheaper goods in the consumer economy, as may be the case in the renewable energy sector. However, these developments also feed into fears of workers' replacement with robots and the overshadowing of other technical and non-technical solutions.

The innovation of maintenance services is particularly interesting for scholarship in science and innovation policy because it calls for a partial removal of the boundary that divides formal and certified scientific and technological expertise on the one hand, and the usually overlooked lay expertise of maintenance workers on the other. Furthermore, the diversity of infrastructure asset sectors (transport, communications, water, energy, etc.) suggest the prospect of transference of technological solutions across sectors constituted by different working styles, routines and ecosystems.

The topic of maintenance innovation sheds light on two activities that are usually dealt with in the literature as being disconnected and mutually exclusive. Innovation looks at the new and exotic while maintenance looks at the old and ordinary (Edgerton 2008; Vinsel and Russell 2020). Bringing these activities together implies a mutual shift in the logics of both practices. In this talk, therefore, we propose ways in which science and innovation policy can select from amongst a wide range of nascent policy instruments and examine barriers to their successful implementation.

Theoretical framework

In this paper, we draw from three theoretical frameworks. First, maintenance and repair studies (stemming from science and technology studies) have in recent years called attention to the particular concerns and value of this sector for society (Graham and Thrift 2007). Second, insights from innovation policy studies allow us to consider the broader political economy in which innovation activities, and repair and maintenance are embedded (Kuhlmann, Shapira, and Smits 2010). Finally, we will draw on the 'public value' framework (Moore 1995; Mazzucato, European Commission, and Directorate-General for Research and Innovation 2018) as an evaluative framework that aims to capture the value of public sector activity, but which goes beyond mere economistic measurement. Thus, our discussion hangs on broader political philosophical concerns about the role of the state in the economy and in innovation.

Maintenance and repair studies highlight the invisibility of these activities and of the people who usually carry them out. However, the literature has not looked too much beyond the different levels of institutional decision-making determining infrastructure-asset management, let alone the crossover between innovation activity and infrastructure-asset management.

By contrast, innovation policy studies rarely pay attention to maintenance and repair activities. As sociologists and historians of science note (Godin and Vinck 2017), the literature suffers from a pro-innovation bias that is rarely addressed. The emerging wave of maintenance and repair studies addresses this bias, but goes too far in the opposite direction, away from innovation policy considerations.

Finally, political philosophy and the recently advocated public value framework has so far been insufficiently applied to innovation policy and maintenance and repair. Employing the public value framework will allow us to account for a greater variety of benefits flowing from maintenance and repair. In particular, it allows us to consider the value that improved public sector capabilities or dynamic economic consequences (such as the creation of new markets) have.

Data and methodological approaches

We draw on over three years of empirical research on robotics innovation in the infrastructure maintenance sector. One of the authors (Cuevas Garcia) carried out research on the scaling up of co-creation instruments in European robotics innovation policy, paying particular attention to pre-commercial procurement. This paper pays particular attention to two case studies. The first is a project called Public end user-Driven Technological Innovation (PDTI), a Financial Support for Third Parties initiative coordinated by the European Coordination Hub for Open Robotics Development (ECHORD++, 2014-2019) and hosted by the water infrastructure manager of Barcelona. The second is a pre-commercial procurement project coordinated by the water infrastructure manager of Madrid. Both projects focused on the development of autonomous robots for the inspection and maintenance of sewer infrastructures. Around 12 interviews with project participants were conducted together with empirical observation during the final evaluations of one of these. These materials are complemented by document analysis of both initiatives and of guidelines for other European projects on inspection and maintenance robots.

Drawing on previous research of the other author (Fuchs), we will use these two examples, as well as their economic, social and political consequences and use them to consider the applicability of the public value framework to these cases. We consider four different types of economic consequences and analyse it through the public value lense. First, the value that is directly generated by improvements in the public infrastructure. Second, the dynamic economic consequences which include the creation of new markets, growth and innovation. Third, it considers the dynamic capabilities for future action in the public sector. Finally, the relationships between the public and private sector are analysed. What types of collaborations between these sectors are more likely to generate public value in the long run?

Expected results and conclusion

We aim at both advancing our understanding of different types of innovation procurement in the maintenance and repair sector and thus create a framework for helping policy makers and administrators to make decisions in this area. There seem to be a great variety of policy mechanisms, but no systematic way of assessing them and comparing them from a normative perspective. Furthermore, we hope to apply the normative and political discussion of the role of the state in economic and infrastructural affairs to the maintenance and repair sector. We expect that by employing the public value framework we can adequately capture many of the beneficial benefits, as well as value conflicts, which may arise.

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Keywords: Maintenance, Innovation, Public procurement, Robotics, Public value

[163] Sergey Kolesnikov (University of Cambridge), Gabriel Chan (University of Minnesota), Anna Goldstein (University of Massachusetts Amherst), Laura Diaz Anadon (University of Cambridge) and Venkatesh Narayanamurti (Harvard University). *Technology Spillovers as Drivers of Clean Energy Innovation: Mechanisms, Enablers and Policy Implications.*

Abstract. Spillovers of knowledge across technology domains are among the key drivers of technological innovation, as knowledge initially developed in one technology area can be applied in another area to enable breakthroughs, improve technology cost and performance and advance technologies across innovation stages. Contributions of technology spillovers to clean energy innovation, in particular, are expected to play a major role in the global push towards cost-effective decarbonization of the energy system (International Energy Agency, 2020). Despite the importance of technology spillovers, we have limited understanding of how knowledge spillovers across technology domains can occur, what factors enable or affect spillovers, or how spillovers can be most effectively spurred by public policies for the decarbonization of the energy sector.

To fill this gap in knowledge, we have undertaken a multi-year mixed-methods investigation of technology spillovers in three important clean energy technologies: solar photovoltaics (PV), lithium-ion batteries (LIB), and white light-emitting diodes (LED). We combine quantitative and qualitative empirical evidence from a broad literature survey, analysis of primary documents, expert interviews, patent and scientific paper citation analysis, and a machine learning-based method of patent text analytics across the three technologies to understand the mechanisms and enablers of technology spillovers. We integrate these methods to trace the history and contributions of spillovers to individual innovations in the three technology areas, and from these, we iteratively work to generalize toward a typology of technology spillover mechanisms and enabling factors.

We have found evidence of crucial knowledge contributions made by technology spillovers to 15 innovations in solar PV, 12 innovations in LIB, and 7 innovations in white LED. In all three domains, identified spillovers were particularly important at the early stages of innovation, as they enabled key components and manufacturing processes that eventually became integral parts of the first commercial LIB and white LED products and the “Aluminum Back Surface Field” (Al-BSF) solar PV technology design that dominated the market for several decades. However, the impact of spillovers in our set was not limited only to the stages of early research and development (R&D). We also found evidence of spillovers occurring at later stages of technology demonstration and market deployment. Across the three areas, spillovers contributed to innovations in technology components, architecture, and manufacturing processes. In addition, spillovers drove a majority of improvements in consumer experience characteristics of white LED light sources used in solid-state lighting applications.

Based on the analysis of identified spillover processes in three technologies, we distinguish between four types of spillover mechanisms, i.e., different ways by which a spillover can occur. Technology spillovers can be a result of (1) learning and researching, (2) communication and collaboration, or (3) human mobility (both physical and across disciplines or fields). They can also be (4) embedded in physical objects, such as manufacturing equipment. Importantly, these four mechanisms are not exclusive of each other, as a spillover can occur by several simultaneously operating and mutually supporting mechanisms. Observed spillovers also differed in how intentional they were. In many cases, spillovers occurred as a result of a targeted search for external knowledge needed to solve a local problem or targeted application of available knowledge in a new area or for a new purpose. However, a few notable spillover cases also occurred serendipitously in the process of undirected "blue-sky" research.

We also identify many broad categories of enabling factors for technology spillovers, including, but not limited to external sectoral and market shocks; booms of R&D in external but related technology domains; freedom of search in the laboratory setting both in academia and industry; multidisciplinary education and training; cross-disciplinary hiring and team composition; multi-sectoral firms; and academic-government-industry partnerships and knowledge exchange events. In addition, we highlight four categories of public policy that enabled spillovers in the three studied technologies: (1) public R&D funding that stimulates cross-disciplinary knowledge search and collaboration, (2) public funding for demonstration projects, (3) deployment policies that create incentives for strategic entrepreneurial knowledge search by incumbent firms in other industries, and (4) cross-cutting policy that supports coordination—such as government-industry round tables and roadmapping exercises. We also find that "stop-go" funding cycles negatively affected spillovers into clean energy technologies, delaying resulting innovation and technology deployment.

Based on insights gained from the study, we propose a set of principles that can guide the design of energy and innovation policies and management practices that leverage technology spillovers to accelerate clean energy innovation. First, for any organization, firm, or funding agency, there is a need to recognize and acknowledge the trade-offs that exist in funding and supporting R&D and innovation activities in the focal knowledge domain with developing and supporting a broader multi-disciplinary knowledge base involving multiple knowledge domains. Access to a broad pool of knowledge can accelerate innovation in the focal domain through technology spillovers, but it may not work on its own without a deep understanding of the focal domain and the ways by which external spillover knowledge can be applied in it. These trade-offs suggest that there is a balance to be found between the depth and breadth of knowledge search in an organization, and that this balance can be proactively pursued and managed. Second, policies that aim to leverage technology spillovers for innovation should be flexible both in the choice of particular policy and funding instruments and in the policy design to allow for knowledge search in unexpected directions. Some of the most notable spillovers in our set occurred when researchers were able to pursue "blue-sky" research or participated in public- or industry-funded mission-oriented R&D but were still allowed for a certain freedom of search. Third, we found that continuous knowledge exchange between science, engineering and manufacturing is important for the generation of spillovers, as knowledge exchange can occur between different technologies at any stage of innovation. Such cross-disciplinary, cross-sectoral exchange should be broadly supported at all levels: from individuals (e.g., through industry placements) and events (e.g., conferences mixing scientists, engineers, and industry representatives) to organizations (e.g., through academia-industry collaborations and alliances) and platforms for broad cross-sectoral and cross-disciplinary collaboration (e.g., industry roundtables, roadmapping, and foresight exercises). Finally, all instruments and activities supporting technology spillovers should not be restricted only to R&D policy. They should also be included in the policy toolkit for the support of innovation across all stages, including technology demonstration and market deployment. This principle is particularly relevant for innovation in clean energy technologies, in which deployment policies are known to have played a crucial role in stimulating dramatic cost reductions and technology deployment over time and are expected to continue playing this role in the future.

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Keywords: knowledge spillovers, technology spillovers, knowledge exchange mechanisms, research and innovation policy, clean energy technologies, decarbonization

[164] Joshua Moon (University of Sussex), Frederique Bone (Science Policy Research Unit (SPRU),), Duncan Moore (Science Policy Research Unit (SPRU), University of Sussex), Kate Jones (Science Policy Research Unit (SPRU), University of Sussex) and Michael Hopkins (Science Policy Research Unit (SPRU), University of Sussex). *Connecting capabilities: A role for specialist knowledge exchange professionals in boundary-spanning university research projects.*

Abstract. This study was commissioned by the AGENET network in order to track the development of the AGENET network, showing the progress achieved in boundary-spanning collaborations within and between Higher Education Institutions (HEIs) and between HEIs and industry. This paper's primary focus is on exploring the role of Knowledge Exchange (KE) professionals in supporting these collaborations.

The working paper's main aim is to contribute to the science policy literature on understandings of how KE Professionals can support transdisciplinary research projects such as AGENET by promoting boundary spanning collaborations. KE is an emerging specialisation, with a novel, boundary-spanning role in UK HEIs. The emergence of this new role, and the recognition of its centrality to impact, has led to increasingly specialised and project-specific posts in UK HEIs that seek to leverage these new KE professionals and their skills to connect researchers and stakeholders across a wide range of organisational, disciplinary, and institutional boundaries. Much literature focusses on the role and mechanisms of boundary-spanners in technology transfer, but limited attention has been paid to this new, broader class of broker; the KE professional. As such, many questions remain as to how KE professionals can be integrated into wider organisational structures and the approaches that can be used to enhance their effectiveness as knowledge brokers. This is an area that has rarely been studied, despite the growing importance attached to KE by policy makers seeking to encourage the uptake of academic research in order to address grand challenges, such as ageing.

The Diversity Approach to Research Evaluation (DARE) was selected for this study due to its combined use of maps, measures and narrative, in order to understand research collaboration processes. DARE asks interviewees to map out the network of collaborators on their research projects while talking about the ways in which they and their colleagues work, how their connections have been made, and how KE professionals have facilitated and supported these activities. Findings have been derived from 33 interviews with 32 core members of the UK SPINE network, as well as documentary analysis. These interviews were broken into 11 KE professionals and 22 researchers and principal investigators to gain a good understanding of the role of KE professionals from both their own perspective and the perspective of the researchers who interact with them.

The AGENET network has grown substantially in its first three years, with at least 292 participants detected, increasing from a core network of at least 69 before the project started. Industry participation in the network has increased with 33 new industry participants, bringing the total to at least 41 individuals from industry, representing at least 29 companies. The AGENET hubs themselves are also now connected through at least weekly interactions, including cross-KE professional meetings. Furthermore, we find that AGENET participants are tending to work with others in AGENET across organisations more than within organisations; suggesting more intensive facilitation of inter-organisational brokerage. Participants are tending to work with others in AGENET across institutional types (e.g. university with industry) more than with others of the same institutional type (e.g. university with university), again suggesting more intensive facilitation across institutional types. Generally, the project outcome KE professionals most valued was the formation of new connections. Observed outcomes by AGENET interviewees include firstly, development of highly skilled people, followed by (jointly) collaboration with industry and public engagement.

KE professionals have become central to the AGENET network, demonstrated by mapping interactions across the AGENET network, where they play key roles catalysing inter-personal links and new projects. Their roles are even more prominent in the network than perhaps anticipated (e.g. by job descriptions), and include representation at the highest levels of the project's management structures. KE professionals were also found to undertake activities previously associated with academic roles, such as: organising research meetings, workshops, and seminars; co-authoring bids for funding; and overseeing funding competitions.

KE professionals were found to be effective when embedded in pre-existing functional teams, whilst working in project teams with KE colleagues across departments and organisations. KE professionals were also found to be increasingly specialised in particular aspects of the role including coordination, university-industry transfer, programme management, etc.

Some key challenges identified for AGENET include: engaging physician researchers; the potential need to rebalance the lead organisation's role with other partners as the network's projects advance 'downstream'; and the mismatch between AGENET's long term goals and the short-term funding provided by many channels in the UK funding system.

However, central to this research is the threat to the KE team's network cohesiveness due to short term funding uncertainties. This has already led to significant turnover, with four KE professionals leaving AGENET and being replaced in the time since interviews were conducted. Given the central role that these KE professionals played in the network, the skills developed by personnel, and the team built up around the AGENET programme, this loss of institutional memory may have significant implications.

This study of AGENET demonstrates the role that KE professionals can play in ambitious projects that seek to address the grand challenges set by policy makers for universities. KE professionals are now taking up prominent roles in these projects, facilitated by dedicated posts and targeted funding. They play a crucial role in facilitating boundary-spanning collaboration, aided by sector- and field-specific experience. However, funders and universities are yet to fully ensure the sustainability of these posts, placing the relational gains (i.e. interpersonal networks) that these KE professionals achieve, at risk. While intense funding has been offered for the establishment of KE networks and concomitant investments in KE professionals' training and hiring made, the core policy challenge for the future of KE in UK Higher Education is a question of sustainability rather than scale.

Keywords: Knowledge Exchange, Science Policy, Boundary Spanning, Knowledge Brokers

[166] Jip Leendertse (Utrecht University) and Frank van Rijnsoever (Utrecht University). *Finding Neverland, Entrepreneurial Ecosystems for Sustainable Entrepreneurship.*

Abstract. 1. Introduction

To overcome the grand societal challenges, such as climate change, there is a need for a socio-technical transition to a more sustainable society (Alkemade et al., 2011). Sustainability transitions are, for an important part, driven by entrepreneurs who introduce new sustainable technologies and business models (Bjornali and Ellingsen, 2014; Cohen and Winn, 2007; Leendertse et al., 2020; Tiba et al., 2021). City, regional, and national governments are increasingly implementing policies to facilitate sustainability transitions (Truffer et al., 2015), and to develop their region into an ecosystem for sustainable entrepreneurship (Tiba et al., 2021).

For these policies to be effective, policy makers need to understand which regional factors stimulate and facilitate the founding of these transformative sustainable start-ups (Giudici et al., 2017; Tiba et al., 2021). Regional factors are important for entrepreneurship because they influence the availability of entrepreneurial opportunities (Ács et al., 2014; Acs and Audretsch, 2005; Alvedalen and Boschma, 2017; Stam, 2015) on which the occurrence of entrepreneurship depends (Shane and Venkataraman, 2000). These factors, such as the institutions, the infrastructure, and the availability of talent and finance, are a widely studied topic and have been summarized in the entrepreneurial ecosystem framework (Alvedalen and Boschma, 2017; Andersson and Koster, 2011; Stam, 2015). An entrepreneurial ecosystem (EE) comprises a set of interdependent actors and factors that are governed in such a way that they enable productive entrepreneurship within a particular territory (Stam, 2015; Stam and Spigel, 2018).

However, the presence of start-ups who contribute to sustainability transitions is likely to be influenced by factors that are partially different than regular entrepreneurship, because sustainable entrepreneurs have different motivations and encounter additional market challenges in comparison with other entrepreneurs (Gibbs, 2006; Hart, 2006; Leendertse et al., 2020; Linnanen, 2002; Tiba et al., 2021). This difference is potentially due to the fact that the benefits of sustainability are often not just for the user (Geels, 2011). Furthermore, previous research suggests that regional factors are particularly important for sustainable start-ups because internal drivers to establish sustainable start-ups are likely to remain dormant without a supportive socio-economic environment (Pastakia 2002; Ohen & Musson 2000; Gibbs 2006).

It is thus uncertain if the entrepreneurial ecosystem framework literature currently provides the insights that policy makers need to increase the conditions for transformative sustainable entrepreneurship in their region (Giudici et al., 2017; Tiba et al., 2021). We therefore study if the factors from the entrepreneurial ecosystem literature have a different influence on sustainable entrepreneurship and if there are additional factors that play a crucial role. Sustainable entrepreneurial ecosystems are increasingly receiving attention as an emerging research field (Volkmann et al., 2021). However, the concept still lacks theoretical depth. We argue that this can be improved by enriching the concept with insights from the literature on sustainability transitions. In particular we expand the entrepreneurial ecosystem framework with insights from the multi-level perspective (MLP), which is the dominant framework in transition studies (Geels, 2011; van Rijnsoever and Leendertse, 2020).

In doing so we fill two research gaps. First, we explore the applicability of the entrepreneurial ecosystem literature to contexts of socio-technical transitions. Second, our research addresses a void in the geography of sustainability transitions literature, which does not yet sufficiently address the role of entrepreneurship (Truffer et al., 2015). We address these research gaps through the following research question:

What regional factors determine the presence of sustainability transition start-ups in a region?

We will answer this research question using quantitative analyses on 50,000 start-ups from 274 European NUTS2 regions in 28 countries. Policy makers can use our results to establish policies that help build ecosystems for sustainable transformative entrepreneurship in their region.

2. Theory

2.1. Entrepreneurial ecosystems

The geography of entrepreneurship literature has provided numerous insights into the role of different factors causing the spatial allocation of start-ups. Following (Leendertse et al., 2021; Erik Stam and Van de Ven, 2021) we summarize the empirical geography of entrepreneurship literature with ten elements affecting the prevalence of entrepreneurship. Institutions, the entrepreneurial culture, networks, leadership, access to finance, talent, intermediaires, the physical infrastructure, knowledge, and local demand.

Previous empiric work has shown that these ten elements have a strong influence on the presence of productive entrepreneurship in specific regions (Leendertse et al., 2021). Transformative sustainable start-ups often encounter additional market and institutional constraints (Hoogendoorn, 2016; Leendertse et al., 2020). A supportive entrepreneurial ecosystem can help these start-ups overcome these constraints. The quality of the entrepreneurial ecosystem is thus very important for transformative sustainable start-ups. We therefore hypothesize that the ten elements identified from the entrepreneurial ecosystem literature have a similar but stronger influence on transformative sustainable entrepreneurship than on regular entrepreneurship.

2.2. Geography of sustainability transitions

Understanding the geography of transformative sustainable entrepreneurs requires an integration of the entrepreneurial ecosystem framework with a transition framework. We do so using the MLP, because this is the dominant framework used in transition studies (Geels, 2011; van Rijnsoever and Leendertse, 2020).

According to the MLP, societal functions (mobility, food production, or energy supply) result from socio-technical systems. According to the MLP (see fig. 2) a transition entails the disruption of an incumbent socio-technological system and its eventual replacement by or merge with an alternative, newly developed socio-technical system(s), which are the so-called niche systems (Geels, 2005; van Rijnsoever and Leendertse, 2020). Both types of socio-technical systems consist of three basic interacting elements. First, there are actors that exchange resources and form networks. Together, they develop and deliver products or services. They do so under an institutional regime (the second element), which is a semi-coherent set of rules that guide actors' behaviors (Kemp, 1994). The regime is continuously reproduced by the actors that adhere to these (formal or informal) rules. The third element is infrastructure, which is all the physical resources that are needed at minimum for the socio-technical system to function (Chappelow, 2019).

Transformative sustainable start-ups and scale-ups are actors who introduce new products or services that play a central role in the emergence of niche systems. The fate of these start-ups is thus tied to the growth of the niche and its potential overtaking of or merge with the incumbent system. The strength of incumbent systems and opportunities for niche systems are (partly) geographical (Truffer et al., 2015) and these thus influence the favorability of a region for transformative sustainable entrepreneurship. An overview of the regional factors that determine the presence of transformative sustainable start-ups and scale-ups in a region thus requires expanding the entrepreneurial ecosystem framework with insights from the MLP. In particular, how resilient the local incumbent system is to the changes introduced by transformative sustainable start-ups. However, our work on the integration is currently still in progress. We have therefore not yet included this integration and the metrics for the state of the incumbent and niche socio-technical systems in this abstract.

3. Methodology

In the European context we define the ecosystem through the NUTS-2 classification, which identifies 281 geographical regions over the 28 member states (European Commission, 2018). To measure EE elements at this level we use the operationalization and data collection as outlined in (Leendertse et al., 2021). Subsequently we use the methodology employed by Leendertse et al. (2021) to create an entrepreneurial ecosystem index (EEI) based on these ten elements.

To identify the start-ups, we use Crunchbase, which contains the most comprehensive start-up database available at the European level. To determine which of these start-ups are sustainability start-ups we combine a short description of each start-up from Crunchbase with the a scraped version of the internet archive of each start-ups website. We combine the website and Crunchbase text into one text document. We use text analysis, in the form of a dictionary based approach, on these descriptions to determine whether a start-up is sustainable. In order to account for the size of the ecosystem we define our dependent variable as the amount of sustainable start-ups in the region per 10,000 inhabitants and as divided by the total number of start-ups.

4. Results

To study the influence of the quality of the entrepreneurial ecosystem on the amount of sustainable start-ups in the regions we perform a series of regression analyses. The results of Leendertse et al. (2021) showed that the relation between the quality of the entrepreneurial ecosystem as measured by the EEI and the amount of start-ups per 1,000 inhabitants in an ecosystem is not linear.

When we run the two models using the amount of sustainable start-ups in a region per 1,000 inhabitants. The basic ($R2 =0.417$) and quadratic model($R2 =0.455$) both show that the EEI has a significant influence on the sustainable start-up output and that the quadratic model outperforms the linear model. The R2 for these models is higher than for the models with regular entrepreneurship as output. These preliminary results are thus in line with our hypothesis that the ten elements identified from the entrepreneurial ecosystem literature have a similar but stronger influence on transformative sustainable entrepreneurship than on regular entrepreneurship.

We then use the share of all start-ups that are sustainable start-ups as a second output measure for sustainable entrepreneurial ecosystems. Both models ($R2 =0.000$) and ($R2 =0.000$) show no significant influence from the EEI on this output variable. In robustness checks in which only ecosystems with more than 10, 50, or 100 start-ups are included the results stay the same. We thus find that the quality of an entrepreneurial ecosystem has no significant influence on the share of sustainable start-ups in that ecosystem. These findings remain the same when including the individual elements rather than the EEI in regression analyses.

5. Discussion

We study which regional factors determine the presence of sustainability transition start-ups in a region. We find that the quality of an entrepreneurial ecosystem has a strong correlation with the absolute number of sustainable start-ups per 1,000 inhabitants of that ecosystem. However, the quality of the entrepreneurial ecosystem has no relation with the share of start-ups in an ecosystem that are sustainable. These preliminary results provide some early insights in the applicability of the entrepreneurial ecosystem literature to contexts of socio-technical transitions.

The next step of our research is to find out which factors determine the share of sustainable start-ups in entrepreneurial ecosystems. This is particularly relevant because our dataset does contain big differences in the share of sustainable start-ups in different ecosystems. To tackle this research question we will integrate the MLP on transitions with the entrepreneurial ecosystem framework. In this extended abstract we already shortly cover the MLP and our reasoning for its use in the theory section but the full integration and resulting metrics are still a work in progress.

In short the next steps taken into this research are to 1) Integrate the MLP and EE frameworks and determine metrics that show how resilient the local incumbent system is to the changes introduced by transformative sustainable start-ups. 2) Identify which regional factors influence the favorability of regional ecosystems for sustainable start-ups and if there are different constellations possible.

In doing so, our first, and foremost, contribution to the literature is that by studying the factors that influence the founding of sustainable transition start-ups, we add a transformative sustainability focus to the literature on entrepreneurial ecosystems. Second, we integrate entrepreneurship into the literature on the geography of sustainability transitions (Truffer et al., 2015). Policy makers can use our results to establish policies that help build ecosystems for sustainable transformative entrepreneurship in their region.

Keywords: Sustainable entrepreneurship, Sustainable entrepreneurial ecosystems, Sustainability transitions, Responsible entrepreneurship, Entrepreneurship for Societal Challenges

[168] Sajad Ashouri (VTT Technical Research Centre of Finland), Arash Hajikhani (VTT Technical Research Centre of Finland), Arho Suominen (VTT Technical Research Centre of Finland), Ari Hyytinen (Hanken School of Economics) and Perti Rouvinen (VTT Technical Research Centre of Finland). *Are Sustainable-Oriented Technologies Disruptive? An Approach to Measuring Technology Disruptivness Using Patents.*

Abstract. Standing on the shoulders of giants is a necessary part of creativity, innovation, and development. Innovation does not come from a vacuum, but develops based on our experiences and on the achievements of those who have gone before us. As innovation speeds up, product-life cycles shorten, and markets become more globalized, companies of all sizes must monitor the competitive landscape in order to gain an advantage over their rivals. A record number of patents have been filed worldwide as a result of global disruptions like these (World Intellectual Property Organization 2020). The transformative leap of the evolutionary dynamics of innovation often results in disruption in the mainstream trends. Since the introduction of 'disruptive innovation' (C M Christensen 1997; Clayton M. Christensen et al. 2002), recent decades have seen the theory become a research hotspot. According to Christensen, even if some innovations are disruptive to one group, the same innovations could be sustaining to another (Adner 2002; Clayton M. Christensen et al. 2002; Deck 2005). While "disruptive innovation" defines as a single product or service at one fixed point, the more accurate interpretation describes it as the evolution of that product or service over time (Clayton M. Christensen et al. 2016).

Technology disruptions and large-scale technological changes produce winners and losers, as well as new forms of interaction that challenge existing social and institutional mechanisms of distribution. Disruptive technology and innovations create new markets and provide new functions, which, in turn, disrupt existing market value chains (Adner 2002; Clayton M. Christensen et al. 2016, 2018; Constantinos D. Charitou and Constantinos C. Markides 2012). Consequently, technological change is at once a constant threat and an opportunity for economies. With disruption in technology, the recent productivity slowdown observed across Europe and the US over the past few decades has caused a divide among researchers, with some viewing technology adoption - or lack thereof - as the main source of slowdown, and others concerned about the prospects of technological advances (for a review, see Goldin, Koutroumpis, Lafond, Rochowicz, & Winkler (2019)). In recent years, disruptive innovation has been the subject of intense debates -- from its existence and prevalence to its measurement and assessment, to its applicability to different industries (Clayton M. Christensen et al. 2018; Nagy et al. 2016). Previous research has experimented on measurement dimension and regimes for disruptive innovation (i.e. (Danneels 2006; Govindarajan and Kopalle 2006) in contrast, the lack of quantifiable measures to assess innovation's disruptive potential is a persistent problem (Nagy et al. 2016). Quantifying innovation disruptiveness could enhance the predictive capabilities as it is essential knowledge for market incumbents 1) to adopt and modify the research and development objectives 2) to avoid inimical consequences from ignoring a disruptive innovation.

Our research will focus on the measurement aspect of disruptive innovation, indicator design and interpretation and its application on a comprehensive set. We contributed to Funk and Owen-Smith (2017) work that suggests a measure quantifying the degree to which an invention consolidates (or develops incrementally) or destabilizes (or disrupts) the trajectory of technology. The dynamic network measure of technological change compiled by Funk and Owen-Smith (2017) has utilized for studying team size effect in disruption in science and technology (Wu et al. 2019), originality in science (Shibayama and Wang 2020) and technological convergence and prediction trends (Park and Yoon 2018; Sam Arts et al. 2021). Our study aims to benchmark and utilize a computational measure to capture the ways in which technologies in the form of patents are novel. We distinguish the novelty of artefacts by identifying which ones are more likely to disrupt knowledge streams and which is more likely to consolidate them. While advancing the measure for estimating the disruptiveness of technological artefacts (i.e. Patent), we apply the measurement to a comprehensive database of The United States Patent and Trademark Office (USPTO).

To contextualise our measurement and findings, we focus on green or sustainable technologies and their disruptions compared to other technological progress. Since the industrial revolution, and even before, the advancement of human societies has relied on a seemingly unlimited supply of natural resources. Technological innovations up until recently have paid little attention to their impacts on the environment and climate. Since innovative activity is cumulative and path-dependent, the current urgent need for sustainable innovations seems to call for completely new kinds of solutions and for a distinct break from the past. Nevertheless, is such a break taking place? Are "green" innovations more disruptive than other innovations? This research sets the methodological building blocks in order to provide evidence on the absolute and the relative disruptiveness of sustainability patents.

Keywords: Technology Disruption, Sustainability, Measurement, Indicators, Patents

[169] Philip Shapira (University of Manchester/ Georgia Institute of Technology), Claire Holland (University of Manchester), Priscila Ferri de Oliveira (University of Manchester) and Adam McCarthy (University of Manchester). *Innovation intermediaries at the convergence of digital technologies, sustainability, and system governance.*

Abstract. Theoretical Framework:

In the scaling and transfer of emerging technologies for applications, there are critical roles for innovation intermediaries. These comprise governmental, private, or non-profit organisations that support innovation development, knowledge transfer, and the transition of innovation from lab-to-market. The role of intermediaries is typically presented in a linear way, with intermediaries spanning gaps in the technology transfer process that arise between upstream research and close-to-market product and process development (Islam, 2017). However, the process of transferring technology whilst simultaneously addressing the business model, sustainability, and responsibility challenges of emerging technologies means that innovation intermediation is likely to present iterative and complex challenges. We conceptualise these challenges in the form of dilemmas – using the everyday meaning of "dilemma" as a situation where difficult choices must be navigated (rather than the purist usage of the impossibility of choice).

We initially focus on three dilemmas: (1) Sustainable development, which encompasses the problem of reconciling promissory claims about how an emerging technology will address sustainability objectives when confronted with realities associated with trade-offs (environmental, economic, or societal) that arise in scaling; (2) Governance, comprising issues associated with coordinating diverse governance approaches, understandings, and responsibilities associated with converging technologies (e.g., those associated with synthetic biology, artificial intelligence (AI), and automation) (van de Poel & Sand, 2018); and (3) Societal control and alignment, combining problems of knowledge uncertainty about the implications of emerging technologies (Collingridge, 1980) with challenges of who should be involved in decision-making about applications and scaling of technologies (Ribeiro et al., 2018).

These dilemmas are not mutually exclusive. They are embedded in both research and innovation, and in broader governance processes, but particularly come together in the processes of innovation intermediation. Moreover, as this work develops, these initial "starting" dilemmas, which are derived from the literature, alongside our framework are likely to evolve, particularly as we learn from their application in our target convergent emergent technology. The knowledge and skills that were crucial to intermediary roles a decade ago may not be the same as those needed in new technological and market environments (Lopez and Vanhaverbeke, 2009; Rodriguez et al., 2017). Given rapidly changing technological contexts, what we know about the features and activities of intermediaries from research done even a few years ago might now be less applicable, justifying new work specifically focusing on intermediaries operating in the context of advanced digital technologies. In particular, by considering the characteristics of these dilemmas in the context of the strategies and operations of innovation intermediaries, we seek to: (1) advance understanding of intermediary functions (and dysfunctions); (2) promote anticipation about the full range of challenges associated with responsible and sustainable development and diffusion of emerging technologies; (3) identify insights, both for theory and practice, about the roles that intermediaries can perform in navigating these quandaries, and; (4) draw policy recommendations to help organisations in addressing such dilemmas.

Data and Methodological Approaches:

The target technology for empirical analysis is engineering biology, with a focus on the applications of AI in this domain. The convergence of biology with advanced digital technologies, big data, and increased automation, has positioned engineering biology as a promising driver for bio-economic development and sustainable transition (McKinsey, 2020). Building on knowledge and methods for designing biological components and devices developed through synthetic biology, the domain of engineering biology aims to scale and exploit these capabilities in commercial and public spheres (UKRI, 2021). Engineering biology is positioned as a means to address multiple societal challenges, including climate change, sustainability, secure food and energy sources, global health, and bio-manufacturing.

In the engineering biology domain, over recent years, there has been growth (mainly in advanced economies but also in some emerging economies) in the scale and scope of intermediaries, including bio-refineries, bio-foundries, bio-manufacturing hubs, smart centres, and transition projects (Hillson et al., 2019). For this paper, we will undertake pilot studies with selected innovation bio-intermediaries to probe a series of questions, in three categories: (1) understanding the current functions of bio-intermediaries in applications of AI/automation (What are anticipated future uses of digital technologies, AI, and automation, and what roles are bio-intermediaries anticipated play?); (2) probing the materialisation of the three dilemmas in the bio-intermediaries (i.e., of sustainable development, governance approaches, and social control and alignment), and; (3) probing how bio-innovation intermediaries understand these dilemmas, how they navigate them, and how future navigation might be pursued, given anticipated convergent technology developments.

We will pursue these questions in three types of bio-intermediaries; transition projects, where research discovery is focused at engineering biology/AI/automation interfaces with intent for commercialisation; bio-refineries that employ advanced automation and computational analytics to significantly improve translational speed of bioengineering applications; and bio-manufacturing hubs, where companies are explicitly involved in translating research to potential commercial processes and products. We anticipate six cases (two from each category) focussed on UK bio-intermediaries, using a combination of interviews, action-research participation in workshops, and analysis of secondary materials (reports, public online information, etc.). Qualitative methods will be used for analysis, including content and narrative analysis. These cases should be regarded as exploratory cases to test and expand concepts and understandings.

Expected Results:

We expect that this work will contribute to the scholarly literature by advancing conceptual understandings of the dilemmas of the convergence of AI and digital technologies within innovation intermediaries, at the cross-section of sustainability, society, and governance.

Specific results will consider:

(1) How today's bio-intermediaries operate in the context of convergent technologies (with comparisons to earlier models of innovation intermediaries), and how those roles are expected to evolve. This will include investigation of the practical realities of convergence around engineering biology and AI, providing insight into the current state of application beyond proof of concept and theoretical use cases. The use of qualitative methods should enable an evaluation of the current uses and limits of these technologies in the context of an innovation intermediary.

(2) The realisation and relevance of the three conceptualised dilemmas for innovation bio-intermediaries, whether there are modifications or extensions to these dilemmas. Empirical evidence of whether these dilemmas are veridical should form the foundation to push our analysis beyond descriptive 'stock taking' and provide useful insights about potential new roles of innovation intermediaries with the convergence of technological developments.

(3) How bio-innovation intermediaries navigate these dilemmas of the convergence of digital technologies, sustainability, and system governance, and with what implications and for whom. These intermediary organisations provide an opportunity for the integration of expertise, knowledge and capabilities, and are consequently well placed for innovation based on technological convergence. That being said, uncertainty remains about real use cases (beyond promissory narratives) and their associated challenges. As such, the work proposed here can be valuable in advancing discussions around intermediaries while simultaneously investigating both dilemmas presented in the literature, and those that arise through the development of our exemplary cases.

(4) Policy recommendations that aim to reconcile some of these dilemmas. This is particularly important with the increasing expectation that innovation intermediaries should be innovative, yet still serve the societies that they operate in. By probing how innovation intermediaries navigate the proposed dilemmas, we expect to generate fruitful insights to offer a proactive approach to the design of private and public policy responses to these challenges. Therefore, the results of this work are expected to inform not only theory but also practise in innovation intermediaries at the interface of converging technologies.

Overall, this work contributes to expanding our knowledge of the continuing evolution of artificial intelligence, digital technologies, and automation in innovation, particularly within the context of innovation bio-intermediaries, by investigating the dilemmas that they face at the cross-section of technology, sustainability, and system governance.

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Keywords: Innovation intermediaries, Responsible innovation, Technological convergence

[170] Jan Peuckert (Institute for Ecological Economy Research) and Florian Kern (Institute for Ecological Economy Research). *Assessing how peer communities contribute to socio-technical change: three case studies of open source communities.*

Abstract. Private end users are essential actors in the process of sociotechnical change (Nielsen et al., 2016). Transition studies have demonstrated that users play various important roles in developing and diffusing sustainable innovations, ranging from user-producers, user-legitimators, user-intermediaries, user-citizens to user-consumers (Schot et al., 2016). Despite a growing recognition of the importance of household sector activities for innovation in general (von Hippel 2016, OECD & Eurostat, 2018) and for the development and diffusion of sustainable technologies in particular (Nielsen, 2020), decision makers still significantly underestimate the role of private actors as the original source of innovation (Bradonjic, Franke, Lüthje 2019). This misconception is all the more problematic as the internet has magnified the possibilities for peer-to-peer exchange and collaborative knowledge production via online community platforms (Hyysalo2021). The growing importance of open source communities illustrates the relevance of this problem.

A recently published EU report (Blind et al. 2021) points at the significant economic impact that open source developments, i.e. technical solutions that are made publicly available so that anyone can study, modify, distribute, produce and sell them. It is to be expected that this mode of innovation will significantly influence the shape of future technology fields, such as robotics and automation, machine learning and artificial intelligence, additive and distributed manufacturing. It also promises great potential for developing innovations in broad sustainability fields of action such as resource efficiency and the circular economy. Transformative innovation policy therefore needs to better understand and harness this kind of organizing the production of knowledge to explore and stabilise alternative, more sustainable technological pathways.

The study is concerned with understanding, how online peer communities advance the creation and diffusion of sustainable innovation at the level of the innovation system and what their actual contributions to sociotechnical change are. We look in detail at three open source communities and describe the main mechanisms by which they support systemic change. As case studies, we chose well-established and active peer communities with a minimum level of project maturity, community size and online interaction from three fields of sustainability action (energy, mobility and recycling). The communities that were selected are: (1) OpenEnergyMonitor (OEM), a community that develops open source electronics for monitoring home energy consumption, (2) OpenStreetMap (OSM), a community that develops open maps and geodata, and (3) Precious Plastic (PP), a community that develops local plastic recycling systems.

Conceptually, the analysis builds on the functional approach to technological innovation systems (Bergek et al., 2008, 2015). It assesses the role of each peer community as a network of actors of a given technological innovation system (TIS) by tracing its contribution to the fulfilment of the essential system functions. We evaluated the role of the OEM community for the TIS of “smart energy monitoring technologies”, of the OSM community for the TIS of “geo-information services”, and of the PP community for the TIS of “local plastic recycling solutions”, respectively. For the assessment of the TIS contributions, we use a mixed-methods approach that combines a network and contribution analysis of the online interaction data and semi-structured expert interviews with community members. In this way, three distinct ways in which peer communities support socio-technical change are identified and described, which again can be related to the typology of user roles proposed by the transition literature (Schot et al., 2016).

We collected interaction data by scraping all posts and author profiles that were publicly available in the online forums of the open source communities. We restricted the analysis to posts that were published in the time period of 01/2017 to 12/2019. In total, the resulting dataset contained more than 200,000 posts (20,000 threads) by 12,000 registered users. The data was analysed with regard to key figures of contribution behaviour (e.g., number of posts per user, length of contributions, response rate) and network metrics (e.g., network density, network degrees). In addition, the interviews aimed to elicit key activities and processes in the communities relevant to the fulfilment of the innovation system functions. The interviewer could choose from a set of diagnostic questions, in order to steer the conversation towards the potentially relevant activities of the community. Among other things, interviewees were asked how technical knowledge was developed and passed on in the networks, how people worked together and exchanged information, how people joined and what common goals they perceived, how decisions were made and what resources were used. A total of eighteen half-hour to one-hour interviews were conducted and recorded with MS teams, professionally transcribed and then coded by two researchers using TIS functions as a deductive category system.

The comparison of the case studies shows that open source communities differ substantially with regard to diversity of member composition, community orientation, response behaviour, relevance of online communication, power structure, outward reach, for instance. Based on the statements of the interviewed community members, the OEM community can be labelled as a “tech community” that serves as a network of primarily “user-consumers” and “user-producers”, the OSM community can be labelled as a “citizen science community” that serves as a network of primarily “user-producers” and “user-intermediaries”, and the PP community can be labelled as a “civic engagement community” that serves as a network of primarily “user-intermediaries”, “user-legitimators” and “user-citizens”. Depending on the predominant user roles, it can be assumed that the communities as networks of actors within the TIS fulfil different systemic functions. Moreover, the community type can be linked back to some measurable characteristics of the observable online interaction of the peer community.

Our findings therefore give confidence that community metrics based on data of online interactions in peer networks can be used as indicators for the main contributions to socio-technical change. The indicator framework may help policy makers, business managers and civil society alike to easily assess the roles and compare the performance of peer communities for sustainable innovation. This could, on the one hand, improve the general recognition and visibility of peer innovation activities and, at the same time, help decision-makers to find effective policy instruments to promote and support the role of peer communities in socio-technical change.

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Keywords: peer production, open source, online communities, sustainable innovation, TIS functions

[171] Hazal Baytok (Université Paris-Saclay, Univ Evry, IMT-BS, LITEM), Nicolas Julllien (IMT Atlantique/LEGO) and Müge Özman (Institut Mines-Télécom Business School/LITEM). *The Feedback Loop Between the Online Citizen Science Platforms and Their Participants: An Empirical Study of How Institutions and Motivations are Shaped.*

Abstract. The earlier studies on commons focused on natural resources as commons, whereas the rise of internet in the beginning of 90s brought the idea of knowledge being a common resource as well (Hess & Ostrom, 2007). Considering that the natural commons face social dilemmas such as rivalry, where one person's use subtracts from another's, commons governance means collectively organizing the excludability in such a way that the resource is sustainable (Ostrom, 1990). If knowledge goods do not suffer from rivalry, its production raises social dilemmas (Hess & Ostrom, 2007), in terms of quality management. Knowledge is also a resource which has to be maintained and brings forth the need of corresponding collective governance mechanisms (Hess & Ostrom, 2007), and of studies of such mechanisms.

One of the frameworks being used to analyze the institutional structures of the commons, both classic and knowledge based, is Institutional Analysis and Development Framework (IAD) (Ostrom et al., 1994, Hess & Ostrom, 2007). In knowledge commons, participants both share the resource and take part in its creation process, which creates a distinction from natural commons where people only share the resource. Therefore, a governance mechanism that corresponds to this difference is needed (Frischmann et al., 2014). Understanding how people interact with these online platforms and also with each other in the platforms is a way to understand their role and foresee new potential roles for those online intermediaries. More precisely, the motivations that constitute a basis for these interactions that result in participation behavior have to be investigated.

Although it is well known that participation in such online communities is also a career (Rullani & Haefliger, 2013) the impact of the platform's and project's organization, rules, participant feedback on the motivation, and, ultimately on people's participation over time is not yet fully understood. What the IAD framework stressed is that the organization of the platform, its governance mechanisms, rules, positions of actors, goals and objectives impact the expected outcomes for the participants, hence their benefits. What social-psychology theories show (Ajzen, 1991, Deci & Ryan, 2015) is that people's motivation to act are constructed by their personal goals and expectations, but also by the external environment regarding these goals. We argue that the interaction of users with the platform creates a feedback loop between them and the platform, which affects the governance mechanisms of the platform and also the motivations of users to participate. Therefore, a feedback loop takes place between the platform and its participants.

The theory of Planned Behavior (TPB, Ajzen, 1991) aims at explaining the human behavior by taking into consideration: the attitude toward the behavior, that is how the person views the behavior in question; the subjective norms, that is what others think of the behavior; and perceived behavioral control, which is the person's perception of difficulty or ease of performing the behavior. These three elements jointly affect the intention, which results in performing the behavior (Ajzen, 1991). On the other hand, Self Determination Theory is a theory of motivation, which examines the social contexts and individual differences to understand autonomous motivations and controlled motivations (Deci & Ryan, 2015). These theories have been fruitfully combined to analyze the evolution of people's motivations to pursue a behavior over time, considering the results of such behavior (Hagger et al., 2003; Hagger & Chatzisarantis, 2009; Jacobs et al., 2011; Hagger & Chatzisarantis, 2014).

Linking these individual based elements with institutional elements needs to analyze the impact of the platform on user motivations and also the impact of these motivations on the platform. This is done through integrating TPB, SDT and IAD Framework, where TPB and SDT represent the individual based elements, and IAD Framework focuses on institutional elements. A unified model of TPB and SDT, that also creates a link with the platform, is proposed to exhibit the feedback loop between the platform and its participants. We use this model to evaluate the role of motivations in the IAD Framework in case studies, which were not explicit before.

We do so by studying citizen science platforms. Citizen science is the public participation in scientific research by gathering, submitting, or analyzing data (Bonney et al., 2016). These projects often have online collaborative structures and are a type of open movement with collective goals that are reached through open participation (Wiggins & Crowston, 2011). With the development of the internet, citizen science projects increasingly gained momentum considering the facilitation of data collection, data analysis (Bonney et al., 2016), and also data storage.

We look at three citizen science cases in the field of ornithology and biodiversity conservation, from two countries, Turkey and France. We examined these cases in terms of the entangled relationship between the online citizen science platform and its users.

To understand these dynamics, twenty six in depth interviews with the participants of these platforms are analyzed, and the model explaining the mutual impacts between the platform and its participants is developed. These interviews are conducted with the participants of the platforms and with the people who played a key role in the platform or in managerial positions in the platform. Nine of them are with the participants of platforms in Turkey and sixteen of them are with the participants of the platforms in France. The platforms are trakuş and eKuşbank (now eBird Turkey) in Turkey, and Faune-France in France. The coding of the interviews for the analysis are made by using QDA Miner qualitative analysis software.

Understanding this mutual impact offers potential policy implications for the design and governance of citizen science platforms, which may further be stretched to similar digital platforms, as well as shed light to the potential incentives for online participation. As the preliminary interview analysis suggests, there are different profiles of people that participate in the platforms. These profiles are constructed, based on different motivations that are identified, either autonomous or controlled. The motivations are not stable but rather evolving and changing over time with the impact of different factors, one of which is the interaction with the platform. The initial motivations that result in the participation behavior may continue, increase, decrease, and/or change. For some people, the initial autonomous motivation evolves into controlled motivation, whereas for other people the initial controlled motivation evolves into autonomous motivation. This process is exemplified in starting birdwatching because of the desire to see beautiful birds by being in nature, then start sharing the observation data on the platforms, and later being appreciated because of sharing the observation data, which becomes the major reason to continue birdwatching and participating in the platform. Therefore, in this example the autonomous motivation of seeing beautiful birds and being in nature evolves into a controlled motivation of being appreciated and being socially accepted. At the same time, this change of motivations sometimes paves way to social dilemmas as well. For example, the motivation of seeing the highest number of different species which is rooted in the competition between the platform participants, may encourage someone to hide the information of a species from others, which results in the loss of scientific data. These detailed insights provide steps to understand the interaction between the platform and its participants.

Our study aims at acquiring a comprehensive understanding of the interactive nature between these platforms' architecture and governance mechanisms and their participants' motivations, activities, and roles.

In this study, the role of participants in the platforms is analyzed, the interaction between the participants and the platform is examined by considering the institutional elements offered in IAD framework, especially the governance mechanisms, rules, positions of actors, goals and objectives of the platform, costs and benefits associated with the platform, and the outcomes for the participants. And the results of these interactions are examined by the model proposed by integrating Theory of Planned Behavior (TPB), Self Determination Theory (SDT), and the IAD Framework.

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Keywords: knowledge commons, citizen science, motivations, participation behavior, Institutional Analysis and Development (IAD) Framework, Theory of Planned Behavior (TPB), Self Determination Theory (SDT)

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Conceptualising the orchestra of innovation policy instruments – A literature review of implementation requirements, design properties and instrument mixes.

Abstract. Importance of the topic

Innovation policy creates framework conditions and incentives for innovation processes. As a cross-cutting policy, it has a wide range of instruments at its disposal – from economic, research and education policy to health, environmental or digital policy. This broad instrument character often challenges innovation policy researchers because the choice of analysed (or recommended) policy instruments is difficult to delineate. While some researchers delineate innovation policy instruments through their intention to stimulate innovation processes (delineation by purpose), others rather delineate innovation policy instruments by their relevance for innovation processes (delineation by relevance).

Both instrument delineation perspectives are subject to advantages and inconveniences. A delineation by purpose can easily omit relevant policies, but the far broader delineation by relevance can lead to the inclusion of everything – without adequately reducing the complexity of policy mixes. We argue that there is a strong need for more explicit reasoning why a purpose- or relevance-driven delineation has been chosen, discussing moreover how purposes or relevance criteria are defined from a normative viewpoint. Still, innovation system and policy studies often omit clear reasoning on why certain instruments are in- or excluded in their analysis or proposed to overcome a specific problem or failure in innovation systems.

Although the theoretical justification using innovation system or transformation failures has been a useful orientation mechanism for policy makers, there are shortcomings comparing with some kind of unspecified optimality ("nirvana fallacy"). It might not be sufficient for justifying innovation policymaking towards specific directions because the true normative nature of recommendations is not revealed. More important is moreover, that recommendations are barely discussed in the context of the embedded policy instruments, their specific path dependencies and policy process dynamics (Schmidt, 2018).

The project "Innovation Policy Orchestra" (IPO) aims at addressing these conceptual research gaps. It is granted and financed by the German Federal Ministry for Research and Education and conducted by researchers at the Professorship for Innovation Management at Freie Universität Berlin. The orchestra metaphor has been used to emphasise the complexity of the innovation policy system and its processes. Like an orchestra, innovation policy can be considered an ensemble of instruments in which the mastery of one's instrument is a necessary but not sufficient condition for success. Success only unfolds in the harmonious interplay of all chosen instruments. The responsible departments in ministries, subordinate authorities, or project executing agencies need to be able to play the instruments and communicate and interact with each other. Political decision-makers who coordinate their efforts conduct the orchestra to harmoniously address companies, researchers, consumers, or other innovation system actors. By continuously adapting instruments and their interplay, the innovation policy orchestra can react to socio-technical dynamics concerning the addressees and provide impulses for socio-technical change by themselves.

In contrast to toolbox metaphors for innovation policy with static and isolated instrument analysis (Flanagan and Uyarra, 2016), the orchestra logic focuses on how to create agile and tentative governance of innovation processes. This perspective includes generic innovation activities and technology-, mission- or transformation-oriented activities in the related innovation systems.

Research question and objective of the paper

The literature of innovation policy and policy mixes for socio-technical change is subject to a large diversity. While many innovation system approaches or the Multi-Level-Perspective include policy-making within their framework to analyse innovation, new concepts on policy mixes, new roles of the state in innovation or tentative governance emerged. Though all these concepts address the challenge to conceptualise innovation governance, these approaches are not linked with each other. There is a need to discuss common or divergent views and merge concepts towards an integrated approach for a complete analysis of the innovation policy orchestra.

Therefore, the IPO project decided to start with a structured literature review of conceptual approaches and empirical research contributing to the innovation policy debate. This review aims to answer the research questions:

• What are the existing definitions and delineations of innovation policy?

• What criteria is used for searching relevant or purpose-driven innovation policy instruments?

• What design principles of innovation policy instruments are discussed?

The three search questions are used to collect search criteria for the literature review process. The study's ambition is to integrate different streams of innovation policy literature to map common and divergent understandings, such that the IPO project can be best on selected conceptual building blocks from complementary literature.

Theoretical framework

The first research question considers different innovation policy conceptions. Many innovation system approaches, for example, have a particular conception of innovation policy integrated into their frameworks. For the case of technological innovation systems, policy-making is considered within the function guidance of search investigating the provision of appropriate normative directions towards technologies. Functional analysis of national innovation systems includes policymaking as a specific actor or building block (Bergek et al., 2008; Hekkert et al., 2007). The mission-oriented innovation system (MIS) approach enlarges the functional perspective by three additional functions for the guidance of search: problem directionality, solution directionality and reflexivity. Moreover, the MIS concept enlarges the structural analysis by a further policy perspective (Wesseling and Meijerhof, 2020).

Other concepts are based on the idea that policymaking needs to be treated as a kind of system with specific innovation system actors, processes, and institutions for innovation governance. For example, Edmondson et al. (2019), analyse the feedback and effect cycles between the socio-technical system and the policy system. Söderholm et al. (2019) conceptualise challenges and options for policy-making in the governance of innovations at different maturity stages of the innovation process. They consider the complex interplay between policy-making as an impulse for innovation activities and socio-technical dynamics forcing policy-making to decide and adapt towards new developments. Both perspectives require not only the analysis of instruments but also instrument-timing and a discussion on the way how they have been imposed politically and implemented by the concerned innovation policy actors (Kay, 2006; Slembeck, 2004)

Our approach follows the idea that innovation policy requires a more specific analysis, which goes beyond the rather general integration of policymaking in the MLP or the functional TIS analysis. Therefore, this literature review aims at collecting the existing conceptual and empirical contributions to provide a first methodological step through comparing search and selection processes of innovation policy instruments and discussing as well as clarifying specific design options, implementation, and coordination requirements with other instruments.

Data and methodology

We apply a structured literature review focusing on methodological issues in conceptual and empirical research (Gentles et al., 2016). Our search strategy for papers follows a three-stage process. First, we use keywords for innovation policy and policy instruments in the most important scientific publication databases (Ebsco, Scopus, web of science, google scholar). Second, the merged list of around 550 publications from peer-reviews journals is cleared up by reading titles, keywords and abstracts and deleting all irrelevant articles. Third, additional literature is added from our and others' experiences. This includes other relevant journal articles omitted by the structured search and project reports, grey literature and other scientific publications.

The final list of investigated literature is divided into three groups:

• Conceptual innovation policy literature without a focus on specific policies or innovation process cases (e.g., Edmondson et al., 2019; Nill and Kemp, 2009; Söderholm et al., 2019; Wieczorek and Hekkert, 2012)

• Empirical innovation policy research with innovation policy as the genuine research object (e.g., Hoppmann et al., 2014; Kovač, 2019; Reichardt et al., 2017)

• Empirical innovation studies based on concepts such as TIS, MIS, MLP or other empirical concepts or quantitative and qualitative methodologies with the ambition to deduce policy recommendations (e.g., Jacobsson and Karltorp, 2013; Purkus et al., 2018; Sawulski et al., 2019)

These literature groups are analysed by their choice and delineation of the investigated instruments, design principles and policy mix conceptualisations. To structure the explored conceptual ideas, lists of criteria are developed iteratively. The criteria are used to code the relevant sections of the read papers (Saldaña, 2013). For the coding process, we used the qualitative analytical software MAXQDA.

(Expected) Findings

The proposed paper is still a work in progress, which is supposed to be finished by the conference deadline to submit the final paper. So far, our investigation has led to several interesting findings. While many studies on innovation research have the ambition to recommend policy instruments, studies omit to describe the selection and discussion of recommended tools following the existing policy context and processes. This aligns with the discovered research gap of missing polity and politics perspectives in conceptual and empirical research. Only a few studies clearly focus on the considerations of policy processes (politics) and their role in strengthening or hindering innovation policy from the decision-making to the implementation. Moreover, institutional structures and relevant innovation policy actors (polity) are a necessary subject of analysis because they are conducting the recommended instruments in the innovation policy orchestra.

Regarding the policy dimension, instruments' rationales and impact mechanisms are analysed to address specific problems and objectives. The inclusion of different types of rationales from generic to technology-mission-oriented or transformative objectives demonstrates how from rationale to rationale, similar or other instruments and instrument designs and mixes are discussed.

Concerning the polity dimension, instruments are analysed with regard to implementation requirements for the related innovation policy actors to conduct the instruments. This includes the role of parliament, ministries, specific department in ministries, public authorities, NGOs, experts and relevant policy actors from regional or supranational levels of policy-making. Actor structures are necessary to analyse to understand necessary coordination and knowledge flow relations within the innovation policy system, as such structures are necessary for a successful implementation of policy.

For the politics dimension, agenda-setting, decision-making, implementation and adjustment process is in focus. Therefore, criteria for adjustment processes of instruments need to be discussed. Who is adjusting when, why and how a specific policy instrument? How can monitoring as a dynamic capability guarantee sufficient knowledge and discussion of feedback from the governed innovation processes? What kind of data and systemic coordination in innovation systems is necessary to strengthen the agility of innovation policy actors?

Conclusions, policy implications and outlook

Our preliminary conclusions are two-folded. Our research on innovation policy and policy recommendations from innovation studies demonstrates the relevance for a more complex understanding of policymaking as necessary for suitable innovation policy concepts and recommendations. Therefore, the following research step of the IPO project aims to conduct interviews in ministries, public authorities, and project operators to better understand the complexity of innovation policy implementation and adjustment. This empirical qualitative case study approach shall result in a morphological matrix consisting of innovation policy instrument and all relevant design principles, relevant innovation policy actors conducting the instrument and institutional processes to strengthen agile monitoring and decision-making process for policy adjustments.

For the practice of innovation policy, we highlight the necessity to discuss instrument alternatives from a policy perspective and from the specific institutional and procedural contexts of the related innovation policy systems of related regions or countries.

Keywords: innovation policy, policy mixes, policy design, governance

[174] Priscila Ferri (Manchester Institute of Innovation Research, Alliance Manchester Business School, The University of Manchester). *The impact of artificial intelligence on scientific collaboration: Setting the scene for a future research agenda.*

Abstract. 1. Background

There is an ongoing debate that knowledge production is slowing down and that new ideas are getting harder to find (Jones, 2009, Bloom, 2020). This is claimed to be the result of a 'fishing out' effect whereby new scientific knowledge is now more difficult to be discovered, and of cognitive limitations to realise potential valuable combinations of knowledge across the plethora of data currently available (Bianchini et al., 2020). In this scenario, there are great expectations that artificial intelligence (AI) – here defined as a technology (intelligent computer programs) and a social practice (Keyes et al., 2021) may help to solve the issue (Agrawal et al., 2018, Cockburn et al., 2019).

The interest in using AI technologies for science is nothing new. Indeed, AI systems have been employed to the automation and replication of scientific processes since at least the late 1960s (e.g., Simon 1969, Langley et al., 1987). However, recent breakthroughs in AI, such as 'learning' approaches able to analyse vast sets of data, learn from examples and generalise to explore patterns (Giza, 2021), are now discussed to be a general-purpose technology and a new method of invention (Cockburn et al., 2019). With the diffusion of these technological innovations, advances in computational power, and an exponential increase in data availability, scientific practices and processes are expected to change in unprecedented ways (Agrawal et al., 2018).

2. Relevance and contribution

Researchers have increasingly claimed that we are in the midst of a revolution in science, premised on the automation of scientific processes made possible by the use of modern AI technologies (Gil et al., 2014, Rotman, 2019). Thus, a renewed academic interest in unpacking the consequences of AI for science has emerged which remains little understood (Chubb et al., 2021).

This study addresses this gap by investigating the impact of AI on a specific scientific practice namely collaboration. While collaboration is already central for the practice of science in the 21st century regardless of digitalisation (Silas & Allison, 2018), investigating the relationship between AI and research collaboration becomes relevant because with the introduction of this digital technology, the way researchers and scientists collaborate might be changing. Therefore, reflecting on these potential changes contributes to anticipating implications for research management and policy.

3. Aim and research question

The aim of this paper is to unfold what researchers investigating the relationship of AI and scientific practices expect as opportunities and challenges, with a focus on the impact of AI on scientific collaboration. In doing so, this paper seeks to answer the following question: How AI technologies are expected to change collaboration practices in science?

In answering this question, this study (1) advances our understanding on potential changes in collaboration practices derived by the increasing use of AI technologies in science, (2) highlights potential implications for research management and policy, and (3) indicates some future research avenues.

4. Method: a scoping literature review approach

I carried out a scoping review to set the scene for future research agenda which involved an exploratory search of core references. Although the process underlying scoping reviews might not be as objective and transparent as systematic reviews', this approach is valuable as it often provides insights that can be overlooked in the steps towards the selection process in more standardised models (Jesson et al., 2011).

I conducted a keyword search on the Web of Science Core Collection database to find relevant references (in December 2021). The search strategy included different combinations and variations of the terms "artificial intelligence", scientific practices", "artificial intelligence in science", "artificial intelligence in the lab", "scientific collaboration*", "research collaboration*", "project team*" in the title, abstract, author's keywords, and Keyword Plus under the "Social Sciences Interdisciplinary" category. To ensure that pertinent documents were not neglected, I also backward tracked and forward tracked literature using the list of references found in the key articles (Hart, 2018).

The final sample comprises 30 scientific articles published between 1997 and 2021 that were analysed qualitatively with the support of NVivo software. Following the thematic analysis by Flick (2014), I iteratively generated codes and initial categories based on literature, and then, aggregated them into main themes.

5. Preliminary results

Three categories of scientific collaboration namely human-machine collaboration, interdisciplinary collaboration, and boundless collaboration emerged as relevant configurations of collaboration practices.

5.1 Human-machine collaboration

The strengths of AI applied to scientific research compared to human scientists are highlighted, i.e., they are faster, more accurate, scalable, can work longer, and perform repetitive tasks easily (King et al., 2018). Yet, while the deployment of AI technologies might benefit science with gains in productivity and quality (Agrawal et al., 2018, Cockburn et al., 2019), human creativity, insight, improvisation, intuition, judging, social and leadership abilities are believed to remain to play a vital role (Bianchini et al., 2020). Therefore, researchers expect that scientific research will benefit more from the cooperation between robot scientists and human experts than either alone (Langley et al., 2000, Waltz & Buchanan, 2009, Kitano, 2016).

Future research might be directed to understanding and exploring the possible benefits of the human-machine relationship, taking a close look at the anthropological and sociological issues underpinning this partnership (King et al., 2018). Questions that might be worthy of future investigation include: How do scientists cooperate with AI technologies as they conduct their work? What specific scientific tasks are being affected and perhaps reshaped by AI? And how?

5.2 Interdisciplinary collaboration

Multi and interdisciplinarity in research teams are not new, but with the use of AI technologies in science, they are expected to increase. Researchers expect that AI might advance multi and interdisciplinarity in scientific research, support knowledge exchange across disciplines (Chubb et al., 2021), and facilitate collaborative science (Honavar et al., 2016). The promise is that this will lead to a boost of scale-up research (Waltz & Buchanan, 2009). Moreover, science teams are expected to become more diverse with a variety of gender, backgrounds, expertise, and skills. As a result of this increase in interdisciplinary collaboration, the ability to work in multi-disciplinary teams might become critical (Agrawal et al., 2019). For instance, biologists working with AI might need to know sufficiently about AI, and AI experts working with biology might need to have enough knowledge about biology to perform their research tasks. At the same time, interdisciplinary collaboration might also require the ability of team members to communicate with experts of diverse communities with different cultures (practices, processes, vocabulary, etc).

These changes in the skills set might lead to a number of policy and management implications such as workforce planning in universities and private labs, and demands for upskilling and modifications in the hiring requirements (Cockburn et al., 2019). Understanding how the introduction of digital technologies such as AI is changing the culture of scientific communities and professional identities might be an opportunity for future inquiry.

5.3 Boundless collaboration

Science is a collaborative endeavour (Honavar, 2014); yet, with the advance of AI in scientific research, collaboration might go beyond the boundaries of the lab to make science more open and accessible through civil participation (Wang, 2019, Bianchini et al., 2020). As Kitano (2016) argues, there is an expectation that AI will become a fundamental part of the future research enterprise. And this may require the contribution of not only researchers of different fields but also the public to build a type of collaborative intelligence that could inform and be orchestrated by AI systems. The increasing participation of different groups of society might lead to democratisation and decentralisation of science (Chubb et al., 2021).

To enable that however, the organisation of scientific research may need to be redesigned. For instance, scientific processes might have to become more sharable and communicable, organisational and social structures and processes might need to become more integrative, and mechanisms for engaging a large number of participants with varying backgrounds, expertise, and skills might also have to be developed (Honavar, 2014). Thus, anticipating and examining how research practices and processes will change to integrate the society component might be a fruitful future research avenue.

Keywords: artificial intelligence, digitalisation of science, scientific practices, scientific collaboration, scoping review

[175] Karl Matthias Weber (AIT Austrian Institute of Technology), Bernhard Dachs (AIT Austrian Institute of Technology), Sylvia Schwaag-Serger (Lund University), Lennart Stenberg (VINNOVA), Daniel Johannson (VINNOVA), Paula Kivimaa (SYKE), David Lazarevic (SYKE) and Jari Lukkarinen (SYKE). *The transformative potential of COVID-19 recovery packages: A multi-level and multi-policy domain perspective.*

Abstract. Introduction

The recovery and resilience packages (RRP) have been launched in 2020 at the initiative of the European Commission with two aims: first, to address the immediate consequences of the COVID-19 pandemic; second as triggers for transforming key socio-technical and innovation systems. This was recognised by the EU Expert group on the Societal and Economic Impact of Research and Innovation (ESIR), which described the ambition of the European Resilience and Recovery Package using the notions of 'protect-prepare-transform' proposed by the (ESIR, 2020): the need to protect the overall wellbeing of individuals during the crisis, the need to prepare for future pandemics and crises and the need to transform the European economy and society towards more resilience against future crises.

The three target dimensions of this framework are complementary to each other, but we are particularly interested in this paper in the third, transformative dimension. More specifically, we explore what characteristics make the recovery packages ‚transformative'. The analysis focusses on Austria, Finland and Sweden, three countries with high transformative ambitions.

Answering this question is important for designing policy mixes for the post-COVID era, which are to be effective in creating and shaping systems able to address current overarching policy ambitions (e.g. in terms of the twin digital and green transition, etc.) and at the same time strengthen the resilience and preparedness with regard to future shocks of various sorts, from further pandemics to global conflicts. It is also particularly relevant in light of both the unique size and the clearly stated transformative ambitions of the packages.

Theoretical framework

The COVID-19 crisis has triggered a re-thinking of the purposes of innovation policy. Not only does a new generation of innovation policy need to address the transformation of socio-technical systems, but it must also take into consideration the need for resilience and preparedness with regard to future crisis, and thus dispose of a high-level of responsiveness to changing circumstances. A traditional innovation systems perspective is no longer appropriate from this angle, and neither is a long-term transition policy framework as developed over the past ten years sufficient.

Assessing the effects of the recovery packages thus requires first revisiting our conceptual apparatus. First of all, we suggest adopting a wider normative frame of reference which is given by the „protect – prepare – transform" goals and their political specifications. More specifically, the transformative dimension is addressed by drawing on insights from sustainability transitions research, looking at parallel processes of experimentation in niches, destabilisation of dominant regimes and consolidation of novel regime elements and structures (Kivimaa and Kern 2016).

Second, it requires a theoretical framework allowing us to understand and conceptualise the joint effect of both EU and national recovery packages in conjunction, but seen against the background of already existing and planned policies at European, national and - where suitable – regional levels. As a starting point of such a comprehensive policy mix perspective we draw on Rogge and Reichardt (2016) who propose three main elements of a policy mix: i) policy strategies, ii) mix of policy instruments, and iii) policy processes. All three elements together need to be consistent, coherent, credible and comprehensive in order to be effective, with comprehensiveness referring to both a multi-level and multi-domain policy perspective.

In addition, we propose to add an organisational perspective on policy design and implementation, because organisational structures and mechanisms play a key role when preparing, designing and implementing transformative policies. In fact, as we could observe over the past two years, the implementation of the COVID-19 related measures hinges upon the capabilities in public administration of putting new measures adequately in place, at a time when the ability to act and learn fast in response to the crisis is imperative. These organisational requirements can be summarised in terms of the 'agility' in policy making and policy implementation, drawing on five main characteristics of agile innovation policy: flexibility, proactivity, participation, ambidexterity and reflexivity (Weber et al., 2021).

Methodological approach

Empirically, this paper draws on insights from a set of national studies of national and European recovery packages in Austria, Finland and Sweden, i.e. countries that are quite similar in terms of size, but also in terms of their innovation performance in various rankings. One of the consequences is that the financial weight of the European RRPs may not be as significant as in some southern or eastern European countries, but they are nevertheless important complements to the national measures and – as we will see in more detail in the full paper – governance lever.

In oder to assess the ‚transformativeness' of the policy mixes and their organisational conditions for design and implementation, we draw on five main dimensions:

1. Strategic Intent, in terms of the ‚revealed thinking' in public administration when developing the packages (it is still too early really analyse impacts). This includes, for instance, also the extent to which national and European packages were conceived as being part of an integrated strategy that is at the core of overarching transformative policy ambitions. Moreover, it implies that the packages should not be seen in isolation but as firmly embedded in the portfolio of existing policies, as transformations can occur in different ways and needs different types of stimuli from the public sector.

2. Destabilisation of existing paradigms and systems, i.e. the role of the recovery packages as important triggers of significant reforms governance and policy frameworks; an element foreseen in the European RRPs. This comprises the building of new and the unlearning of old capabilities and skills in the public sector; an issue that is prone to strong path-dependencies and lock-ins.

3. Mobilisation of system innovation, i.e. the combination of experimentation/piloting and the mobilisation of new market/demand creating forces. This dimension requires involving a wide range of actors and stakeholders in collective learning processes (e.g. regulatory sandboxes).

4. Generalisation of new technological and non-technological solutions through scaling, replication and institutionalisation. This dimension addresses also the complementarity of large-scale public investment into new solutions, including investments in infrastructures, human capabilities and organisational capaciteis. This is also the dimension for which sectoral policies play the decisive role.

5. Fundamental changes in governance, i.e. in the structures and processes of what is being done and how it is being done.

Results and policy implications

It is of little surprise that the recovery packages in the three countries show very different characteristics in terms of both policy mix and agility. They are the latest addition to long-standing trajectories in the evolution of national innovation systems and policies.

As regards the ’protect – prepare - transform’ ambitions underpinning the recovery packages, the ‚protect’ dimension is mainly addressed by (national) measures outside of European RRF-plan, and generally with much larger resources. Moreover, the distinction between the three categories is not always clear-cut: "protect" and "prepare" elements can bepre-conditions for "transform" elements, but there may also hamper them (e.g. when they serve to conserve existing industries, practices or behaviors that are not conducive to transformation). This is why one of the key lessons from the analysis is that a transformative ambition requires a good orchestration of the policy mix as part of a national strategy, considering existing national policies and context.

However, the extent to which such a national strategy frames the national and European recovery packages in practice differs across the three countries. The Austrian and Finnish cases show, though implemented in different ways, a quite conscious embedding in and complementarity with national strategy, driven also be recent changes in government. This seems to be less so in Sweden, where the plan seems to be more of an ‚off the shelf‘ solution, with elements largely mirroring already planned or existing national policies and initiatives.

In spite of their limited volumes in the three countries, the European RRPs turned out to play a crucial role for ensuring a transformative commitment. A policy innovation: By tying the RRF investments to institutional reforms (e.g. setting targets for climate funding, implementing the do-no-significant-harm principle), it is difficult to soften the commitments made.

Finally, it is important to keep in mind that the transformative success of the recovery packages depends a lot on context. All three countries pursue proactive R&I policy with comparatively high levels of R&D funding, they tend to have quite effective governance systems, and (in particular in Finland and Austria) have assigned a central role to climate policies. There are at the same time important differences in governance structures across the three countires, with quite diverse mandates for STI funding agencies (from mainly implementing in Austria to strategic in Sweden and Finland), as well as differences in the levels of coordination of sectoral and R&I policy, in particular when compared to traditional STI policy approaches.

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Keywords: recovery package, transformation, policy mix, preparedness

[176] Koen Frenken (Copernicus Institute of Sustainable Development, Utrecht University), Victo Silva (DPCT - IG, Universidade Estadual de Campinas), Jarno Hoekman (Copernicus Institute of Sustainable Development, Utrecht University) and Iryna Susha (Copernicus Institute of Sustainable Development, Utrecht University). *How academia works with/around platform data.*

Abstract.

In recent years, we have witnessed the rise of digital platforms as the new means of organizing economic activity. Asset sharing platforms like AirBnB and labour platforms like Uber are disrupting the conventional ways of service delivery and sending shock waves across respective sectors. They have also drawn much criticism, and in some cases public outcry, because of societal concerns regarding safety, unfair competition, working conditions and privacy.

In an attempt to increase transparency, a number of platforms started to engage in initiatives to share their data with academic researchers and other interested parties. This is a relatively new development in the practice of industry-academia partnerships. These data sharing initiatives have taken different forms: bilateral agreements, challenge competitions, open data.

For instance, Uber established a data sharing initiative called Uber Movement whereby aggregated data is made publicly available. However, the company has been criticized for withholding more detailed data and collaborating only with researchers whose findings are in favor of the company (WIRED, 2018). The latter risks leading to the so-called “academic capture” (Zingales, 2019) when academic research becomes part of the platform’s lobbying efforts. This is illustrated in a discussion piece of the Stigler Centre analyzing four prominent collaborations between Uber and academics and concluding that these were problematic in being incomplete and non-replicable (Horan, 2019). So, while data sharing brings great opportunities for academic researchers to scrutinize the societal effects of platformization, they also pose challenges to the standards of academic research.

While strong opinions and concerns over this problem are voiced, alongside a handful of examples, there has so far been no systematic research into data sharing practices of platform companies with researchers. This leads us to the following research question: How does data sharing by platforms, or the lack thereof, shape research on platforms? We limit our analysis to labour platforms.

Our research objectives are:

• to identify academic studies on platforms and the data source(s) used, which may include data shared by platforms, an/or other data sources (e.g., surveys, interviews, scrapped data);

• to shed light on how, under what conditions, and to whom access to platform data was provided;

• to analyze the public interests addressed in each study, if any, and how this depends on data source used;

• what workarounds academic researchers develop in case no data are being shared.

This research contributes to our understanding of data sharing practices of platform companies and the extent to which public interests remain ill-researched due to a lack of data sharing by platforms.

Academic engagement

We situate our research into the relations between platforms and academia in the broader literature on academic engagement. Academic engagement refers to “knowledge-related interactions by academic researchers with non-academic organisations, as distinct from teaching and commercialization” (Perkmann et al., 2021). Research on academic engagement received additional impetus in the context of debates about “socially engaged university” (Grau et al., 2017) and that academic engagement should contribute to creating impact for the society and industry. Furthermore, the open science movement and the shift to open science principles and practices puts new demands on how academics engage with commercial actors many of whom traditionally favor secrecy (Perkmann et al., 2021).

The literature on academic engagement has grown significantly since 2011 and has made important advances in mapping what motivates researchers to engage with non-academic actors and what the outcomes are. However, research predominantly focused on the positive outcomes of academic engagement (Perkmann et al., 2021), whereas the issue of potential negative effects, such as for instance increased secrecy and neglect of scientific inquiry, are becoming more topical. Therefore, Perkmann et al. call on more research into how academic engagement influences the direction of research and its quality. These issues received attention in biomedical research, where partnerships between researchers and industry are very common. For instance, industry funding (in the context of clinical trials) is found to be associated with bias in reporting of scientific results, particularly if any of the co-authors were affiliated with the company (Salandra, 2018). There may also be a relationship between the kind of innovation pursued in the research (incremental or radical) and the likelihood of bias in reporting (Ibid.), however there is conflicting evidence of that which may be sector-specific.

Besides the literature on academic engagement, we also leverage insights from research that discusses the issues of access to the field and access to data in the context of industry-academia relations (Bonini & Gardini, 2020). Difficulties experienced by researchers in accessing the field (for data collection purposes, such as interviews and observations) have been reported earlier in reference to non-platform companies, such as large consultancies (Karjalainen et al., 2015). These authors discussed different levels of access, ranging from access to gatekeepers, to documents and data, to individual company members etc (Ibid.). However, this issue gained more prominence in recent literature providing accounts of so-called "black-boxing strategies" of the big technology companies in relations with researchers (Marrazzo, 2022). For instance, Bonini & Gardini (2020) elaborate on their attempts to get access to platform employees for research interviews and discuss alternate tactics for accessing the field that researchers had to resort to (including being undercover, interviewing ex-workers etc.). Bruns (2019) put these developments in perspective and described the evolution (degradation) of platform-academia relations in the case of big social media platforms (Facebook and Twitter).

Research design

Our research follows a two-step process: First, we map the literature on platforms: we depart from a set of 593 labour platforms listed by a recent EU-study carried out by CEPS (De Groen et al., 2021). These labour platforms are defined as "private internet-based companies that act as intermediaries, with greater or lesser extent of control, for on-demand services requested by individual or corporate consumers." Platforms considered in this report operate in at least one European Union member country; however, 135 platforms in the set are global in scope, which provides a rich sample of the labour platform universe.

We consider scientific articles and conference proceedings as objects that can reveal patterns of collaboration between academia and the platforms in question. We chose to map this literature in Scopus and we developed protocols to filter out relevant work using the platform company name from the CEPS database. See for further details the protocol added as 'additional material'.

We completed the first step and found 355 valid articles. Based on these data, we will sketch a descriptive analysis regarding how many papers are written about which platforms, the timeline of publications and its geographic distribution.

In a second step, we further analyze the research questions posed in each article to investigate whether studies with and without data sharing by platforms are associated with specific research questions.

Expected results

Given the great controversies surrounding Uber in many countries, we expect a large concentration of studies to be about Uber and only very few about other platforms. If so, this suggests that current academic research on labour platforms poorly reflects the sheer number and heterogeneity of labour platforms currently active in Europe (and beyond).

We further expect data sharing not to be a common practice, given the strategic value of data for platforms (both economic and political). In particular, data sharing may foster new scientific evidence about the downsides of platformization in society, including refutations of previous, positive claims about platformization made by labour platforms in public.

Finally, we expect that studies using data shared by platforms are skewed towards research questions regarding consumer surplus (which can be expected to be positive due to lower prices and higher availability for clients. We compare these studies with studies without data shared by platforms, but instead using 'workarounds' defined as second-best data collection methods compared to platform data. Such workarounds may include scraping, surveys, and interviews. We expect such studies to be more skewed towards research questions addressing lack of worker rights, discrimination and (lack of) sustainability benefits.

Conclusions

If we find that datasharing by platforms is limited and skewed towards certain research questions, it raises the policy issue of whether government can require platforms to share data for academic purposes. This may be justified given the societal concerns raised by many political parties and unions as well as the ongoing public debate about platformization more generally. What is more, the administrative burden for platforms may not be excessively high, since they gather data already for their own purposes and operations, while alternative means of data collection as employed by scientists through various workarounds generally deliver only a limited evidence.

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Keywords: digital platforms, academic engagement, data sharing, academic standards, Uber

[177] Carsten Schwäbe (Freie Universität Berlin) and Carsten Dreher (Freie Universität berlin). *The role of Creative and Cultural Industries for socio-technical change – A qualitative sectoral innovation system analysis of a European consortium.*

Abstract. Importance of the topic

Creativity and culture have been omitted for a long time in the economic and in the political discourse. Often, it has not been acknowledged as important driver of economic growth compared with other technology and industry-oriented sectors. However, the creative and cultural industries represent an important cross-sectional economic activity, which plays a significant role in all other sectors. Marketing, for example, is depending on creative ways of communication that are appropriate to the specific cultural practices of the regions and the addressed consumers (Rogers, 2003). Moreover, the legitimacy as an important function of the development of technological innovation systems depends on an understandable and coherent narrative (Hekkert et al., 2007; Markard et al., 2016), which can only be developed via the on-going discussion in creative and cultural formats such as books, music, films, the media, games etc. The Creative and Cultural Sectors and Industries (CCSI), therefore, provide some of the main prerequisites for a successful technological innovation process (BMWi, 2019: 3).

While this cross-sectional role of CCSI reveals the true potential of CCSI for the existing economy, it has a more significant contribution to give in the current mission-oriented and transformative innovation processes. The normative turn in innovation policies focuses on the debate on societal challenges and other objectives and missions of innovation policy – beyond economic growth (Daimer et al., 2012). While sustainability has already influenced largely the normative direction of innovation processes through policy as well as through changing consumer preferences (Turnheim et al., 2015), the shaping of technological progress towards societal preferences is another normative concern of digital innovation policy. In addition to that, a normative turn in innovation policy can be seen in the bigger focus of European innovation policy on technological sovereignty (notably with regard to digitisation, Edler et al., 2021) as well as the reinforcing of the EU Single Market by supporting a European identity (Chapain and Stryjakiewicz, 2017: 1-4). “The economic-oriented emphasis resounds in EU documents on cultural industries. EU institutions and their departments take a unanimous stand that cultural industries will help to realize the Lisbon Strategy’s targets of European growth and cohesion.” (Huijgh, 2007: 211)

For all of these mission or technology-driven fields of innovation policy, the CCSI plays a crucial role in supporting diffusion processes via the telling and communicating of convincing narratives and via creative and cultural activities fostering the societal debate on how to achieve missions and objectives (Kattel and Mazzucato, 2018: 797).

Moreover, in combination with the role of the EU as one important regional player in the global economy and politics, the telling of a plausible narrative as well as the strengthening of identity represents a key factor for a successful cultural diplomacy, which also enhances the political power of the EU on other global policy fields. Though the importance of CCSI has been acknowledged by research and European policy makers, CCSI is often omitted within policy strategies and priority setting at the political, and also the firm level. For example, the European Innovation Council (EIC) has implemented the intense support of European clusters on specific mission- or technology-oriented fields as sources for innovative economic, social and ecological development. Eight “Knowledge and Innovation Communities” have been formed and supported along the societal challenges climate change, the digitisation, food, health, energy, the future of manufacturing, the mobilisation of raw materials and urban mobility (Karbowski and Lachowicz, 2018). Though all of these KICs might profit from a stronger role of CCSI, a specific KIC for the role of creativity and cultural activities for the societal objectives has been omitted so far.

Research question and objective of the paper

This paper aims at exploring the cross-sectional contributions of the CCSI to mission-oriented or transformative processes of socio-technical change. Therefore, the CCSI are conceptualised as a sectoral innovation system (SIS). “A sectoral system of innovation and production is a set of new and established products for specific uses and the set of agents carrying out market and non-market interactions for the creation, production and sale of those products.” (Malerba, 2002: 250) For the case of CCSI, creative and cultural activities represent the common base, which can be found in all of the different products and services of CCSI.

The general research question is: What kind of creative and cultural activities contribute to socio-technical change and need to be addressed by innovation policy making? In order to structure the analysis, this paper investigates several analytical dimensions of the research question:

1. The need for action needs to be defined with regard to specific sectors roles and innovation types and why they are subject to barriers to be removed or certain strategic strength and chances to be supported.

2. While strategic decisions for the CCSI need to be discussed and made by their firms and other actors themselves, rationales for innovation policy making for CCSI need to be formulated concerning the societal impact of CCSI and its activities supposed to be supported.

3. The directionality of innovation activities deals with the question how far the variety or one or several selected creative or innovative activities shall be supported in accordance with a specific sectoral or societal challenge. Rationales can be market or system failures, but also specific contributions considered as important for a specific normative objective such as a societal mission.

4. Target groups define which kind of concrete actors from different actor groups in CCSI (with regard to the subsectors or the roles within the CCSI as SIS) need to be involved in the supported projects and to be supported by innovation policy making in order to address their specific barriers and chances for contributing to the innovation activity.

Theoretical framework

The SIS approach focuses on the interlinkages of innovation activities, as often not one, but a range of different actors contribute to successful innovation. The CCSI is an example for which such a broad perspective on related actors needs to be considered. Creativity and cultural activities represent important aspects for marketing, but also a public good, which is provided and strengthened by the state as well. Therefore, the analysis of CCSI as SIS needs to focus not only on the specific actors, but also on the way how they are connected with each other by different kinds of relations including market-based competition as well as complementary and cooperative interactions, notably with the broad range of actors coming from non-profit activities (foundations, public actors, research facilities, other kinds of intermediaries, etc.) and from social entrepreneurship.

Weber and Schaper-Rinkel (2017), for example, apply the SIS concept on several sectors with ties to CCSI (e.g., knowledge intensive business services or the textile industry) and apply strategic foresight methodologies on them. Their application of the SIS approach bases on four building blocks: shared knowledge and technologies, actors and networks, formal and informal institutions, demand. Interestingly, Weber and Schaper-Rinkel (2017: 242) emphasise the role of the demand, which consists of heterogeneous individual and collective buyers and consumers from the public and the private sector. Demand-driven innovation and transformation processes shape the sector development and, vice versa, new innovations coming from the sector also need to convince the related demand. Notably for sectoral innovation foresight future demand dynamics need to be anticipated in order to adapt properly.

In addition to these building blocks, the concept of Weber and Schaper-Rinkel (2017: 244) provide four kinds of factors as sources for strengths and weaknesses of specific actors or of the entire SIS, which allow the analysis of barriers, enablers and drivers for specific missions and transformative processes:

• Driving forces encompass the emerging internal and external trends with regard to preferences and behaviours of actors.

• Innovation themes result from the driving forces and represent specific areas of the socio-technical development, which needs to be highlighted in order to answer on the driving forces and trends.

• Emerging markets result from a successful application of an innovation theme at a market, which includes the maturity of the innovation as well as the removal of external diffusion barriers.

• Requirements and co-developments in the SIS represent the enablers and barriers to innovate (such as organisational changes, business strategies, skills, access to funding, institutional changes etc.)

Data and methodology

This study uses a qualitative case study methodology based on semi-structured expert interviews. The experts have been selected from a European consortium of firms, research and education facilities or public institutions involved in CCSI. The consortium was founded to apply for the support as a Knowledge and Innovation Community of the European Union. As the consortium consists of all subsectors of CCSI as well as all kinds of relevant actors groups, it was possible to select 22 interview partners representing the entire variety of CCSI. The interview material (31 hours) has been transcribed, anonymised and coded via MAXQDA. The building blocks and factors for supporting or inhibiting innovation processes in SIS are used as issues to be discussed within the interviews in order to find CCSI specific enablers, barriers and drivers of innovative activities providing rationales for innovation policy making. Therefore, these concepts have also been used for the coding process and enlarged with regard to the insights of the interviews.

Findings and policy implications

As the entire range of findings cannot be described within the range of this abstract, some findings are highlighted in the following.

Addressing the digitalisation as one of the main challenges for CCSI activities is confronted with structural challenges for CCSI as a sector. Other more technology-oriented sectors have still not realised the potential of CCSI for their innovation design processes as well as for the storytelling to support diffusion processes, notably for the case of digital or sustainability transitions. The financial sector, as well, is more reluctant to CCSI activities, which is also linked to the problem of fragmentation of CCSI actors. On the other hand, the CCSI has also still not covered the strategic chances to address other sectors directly, as this requires a different, more market-oriented picture of CCSI activities, without losing creative freedom or cultural diversity. Policy instruments can contribute to the development of skills as well as the necessary strategic perspective to improve the relevance of CCSI. As other sectors and businesses are challenged by reconsidering the narratives of their business model towards values such as sustainability, social inclusiveness, diversity or a European identity, CCSI represent a chance to contribute to new firm narratives helping to address the increasing ethical standards by consumers and other economic actors.

The organisational mechanisms within CCSI actors have often been mentioned as the main source for its strengths and its weaknesses. On the one hand, many small actors provide a very high potential for experimentation and individuality, which supports not only the creation of a variety of content and products, but also competition among them. Another strength of CCSI is the close linkage to their consumers or audiences. CCSI provides different kinds of communication channels compared with conventional marketing, which can improve firm marketing as well as the acceptance of socio-technical transitions. On the other hand, the fragmentation in form of small, sometimes single-person actors leads to a lower professionalization of processes and complicates knowledge diffusion and learning processes. While, from a strategic point of view, many actors understood the necessity for change towards the resolution of societal challenges, the implementation lacks of funding and of skilled personnel.

Because of the challenges coming from the digitalisation and the fragmentation of the sector, many interviewees talk about phases of re-orientation in case of necessities to enter digital technologies. The ICE KIC can provide a safe space for experimenting with digital opportunities to enable re-orientations without economic disadvantages for the related actors. Furthermore, the ICE KIC can also support CCSI subsectors and activities, which have or might emerge as highly promising in the future. The gaming industry – including e-sports athletes – represent such a future field, which can demonstrate how CCSI activities can achieve high ranges on gaming and other social platforms.

Keywords: Creative and cultural sectors and industries, Sectoral innovation systems, rationales for innovation policy

[179] Silje Tellmann (University of Oslo) and Magnus Gulbrandsen (University of Oslo, Centre for Technology, Innovation and Culture). *Demanding research: an analysis of contract research in policymaking.*

Abstract. In this paper, we study the practices of contracting research in three policy fields in the Norwegian central government. Contract research is a common and user-oriented form of research tied to policymaking, but little is known about its characteristics compared to, for example, academic research or large-scale activities targeting society's grand challenges. Even though contracts represent smaller research efforts, they may still be tied to such challenges and play a major role in engaging users and coordinating the demand side of science-society interactions. Through a unique study of contract research announcements, we analyze aspects such as themes, funding arrangements, methodologies and knowledge suppliers.

Funding is the most important mechanism whereby external actors may influence research (Gläser, 2019). Hence, much research on science policy and the governing of science has been concerned with unpacking and understanding the different ways that funding is channeled into research and how these may ensure the envisaged outputs (Lepori, 2011; Aagaard et al., 2021; Ramos-Vielba et al., 2022; Cocos and Lepori, 2020).

A general concern in the literature is the risk involved in research funding, and funders' lack of control over outputs (Braun, 2006). Researchers often have other interests and objectives than their funder and may therefore seek to compromise with the demands and expectations of the funder. Braun likened the relationship between the funder (user) and the performer (researcher) to that of a principal and an agent in need of an intermediary to establish trust, select the best knowledge providers and exercise control over activities and outcomes. Such intermediaries are typically funding agencies, which form a key function in the distribution of public research funding in most countries, and where coordination between policymakers and researchers happens by a set of means to balance control with efficiency.

Despite the long-term awareness about the challenges of ensuring specific outputs of funding, there are hardly any mentions in the previous literature about the special features of contract research as a funding scheme which operates with detailed announcements and contracts as the regulatory intermediary between the funder and the researchers. One would accordingly expect that contract research is less subject to the moral hazard risks of research funding compared to other forms of public research funding. Contract research is accordingly regularly used by governments (as well as by industry) which are in need of specific knowledge – for immediate or longer-term needs – in their working processes and who enters into a contractual relationship to make the researchers to provide the required knowledge (cf. Gläser, 2019). Hence, the relationship between the funder and the researcher is direct and regulated only primarily by the contract which specifies the expected outputs tied to the funding.

The contexts of contract research has led to several concerns, including how research integrity can be safeguarded under conditions of pressure (Vie, 2021) and how field-internal notions can be maintained (cf. Langfeldt et al., 2020) involved in contract research compared to other public funding schemes. Apart from this, there is reason to ask whether the output-oriented focus of contract research in policymaking contexts may lead to policy-based evidence rather than evidence-based policy (Strassheim and Kettunen, 2014). The institutional set-up of contract research means that the boundary between science and policy is temporarily suspended (Tellmann and Gulbrandsen, forthcoming), and that policymakers may dictate the terms of the knowledge production. While this may bring relevance to the knowledge production and solve immediate policy needs, this may also harm the independence and legitimacy of the outputs in the further policy process (Lentsch and Weingart 2011). The relationship between the policymaker as the principal and the researcher as the agent also means that there is an asymmetry between the two which is not only about information, but also about expertise and the ability to monitor the knowledge production and thus ensure the demanded output (Gläser, 2019).

Despite such concerns, contract research remains a stable part of the research system which is used regularly by policymakers in parallel with other forms of research. Yet while the steering of research that is funded through research funding organizations and/or take place in higher education institutions and public research institutions has been subject to extensive research (see Cocos and Lepori 2020), the role and characteristics of contract research within this system has received little attention.

In this study, we will make these issues the object of empirical scrutiny. The central administration in Norway, like in many other countries, have separate budgets for procuring contract research to solve policy needs, yet how these budgets are spent, and on what conditions, is largely unknown. By analyzing the announcements for contract research in three policy fields which are among the most active in purchasing research (Askim et al., 2021) over the past 5 years, we set out to understand how policy demands for research are formulated and communicated, and how the terms of knowledge production and monitoring of the research process with expected outputs is established. The analysis follows an exploratory strategy, aiming at distilling characteristics and patterns of contracting practices. As such an inspiration is earlier mappings of the profiles of research units (e.g., Larédo & Mustar 2000) but where we are interested in analysing the different types of research, methodological approaches, research providers and more that are found in the contracting sphere. This also include mapping and analysing the different ways in which policymakers may influence the content and form of the output, as well as the scope for researchers own interpretations in the research process.

The wider purpose of the analysis is two-fold. Firstly, we set out to map the content and the characteristics of the demands that researchers meet in contract research: What are the problems that policymakers seek to solve by contracting research (are they part of or complementary to 'grand challenges'), what kinds of demands are placed on the knowledge production process, and what plans for monitoring and interacting with researchers do we observe in calls for contract research? Secondly, and based on the analysis of the calls, we will discuss the preconditions for contract research as an arrangement for reconciling the demands and supply of research and the role of contract research within the broader research policy mix.

The analysis is ongoing, but it will include in total about 170 calls for research within work inclusion, integration and environmental policies. The policy fields differ in size and in the political attention they attract, but also in the surrounding landscape of knowledge providers. While Norway has a strong research institute sector which has served the government with knowledge and analyses for decades, there is an ongoing drift in the knowledge system which involves an academization on the part of the research institutes, and the entry of consultancy firms in the market of contract research. Hence, the study will also touch upon the dynamics of the supply-side in this market, and whether we can see a hidden division of labour forming between consultancy firms and research institutes, or if they compete over the same contracts.

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Keywords: The role of science in policy, Contract research, Public research funding, Grand challenges

[180] Kejia Yang (TIK Centre for Technology, Innovation and Culture, University of Oslo) and Kaidong Feng (School of Government, Peking University). *From industry development to system wide transformation: policy instruments of RE and EV development in China.*

Abstract. Recent years have witnessed the significant conceptual advance of how science, technology and innovation (STI) policy can play a role to address the grand challenges. This has been reflected in the recent debates of mission-oriented innovation policy (Mowery et al. 2010, Mazzucato 2018, Wanzenböck et al. 2020) and transformative innovation policy (Weber and Rohracher 2012, Schot and Steinmueller 2018, Diercks et al. 2019). However, there are still limited empirical insights on what are the efficient policy instruments that can be mobilized to achieve this goal.

Sustainability transitions studies suggest this hinges on the system transformation, which generally goes beyond the diffusion of technological products (such as the market adoption of solar panels, wind turbines or electrical vehicles) but also the change of market rules, infrastructures, regulations, culture and social values. Therefore, it requires a wide range of policy instruments that go beyond the dichotomy of technology-push or market demand debate which has predominantly focused on the nurturing of an emerging green industry, but it requires coherent policy instruments targeted for electricity or mobility system-level changes. However, the question is how these policy instruments play out in reality? Especially for system transformation, it generally requires a long period of development and different policy instruments may be adopted at different stages. Moreover, system-level policy change demands coordination across a wide range of stakeholders beyond a singular industry sector. How do different policy instruments change over time? How to overcome barriers to build coordination?

In this paper, we will examine the longitudinal cases of renewable energy (RE) and electric vehicle (EV) development in China from their initial stage to current development. These two cases are selected as revealing cases or exemplary cases (Yin 2013). For RE development, we specifically focus on wind and solar power development which have been diffused rapidly in China over the last two decades. Moreover, they both have challenged China's current coal power entrenched electricity sector (Yang 2021). EV has been perceived as holding great potential to decarbonize China's mobility system (Jin et al. 2021). Longitudinal case studies are regarded as appropriate as they could offer rich empirical data to investigate how different policies evolve and play a role to shape the recent system transformation. Multiple cases are adopted to serve as replications, contrasts and extensions to the emerging theory (Eisenhardt and Graebner 2007, Yin 2013).

Our analysis concerns three key questions: (a) what are the policy instruments adopted to shape RE and EV development in China? (b) how do these policy instruments change over time? (c) who are the actors involved to drive these changes? Especially how has China coordinated across sectors to set up different policy instruments?

We collect data through desk-searching as well as through interviews. We collate all the policy documents relate to the RE and EV development and conduct text analysis to identify the policy goals and rationales so that to categorise different policy instruments. We also conduct interviews to identify how these policy instruments change and who are the actors involved in these policy changes.

The preliminary research results indicate that both RE development and EV development have gone through two different stages of development with policy instruments targeted for divergent policy goals and rationales. This is characterized as a shift from previous industry focused policy (combing technology push and market demand instruments) towards system wide policy transformation. For the system wide transformation, it goes beyond nurturing certain industry or technology development through R&D investment, technology experimentations, taxes deduction, market incentives and regulations, but it requires system oriented policy thinking and policy instruments with goals to coordinate different socio-technical system elements for transformative change. This includes the regulations of coal power regime or fossil fuel vehicles, as well as the change of grid dispatching practices (from controlling and planning oriented towards renewable energy prioritised flexible dispatching practices), the deployment of EV chargers and improvement of grid flexibility. These two different paradigms distinguish from each other with divergent policy goals, policy rationales, policy instruments adopted and actors involved. They are formalized at different stages of development.

To put in place such policy instruments, it demands coordination across different government bodies, the traditional STI policy agency, industry policy agency as well as environmental protection agency. Thus, this shift from the industry focused policy towards this system level transformation is not a tidy process but full of contentions and struggles among different stakeholders. This requires overcoming policy silos and coordinating among different actors who never worked together before such as the grid companies with the mobility sector. Especially there were generally strong political contentions between new entrants (such as renewable energy and EV manufacturers) and incumbents (such as coal power generators). Therefore, how to overcome these contentions to implement these policy instruments become a huge challenge. Macro level policy instruments, such as clean air, carbon neutrality policies play a crucial role to create political legitimacy to overcome these constraints and challenges.

These policy changes are based on short cycles of policy adjustments and learning in responding to failures or driven by problem-solving. This learning capability to adjust and to adapt to the different problems exposed at different stages of development matter for the system transformation. The two cases also indicated the flexibility between top-down and bottom-up processes played a significant role for the success.From this point of view, the conceptually developed framework, provided by (Kanger et al. 2020), recognised different policy interventions points at different stages, although conceptually useful as searching heuristics for developing different policy instruments, however, in reality, policies are developed through processes of continuously adjustments based on previous failures and learning experience. It is hard to recognise what is the right point of time to implement the right policy instruments. Moreover, the political struggles also make it hard to adopt the right policy tools to fix the problems. These contentions and politics are especially visible when it comes to this system transformation oriented policy interventions, as it requires extensive involvement of a wide variety of stakeholders and collaborations across different government bodies and industry sectors.

Our study contributes to existing studies from three aspects. Firstly, it systematically traces how the policy instruments evolve to shape China’s RE and EV development. Secondly, it argues that their development goes beyond the previous studies of top-down catch-up oriented technology push argument. We argue that different policy instruments have been adopted at different stages of development fit for different purposes. Especially we indicate that China has shown great policy flexibility to respond to the different problems that emerged at different stages. Thirdly, we contribute to the understanding of policy instruments for system transformation. However, instead of providing the one-size-fits-all policy solution, i.e., adopting the right policy instruments at the right time, we argue what matters is building the learning capacity and reflexivity/ flexibility to respond to failures and problems, as well as to build the capacity to coordinate a wide range of stakeholders to implement these policy instruments.

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Keywords: System transformation, Policy instruments, Renewable energy, Electric Vehicle, China

[181] Caleb Adelowo (North-West University) and Willie Siyanbola (centre for energy research and development). *Science, Technology and Innovation Policy Implementation and Evaluation in a Developing Country: Evidence from Nigeria.*

Abstract. Introduction

Globally, STI has become the fulcrum of development in the developed, newly industrializing and developing economies. Governments around the world govern through well-articulated policies, and good governance demands sound policies. Specifically, the process of transforming national economic landscape for inclusive growth and development through STI requires coherent coordination of programmes, institutions and activities of government using robust STI policy. 2012 STI policy was uniquely designed in many ways: first, it was the first time in Nigeria that Science and Technology policy is tied intricately with innovation; second, the policy design was almost wholly informed by scientific evidence and third; the policy is accompanied with well-articulated implementation framework and a broadly debated and approved governance structure. To ease its implementation, the policy was anchored on the triple-helix model and national innovation system approach, for ownership and to foster active engagement and interactions among all key stakeholders in the STI sector.

To further drive the development aspiration of government with STI instrument, the Science, Technology and Innovation Roadmap was designed and introduced in 2017 to transform Nigeria into a knowledge economy, and provide levers after the expiration of the extant policy. The Roadmap (2017-2030) articulates programmes and activities to enhance national innovation capability through apt investment in R&D and innovation infrastructure, human resources development and national technopreneurial ecosystem. In line with the global standards, it is important to evaluate the performance of the extant STI policy to chart appropriate path for its review. Therefore, this paper provides insights into the policy performance evaluation conducted between May and July 2021. The evaluation aims to examined the extent of STI policy implementation among the key actors/stakeholders with a view to providing appropriate lessons and inputs to drive the policy revision.

Methodology

Appropriate evaluation approach for STI policy would have been experimental approach such as randomized control trials that supports the theory of change and allows for pre and post policy assessment. However, lack of baseline data and inadequate longitudinal data within the country necessitate the use of alternative methods. Here, a cross sectional survey was designed to map the degree of policy implementation and key challenges to its full implementation among the key stakeholders in the Nigerian STI landscape. A set of evaluation questionnaire was designed and used to elicit information on stakeholders' assessment of policy implementation, key policy performance outputs and the challenges of implementation. Stakeholders' analysis was conducted and purposive sampling techniques were adopted to select mainstream stakeholders with high power and high interest from both public and private institutions. 'High power and high interest' stakeholders are those institutions with significantly high influential power based on multiple assigned roles in the implementation framework that accompanied the STI policy. Specifically, the Federal Ministry of Science and Technology and its Agencies, cognate MDAs, selected state ministry of science and technology, and selected trade associations/ organised private sectors operators belong to this categories of stakeholders. Of the forty-five (45) key stakeholders that participated in the study, thirty-six (36) institutions returned the evaluation instruments, representing 80% response rate.

Key Results and Discussion

The results revealed that majority (82%) of the stakeholders affirmed that they participated in the design of the 2012 STI policy which suggests that the right institutions were selected for the evaluation. And that their perceptions could be taken as true reflections of the status and activities in the Nigeria's STI sector. The selected stakeholders were involved, at different degrees in policy advocacy and promotion, development of implementation framework, communication and publicity. Majority of them (84.0%) also reported that the policy document reflected their contributions at the time and that the policy could be regarded as the most inclusive one ever. There is overwhelming perception that the policy received wider circulation and attention among the stakeholders, including the development partners. However, the extent of the policy implementation is generally described as fair or average. For instance, only few stakeholders (18.2%) perceived the policy to have been excellently implemented, contrary to the majority (66.7%) who perceived it to be only fairly implemented. These ratings are perhaps not surprising. We know for a fact that the policy and its implementation framework were built around a governance structure; namely, the National Research and Innovation Council (NRIC) that have Mr President as the Chair and a funding mechanism, National Research and Innovation Fund (NRIF), which was uniquely designed to provide reliable funding for R&D and innovation activities in the country. The NRIC was constituted but largely inactive while the NRIF was approved by the 8th Assembly but never received Presidential assent. The perceived 'average performance' of the policy could not be unconnected with the observed weak or lack of, political will to functionalise the two strategic policy instruments designed specifically to drive the policy implementation.

Nonetheless, it was reported that many stakeholders (81.3%) implemented some projects that have direct bearings on their mandate and which are in tandem with STI policy objectives. Some of these projects include the deployment of renewable Energy System (off-grid) to increase energy access and promote sustainable energy development in Nigeria, the use of Innovative Technologies for the development and promotion of improved planting materials to enhance food security and the use of technologies for the development and evaluation of identified herbal recipes among others. To fund these projects and other vital activities none of the stakeholders explored diaspora donations but development partners (45.7%) and research grants (42.9%) were largely explored in addition to their usual budgetary allocations. Strikingly also, sourcing private sector funding for STI related activities has improved among the stakeholders as 28.6% of the respondents reported that they explored private sector support/ commitment for their projects.

Policy instruments matter for holistic implementation of the STI policy. To that extent, majority of the stakeholders reported that they leveraged on and/or utilised a number of policy instruments to implement policy related projects and activities in their institutions during the periods under review (2014-2018); these include: annual budgetary allocations (79.3%), National Council on Science and Technology (88.5%), Council memos (86.2%) and Executive Order 5 (60.51%), amongst others. Surprisingly, the NRIC (42.2%) and the NRIF (16.7) ranked least on the policy instruments utilised.

These results are particularly instructive in that they could be suggesting that improvement witnessed over the periods under review may not necessarily be attributable to policy implementation per se, but could be due to normal cause of events or simply happenstance.

In terms of STI outputs, about 70% of the stakeholders remarked that their organisations performed well and/or excellently well in the area of research paper publications during the period of STI policy implementation than in the years preceding the policy approval. Only few stakeholders (3.8%) performed below expectation or poorly on paper publication outputs. Another important output indicator is the number of Patents generated over the period. Many respondents (33.3%) reported that their institutions actually performed very well. The perception on the inventions produced and R&D outputs commercialised are also generally good. An initiative of the past (and supported by the present administration) as part of the STI policy implementation is the annual Technology Expo to showcase new discoveries, products and process innovations. Most stakeholders rated their level of participation at the Tech Expos to be very good.

In the area of human capital development in STI, a considerable number of respondents remarked that capacity building and staff training require more attention, as 33.3% of them reported that their institution performed poorly in staff training, especially regarding the broad area of STI management. They also remarked that the capacity to formulate and implement policies are still considered generally weak, therefore regular training of staff is central to bridging these gaps.

In terms of specific output indicators, there are obvious improvement in the number of scientific research articles produced between 2014 and 2018 although only very few institutions reported their number of scientific publications. The average article production per year as reported by the stakeholders was 18, except for 2015 and 2016 where the figures stood at 17 and 14 respectively. There is numerical increase in the number of research reports produced, showing apparent improvement in research activities. The number of inventions produced, prototypes developed, spin-offs created and tangible commercialised R&D during the period also showed significant improvements. The results further showed significant increase in the number of public-private institutions' research collaboration, signifying improvement in interactions within the NIS and the private sector's commitment to research activities as compared to the past experiences before the STI policy was approved.

The level of funding (measured by budgetary allocations and releases) determines, to a large extent, the depth of activities that each institution can undertake as part of their policy implementation efforts. Although only few stakeholders provided the figures for the core R&D projects implemented during the period under review, there appears to be no pattern or any form of consistency in the amount of budget releases. However, it is worth noting that most of the stakeholders' institutions have poor record keeping culture/ability, hence their outright refusal to provide accurate figures whenever demanded. The challenge of record keeping and transparency must therefore be addressed in any future policy evaluations to enrich our understanding of the policy performance and also, the policy learning experience

On the challenges facing STI policy implementation, overwhelming majority of the stakeholders (95.8%) affirmed inadequate funding as a major barrier. As earlier observed, this may not be unconnected to the unwillingness of Mr President to assent to the NRIF that could have removed financial bottlenecks and jumpstart copious generation of innovation outputs within the STI system. Other key constraints perceived high by the stakeholders are poor understanding of the policy objectives (62.5%), poor coordination among the implementing institutions (54.1%), inadequate awareness and poor sensitisation (56.5%), change of administration (60.8%) and lack of policy instruments' approval (40.9%).

Policy Recommendations

The government needs to review the extant STI policy in the light of current technological and socio-economic changes at the national and global levels so as to reflect the current realities and, to also actively address the emerging challenges. For this to be done, existing relationships and interactions among the key stakeholders have to be maintained and/or strengthened, through appropriate platforms. Also, the NRIC and NRIF need urgent attention, where applicable for government to provide the necessary assent making it a law that must be implemented. The practical example of Brazilian case, how they moved from STI policy to innovation laws and later the law of goodness to drive strong technological capability in the country, is worthy of emulation. Building adequate skills and competences among senior staff/workforce in the STI system for comprehensive implementation and adequate monitoring is equally important, going forward.

Institutionalization of diaspora engagement in Nigeria's STI system is important. The Ministry of STI could work with the diaspora commission to champion brain circulation (as against brain drain) through active involvement of the diaspora in the design, implementation, monitoring and evaluation of STI activities in the country. With the recent inclusion of 'Innovation' in the Ministry's nomenclature, it is important to overhaul the mandates of all agencies to reflect true innovation where technology commercialisation is emphasised.

Future policy and its implementation framework should assign specific roles to each stakeholder institutions against which their performance would be measured. Provision of adequate and timely release of budgetary allocations to fund and implement policy projects and programme must be assured. Where possible, government need to make extra budgetary allocations to provide a critical research and innovation infrastructure to enhance innovation outputs in the country. In general, the culture of record/book keeping by institutions is fairly weak, this must be addressed urgently. There is also urgent need to create databank of activities in the STI system to improve M&E and timely delivery of the policy related projects.

Keywords: STI policy, Performance evaluation, implementation, Developing country, Nigeria

[183] Trust Saidi (University of Oslo). *Towards translating scientific excellence into societal impact in health care – A critical assessment of the opportunities and challenges posed by social innovation in bridging the missing link.*

Abstract. Globally, there is an emerging trend in which researchers are increasingly required to describe the impact of their work, for example in grant proposals, project reports, press releases and research assessment exercises (Lutz Bornmann, 2013; Kuruvilla, Mays, Pleasant, & Walt, 2006). The focus on both scientific excellence and societal impacts, particularly from publicly-funded research to demonstrate the broader 'public value' of research to society transcends beyond the traditional importance of publications (Bozeman & Sarewitz, 2011; D'Este, Ramos-Vielba, Woolley, & Amara, 2018). However, there is a bias towards scientific quality of research in terms of the number of citations and impact factor rather than value on society (R. Smith, 2001). The pre-occupation with scientific excellence is criticised because of its incapability to capture user value and impact (S. Smith, Ward, & House, 2011). Several authors have questioned whether 'high-quality research' will necessarily have an impact on society (Derrick & Samuel, 2016; R. Smith, 2001), or even if its impact on society will be beneficial (Nightingale & Scott, 2007).

Funding agencies are increasingly becoming sceptical of the academic claims of a strong relationship between scientific excellence and the degree of societal impact (Davison & Bjørn-Andersen, 2019). Researchers are being asked to demonstrate that funded research represents value for money, not only through the generation of novel scientific knowledge, but also by contributing to economy, society, culture and public policy (Martin, 2011; Newson, King, Rychetnik, Milat, & Bauman, 2018). This has resulted in the broadening of the scope of scientific research by focusing not only on excellence, but also the benefits which it brings to society (Spaapen et al., 2011). Despite its fundamental orientation, health research has only recently increased its explicit attention to the societal impacts of knowledge generation to the patients (Pedrini, Langella, Battaglia, & Zaratin, 2018). The societal impacts from health research are no longer taken for granted, but are increasingly being tied directly to the research funding system. An explicit emphasis on societal impact of health research holds the promise for producing knowledge about treatments, services, programmes, or strategies that could improve human livelihoods by influencing future policy and practice (Lutz Bornmann, 2013; Cohen et al., 2015; Grimshaw, Eccles, Lavis, Hill, & Squires, 2012).

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Studies that have been carried to date on societal impact of health research tend to focus on methods and practices of appraisal (Lutz Bornmann, 2013; Brereton, O'Neill, & Dunne, 2017; Donovan & Hanney, 2011; Klautzer et al., 2011; Lavis, Ross, McLeod, Gildiner, & Policy, 2003; Pedrini et al., 2018), but rarely problematise the notion of societal impact and open it for enquiry.. The assessment of societal impact has been the subject of considerable academic research, yet the parallel process in which it occurs has received little attention and rarely goes beyond anecdotes and vague generalisations. Until recently, much emphasis was put on promoting the so-called 'excellent research', following the linear logic that the best research lead to social change and respond to current societal challenges (Robinson-Garcia, 2017). This has been proven not to be always the case as there is no direct link between scientific excellence of a research project and its societal value. For example, research that is considered to be excellent in the academia because it is highly cited or published in top journals may be good for the academic community, but not for society at large (Lutz Bornmann, 2012; Nightingale & Scott, 2007).

There is paucity of studies that focus on how results from scientific studies can be implemented for societal benefit. A study based on review of literature by D'Este et al. (2018) proposed an analytical and operational framework for explaining the distinct configurations of scientific research and societal impacts and recommended that empirical results highlighting their extant heterogeneity would be a useful contribution to work on the impacts of research. There is a need to investigate the implementation practice of scientific results into societal impacts through alternative methods that provide insights into the nature of the process in healthcare systems. This is motivated by the fact that existing translational methods have limitations as they produce only small to moderate effects with research suggesting that the successful uptake of research results into implementable actions for societal benefit requires more than merely making the results accessible for local practice (Boaz, Baeza, & Fraser, 2011; Rangachari, Rissing, & Rethemeyer, 2013). It is against this background that this paper attempts to fill the research gaps by firstly exploring empirically the missing link between scientific excellence and societal impact and secondly critically assessing the extent to which social innovation could be used as a potential approach for bridging the gap. The study comes at a time when the demands for both science-internal excellence and societal impact are increasing, yet it is unclear how they can be addressed.

Focusing on Norway, a country that prioritises health research, both in terms of its relative size in the national research system and position in the science, technology and innovation landscape, this study explores the relationship between scientific excellence and societal impacts. The study comes against a background in which there are mounting calls by the Research Council of Norway for researchers to demonstrate the impact of their work on society. Based on an exploratory interview study, the paper investigates the challenges in implementing health research for the benefit of society. The results revealed that although there is a growing emphasis on the benefits of health research to the users, societal impact is more postulated than demonstrated. This is due to a culmination of several intervening factors such as the absence of defined responsibilities on the implementation of research findings, skewed incentive systems, attribution problem, and incompatible time frames. To ameliorate the challenges, the study critically assesses how social innovation can be used as an alternative approach to social change that is oriented towards the creation of common societal goods. By focussing on innovations that are social, both in their ends and in their means, social innovation is regarded as an effective way of empowering people and driving societal change (Hubert, 2010). Although, social innovation by virtue of being anchored on novel ways of doing, knowing, framing and organizing (Pel et al., 2020), offers prospects for bridging the gap between scientific excellence and societal impact, the process is not linear, but complex. It is on this basis that this study critically assesses the opportunities and challenges in the use of social innovation, not as a panacea but an entry point for achieving societal impact from scientific research.

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Keywords: Health research, societal impact, scientific excellence, social innovation

[184] Krishna Tripathi (Centre for Studies in Science Policy, Jawaharlal Nehru University). *Approaching e-mobility responsibly: A case of charging infrastructure for electric rickshaw in the NCT of Delhi.*

Abstract. Introduction

In the backdrop of increasing traffic congestion, deteriorating quality of breathable air, oil import bills and climate change concerns, the public transport sector in India is being attempted to be overhauled. Transport department of various state governments have started to explore innovative and effective ways to tackle aforementioned issues. One of the most widespread initiatives gaining popularity is introduction and adoption of electric mobility for achieving decarbonisation of the transport sector which currently is responsible for 14% of India's energy related emissions (Shukla et al. 2014). National Electricity Mobility Mission Plan (2013) aiming at 6-7 million of new electric/hybrid vehicle sales by 2020 and Faster adoption and manufacturing of (hybrid) and electric vehicles (FAME)(2015) to support hybrid/electric vehicles market development and manufacturing ecosystem, have been major initiatives for promotion and adoption of e-vehicles in India. Recently released India's Energy Storage Mission (2017) document by the Ministry of Transport predicts that India can save 64% of anticipated road-based mobility-related energy demand and 37% of carbon emissions in 2030 by pursuing a shared, electric, and connected mobility future (Juyal et al. 2017). Hitherto, despite various efforts of the government, the share of e-vehicle to total vehicle has remained minimal. The most important hindrance is created by lack of appropriate charging infrastructure which causes uncertainty about futures of e-mobility as a viable transport mean.

This paper presents a case study of electric rickshaw (a three- wheeler battery operated electric vehicle) in NCT (National Capital Territory) of Delhi which has been deployed as low cost last mile connectivity in the public transport system. However, the implications of sudden boom in their numbers on the city roads along with paucity of apt infrastructure to promote them have become a major concern for the policy makers keen on brining e-mobility to main stream. Among other challenges curtailing its successful adoption, the lack of battery charging infrastructure has proven to be a major hurdle. The current practices and methods of charging these vehicles are at best questionable and have caused reliability and sustainability issues for not only for e-rickshaws, but also have potential to jeopardise a large scale adoption of e-mobility in the city. Given these consideration, there is a need for an integrated and sustainable charging infrastructure which can deal with these challenges.

Theoretical framework for the study

As the Delhi government is pursuing e-mobility as a large scale transport option in the city, charging infrastructure should not only address the current issues but also provide a long term solutions. In order to deal with the issues discussed above, a prospective charging infrastructure should be innovated in a way that the end product should be economically viable, socially acceptable and environmentally sustainable; and should impart the aspect of accountability and responsibility in e-rickshaws as an innovation. In this context, the responsible innovation approach becomes the most suited, as it is charting out the idea of 'how to innovate' in the existing STS literature. Using RI would allow accountability in the innovation process by creating ecosystems and conditions for deliberations, participation and anticipation from all stakeholders from the onset of the research and innovation (Setiawan and Singh 2015, Setiawan, Singh, and Romijin 2014, Koops 2015, Pesch 2012, Michavila 2013, Grinbaum and Groves 2013). A thorough scheme of anticipation by ensuring people's participation in the innovation process itself would facilitate the resulting innovations to be reflective of the requirements and realities of their user base by bridging the gaps between the societal needs and the innovation coming up as its response (Singh and Kroesen 2012). The RI approach suggested by Singh and Kroesen (2012) conveys that the innovators/actor should ensure that the dimensions of anticipation, participation, deliberation, reflexivity and responsiveness are to be utilised in order for an emerging innovation to be economically, environmentally and socially responsible. In this study, a potential battery charging and swapping infrastructure (energy networks) for e-rickshaws has been conceptualised by using dimension of anticipation and participation of the RI framework. The present study attempts to deal with following questions- what are the challenges with existing charging infrastructure hindering adoption of e-rickshaws as a transport option in Delhi? How these challenges could be addressed by sustainable and accountable energy networks? What could be potential structural, functional and operational aspects of the proposed energy networks for e-rickshaws in Delhi? The case of e-rickshaw presents an ideal instance of the challenges faced by emerging innovations due to their precariousness and has potential to demonstrate the deployability of RI mechanisms in cultural grounds of developing countries like India.

Methodology and main findings

A case study based on structured questionnaires and focused group discussion involving e-rickshaw drivers and structured interviews with experts from e-rickshaw manufacturing companies, consultancy, government and private think tanks was conducted to collect the primary data. In the first phase of the field work, a survey followed by focused group discussions was conducted with the drivers of e-rickshaws in the city (the users of e-rickshaws) to find out the ground problems faced by them in battery charging operations, their requirements and aspirations in terms of charging infrastructure. In the next phase, experts' opinion was gathered by structured interviews via open ended questions followed by structured questionnaire for anticipating the need and requirements for the proposed energy networks. The study brought out the major challenges and possible solutions for the charging infrastructure to be- long charging hours of the batteries, initial cost of the batteries, lack of availability for charging infrastructure and periodic replacement of the batteries. It was found that the proposed 'energy networks' (network of battery charging and swapping stations) on the lines of refuelling station for internal combustion vehicles is the most favoured option as it would provide easy access to energy for e-rickshaws. Functional Analysis System Technique (FAST) was utilised to demonstrate various components and functions performed by the energy networks based on experts' responses on its charging and swapping related functions along with monitoring, maintenance and peripheral functions.

Implications/Originality

Given both the federal and state government attempting to explore novel avenues to promote e-mobility especially by focused efforts on charging infrastructure, the findings of the study could be utilised to provide a constructive and efficient outlook to many initiative in this area. The finding of the study could be utilised by innovators and/or industry partners for planning and producing a charging infrastructure for e-vehicles. The novel component of the study lies in proposing an innovative charging infrastructure outlook in combining the concept of charging stations and swapping stations by utilising anticipation and participation dimensions of responsible innovation approach to put forth the idea of energy networks for promotion of e-mobility.

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Keywords: Anticipation, Charging infrastructure, E-mobility, Responsible innovation

[185] Vairaj Arjune (Jawaharlal Nehru University), Dr Rajbeer Singh (Jawaharlal Nehru University) and Prof. Pranav Desai (Jawaharlal Nehru University). *Challenges and Opportunities of Science and Technology Collaboration in the Agriculture Sector: Why Caribbean scientists collaborate with international partners?*

Abstract. Abstract

The architecture of world science is changing and many believe that the present scientific and technical revolution is truly unprecedented, particularly in areas of expansion and integration of global networks which is most evident in global spending on R&D, information communication technologies, transport, and defense. Most of these networks are initiated on collaborations with international organisations, multinational corporations, major foundations, and cross-national structures (Royal Society, 2011). So, building technological capacity through knowledge creation in developing countries is significantly linked to the globalisation of science. This is evident in the growing number of researchers and increased scientific publications that are initiated through collaborations with cross-national structures and organisations. Developing countries of the Caribbean Community have recently witnessed increasing rates in publications written with scientists from other regions of the world and technical projects initiated at the governmental level. In this paper, we analyse two research questions: a) what are the mechanisms for building science and technology with far-flung reasons and b) why researchers and scientists collaborate with far regions. Through the deployment of questionnaires, we analyse the responses from 25 Caribbean practitioners from the Caribbean Agricultural Research and Development Institute; University of the West Indies; University of Guyana; and the CARICOM Secretariat to understand the hierarchical nature and power structure of collaboration. We found that collaboration activities involve sharing knowledge in the context of a particular innovation or the critical scientific knowledge embedded in the innovation. For the first research question, three dominant mechanisms account for almost 75 per cent of all collaborations: joint research activities with universities; in-house R&D; and joint research activities with government R&D centres. This is because efforts are geared towards developing scientific infrastructure that is conducive to local user characteristics and environmental conditions. The second research question, optimising resources and mutual beneficial technology arrangements, are the significant factors that Caribbean practitioners consider for engaging with far regions. A gradual change in this direction is evident with the shift from the large-scale transfer of agricultural products from the advanced countries to fostering South partnerships to promote food and nutrition security cooperation. These emerging trends are significant drivers for South to South collaboration representing the links between developing countries to build science and technology capacity.

Analytical Framework

Collaboration is regarded as a need-driven activity with the aim of attracting the best talents and expertise to conduct scientific investigations and enquiries. Many times, these collaborations are usually motivated around economic needs, historical interactions such as colonial relationships, economic ties or similarities in linguistics and culture, and geographic proximity (Wagner et al., 2001). The impact of these drivers on the structure of a country's collaboration pattern can be long lasting and even deter national governments from making their own scientific investigations. More importantly, what needs to be investigated pertains to whether the objectives of collaboration and the resulting socio-economic benefits are suitable and appropriate for all collaborating partners and not just in the interest of selective partners. In fact, Wagner et al. (2001) provided a rather revealing analysis regarding the ranking for engaging in collaboration by developed countries scientists. Their extensive study concluded that 54 percent of the surveyed scientists collaborate due to previous interactions stemming from visits or meetings by the international collaborator. This was followed by the expertise of the foreign partner and only around 20 per cent of scientists collaborate in the international area to optimize equipment and facilities. Though not surprising as developed countries are heavily endowed with resources, the situation for developing countries and low-income developing countries warrant a similar analysis. Most of the time, interest in collaboration grew out of diplomatic ties with scientific and socio-economic motivations taking a back seat, reaping international funding and low S&T capacity building.

The process for building technological innovations in developing countries depends to a large extent on the diffusion and absorption of scientific and technical knowledge as well as the conversion of these into new products and production processes. This paints an interactive and complex system involving science, technology, learning, policy, and demand (Edquist, 1997). The use of the system of innovation approach to the study of knowledge exchange is not new (Carlsson et al., 2002; Edquist, 1997). The system of innovation approach is compatible with the notion that processes of innovation are, to a large extent, characterized by interactive learning (Edquist, 1997). The fact that successful innovations are not isolated events (Schumpeter, 1939) but occur in collaboration and interdependence with other organization gives rise to the emergence of the System of Innovation (SI) approach (Edquist, 2004). However, these frameworks place emphasis on understanding how innovations emerge without considering what precedes the interaction for networking as well as the socio-economic implications of collaboration. Recently, scholars suggest an international system of innovation, for which we have adopted in this study. Desai (2009) in dissecting international technology transfer channels in developing Asian countries generated three underpinnings of the international system of innovation: dynamic, hierarchial and power structure. These three descriptive foundations of the international system of innovation can be captured visually by an inverted triangle depicting the hierarchical S&T resource chain where countries try to harness and acquire technological capabilities. As developing countries try to acquire technical competence and build S&T capabilities through R&D research, scientific collaboration, and strategic alliances among others, they shift upwards the S&T resource chain. Those countries, while progressively strengthening their core scientific competence, could displace actors (high endowment) who once dominated that particular domain through technological competence and competitiveness. Thus, the system can be considered as non-static and gradually changing as actors' moves up and down the S&T resource chain. A critical point to note here is that building technical competence and having a high concentration of S&T resources also peddles the kind and magnitude of scientific collaboration an actor forms with another actor at the bottom or any other position of the resource chain. Contrary of research efforts that employ innovation system approaches and system analysis actually provide any detailed analysis of international scientific collaboration by focusing entirely on corporate R&D (Fromhold-Eisebith, 2007), internationalization of S&T should extend to include global scientific and technological policies and strategic alliances (Chesnais, 1992, 2010).

Methodology

The study is based predominantly on empirical data as well as secondary data. To collect primary information on the patterns and reasons for engaging in international collaboration related to agriculture we deployed structured questionnaires. The questionnaire was designed and comprised of 26 questions that captured information about areas of collaboration, conditions for initiating collaboration, preferred institutions when establishing international collaboration, among others. In addition, interviews were held with experts, policy officials and prominent people of the Caribbean Secretariat, such as Deputy Programme Managers, Scientists and Organisational Heads to collect additional information. The basis for selecting these persons is their knowledge about their areas, especially the deputy programme managers under the Council for Trade and Economic Development, who were able to provide valuable information on the current collaboration projects and initiatives in their areas of work. In this study, we analyse the twenty-five (25) responses from Caribbean policymakers, scientists and academicians in the area of science and technology for agriculture.

Discussion and Findings

Agriculture remains a vital area of regional and international collaboration for agro-processing and nutritional security and is a potential opportunity to be unlocked in the Caribbean. However, globalisation and trade liberalisation have compelled CARICOM's leaders to confront difficult decisions about the Region's policy orientation, particularly concerning mechanisms to ensure collaboration between the public and private sector and the creation of an enabling environment favourable to food industry and agricultural growth and development. We found the agriculture sector lags behind other sectors in terms of R&D development. The rapid growth of new industrial and service sectors in many of the Member States has put agriculture on the lower end of the scale. This is obvious from an economic standpoint and because structural transformation prescribes a smaller share of the agricultural sector in the national GDP as an economy develops. The result of declining agricultural share seems to be linked to the tremendous growth in other economic sectors rather than the shrinking agricultural production, although population demand for food would have increased over the years. As such, what is required is a more integrated information flow to be put in place along with infrastructural improvements to offset the historical emphasis on traditional crop production varieties. If the right configuration is achieved between stakeholders and policy infrastructure, many Member States, or even the Caribbean Community could be a massive Agri-Hub of the world as there is untapped natural resources and crop-tolerant climatic conditions.

From our analysis, there are three major approaches across all organisations for developing and strengthening science and technology capacity: joint research activities with universities and technical institutes; in-house research design and development; and joint research activities with government R&D centres. These dominant mechanisms account for 75 percent of the international collaboration. This is because efforts are geared towards developing scientific infrastructure that is conducive to local user characteristics and environment conditions. For the less-scientific countries, establishing collaboration for developing technologies and innovative products requires developing countries to carefully assess the selection and utilisation of technologies and to identify the relevant local weaknesses and advantages in order to minimise the adaptation period (Cohen, 2004). A significant step towards this direction is visible where there is a break from traditional approaches of adopting imported innovations from the developed world that is not suited for the production and process system of Member States. Several attempts in the past to assist Member States to boost agricultural-related production have generally focused on the transfer of large-scale transfer of agricultural products and machinery from the advanced countries.

Many efforts in Member States are now directed towards modifications to local conditions of S&T collaboration. For example, licensing of new technology and research arrangements with private firms are on the lower rank of the preferred method of collaboration, particularly for regional R&D organisations, educational institutions and national organisations. Another implication for the channels of international collaboration and the mechanisms that induce accumulation of technological skills rests with budgetary allocations that have potential to derail project priorities depending on the funding partner or institution. For instance, 50 percent of experts, when asked about the source of funding for international collaboration, pointed out that collaboration is usually initiated with the international partner providing full funding for the research activity. Almost 60 percent of experts from CARICOM R&D organisations and educational institutions indicate that they need to secure their own funding or source third party sponsors (international organisations, banks) for partnering in international collaborations. At the central level, government expenditure in the form of national budgetary allocation for international research and development was the most negligible as only few regional institutions like CARDI (Belize and Dominica), representing 14 percent of the sample organisations, have access to provisions in National Budget for S&T collaboration. Around 36 percent of experts (majority from R&D organisations) indicate that government ministries with responsibility for science and technology generally provide funding for supporting projects with an international partner. The confluence of these indicators has a tremendous effect on the economic and social stability of the agri-economy in Member States. Thus, targeted and holistic policy interventions are required to achieve long-lasting solutions in the changing environment of the Caribbean Community. Also, proper alignment of the reasons for engaging in cross-border knowledge exchange can be exploited as significant drivers for South to South collaboration representing the links between developing countries to build science and technology capacity.

Keywords: CARDI, Caribbean Community, International Collaboration, International System of Innovation, S&T Resources

[186] Marius Berger (ZEW - Leibniz Centre for European Economic Research) and Johannes Bersch (ZEW - Leibniz Centre for European Economic Research). *Outside Equity and Startup Innovation: Evidence from the German INVEST Program.*

Abstract. Over the past three decades, equity financing has gained considerable interest from academics and policymakers as a market based solution to finance radical innovation in entrepreneurial firms. The innovation literature stresses the importance of equity finance (or venture capital) as a driver of technological change (Florida and Kenney, 1988), as firms that receive venture capital (VC) are associated with more radical innovations and knowledge spillovers (Schnitzer and Watzinger, 2020).

Although not a necessary condition for innovation, research and development (R&D) activities constitute a central element in creating them. The cost of capital for R&D tends to be high for young entrepreneurial firms (Hall and Lerner, 2010), and at the same time these firms are more likely to be subject to financing constraints

(Czarnitzki and Hottenrott, 2009; Kerr and Nanda, 2009). As informed inside investors venture capitalists are viewed to overcome such constraints (Admati and Pfleiderer, 1994; Myers, 2000). Prima facie, there is an obvious

link between equity financing and investments into R&D related activities. It is therefore often assumed that "the bulk of venture financing supports innovative activities", and only "some of the venture financing goes to low-technology concerns or is devoted for marketing activities" (Kortum and Lerner, 2000, p.677). However, data on R&D investments in non-publicly traded firms is rarely reported, so there is little empirical evidence regarding the direct link between equity financing on R&D investments in the context of privately held entrepreneurial ventures.

Given that many of these firms raise public funds before going to a venture capitalist (Berger and Hottenrott, 2021; Conti, 2018; Cumming, 2007; Feldman and Kelley, 2006; Giraudo et al., 2019; Hottenrott and Richstein, 2020;

Howell, 2017; Islam et al., 2018; Lerner, 2000; Söderblom et al., 2015; Zhao and Ziedonis, 2020), it is not clear whether financing from venture capitalists adds to firms' R&D investments. An open question in this context is whether external equity financing allows entrepreneurial firms to make more investments in R&D. In other words: Does outside equity cause an increase in startups' R&D activity?

Existing research on the relation between equity financing and innovation has focused on patents as a measure for innovation (Bernstein et al., 2016; Caselli et al., 2009; Engel and Keilbach, 2007; Hirukawa and Ueda, 2011;

Kortum and Lerner, 2000; Lahr and Mina, 2016; Peneder, 2010; Popov and Roosenboom, 2012). However patents only measure innovation outputs, and may be an imperfect indicator of innovation inputs, as patents may be filed strategically and some technologies are not patented at all. Instead, this paper takes a different approach and explicitly distinguishes between innovation inputs (R&D) and innovation outputs (market novelties). To do so, we use data from the IAB/ZEW Startup Panel, a large scale survey panel of startups that contains detailed information on startups financing and innovation activity. The Startup Panel is constructed as a replacement sample to account for attrition, and based on a stratified random sample of young firms in Germany. It covers firms up to the age of seven years and over-represents firms from high-tech sectors. For our analysis we use a sample of roughly 10,500

startups in the period from 2007 to 2018.

An empirical assessment of the causal link between equity financing and innovation is complicated by the fact that financing decisions are endogenous to firms' technological opportunities. More technological opportunities may affect both the level of innovation as well as the propensity to finance with outside equity. To account for the endogenous nature of equity financing decisions, we consider the introduction of the German INVEST program - a major subsidy program for private individuals (angel investors) who directly invest in startup companies. The

program partially reimburses investors for their investments, which results in exogenous variation in the cost of external equity capital for eligible firms over time.

The introduction of the program allows for the construction of an instrumental variable to estimate our empirical model using a Wald Difference-in-Differences estimator (see for example Chaisemartin and D'HaultfOEuille (2017)

and Duflo (2001)). Assuming that the policymaker was not able to predict the arrival of new technological opportunities allows us to identify the effect of equity capital on firms' innovation inputs and outputs.

Our results indicate that the policy increased the level of external equity financing for eligible firms by about 30% (see Figure 2). We further find that financing from outside equity investors is positively related to startups' innovation inputs and outputs. However, when accounting for the endogenous nature of financing decisions in our instrumental variable regressions, we find that the causal relation only holds for innovation outputs.

For the group of firms that raised outside equity as a result of the policy the likelihood to introduce a global market novelty increases by 83%. However, there is no effect on any of the R&D inputs that we consider. These results suggests that firms use outside equity financing to commercialize their ideas, rather than increasing their R&D efforts in the first place.

The results of our paper have important implications for innovation policy. The main message of our findings is that equity investments in young firms do not increase investments in innovation activities per se. Stimulating investments from private individuals in startups companies through investor subsidies may therefore not be sufficient to stimulate the development of radical innovations. Rather direct subsidies to startups such as development grants may be required. Yet, investors seem to play an important role in the commercialization of potentially radical

innovations. Easing access to angel investors and other venture capitalists therefore may help more firms that are developing radical innovations to bring their products to market. Effective innovation policy should comprise a mix of policy instruments, allowing for both the development and commercialization of radical innovations.

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Keywords: Venture Capital, Angel Investors, Investor Subsidies, Radical Innovation, Research and Development, Wald Difference-in-Differences

[187] Attila Havas (AIT Austrian Institute of Technology & Institute of Economics, Centre for Economic and Regional Studies), Doris Schartinger (AIT Austrian Institute of Technology) and Matthias Weber (AIT Austrian Institute of Technlogy & & Université Gustave Eiffel, LISIS). *Innovation Studies, Social Innovation, and Sustainability Transitions Research: From mutual ignorance towards an integrated approach?*

Abstract. Transformative change has become the focus of various strands of innovation research in recent years. This paper focuses on the confluence of three main strands of innovation research and their contributions to better understanding processes of goal-oriented transformative change in society, namely i) innovation studies; ii) social innovation research; and iii) transitions research, with its particular emphasis on sustainability transitions.

This focus on transformative change is particularly relevant in the context of the ‘normative’ or ‘strategic’ turn in innovation policy that set on about ten years ago (Daimer et al. 2012; Weber and Rohracher 2012). By evolving sometimes in conjunction and sometimes in separation from one other, the three strands of innovation research might provide complementary underpinnings for a more integrated approach to better understand innovation processes.

With this paper, we revisit the basic assumptions underpinning the three streams in relation to innovation and transformation and explore the room for establishing a common framework to analyse transformative change processes – or at least achieving a clearer understanding of the major differences.

The notions of transformation and transition, as well as the differences between them have been debated extensively (Hölscher et al. 2018; Truffer et al. 2022). For the purposes of this paper, we prefer to speak of 'goal-oriented transformative change in society', because it is sufficiently open to capture a variety of normative goals, which innovation and transformation are meant to contribute to, as well as different conceptual understandings of how changes come about. With this, we want to stress that these goals are subject to political and societal negotiations and thus should not be taken for granted. The notion of sustainability is widely used as an umbrella goal, and for good reasons. Yet, not only may there be alternative ways of formulating societal goals and visions, but also our understanding of what we mean by sustainability evolves and is permanently re-negotiated. Further, we also prefer to speak of transformations rather than transitions, because we deliberately want to include in our perspective also disruptive and paradigmatic changes that are largely out of control and escape the understanding of transitions as comparatively smooth and purposefully governed processes of change. In other words, transitions are in our view a specific type of transformations.

Our research questions are as follows:

• What are the similarities, differences, and complementarities in the conceptual underpinnings of these three strands of innovation research?

• What conceptual building blocks of transformation are used? What linkages can we identify in the respective understanding of transformation?

• What contours of an integrated perspective on innovation and transformative change can be derived from the three strands?

Innovation Studies has emerged as an inter-discipline in the second half of the 1960s, later on inspired by insights from management, innovation economics and social studies of science and technology. The field has gained coherence from the 1980s onwards, through the influence of evolutionary economics, the recognition of the non-linearity of innovation processes, and the systemic perspective on innovation. These lines of research provided the basis for setting standards for data collection, at least in OECD countries, thus establishing a shared understanding, a common research framework, and an extensive data infrastructure for comparative empirical analyses across countries. It identified many critical mechanisms, thus contributing to a nuanced understanding of how innovation activities come about and diffuse. In recent years, these foundations have been opened up to new influences, in order to give room to a broader understanding of innovation and relevance to new policy debates associated to the directionality of innovation activities in a societal context. With the establishment of a dedicated sustainability transitions research community, a new inter-discipline emerged which continues to maintain close ties with innovation studies.

Such a consolidation process has not (yet) happened in social innovation research. Being of diverse origin as well, it still struggles with problems of definition and a shared understanding. Depending on the specific communities, the social nature of innovation (and thus the range of actors and key mechanisms) is emphasised or its social purpose. At the same time, social innovation research is (re-)discovering the multitude of mechanisms underpinning innovation system change and sustainability transitions that have been elaborated for a long period of time in innovation studies and sustainability transitions research.

Moreover, boundaries have become blurred between innovation studies, sustainability transitions studies and social innovation research in recent years, not least driven by the strategic or normative turn in R&I policy, where attention started to shift first to environmental concerns, and more lately to a wide range of social goals. It is thus time to overcome the mutual demarcation between the three fields of research and look rather for the complementarities and potential synergies. "Pairs" of these strands of the literature have already been considered, e.g. i) social and business innovations (Havas 2016; Havas and Molnár 2020), ii) social and technological innovations (Howaldt 2019; Weber 2019), and iii) social innovation and transformative innovation policy (Schot 2019) – but not the three strands together. Thus, we compare these three strands of literature by highlighting the major differences in their conceptual frameworks, methods, and insights.

The paper is based on a focussed literature review, composed of two main blocks: i) the results of several major research projects on social and business innovation (TRANSIT, SI DRIVE, and CrESSI) that relied on extensive literature surveys which we had contributed to; and ii) the more recent discourse on social innovation and societal transformation, identified through a systematic, focussed search in ScienceDirect of papers published between 2016 and mid-2021.

We characterise the three strands of literature along the key features of innovation processes, namely: the motivations ('incentives') to innovate, the principal aim of innovations, the 'subject' and the levels of change induced by innovation, the main actors and their interactions during an innovation process, the sources and types of knowledge (co-)produced, utilised and exchanged during the innovation processes, how success and impact are defined and measured, and the diffusion mechanisms. We also discuss another distinctive feature, namely how transformation dynamics is understood in these strands of the literature.

For historical and sociological reasons these three strands so far have evolved in isolation, and thus possibilities for mutual learning have been hardly seized – despite their common fundamental intellectual quest to describe and understand intentional change processes. Our first attempt to provide a structured characterisation and a 'friendly' critique of the three strands has yielded several lessons. While they each provide a perspective on goal-oriented transformations in society, these perspectives are partial. Further, each has its particular deficits.

Innovation studies still limits its analytical efforts on business innovations, in spite of the 'all-encompassing' label of this paradigm. While there have been non-negligible advances in service innovation research, analysing non-marketable innovations is still at the fringe. Compared to the other two strands, this paradigm would need to put more emphasis on considering the various actors' – investors, managers, researchers and engineers, users as co-producers of innovations, consumers, and policy-makers – cognitive frames as major driving forces shaping innovation processes. As its firmly rooted in the business logic, its normative dimension is underdeveloped yet, although there are signs to consider innovations not only as sources of commercial success but also recognise and assess their – often unintended – social and environmental impacts. In other words, not only fanfare 'creative destruction' but notice and critique 'destructive creation' as well.

Social innovation research lacks the conceptual sophistication of innovation studies and sustainability transitions research. It tends to downplay the role of science and technology as major drivers of social change, as well as that of top-down changes as drivers of innovation and transformation. Further, SI research does not distinguish different levels of change in a systematic, clear-cut way as the other two strand do. As a closely related issue, measurement remains a largely unresolved task, in particular monitoring SI initiatives, quantifying inputs, throughputs, outputs, outcomes and assessing impacts of SIs. Of course, this relative 'underdevelopment' is to a large extent due to intrinsic difficulties, namely the complex and complicated nature of SI processes and the social issues that SI initiatives attempt to tackle. We also need to realise that not everything that is important can be measured, and not everything that can be measured is relevant.

Sustainability transitions pursues a strongly normative agenda and tends to ignore the multitude of societal goals and transformation drivers that may guide and shape transformations, in particular the role of generic and disruptive technologies. This goes hand in hand with over-emphasising bottom-up learning processes and down-playing the influence of top-down impulses to trigger transformation processes.

These deficiencies clearly show that a better integration of these three strands, as well as mutual learning among their scholars is needed as a foundation of a deeper and more germane understanding of goal-oriented transformation processes in economy and society. We can distinguish four types of advantages of a potentially fruitful integration of these three strands of the literature.

First, we might arrive at a better understanding of normative issues. Can we identify further meaningful, desirable ambitions other than sustainability transition? Earlier the parlance used to be "economically, socially, and environmentally sustainable development". Nowadays these ideas are enshrined in SDGs, sustainable development goals. This evolution and reframing suggest that we should not just take "Sustainability Transition" as given, as an ambition set in stone; there might be possibilities to arrive at more meaningful normative ambitions. To explore that we need transparent, more appropriate – and cost-efficient – methods for organising normative dialogues, better serving societal needs. Those dialogues can identify inevitable tensions among countries and social groups with different experience, worldviews, values, and ambitions and after participatory, systematic deliberations the actors can arrive at shared visions, specific objectives, and joint, effective actions.

This leads to further theoretical and methodological implications. A common framing of goal-oriented transformations in society would advance theory building. Currently we have different levels of abstraction in IS, IS, and TS. A move towards an integrated framework would rectify this deficit. As a crucial step to construct this integrated framework, we would need to systematically analyse what models of innovation have been developed and used (favoured) in the IS, SI, and ST literature. As a preliminary – and somewhat surprising – result of this future work, we can establish that some learning has already occurred: there are linear models of social innovation as well, although the IS literature has long claimed that "the linear model of innovation is dead". A closely related question would be: What policy rationales – justification for policy interventions – have been distilled from the various models of innovation developed and applied in the three strands of literature?

Considering these three strands of literature together can lead to a new, more comprehensive theory of change. The main building blocks of this theory would be the identification of the possible i) types and levels of change, together with degree of novelty; ii) sources of change; iii) mechanisms and processes of change; iv) goals of change; v) a set of criteria to assess the impacts of various types of change and transformations; and vi) the roles, strategies, and tools of actors in inducing, altering, or blocking change processes, adapting to, or benefitting from, changes and transformations.

Building on those results, strategic and policy implications could also be derived. An integrated approach to goal-oriented transformations can underpin more effective strategies for various types of actors, as well as more effective public policies. While there are inevitable tensions among the different types of actors, there are also complementarities among them in terms of their capabilities and opportunities to act, e.g., when orchestration of changing technologies, infrastructures, social and business networks, cognitive frames, institutions, and social practices is needed to set in motion certain goal-oriented transformation processes. This is a practical implication for innovators – 'change agents' – who need several, if not all types of approaches currently 'treated' in isolated ways in the three strands in terms of theorising, policy-making, and acting.

Keywords: Business innovation studies, Social innovation research, Sustainability transitions research, Conceptual underpinnings, Comparative analysis, Focussed literature review, Goal-oriented transformative change in society, Comprehensive theory of change

[189] Tommaso Ciarli (UNU-MERIT), Hugo Confraria (SPRU - Science Policy Research Unit, University of Sussex), Ed Noyons (Leiden University) and Ismael Rafols (CWTS, Leiden University). *How does SDG Related Research Differ?*

Abstract. Scientific research has contributed to increasing human prosperity (Jones 2021), as well as to creating new human challenges, including environmental sustainability. However, these benefits and challenges are not evenly distributed across the population (Nelson 2011), as a simple look at global inequalities or at the impacts of climate change suggest. This is also due to the directions of research itself. For instance, in health, R&D focuses mainly on the diseases of the richest parts of the world, even if these are not the diseases with the highest burden on human life (Evans, Shim, and Ioannidis 2014). This is the case for private as well as for publicly funded R&D (Yegros-Yegros et al. 2020).

Because the knowledge produced by public R&D is a public good (Jones 2021), a number of authors have called for a realignment of research priorities with societal challenges (Sarewitz and Pielke 2007; Sarewitz 2016). For example, (Ciarli and Ràfols 2019) provide evidence that, at country level, 'revealed' research priorities in agriculture only partially related to 'revealed' demands for new science.

There are several reason why research directions do not align well with the societal demands, including path dependence (Cowan and Gunby 1996), difficulty in navigating the sheer complexity of research and societal demands as priorities are influenced by several, competing and related factors and actors, (Dosi 1984; Christopher Freeman 1991; Chris Freeman 1995; Dosi and Nelson 2013; Smith, Stirling, and Berkhout 2005; Johnstone and Stirling 2020; Bozeman and Sarewitz 2005), with different interests and incentives (Chataway, Tait, and Wield 2004; Wallace and Ràfols 2018), and unequally represented in research and decision making organisations (Cheng and Weinberg 2021; Koning, Samila, and Ferguson 2021; Odekunle 2020; Klerkx and Leeuwis 2008).

Behind these systemic reasons is also how researchers themselves respond to incentives that shape their research trajectories. The evaluation of research based on the scientific excellence of its outputs according, reduces funder's decision making to only one of the potential objectives of investment in research: extending efficiently the frontier of scientific knowledge. And in evaluating this objective, it misses out the multiple, combinatorial ways, in which research may advance the frontier and, equally importantly, its multiple directions (Hicks et al. 2015) and their potential impacts on societies.

In this paper we compare the research that is related to the human development challenges as defined in the Sustainable Development Goals (SDGs) with the rest of the published research. Alongside scientific excellence metrics, we use indicators that measure potentially broader contributions of scientific research to societies. We ask the following questions. Are there specific characteristics that make some research more likely to be SDG-related and that funders should target to increase research relevant to the SDGs? Are there characteristics of SDG-related research that makes it more likely to have an impact? Does SDG-related research also appear in excellent publication using standard bibliometric measures?

To identify research related to the SDGs we devised a method to assign research areas (groups of scientific publications related by citations), to specific SDGs. This approach reduces the uncertainty and ambiguity of assigning individual publications to an SDG, and allows us to include publications that contribute to SDG-related research even if they do not use SDG-specific language in the title or abstract. First, we built a query with a set of terms that are strongly associated with each SDG. To capture a broad understanding of SDGs, we used policy reports, grey literature, scientific publications and web forums, alongside United Nations sources. We extracted relevant fragments from these texts, then selected keywords within them, first using text-mining techniques and then a manual selection. We then used those SDG-related queries to search 4,013 clusters of publications in the Web of Science (WoS) published between 2015 and 2019. A cluster comprises a number of published documents which are related to each other because of their citation pattern. Each cluster, then, represents a research area covering broadly similar topics. Based on the results of the search, we connected each research area to one or more SDGs, depending on the proportion of publications that included our SDG query terms in their title and abstracts. For example, 22% of publications in the 'multidimensional poverty' research area used terms relating to SDG1. The proportion of publications for each SDG was determined by manually reviewing the topic of the research area, and the title and abstract of the most cited publications.

To better understand how different types of research (Fortunato et al. 2018), are related to different SDGs, we used publications meta-data and citations to characterize publications according to four measurable features associated with potential societal impacts of research (Bornmann 2013; Molas-Gallart et al. 2002):

• Collaborations (Etzkowitz and Leydesdorff 2000; Confraria and Vargas 2017; Confraria and Wang 2020)

o extent of international collaborations (co-authors from more than one country)

o extent of collaborations between high income countries and the rest of the world (co-authors from more than one country)

o funding (extracted from acknowledgments)

o industry authorship (co-authors from industry)

• Public use (Noyons 2019; Yin et al. 2021)

o industry (citations in patents, Patstat)

o policy documents (citation in policy documents, Overtone)

o news stories and Twitter posts (citations in news and twitters)

• Open access (Arza and Fressoli 2018; Årdal and Røttingen 2012) (open access paper); and

• Multidisciplinarity (Bromham, Dinnage, and Hua 2016) (Rao-Stirling diversity measure across subject categories (Rafols et al. 2012))

We then compared these measures to standard measures of academic reputation (Kraemer-Mbula et al. 2020; Yin et al. 2021).

Next, we clustered SDGs based on the similarity in each of the above indicators of all publications related to that SDG. This resulted in three clusters: a cluster of social challenges related SDGs (red): SDG 1 (no poverty), SDG 4 (quality education), SDG5 (gender equality), SDG10 (reduced inequalities) and SDG16 (peace, justice and strong institutions), also including growth (SDG 8) and innovation (SDG 9); a cluster of social functions and technical solutions (yellow): SDG 6 (clean water and sanitation), SDG 7 (affordable and clean energy), SDG11 (sustainable cities and communities), SDG 12 (responsible consumption and production), also including SDG 2 (zero hunger); a cluster of natural environment and health (green): SDG 13 (climate action), SDG 14 (life below water) and SDG 15 (life on land), which shares features with health publications (SDG 3).

Here we briefly summarise the main findings. Research related to social challenge SDGs, is more used in policy, potentially more impactful in society, and is the most multidisciplinary. Despite this, and despite being of at least as high quality as the average publication in WoS, it attracts less funding than average, and does not benefit from the same level of collaborations across countries. Research related to social functions and technical solutions SDGs is the most focused on basic sciences and technology applications, and the closest to industry. However, it does not attract much public or policy interest. Research related to natural environment and health SDGs is highly used in policy and society, attracts the most funding, and is most likely to be co-authored internationally and to be open access. SDG-related research, on average, is published in top cited journals as the WoS average

Taken together, the results indicate a need for greater public funding for research that focuses on the complex social determinants of sustainability, to complement, rather than follow, private funding.

As with all studies that map research published in academic journals, the methods are subject to certain limitations. In particular, the WoS does not cover most non-English language journals or those with high local relevance, and much research, especially in low-income contexts, is not published in academic journals. However, our findings are still crucial in mapping and characterizing the contribution to the SDGs of academic research, which accounts for a large proportion of research funding and is widely used in policy and industry. In Rafols et al (2021), we suggest a tool and method that allows users to review the results in this paper using different interpretations of SDG-related research.

Keywords: Scientific Research, Sustainable Development Goals, Research Impact, Evaluation

[190] Masaru Yarime (The Hong Kong University of Science and Technology). *Facilitating Data-Driven Innovation to Address Sustainability Challenges: An Analysis of Data Governance in Smart Cities.*

Abstract. Smart cities play a crucial role in addressing a variety of sustainability issues, such as increasing energy efficiency, reducing air pollution, mitigating traffic congestion, and strengthening resilience to natural disasters. To address these multifaceted challenges, we need to promote innovation via the effective integration of various kinds of data increasingly available from numerous sources through advanced equipment and devices installed across the city. While the collection, sharing, and use of urban data would create societal benefits through innovation, stakeholders who have different types of data may not necessarily be willing to disclose or share their data with others. The general public also has serious concerns about data security and privacy, particularly sensitive personal data. Appropriate systems for data governance are necessary to maximize the potential of data-driven innovation while minimizing risks to individuals and communities for sustainability.

From the perspective of data governance, it is critical to explore how a data platform can be developed and managed and how various types of data can effectively be connected with services to the citizens. It is also important to figure out how consent is secured from the citizens for data collection and use and how a data platform can ask public agencies as well as private companies to provide necessary data. A hypothesis is that government-led smart cities would prefer a centralized approach to data governance with more control and monitoring of the types of databases and applications in the data platform, with the extent of data sharing limited to key actors with technical expertise. On the other hand, smart cities initiated by the public-private partnership would have a more open data platform involving diverse data sources and services operated in a distributed and inclusive way and would be more likely to share data with various stakeholders. Innovation in government-led smart cities would tend to be produced in specific fields directly related to the narrowly defined objectives particularly related to technological development, while smart cities based on public-private partnership would be able to create innovation that would address societal challenges relevant to a wider range of stakeholders in society.

This paper aims to examine the collection, sharing, and use of data in smart cities and the effects of institutional arrangements for data governance on creating innovation for sustainability. First, an overall picture of smart cities in Japan is developed to understand the types of data and the stakeholders involved. Relevant information is obtained by collecting official documents and statistics and developing an original database on smart city projects in Japan. Cases of smart cities are collected from the project databases maintained by government agencies, including the Cabinet Office, Ministry of Economy, Trade, and Industry (METI), Ministry of Land, Infrastructure, Transport and Tourism, Ministry of Internal Affairs and Communications, and the New Energy and Industrial Technology Development Organization (NEDO) and also industry associations, such as the Japan Smart Community Alliance and the Energy Conservation and Homecare Network. These databases contain specific information about smart city projects, including the project name, location, industrial sector, amount of investment, starting date, participating organizations, and contact information. The dataset on smart cities is complemented with data from other resources, including newspapers and industry journals. Based on them, an original database on smart cities in Japan is developed. The possible types of stakeholders involved in smart cities include government agencies, academia, technology and service suppliers, power utilities, and end-users. Government agencies would include the strategic authorities that direct public and private R&D efforts and regulatory authorities for infrastructure development and other associated activities. Technology and service suppliers would consist of engineering firms, infrastructure providers, consumer electronics firms, software firms, and consulting firms. The end users would include industrial users, commercial users, and residential users. Key players that actively participate in creating innovation for smart cities are identified with their characteristics concerning sales, employees, location, industrial sector, and research and development.

Based on the databases on smart cities with key stakeholders, case studies are conducted to obtain detailed information about data governance to facilitate innovation for smart cities. Three cases of smart cities of Yokohama, Kashiwanoha, and Aizu-Wakamatsu are selected by considering different characteristics of the three cities. In-depth interviews are conducted with companies, industry associations, government officials, and business associations. Organizations that will be contacted for interviews include METI, NEDO, Japan Smart Community Alliance (JSCA), Energy Conservation and Homecare Network (ECHONET) Consortium, City of Yokohama, Toshiba, Yokohama Smart Community Association, Tokyo Electric Power Company, and Tokyo Institute of Technology in Yokohama; Mitsui Fusodan, City of Kashiwa, Urban Design Center in Kashiwanoha (UDCK), Hitachi, Nikken Sekkei, National Cancer Research Center, and the University of Tokyo in Kashiwanoha; and Fujitsu, Tohoku Electric Power Company, Aizu-Wakamatsu Smart City Promotion Councill, City of Aizu-Wakamatsu, Aizu University, AiCT, and Accenture in Aizu-Wakamatsu. Detailed information are pursued on the stakeholders' behavior, motivations, and concerns about collecting, sharing, and using data.

The characteristics of the data that is collected, shared, and used include the types of data, such as non-personal, aggregate, and personal data. and the behavior of the organization that deals with data. The data attributes handled by the organization and how it deals with the data are expected to affect the outcome of the organization's data utilization. It is also examined whether there are differences in the mechanisms of data utilization by sectoral types, including energy, transportation, construction, logistics, health, and finance. Questions about the behavioral characteristics of the organization dealing with data address the state of collaboration and sharing of data, including the types of contracts with external stakeholders for using data generated outside the organization. Questions about the outcomes of data utilization include evaluations of the related activities and contributions to creating new technologies or services or acquisitions of know-how and useful ideas. Information is also pursued on how the accessibility to and ownership of the data are managed, how incentives are provided for data sharing, how management systems are implemented to address concerns about privacy and security, and what kinds of obstacles exist in data sharing, including costs of data provision, efforts for data preparation, lack of common standards, ownership and accessibility conflicts, copyright restrictions, a competitive disadvantage from sharing data, lack of control over the usage of data, and systems for privacy and data protection.

Preliminary analysis shows some findings about cases of smart cities in Japan. Examples government-led smart cities include large-scale demonstration projects of smart cities that have been implemented in four major cities since 2010. They have been initiated by the national government to support the development and testing of smart grid and advanced energy-related technologies, including cogeneration, renewable energy, energy storage, electric vehicles, and energy management systems. It has also been an objective to establish robust business models in collaboration with technology suppliers involving local small- and medium-sized enterprises. One of the four large-scale, government-led smart cities has been implemented in Yokohama, a metropolitan city close to Tokyo. The smart city project has been implemented for an introduction of renewable energy and electric vehicles, involving four thousand households equipped with home energy management systems and multiple storage batteries. The experience of developing a smart city in Yokohama shows that large companies in the electric and electronics industries play an important role in facilitating innovation with technical knowledge and expertise on renewable energy, energy storage, community energy management, and applications for home appliances and electric vehicles. At the same time, several challenges in implementing innovation for sustainable smart cities are also found. A clear vision is lacking about for what purposes smart cities should be established, which affects what kinds of data needs to be collected, shared, and used by whom. Lack of transparency in the process of decision making creates an obstacle to data collection and sharing. Robust business models are currently missing, which has the effect of discouraging private companies from sharing data with external organizations. It is also critical to nurture human resources with skills and capacities necessary to understand and integrate various kinds of data available in smart cities. While large established companies tend to have advanced technological expertise and capabilities concerning various instruments and facilities in smart cities, local governments and communities do not necessarily possess sufficient knowledge of or experience with technical measures. Under the existence of the significant degree of asymmetry of knowledge and expertise between large technology companies on the one side, and local government and communities on the other side, it is a serious challenge to secure active participation of end-users in an equal and equitable manner for collecting and sharing data for jointly facilitating innovation. As smart cities consist of various types of hardware and software, the difficulty in coordinating different standards functions as a barrier for sharing and utilizing data.

A case of the joint venture type of smart city is Kashiwanoha, a suburban city outside Tokyo. This smart city was first established in 2008 by a real-estate development company in partnership with the local government. Two universities are also engaged in the research and development of the smart city. The complex collaborative network supported by a non-profit organization has allowed close public-private collaborations among the key stakeholders. The smart city initiative aims to improve the quality of life of the residents by focusing on four main themes. The smart city aims to enhance the convenience of people flow around the station area by introducing self-driving buses and visual traffic monitoring systems. A carbon-free society is pursued by extending and improving the area energy management system, which includes a central monitoring and control center for the renewable energy produced locally. Public engagement has been initiated with an aim to facilitate discussions among citizens with regard to the use of AI-enabled cameras and sensors in a public space so that the views and preferences of citizens are reflected in the use of data. Significant emphasis has also been placed on the consent of local citizens in implementing societal experiments in monitoring and visualization, information provision, and initiatives to promote behavioral change for health and well-being.

Another example of joint venture smart cities is Aizu-Wakamatsu. Located in Fukushima prefecture, the city launched a collaboration with a large technology company and a local electric utility in 2013 to develop a low-carbon and environment-friendly city. The collaboration involving the city government, a university, and a consulting company aims to create new business opportunities and ensure disaster resilience and livability for local residents at the same time. While an energy control center integrates management and visualization of power generation and usage patterns, a disaster prevention facility is designed to utilize EV batteries to supply electricity in emergencies. This smart city explores the integration of ICT, data analysis, and digitalization of public services for tackling specific local challenges such as deterioration of public services, population aging, and improvement of living conditions and resident well-being.

This paper also aims to extract lessons from the empirical analysis and explore implications for public policies and institutional arrangements for data governance. We examine the effects of the government-led and joint venture types on facilitating innovation and addressing societal concerns about privacy and security. Particularly after experiencing the COVID-19 pandemic, it is critical to make an appropriate balance between promoting innovation, protecting privacy, and contributing to the public good. Exploration is made on how transparent, trustworthy, and inclusive systems of data governance for smart cities can be established with relevant stakeholders, including governments, businesses, universities, and citizens.

Keywords: Smart city, Sustainability, Data governance, Data-driven innovation, Japan, Data sharing, Data security, Institutions, Privacy, Stakeholder collaboration

[191] Michael Hopkins (SPRU, University of Sussex), Jorge Mestre-Ferrandiz (Independent economist), Brendan Shaw (Shaw View Consulting), Chirantan Chatterjee (SPRU, University of Sussex), Jin Ding (University of Sheffield) and Preeti Singh (Independent). *Looking beyond the 'Push-Pull' dichotomy: Towards a broad classification and analysis of innovation policy instruments for medical innovation.*

Abstract. 1. Introduction

This paper discusses the findings of work commissioned for the World Health Organisation's (WHO) Oslo Medicines Initiative (OMI). The Initiative aims to 'support universal health coverage and the United Nations Sustainable Development Goals (SDGs)' in particular with a focus on:

'Solidarity: Achieving greater solidarity between stakeholders to meet the SDGs and improve access to effective, novel, high-priced medicines for patients in the WHO European region.

Transparency: Understanding how transparency could be used to build trust and support access.

Sustainability: Considering how to ensure a sustainable industry and health-care systems'. (Source: WHO OMI website)

This paper is one of series of papers, and has been framed by the WHO to identify and describe the available innovation policy instruments to promote medical innovation (limited to new medicines), while excluding those instruments that focus explicitly on price (these are discussed in a separate dedicated OMI paper).

To address the brief, the paper addresses several questions:

1. Based on extant literature, what are the different perspectives that can used to frame and classify innovation policy instruments?

2. To what extent are the different policy instruments implemented in practice?

3. What are the primary effects that policy instruments are expected to have?

The purpose of this paper is to facilitate discussion by providing an extensive 'menu' of policy instruments that could be used to support medical innovation. However, the paper does not prescribe policies, but rather emphasises that the context of instruments and how they are configured will substantially influence their effectiveness.

2. Conceptual framework

New creations of products and services occur within innovation systems, with innovation policy comprised of all combined actions undertaken to influence innovation processes, and innovation policy instruments form part of the implementation of policy (Borrás and Edquist 2013).

Innovation systems rely on a series of functions to produce innovation (Hekkert et al. 2007), and these functions provide 'governance niches' where policy instruments act to have their effect (Hopkins et al. 2019). For the purpose of this paper, a policy instrument is an intervention with a specific mechanism of action to influence a process associated with innovation (e.g. a function such as knowledge creation).

Policy instruments that target the same function can vary considerably in how they are configured (e.g. public funding through research grants can be awarded for basic or applied research, and for individual scientists, or large consortia). However, these are considered part of the same instrument 'family' as they have the same mechanism of action even though they may vary in other aspects or characteristics (Coburn et al. 2021).

For example, public funding through research grants (paid upfront) to explore treatments for disease, uses a different mechanism to prizes awarded (retrospectively) for demonstrating a successful treatment – even if the monetary value is the same. Thus we treat these as different policy instrument types.

Policies may be implemented as laws/ acts or non-statutory regulations by agencies – but are generally composed of multiple policy instruments. The focus here is to disaggregate policies to reveal the instruments that underpin these.

The first question that this paper addresses relates to the classification of innovation policy instruments. Three different perspectives are introduced below, each of which is composed of three subcategories (and providing a 3x3 classification system that already moves well beyond the simple 'push-pull' dichotomy).

Perspective 1: What aim are policy instruments aligned towards?

This perspective draws on a prior synthesis of literature by Schot and Steinmueller (2018) which identifies three frames for innovation policy which have emerged in the post-1945 period – and which continue to co-exist and influence policy conception. These are:

• Invention-oriented policies to address market failures in R&D: firms do not know whether they will be able to appropriate returns from some forms of R&D, and so policy instruments are needed to spur invention (but do not focus on uptake by the market – which is required for innovation to occur).

• System-oriented policies address system failures: nations may have some elements crucial for innovation but policies are needed to address gaps in the system or co-ordinate elements to work together in order for the system to produce innovations effectively.

• Mission-oriented policies address grand societal challenges e.g. climate change or the UN sustainable development goals.

Perspective 2: What is the governance mode that policy instruments apply?

A second perspective characterises the way in which policy instruments can be influential to exert a governance effect, often characterised as 'carrots, sticks and sermons' (Borrás and Edquist 2013, Rogge and Reichardt 2016).

• Economic instruments provide support for specific social and economic activities through financial or market mechanisms. Measures may provide positive incentives (i.e. encouraging or promoting certain activities) or disincentives (discouraging or restraining certain activities).

• Regulatory instruments include legal tools for the regulation of social and market interactions, influencing actors' behaviours. Regulations tend to be compulsory.

• Voluntary (soft or informational) instruments provide recommendations and make normative appeals, and formally influence social and economic action through information and communication. Responding to these measures may appear optional, however, non-compliance could come with negative consequences, such as reputational harm and knock-on effects for investment.

Perspective 3: What is the target constituency of the policy instrument?

Policy instruments may focus on different parts of the innovation system or attempt to link or co-ordinate across these (Borrás and Edquist 2013, Rogge and Reichardt 2016). It is therefore possible to classify policy instruments according to the constituencies that they benefit. A simple three-way categorisation often made includes:

• Supply-side or technology push instruments that focus on the supply side (i.e. on the originator firms supplying the innovations), and on the role of science and technology in promoting development.

• Demand-side or demand-pull instruments are measures to induce innovations and/or speed up their diffusion by increasing demand forces, defining new functional requirements for products and services or better articulating demand.

• Systemic policy instruments act to align other instruments in the mix to the needs of the actors involved by promoting links for collaboration and knowledge transfer amongst market participants.

There are an 'ocean' of policy instrument types (Borrás and Edquist 2013), and it would no doubt be possible to further classify policy instruments using additional framings. However, the objective here is to provide a classification scheme to allow a wide range of policy instruments, already discussed in the literature, to be compared and organised in order to identify gaps in those being used and issues with implementation. We therefore proceed with the 3x3 classification provided by the above three perspectives which each have three sub-types.

3. Methods

The paper is based on a series of literature reviews undertaken in three stages, which have collectively covered hundreds of articles and reports from the peer-reviewed and grey literature on innovation policy.

The aim of the paper is to classify and analyse the degree to which the literature suggests policy instruments have been implemented and the effects that these policy instruments can have. Due to the complex nature of the subject matter, and sometimes partial information from the literature, many of the decisions made in this review could be seen as subjective, relative and context dependent. The authors have therefore discussed many decisions in depth to ensure internal consistency in the results.

4. Results

The literature reviews undertaken for this paper have identified 18 families of policy instruments that can be distinguished because they act on distinct mechanisms across the innovation system (this excludes further instruments that act on price – which were outside the scope of the work commissioned). Based on the results of the searches conducted, it is notable that within the literature on medical innovation, the distribution of policy instrument families is not at all even across the 3x3 classification scheme. There is a preponderance of policy instruments focused on spurring invention (rather than innovation systems or missions) and on the supply-side (rather than demand or systemic instruments), although the distribution of instruments across the three types of governance mode is more even.

Mini-reviews of the literature for each policy instrument family suggests that only a minority have been widely implemented across countries. Many more could be tried by national governments as part of a policy mix tailored to local contexts. Only one family of instruments was described in the literature but does not seem to have been implemented.

Table 2: Families of innovation policy instruments discussed in the medical innovation literature (see separate file attachment)

A further analytical task undertaken as part of this study has been to assess the primary effects of policy instruments. Interestingly, although there are at least 18 families of policy instruments, there seem to be relatively fewer primary effects (only 10) that these appear to generate.

This suggests there may be different ways of producing the same effect, or multiple policy instruments that could be used to re-enforce an effect. The effects anticipated include:

- Provide knowledge/ capabilities/ infrastructure
- Provide new product opportunities
- Create assets
- Reduce up-front costs/ capital at risk
- Reduce uncertainty
- Reduce time to market
- Encourage market entry
- Reduce competition
- Increase financial returns
- Incentivise use

5. Conclusions and policy implications

The push-pull (supply/demand) dichotomy that dominates many publications on policy instruments for medical innovation, is no longer seen in the wider literature on innovation policy. This indicates an opportunity to move beyond the 'push-pull' debate which otherwise could constrain opportunities for policy action. The paper has provided three broad perspectives.

In terms of the target constituencies of policy instruments, in the medical innovation literature, options focus on supply-side instruments, more than on the demand side or on systemic instruments that span supply and demand. This is not the case in the wider literature.

In terms of the aims of policy, the medical innovation literature focuses most on addressing market failure to spur R&D (invention), with less frequent emphasis on supporting innovation systems or societal challenges. This neglects the role of policy co-ordination in innovation.

In terms of governance, there is more diversity in the regulatory and economic instruments than voluntary approaches – but informational/ coordinating policies may be useful.

Many policy instruments have been applied across countries but most are not widely implemented (whether considering different countries or disease areas). There is plenty of choice of instruments to have targeted effects and opportunity for policy experimentation.

This review, based on a 3x3 classification scheme, suggests that many countries could improve their policy mixes by considering not just policies that focus on supply and demand, but also those that promote communication across the innovation system, as well as co-ordination and collaboration. These actions also can be promoted across different countries, as well as within national systems.

Keywords: Innovation Policy Instruments, Medical Innovation, Policy effects, push-pull

[192] Daniel Hain (Aalborg University), Roman Jurowetzki (Aalborg University) and Mariagrazia Squicciarini (UNESCO). *Mapping Complex Technologies via Science-Technology Linkages; The Case of Neuroscience - A transformer based keyword extraction approach.*

Abstract. Times of accelerating technological change (Butler, 2016), growing interdisciplinarity of science and technology (Porter and Rafols, 2009) as well as increasing complexity of science and technology systems (Catalan et al., 2020) call for fast and responsive techniques to quantify, map, and understand technology development. Doing so is paramount to assess, influence, and facilitate the development of complex and interdisciplinary emerging technologies with potentially high economic and social impact, such as neuroscience, genetics, and artificial intelligence.

A large share of technology development builds on advances in science, where existing studies have demonstrated the rising interactions between science and technology and the important role science has played in accelerating technologies (Meyer-Krahmer and Schmoch, 1998; Acosta and Coronado, 2003). Consequently, current developments in science are important signals for identifying future's promising technologies. However, measuring and mapping of science-technology linkages has been proven challenging (Mansfield, 1991; McMillan et al., 2000; Narin et al., 1997). There are several data sources that are leveraged to identify direct science-technology linkages (Bekkers and Freitas, 2008), such as collaborations (Giunta et al., 2016) or the citation of non-patent-literature (NPL) in patents (Acosta and Coronado, 2003; Narin et al., 1997). However, such direct measures tend to be sparse and biased, since for instance joint university-industry patenting is the exception rather than the norm, and NPL citations are rarely used. Without such direct traces, author-matching and natural language processing (NLP) techniques to identify paper-patent pairs (e.g., Magerman et al., 2015) which both relate to the same invention. Again, due to division of labor and corporate IP strategies it is not uncommon that publication authors are not the same as the named inventors on a related patents, leading to similarly sparse results. Alternative indirect approaches to identifying science-technology linkages and to map technology applications arising from a particular field of scientific research focus on the identification of technologies within scientific literature, and in a separate step

map them to technologically similar patents.

In this paper, we present a deep learning (DL) based approach to extract technology related topics within scientific literature, and identify these technologies within patent applications. In detail, we utilize named entity recognition (NER) techniques and transformer-based text embeddings which are specifically fine-tuned to scientific literature to extract technology keywords. In a next step we cluster these keywords into human interpretable topics describing a certain technology application by a set of keywords related to the method as well as application and issues addressed. Finally, we create a large amount of search queries based on combinations of methods and applications, which we use in a semantic search to identify related patents.

We illustrate the workflow as well as results obtained by mapping publications within the field of neuroscience to related patent applications. This represents an interesting field to demonstrate the advantages of our approach, since neuroscience research has traditionally been an interdisciplinary research field where scientists from different disciplines like medicine, psychiatry, psychology, biology, biochemistry and linguistics work together (Schwechheimer and Winterhager, 2001). Throughout the last decade, technological change as well as changing global needs have lead to scientific as well as technological paradigm shifts in neuroscience. Research strands such as brain imaging, brain connectivity (Yeung et al., 2017), and lately neural computing (Savage, 2019) and neurodevices such as Brain Computer Interfaces (BCIs) have added to the diversity of technologies and potential applications. This degree of interdisciplinarity and dynamism limits the usefulness of traditional approaches to technology mapping via existing patent classifications. This has resulted in a limited overview over the types of technology applications in neuroscience, their scale, impact, and geography. Recently, academia and policymakers alike have recognised potential ethical and legal concerns related to the potentials of the latest generation of neuroscience technologies (Allhoff et al., 2011; Anderson et al., 2012; Drew, 2019; Dubljević et al., 2017; Jarchum, 2019), stipulated the formulation of guiding principles and regulations for future development (Garden et al., 2019). However, the formulation as well as the practical implementation of such principles requires a common understanding of what neuroscience is and is made of, in terms of both scientific and technological developments, as well as possible applications.

By doing so, we aim at contributing to the growing body of research on text-based technology mapping and forecasting that leverages latest advanced in NLP and DL (Hain et al., 2022b,a). More specifically, we provide an approach that identifies technology related topics in scientific literature, and allows to disentangle keywords to identify methods and techniques embodied in the technology from the context and issue it is applied to. In contrast to Subject-Action-Object (SAO) (e.g., Yang et al., 2017) or ontology-based (e.g., Soo et al., 2006) approaches which are labor intensive, our workflow allows to do so almost fully automated and is thereby highly scalable. We are able to map these technologies identified in scientific literature to patent applications, thereby providing an empirical foundation for the study of indirect science-technology linkages (e.g., Mansfield, 1991; Bekkers and Freitas, 2008; Acosta and Coronado, 2003). In contrast to existing approaches, neither a direct explicit link between publications and patents such as a NLP citation, nor the use of an exactly matching keyword terminology is necessary to identify applications of certain technologies. Lastly, by providing an inclusive and interdisciplinary mapping of patent applications related to neuroscience technology, we are able to inform the current discussion on the potential needs for regulatory frameworks targeting these technologies.

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Keywords: technology mapping, science-technology linkages, patent data, natural language processing, text embedding techniques

[193] Stefan Philipp (ZSI - Centre for Social Innovation). *Transformation in healthcare: A social innovation perspective on the interaction of technological and organisational change.*

Abstract. The European healthcare sectors are confronted with the combined challenges of increasing demand caused by an aging society with chronic diseases and limited resources (Nolte, 2018). In this context, the increasing number of persons living with diabetes, as with other chronic diseases, represents a public health issue of growing importance, for clinical and economic reasons. In the past three decades, the number of people with Type 2 Diabetes Meletus (T2DM) has quadrupled worldwide, 1 in 11 adults worldwide now have diabetes mellitus and it is the ninth major cause of death (Zheng et al., 2017). Thus, innovations, aiming at providing better and more efficient care, are developed within and outside the sector. However, the literature on healthcare innovation describes that new approaches often fail, are not adopted, or don't achieve wider uptake – even when the benefits of the new approaches are documented (Greenhalgh & Papoutsi, 2019; Marjanovic et al., 2020; Nolte, 2018; Saidi et al., 2020). The reasons for that, are, among others, the complexity and dynamics of healthcare (Greenhalgh et al., 2018), the hidden nature of service innovation (Saidi et al., 2020), and the interdependence of technological and organisational innovation in healthcare (Barlow, 2016).

In diabetes care, two major trends are observable that both build upon the person-centred care approaches, a care delivery philosophy in which services are arranged around the needs of the individual rather than around clinician-oriented workflow models (Ozkaynak et al., 2013). On the one hand, structured and team-based care approaches (e.g., with a doctor, nurse, diabetes educator or other healthcare professional) are being implemented, in order to personalise and professionalise the diabetes care and there is evidence that these approaches improve clinical outcomes compared to traditional care models (IDF, 2019; van Bruggen et al., 2020). On the other hand, there is a trend of e-health and m-health solutions that support, empowerment, self-management and remote monitoring of patients. A review of technology-based self-management support tools found mainly positive results even though some interventions did only short-term improvements (Hunt, 2015). Especially, the educational reinforcement using technological devices has been highlighted as an enabler of diabetes self-management (Adu et al., 2019). In summary, patient-oriented approaches building on empowering, self-management and remote monitoring supported by technological interfaces between patient and care-teams could represent an emerging paradigm in diabetes care, that has the potential for providing better and efficient care. However, if fully implemented such a new approach requires a transformation of current practice, which raises questions of: (a) preparation of the system, (b) preparation of patients, and (c) payment mechanisms (Lorig & Holman, 2003).

Thus, in order to understand these social transformations a social innovation perspective is required to understand the changes in social practices, roles of patients and healthcare professionals, as well as the organisational changes. Transformative Social Innovation (TSI) provides a framework for analysing these changes (Pel et al., 2020) as it takes into account newly evolving relationships, their relation to social and organizational change, and their embeddedness in specific spatial and organizational contexts and innovation systems in order to make sense of non-technological innovations and the reconfiguration of social practices (Zapf, 1989; Murray et al., 2010; Moulaert, 2013; Bock, 2016). The concept also stresses the potential of SI to change actor roles, visions and goals, and add new actors and instruments to the governance of innovation (Oosterlynck et al., 2019). While this constitutes an important premise for socio-technical change, it also points to the significance of agency in assembling the necessary resources for SI and putting transformed roles, visions, and instruments into practice.

The empirical material, is based on a case study of a digital healthcare tool that has been developed in the context of a H2020 PCP project in four European regions. The case describes the implementation process, in the region of Murcia (ES) and has been collected in the context of the H2020 project CHERRIES. The methodology builds on a combination of a regional structural analysis and a study and a comprehensive innovation biography (Butzin & Widmaier, 2016). The case, is the DM4ALL e-health solution, that combines the two trends outlined above. First, it provides patients with a system for collecting data about their health situation as a basis for self-care and self-management. This goes beyond collecting information but is also a means of increasing health literacy, which subsequently empowers patients to control their own health better. Second, it supports healthcare professionals to follow and interact with their patients remotely in a team setting, thus reducing the need for face-to-face meetings. This could potentially lead to more efficient care provision when a higher number of patients can be followed up at lower costs. DM4all combines these two trends in a natural way and the Murcia pilot indicates that this combination of self-management and the feeling of being observed by healthcare professionals worked very well as motivation to improve the personal healthcare outcomes. The success of this tool highlights that such approaches could change healthcare provision for prevention and non-pharmaceutical therapy. However, the project did not go beyond the pilot phase yet, even though all actors want to continue, and thus the questions of how such a technology and new organisational approach can be embedded in a healthcare system and how it would transform the current practice, and what the main barriers are needs to be discussed, deploying a TSI perspective. The contribution will highlight the potentials of such a TSI perspective on the technological and organisational change processes in healthcare provision will discuss the main dimensions of change that need to be addressed in the preparation of the system and the preparation of patients.

Keywords: health, diabetes, social innovation, organisational change

[195] Nikhil John (Copernicus Institute of Sustainable Development, Utrecht University), Joeri Wesseling (Copernicus Institute of Sustainable Development, Utrecht University), Ernst Worrell (Copernicus Institute of Sustainable Development, Utrecht University) and Marko Hekkert (Copernicus Institute of Sustainable Development, Utrecht University). *How key-enabling technologies' regimes influence sociotechnical transitions: The impact of artificial intelligence on decarbonization in the steel industry.*

Abstract. There has been an increased interest in Key Enabling Technologies (KETs), which are pervasive 'groups' of technologies expected to enable innovation. KETs (like digitalization and nanotechnologies) have been promoted as technologies with tremendous potential for boosting economic growth and sustainability in all sectors of society. For instance, policymakers of Energy-Intensive Processing Industries (EPIs) anticipate KETs to solve multiple challenges in EPIs, such as labor shortage, regional competitiveness, resource depletion, and emissions (Branca et al., 2020; European Commission, 2020). Although EPIs face many challenges, the most prominent theme of sustainability in EPIs is decarbonization. Specifically, advanced digital technologies, such as Artificial Intelligence (AI), are seen as a means to boost these sectors' economic performance while expecting this KET also to support the decarbonization transition. The current processes in the EPIs are highly fossil-based and demand significant sustainable innovation to reduce their carbon emissions; however, current literature does not assess how AI can influence such a sectoral transition. Therefore, in this paper, we assess how AI affects the decarbonization transition, which could have implications for industrial policy within these sectors. This paper aims to understand the role of KETs in sustainability transitions, using the empirical case of AI in the decarbonization of the steel industry.

The field of evolutionary economics has uncovered several characteristics of general-purpose technologies (Bekar et al., 2018; Jovanovic and Rousseau, 2005; Lipsey et al., 2005), which served as a starting point to conceptualize KETs in this study further. KETs are not single technologies with narrow applicability but rather a generic group of technologies under an umbrella term (Rip and Voß, 2013). Under this umbrella, KETs enable a range of downstream innovations which depend on the KET but are not identifiable as part of the KET. The 'enabling' features of KETs primarily arise from this complementarity characteristic: they create many beneficial applications across society and subsequently across the many technological functions within individual sectors.

Using an explorative methodology, our research shows how AI creates technological and sociotechnical impacts on the steel industry. First, to capture technological impacts, it is crucial to understand where KETs are being applied in a sector and how the application of KETs improves the techno-economic performance of the underlying sectoral processes (i.e., the technical and organizational processes that enable steel production). Exploring these technological impacts helps reveal patterns and trends relevant to the directionality and speed of the transition being analyzed. To do so, an inventory of AI tools was analyzed, which was built using a Scopus search that yielded 140 technical scientific articles describing various AI applications in the steel industry.

Second, a sociotechnical perspective is necessary to capture the broader, dynamic impact of KETs on the sectoral elements like actors, networks, and institutions. The interaction between a KET and a focal sector is seen as a regime-regime interaction, wherein a potentially significant paradigm shift occurs in the sectoral regime. Drawing on theoretical perspectives from innovation and transitions literature (Andersen et al., 2021; Andersen et al., 2020; Rosenbloom, 2020; Sareen and Haarstad, 2021), this paper views AI as a highly institutionalized KET regime that interacts with the current steel industry regime. This interaction results in dynamics that are relevant for the decarbonization transition. In the context of a transition, we argue that 'barriers to innovation' are specific manifestations of the focal sector's regime characteristics that inhibit niche innovation. The nature of sociotechnical barriers can be technological, organizational, institutional, political, or sociocultural. Sociotechnical barriers are seen by some scholars as crucial intervention or leverage points for facilitating the development and diffusion of niche innovations (Kieft et al., 2021; Negro et al., 2012; Wesseling and Van Der Vooren, 2017). For the case of EPIs, previous sectoral literature (Janipour et al., 2020; Skoczkowski et al., 2020; Svensson et al., 2020; Wesseling et al., 2017) has uncovered these barriers to innovation, namely, (a) Lock-in and path dependency, (b) System integration and flexibility challenges, (c) Lack of demand-side structure, and (d) Emphasis on risk-aversion, risk management, and safety. Understanding the impact of a KET on these barriers to innovation allows us to answer whether the KET facilitates the transition by overcoming barriers or inhibits the transition by reinforcing barriers. To do so, we conducted semi-structured interviews with industry actors, which served as the primary data source.

The results show that, technologically, AI adds value to all areas of the steel industry, from process technologies to organizational functions. It does so through prediction, traceability, automation, or optimization. Further, sociotechnically, AI's diffusion within the industry alters existing system structures such as actors, networks, and institutions and creates new system structures. These impacts lead to complex interactions with the decarbonization transition. Specifically, the results indicate that AI may reinforce the current path dependencies of the steel industry, as AI tools are more focused on incremental improvement for current technologies rather than novel low-carbon technologies. However, AI offers capabilities for the steel industry that can help reduce some barriers to sustainability innovation in the sector. These barriers include system integration challenges, flexibility challenges, demand-side barriers, and risk-related barriers. As a further theoretical contribution, this paper also reflects on how these empirical findings can be generalized to other sectors and transitions by identifying specific regime characteristics of the AI-Digital KET regime.

The results have significant implications for both EPI industrial policy and KET innovation policy as a whole. In this case study, we see that AI taps into the highly institutionalized patterns of innovation within the steel industry without drastically shifting its direction. The bottom-up inventory further reveals that AI development within the sector is directed towards either the already scaled-up processes within the steel industry (such as the blast-furnace-based production) or where data is more readily available to build AI models. This results in narrowing of the capabilities of AI towards certain application areas and potentially hindering the decarbonization transition. Therefore, policies directed towards AI or digital innovation may currently only support short-term benefits rather than pathways towards long-term deep decarbonization. Aligning digital and low-carbon policies would help steer the innovation directionality within EPIs. The results also show that the AI-Digital regime helps reduce other sociotechnical barriers to innovation within EPIs; this could positively impact the transition. Policymakers could direct AI innovation programs to create system resources within EPIs to ensure that these barriers are lowered. Finally, as niche low-carbon innovation (e.g., hydrogen-based steel production) is expected to be scaled up over time, efforts could be directed towards supporting AI projects which create spillovers that are accessible and applicable to future AI projects.

Keywords: Key enabling technologies, Decarbonization, Artificial intelligence, Digitalization, Energy-intensive processing industries, Steel industry, Barriers to innovation, Multiregime interactions, Multi-level perspective, Industrial policy

[196] Diego Hernando Florez Ayala (Univali), Anete Alberton (UNIVALI) and Diego Hernando Florez Ayala (UNIVALI). *Arenas to promote sustainability transitions in the cookstove energy sector.*

Abstract. To the WHO, around 3 billion people still cook using solid fuels (such as wood, crop wastes, charcoal, coal, and dung) and kerosene in open fires and inefficient stoves. Most of these people are poor and live in low- and middle-income countries. These cooking practices are ineffective and use fuels and technologies that produce high levels of household air pollution with many health-damaging pollutants, including small soot particles that penetrate deep into the lungs. Exposure is exceptionally high among women and young children, who spend the most time near the domestic hearth. Sustainability transitions are necessary to promote changes in communities localized poor regions to become more sustainable and healthier, especially in this cookstove energy industry that promotes transitions towards a low carbon future and involves multiple actors. When analyzing the conditions for and processes of transitions, the arenas of the development (AOD) approach provide an alternative framework in the context of sustainability transitions in the cookstove energy sector. Though the problem has been investigated, how can actors and locations engaged promote sustainability transitions in the cookstove energy sector? It aims to characterize how actors' and locations engagement promotes sustainability transitions in the cookstove energy sector. Based on the proposition for transformative social innovation of Pel et al. (2020), this research will bring social innovation to the involved communities to create more sustainable and healthier conditions to the prior situation.

Keywords: energy transitions, social innovation, arenas of development, actors, cookstoves

[198] Attila Havas (AIT Austrian Institute of Technology & Institute of Economics, Centre for Economic and Regional Studies). *Interactions among societal and professional RTDI actors in four different futures.*

Abstract. There is a growing consensus in the literature that it is crucial to better align RTDI activities with societal needs. Hence, in Daimer et al. (2021) we focussed on the interactions between societal and professional actors (ISPA) in RTDI activities. These interactions can evolve by taking radically different directions, and thus we opted for developing scenarios to consider the possible futures of society, research, and innovation in the EU.

Having considered 16 major factors that are likely to shape the future of societally engaged RTDI activities, workshop participants had concluded that the most influential factors are the prevailing ideological stances and political practices; in brief, the future of democracy in the EU member states. Thus, the political system, which is treated as an external condition in the innovation system literature, had been considered to have more impact on ISPA than other factors considered at the workshop. The discussion about the future of RRI at an instrumental level, e.g., about developing and introducing the appropriate tools, methods, and policies to promote inclusive and transparent participation, or devising and applying the adequate evaluation instruments to measure its benefits, is certainly crucial. However, these aspects are of secondary significance compared to the external conditions, especially the dominant ideology and the concomitant political system.

With this approach we contributed to the RRI literature in two ways: i) we considered possible, fundamentally different futures of society, research, and innovation, as opposed to analysing current or recent RRI practices and STI policies; and ii) we put the emphasis on the political conditions, as opposed to proposing future RRI principles and instruments per se.

We identified four radically different types of political systems: participatory, libertarian, authoritarian/ populist, and technocratic. In the Kingdom of RRI citizens participate directly in decision-making processes; Fortress Europe depicts a liberal-with-tendency-to-libertarian system; Failed Democracy is a populist-with-tendency-to-autocratic regime; while Benevolent Green Eurocrats describes a strong, technocratically coordinated state. Clearly, the idea of RRI as an anticipatory, reflexive, deliberative and inclusive approach is completely ignored, manipulated, or very selectively applied in the latter three scenarios.

These scenarios depict somewhat extreme versions of distinct political regimes, relying on the dominant ideological stance, and hence they imply different ISPA framings. These four scenarios offered novel insights into the nature and repercussions of possible policy problems. We discussed issues related to efficacy of STI policies, efficiency of policy-making processes; legitimacy of research and innovation activities; societal involvement in RTDI activities; equity (as access to novel, superior solutions; and freedom of research in each scenario.

All the (groups of) actors have some leeway to shape ISPA in these four different scenarios. The proposed ‘speed talk’ would extend Daimer et al. (2021) by considering the future of ISPA in these four futures. This simple exercise would juxtapose the aims, types, and forms of ISPA, on the one hand, and the major features of the four futures, on the other.

The main aims of a particular interaction range from popularisation of science and technology, dissemination of scientific and technological results, demonstrating their benefits to societies, and attracting young talents to start a career in research. More ambitious aims are to consider ethical and gender aspects of RTDI activities; assess emerging technologies, e.g. their expected societal, economic, and environmental impacts; discuss or jointly set research agendas at various levels (single organisations, regions, countries or group of countries); conduct and/or evaluate RTDI projects in collaboration; deliberate on current and future policy tools aimed at promoting RTDI activities and ISPA, as well as improving their framework conditions; and decide on public funds to support RTDI activities (again, at various levels).

Achieving these goals would necessitate different types and forms of ISPA. For some, one-way communications might be sufficient, while others would require genuine dialogues or even collaboration among partners mobilising their different kinds of expertise, experience, aspirations, values and norms, worldviews, and ways of thinking. Clearly, various means and channels of communications and different types of activities would be appropriate for the above objectives of ISPA.

Further, ISPA can be regular or ad hoc; formal or informal; open or closed (in terms of participation); systemic or sporadic; and transparent or opaque. Finally, ISPA can be genuine and substantive vs. tokenistic, even deceptive; inclusive and responsive vs. condescending and patronising; might develop vs. neglect citizens' capacities; and rely or not on co-creation of knowledge with citizens.

Reference

Daimer, S, A Havas, K Cuhls, M Yorulmaz, P Vrgovic (2021): Multiple futures for society, research, and innovation in the European Union: jumping to 2038, Journal of Responsible Innovation,

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Keywords: Interactions among societal and professional RTDI actors (ISPA), Multiple futures (scenarios), Aims of ISPA, Types of ISPA, Forms of ISPA

[199] Stephanie Daimer (Fraunhofer), Hendrik Berghäuser (Fraunhofer ISI) and Ralf Lindner (Fraunhofer). *The Institutionalisation of a New Paradigm at Policy Level.*

Abstract. Introduction

The debate on Responsible Research and Innovation (RRI) has undergone a dynamic evolution since the term's early conception more than two decades ago. Beginning with debates primarily related to the responsible development of nanotechnologies in the early 2000s, RRI has achieved remarkable attention in the academic discourse on the governance of science and innovation (Rip 2014). Most notably, RRI (or more precisely, a particular conception of it developed by the Euro-pean Commission) was taken up by the European Union and actively promoted in its framework programmes. The high point of this policy journey thus far came with the establishment of RRI as a cross-cutting theme in the EU's Horizon 2020 framework programme (2014-2020) and with its broad embedding within the Science with and for Society (SwafS) funding scheme (Lindner and Kuhlmann 2016, Macnaghten 2020). The rise of RRI as a concept providing novel normative guid-ance in the governance of science, technology and innovation (STI) is closely intertwined with the emergence of a new and highly influential policy paradigm in the field of STI policy: instead of solely targeting the improved performance of research and innovation systems in order to in-crease economic growth and competitiveness, the new paradigm is primarily concerned with ad-dressing so-called grand societal challenges. This strategic reorientation represents a “normative turn” (Daimer et al. 2012) in STI policy, as it entails the articulation and growing importance of the directions research and innovation should take (Lindner et al. 2016, Edler and Boon 2018, Breit-inger et al. 2021). While not re-placing the STI paradigm focused on economic objectives, the new paradigm has clearly exercised a significant impact on the STI strategies of the EU and of many individual countries, and is currently being pursued through the concept of mission-oriented in-novation policy (Kuittinen et al. 2018).

In many ways, RRI complements the quest for directionality (or solution-orientation) in STI as it targets societally desirable long-term impacts. The concept attempts to better align STI processes and outcomes with the needs and expectations of society. It offers a set of operational, practical and process interventions for STI and addresses both institutional transformations and the behav-ioural change of researchers and innovators by promoting specific virtues such as reflectivity, inclusion, anticipation and responsiveness. RRI promotes a set of interventions for STI processes and provides guidance on how research and innovation processes and practices need to be trans-formed in order to reach high levels of directionality consistent with societal needs and values. As such, it can be defined as a new policy paradigm per se.

Research question

Yet, despite favourable conditions at the level of the broader policy landscape for RRI becoming firmly institutionalised within the European Union (EU) research and innovation funding system, particularly in the framework programmes, it may be concluded that the attempt to mainstream RRI has by and large not succeeded (Novitzky et al. 2020). This paper aims to shed light on the reasons for this incomplete institutionalisation of the RRI paradigm. What are the relevant mech-anisms and supporting and hindering factors that help to explain the limited success of RRI main-streaming?

Theoretical framework

To this end, we draw on and adapt the conceptual framework of Deep Institutionalisation (DI), originally developed to study organisational change, with the aim of reaching a better under-standing of the complex processes for interpreting, translating, contextualising and ultimately concretising the RRI paradigm into policy practice (Randles et al. 2014, 2016, Randles 2017). While established frameworks such as multiple streams (Béland and Howlett 2016) or the advocacy coa-litions approach (Sabatier 1998) are instrumental in explaining policy (paradigm) change, they fall short of unlocking the black box on how a newly established policy paradigm becomes firmly embedded in actual policy practice and implementation. It is here that the institutionalisation perspective appears particularly promising, as it provides an analytical lens for uncovering how, between the high-level EU regulation on H2020 and its implementation at the level of funding research and innovation projects, RRI policy has spread, unfolded and been put into practice.

Since the DI concept was originally developed for studying organisational change, it requires a degree of adaptation for application to policy analysis. We argue that the concept can indeed be utilised in this way and provide support for the four elements of institutionalisation with concepts from policy analysis and implementation literature.

→ Evolution of dominant narratives: in policy theory, the concept of discursive institutionalism encapsulates the axis of questioning existing narratives and creating new counter-narratives. Discursive institutionalism represents a dynamic approach to policy change in which change is possible through ideational processes and policy discourse (Kangas et al. 2014, 73–74).

→ Maturation process: the mechanisms of maturation described for organisations may be equated to policy learning. Among the various conceptions in the literature, we follow the structure provided by Bennett and Howlett (1992) which differentiates between three levels: government learning by state officials learning about processes in policymaking and generat-ing organisational change; lesson-drawing by policy networks learning about policy instru-ments and generating policy programme change; and social learning by policy communities learning about ideas and generating policy paradigm shifts (Bennett and Howlett 1992, 289, Borrás 2011, 727). While social learning is defined along similar lines of argumentation as dis-cursive institutionalism, the aspect of lesson-drawing might be an interesting one to focus on in the context of our analysis.

Furthermore, the literature on policy experimentation has discussed mechanisms which also follow the logic of maturation processes in the DI concept. Policy experimentation has been defined as "the process of iterative adaption to new circumstances and experiences that en-tails a certain idea of progress and improvement but no teleological end-point," (Huitema et al. 2018, 146) and "a temporary, controlled field-trial of a policy-relevant innovation that pro-duces evidence for subsequent policy decisions" (McFadgen and Huitema 2018, 164).

→ Systemic consolidation: in the policy context, and particularly in the context of the EUs Framework Programme for Research and Innovation, the systemic consolidation of a new pol-icy priority would mean either the implementation of new instruments or the operationalisa-tion of new policy guidelines of a horizontal nature as cross-cutting issues. Literature on poli-cy implementation is broad and in fact often focuses on new instruments and the issues that might arise for specialised implementation agencies and authorities in the context of imple-mentation. Thematic foci in the implementation literature are knowledge, learning and ca-pacity in implementation, the processes of implementation, the role of actors and agents in implementation, and bureaucratic discretion in implementation (Schofield 2001, 253).

In connection with the horizontal nature of RRI, the literature on "whole-of-government" ap-proaches (WGAs) provides some additional insights. WGAs were first introduced in the UK (under the term "joined-up government") as a reaction to the "pillarisation" of the public sec-tor following New Public Management reforms (Ross et al. 2011, 134). "Whole-of-government denotes public services agencies working across portfolio boundaries to achieve a shared goal and an integrated government response to particular issues.

→ Vertical multilevel alignment: at the policy level, the fourth element of DI is excellently cap-tured in the concepts of policy transfer and policy diffusion. Policy transfer has been defined as the "process in which knowledge about policies, administrative arrangements, institutions and ideas in one political setting (past or present) is used in the development of policies, ad-ministrative arrangements, institutions and ideas in an-other political setting." (Dolowitz and Marsh 2000, 5). Policy diffusion has been characterised by the following elements: a process by which a (policy) innovation is communicated through certain channels over time among the members of a social system (Zito and Schout 2009, 1108, citing Rogers 1983, 10). Marsh and Sharman (2009, 270) have specified the difference between the two in the following way: "work on diffusion tends to emphasize structure while those writing on transfer tend to privi-lege agency", highlighting the fact that in the end both elements are relevant foci of analysis.

Moreover, if one follows neofunctionalism as the most classical theory of European integra-tion, one can expect policy spillovers from the European to the national and regional levels (Scholten and Scholten 2017, 927).

Data and methodological approaches

The adapted DI concept is then applied to the efforts to mainstream RRI in the context of the H2020 European Framework Programme. We did not collect our own primary data for this. In-stead, we draw on the rich evidence generated by relevant RRI projects.

The empirical question we want to answer focuses on the relevant mechanisms and supporting and hindering factors that help explain the limited success of RRI mainstreaming in Horizon 2020. We have argued that translating the DI concept to the policy level promises to add value when it comes to questions of policy practice and implementation, thus complementing studies which seek to explain policy change or the rise of new policy paradigms. Consequently, we aim to un-derstand whether the mainstreaming of RRI across all parts of the Horizon 2020 programme fol-lowed the logic provided by the third element of Randles' DI model, "systemic consolidation" (Randles 2017). Given our understanding of the DI concept as a sequential model, where new narratives are first manifested and new practices subsequently experimented with before consoli-dation or mainstreaming take place, we attempt to trace these elements empirically, too. We ad-ditionally provide empirical insights into the fourth element – vertical multilevel alignment – and how this may have evolved despite the observation that RRI mainstreaming in H2020 by and large failed.

Empirically, we approach the four DI elements on an illustrative basis with each of the four ele-ments supported by different sources.

There are two major empirical studies that we use for illustration purposes: the NewHoRRIzon project and the MoRRI study. In the NewHoRRIzon project, so-called Social Labs are at the core of the work. Their goal is to provide a socially based, experimental and systematic approach for addressing complex social challenges related to RRI. Each Social Lab is dedicated to a different section of Horizon 2020. For every section of H2020, different stakeholders gathered in a Social Lab to define the social challenges at stake and develop social experiments (= pilot actions and activities) to overcome them. The Social Lab process was prepared following diagnosis of the state of RRI in each programme section after three years of H2020 (at the end of 2017). Cross-sectional analysis of the diagnostic reports has been conducted to provide a broad picture of the state of RRI implementation within H2020 (Novitzky et al. 2020). The MoRRI (Monitoring the evo-lution and benefits of Responsible Research and Innovation in Europe) study programme began with an initial scoping of the RRI dimensions (gender equality, public engagement, science litera-cy and science education, open access, ethics, and the overarching dimension of governance). A data collection at the European Union Member State level included more than 36 indicators. Test-ing the data results for robustness and significance led to identification of core indicators and a clustering of EU countries (Mejlgaard et al 2018).

While the NewHoRRIzon diagnosis will serve to illustrate the third DI element (systemic consoli-dation), the MoRRI study provides information on the fourth element (vertical multilevel align-ment). For the first axis of the paradigm shift, we present a summary of the current academic debate for illustrative purposes. There is no significant research available on policy experimenta-tion in the context of RRI or Horizon 2020, which may point to a potential shortfall in policy prac-tice. Hence, for the section on maturation, there is little material to be discussed.

Results

The results suggest that key preconditions for the successful institutionalisation of RRI policies were not fulfilled. Specifically, broader policy debates reaching beyond the confines of a small policy arena within the European Commission, a lack of experimental embedding allowing for adjustment to different contexts, and the development of ownership in particular were not achieved. Building on the cornerstones of the DI concept, the authors conclude that attempts to mainstream RRI in H2020 have been premature.

Conclusions and policy issues

In addition to identifying explanations for past unsuccessful RRI mainstreaming, this paper's find-ings will also provide suggestions on how mainstreaming or institutionalisation of policy paradigms can be supported.

Keywords: Responsible Research and Innovation, Institutionalisation, Policy implementation

[200] Seyedesmaeil Mousavi (Institute for Research and Planning in Higher Education (IRPHE)). *Research Policies and Policy Instruments for Developing and Facilitating Transformative Research at Universities.*

Abstract. The complex nature of grand societal challenges requires that new and diverse knowledge is continuously produced to fuel and drive solutions. Moreover, many of the potential solutions may be at very early stages of development, where knowledge about the pathways linking knowledge production and the implementation of applied solutions are highly uncertain. Thus, the world of research has to be well linked to the discourse on transformative change (Joly et al. 2019). Transformative research seeks to address problems of unsustainability challenges via inventing and assessing possible solutions and by creating related actionable knowledge, including “strategies that can solve (or mitigate) certain problems” (Caniglia et al. 2017, p. 42). In tackling problems of the society, research is important in at least three ways: for understanding the causes and effects that determine the system dynamics of the problem, for clarifying conflicts of interests and value systems, and for contributing to the development of appropriate means for action (Kueffer, 2012).

Many believe that higher education institutions and universities need to become more effective in helping societies to solve societal problems (Kueffer, 2012). Research is a key mission of higher education, and in a globalized and highly competitive knowledge-intensive world, it has become increasingly important to global, regional, and national policy agendas (Leathwood, 2013). While the major advances in knowledge production are extremely important, a major shift towards acceptance and incorporation of new forms of science and research is also needed. In short, transformations towards more viable systems of knowledge production and use are required for wider societal transformations in response to societal problems to occur (Fazey, 2018). To address this need, Transformative research as a new research approach emphasizes the role of scientific knowledge production as a form of societal intervention that aims at catalyzing societal change processes (Schneidewind, 2016).

To find a way to cover this gap, we must first answer the critical question of how to direct research to solve the societal challenges of our time. The misalignment between the stated goals of the research programs and research policy led many scholars to propose rejuvenation of the research policy under an emerging paradigm, which has been labeled into Transformative Research Policy (Mazzucato, 2018). The basic premise of the transformative policy is that a conscious public policy can influence the directionality of research and innovation and, more importantly, change the socio-technical systems (Borrás, 2020). This transformative turn has led to an interest in a mission-oriented approach to research policy in different countries. Many governments are shifting the orientation of parts of their research policies from stimulating economic growth to bringing about transformative change (Kuhlmann and Rip, 2018; Schot and Steinmueller, 2018). In particular, we witness the rise of mission-oriented research policies that draw on frontier knowledge to attain broader societal goals (Mazzucato, 2018).

This new claim has potentially severe consequences for the governance of research programs (Weber, Rohracher 2012). In line with this study, the transformative policy literature also calls for establishing new institutional arrangements and governance structures tailored to achieving societal goals (Rogge, 2020). Research governance can be defined as the broad range of formal and informal mechanisms to regulate, coordinate, and monitor publicly funded research activities, and to generate compliance and desired behavioral regularities to ensure high-quality research (Woelert, 2013). A central question in research governance is then how the research programs can be organized to help tackle global, multi-faceted, societal challenges. The question of managing research and allocating resources according to societal needs has been so far focused on prioritization between competing problems (Wallace, 2018). For example, in Iran, the Supreme Council for Science Research & Technology has also prioritized the problems. However, there is less literature exploring what research governance should be adopted for societal challenges – which affects not only how resources are allocated, but also what type of research is conducted and what type is not (Frickel et al., 2009; Ciarli and Ràfols, 2018). Hence, the main aim of our study is to discuss our understanding of the contribution of research activities to transformative societal impacts. Doing this, we are going to explain what research policies and instruments could be designed, implemented, or adopted to actively direct research towards meeting societal challenges by transforming them into concrete, measurable, and, most importantly, achievable missions for higher education. The other aim of this study is to examine the degree to which current research policies and instruments in Iran's higher education meet the needs of and support transformative research in universities. Another key aim of this study is to get a better understanding of how to organize research programs in universities in such a way that they effectively mobilize different actors in order to contribute to societal transformation. The next aim of our study is to provide policy recommendations to higher education policymakers to further support and facilitate problem-based research in universities. Following these goals, we would like to open the debate and tackle the research questions of:

1. What research policies and instruments could induce universities and researchers to design and conduct transformative research?

2. What research governance arrangements at the research level can support and facilitate transformative research at universities?

Thus, the purpose of the study is to discuss the contribution of research activities to transformative societal impacts in Iranian universities. It aims at analyzing which research policies and instruments could be designed, implemented, or adopted to direct research towards meeting societal challenges. Another goal is to consider how current research policies and instruments in Iran's higher education support transformative research in universities. Finally, we would like to provide policy recommendations to higher education policymakers to further support and facilitate problem-based research at universities.

This study adopts an abductive qualitative research approach (Dubois & Gadde, 2002). The abductive qualitative research approach uses an analytical framework to study an empirical phenomenon and goes back and forth between analytical framework, empirical setting, and analysis. This continuous interplay between analytical framework, empirical observation, and analytical discussion, so-called "matching" (Dubois & Gadde, 2014), enables the development of new knowledge regarding a phenomenon, which is relatively less investigated (Dubois & Gadde, 2002).

We adopted a bottom-up approach (cf. Ossenbrink, Finnsson, Bening, & Hoffmann, 2019) to gather data and delineate the current research policies and instruments in Iranian higher education. The bottom-up approach starts gathering data from a specific domain affected by the policy (here facilitating the transformative research) and identifies the policy instruments that—whether intentionally or otherwise—exert an impact on the focal outcome (cf. Ossenbrink et al., 2019). Hence, we started to gather archival data about the policies and instruments making use of different sources, such as public interviews, reports of the Ministry of Science, Research and Technology and other important actors in the field, their press releases and websites, news about the research activities of universities and research centers in mass media and journals. We also conduct semi-structured interviews with some individual researchers and research deputies and managers at the universities in an attempt to identify all research policy and policy instruments that are considered relevant for the transformative research. The semi-structured interviews enable researchers to cover a broad range of relevant topics and at the same time to emphasize a particular topic based on the responses of the interviewee (cf. Lindlof & Taylor, 2011).

In the next step, the list of identified research policies and related instruments are used to uncover the associated governing entities and the corresponding policy strategies. Accordingly, we contact and interview policy experts and authorities from different governing entities to investigate further what role these policies and instruments play for realizing transformative research at Iranian universities. We use the snowballing method to gradually expand the sample. We complement and develop our understanding of the policies and instruments further by triangulating the interview data with different secondary sources of data such as policy documents and reports (cf. Denzin & Lincoln, 2007).

Thus, we expect to contribute to an empirical understanding of what is needed to

successfully put transformative research approaches into practice, the kind of instruments and activities that can support this, and the extent to which implementation is dependent on its governance at the universities.

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Keywords: Transformative Research, Research Policy, Research Funding, Governance Approaches

[201] Philip Doerr (Friedrich Schiller University Jena), Maximilian Goethner (University of Twente) and Uwe Cantner (Friedrich Schiller University Jena). *TTO-Scientist Interaction and Academic Spin-Off Creation.*

Abstract. The rapid rate of growth in spin-off company creation over the past 40 years (Astebro et al., 2012), the large economic impact of university spin-offs like Google, Cirrus Logic, and Genentech (Shane, 2004), and contributions to pressing health issues like in the recent case of BioNTech, has attracted considerable attention in academic entrepreneurship by scholars and policymakers. Consequently, many universities have adjusted their strategic profile to become entrepreneurial universities. Even though there are many research results, only some scientists recognize business opportunities and even fewer actually found a spin-off (see, e.g. Cantner et al., 2021). Despite spin-offs being considered as direct and efficient ways of knowledge and technology transfer enabling rapid diffusion into society and economy, sometimes there is a substantial time lag between the generation of research results and its application (Agarwal & Bayus, 2002). This time lag might be problematic as the window of opportunity for commercialization might be temporary and in some industries even only opened once (Clarysse & Moray, 2004; Cunneen et al., 2007; Bygrave & Zacharakis, 2010; Müller, 2010).

An important part of this literature emphasizes the role of institutional characteristics as determinants of entrepreneurial activity. For example, it has been found that the nature of research within the university (O'Shea et al., 2005), the size and quality of research faculty (Di Gregorio & Shane, 2003), and a university's entrepreneurial tradition (Lockett & Wright, 2005) all are strong predictors of the probability and number of spin-off companies. Despite this widespread effort to explain why some universities are more active in spin-off creation than others, important questions remain unanswered. For example, previous research focuses on the scale of technology transfer support and relative technology transfer performance, e.g. contingent effectiveness model of technology transfer (Bozeman, 2000; Bozeman et al., 2015). Rare evidence, however, has been provided for the effect of TTO support on spin-off creation success, e.g. spin-offs' time-to-venture duration (Mu¨ller, 2010). This omission is surprising given the general understanding of the important role that TTOs play in the commercialization of university technology (Thursby & Thursby, 2002; Siegel et al., 2003; Owen-Smith & Powell, 2003).

In our study, we shed light on the spin-off creation process supported by TTOs. We investigate the relationship between structural characteristics of TTO's advisory services and academic entrepreneurship in terms of (i) spin-off creation and (ii) time-to-venture and (iii) later firm performance.

With this study, we contribute to the literature by highlighting the role of specific micro-mechanisms of TTO advisory services via meetings with the aspiring founders. We also aim at practitioners giving information for developing actions to increase advisory efficiency and effectiveness.

Scientists with the aspiration to found a firm often lack business-related competencies and resources. For instance, some do not know how to satisfy customer needs and have unrealistic expectations regarding their value proposition (Shane, 2004; Siegel et al., 2004). As a result, some develop business models which go astray for industrial demand. Consequently, some take several time-consuming revision rounds or even fail with creating or sustaining the spin-off.

TTOs are supposed to lower this lack by providing entrepreneurship-specific capital (Bosma et al., 2004; Ucbasaran et al., 2008). Acting as boundary spanners, TTOs provide social capital increasing scientists' network, esp. with experts and financiers (Comacchio et al., 2012) potentially giving access to financial capital. Offering incubation services like face-to-face meetings, workshops, and facilities, they provide access to human capital as well as physical capital.

For achieving a deeper understanding of the impact of TTO support on the spin-off creation process, we focus on one established TTO of a university and its entrepreneurial activities. In particular, we have access to detailed information about TTO consulting services provided to 357 nascent academic spin-off projects created between 2012 and 2020 at the Friedrich Schiller University Jena, Germany. The University of Jena is a traditional research university, organized in 10 schools: Theology, jurisprudence, economics, and business administration, humanities, social and behavioral sciences, mathematics and computer sciences, physics and astronomy, chemical and earth sciences, biology and pharmacy, and medicine and, thus, holds the potential of business ideas from all scientific disciplines. As of 2020, the university has about 18,000 students enrolled and employs 400 professors. The TTO of the University of Jena was established in 2000. It possesses the long-term experience and is therefore well suited for our intended investigation.

The data for our study were collected from written documentation of each meeting be- tween TTO advisors and members of the spin-off projects, from the first contact to the last consultation before the official business creation. These longitudinal data provide a unique micro-level perspective on the emergence of academic entrepreneurship. We can disentangle the impact of the type, magnitude, content, and frequency of TTO consultancy on progress in the new venture creation process. Furthermore, we have information about the team's business idea as well as the team composition. The multi-faceted data allows us to contribute significantly to the rare evidence on the effects of TTO advisory services on spin-off creation success, esp. spin-offs' time-to-venture duration (Mu¨ller, 2010).

As the data stems from internal documentation which was not designed to be scientifically analyzed originally, we needed to conduct several steps of cleaning. For this and for the creation of some variables, we received support from one experienced TTO advisor who has been working at the respective TTO since 2014. The advantage of this advisor is that the one is not only a practitioner but also used to be a researcher in the field of academic entrepreneurship. For analyzing the content of the meetings, we applied inductive qualitative content analysis following the recommended procedure by Mayring (2014). From interviews with the TTO advisor and additional desk research, we know the status of the founding projects, i.e. whether they are still ongoing, aborted, or actually founded.

Descriptive statistics suggest substantial heterogeneity in the magnitude and frequency of TTO consulting services provided to nascent academic spin-off projects. We find that the number of consultation meetings per spin-off project varies between 1 and 30 (M = 2.61 meetings), with the total consultation time ranging from 15 minutes to 50 hours (M = 3.81 hours). On average, a meeting with TTO consultants lasts 1.38 hours.

Out of the 357 nascent spin-off projects in our dataset, 87 spin-offs have been successfully created. In a first preliminary analysis, we find that these 87 projects received significantly more TTO support, in terms of the number of consulting meetings and total consultation time. No significant differences have been found for the average length of individual meetings. In the next step, we consider linking the exchange between the TTOs and the spin-off projects to later firm performance. Doing so, we can analyze TTO's "pampering effect" on future firm performance. More precisely, to what extent does the consultation with the TTO in terms of frequency or average length affect future firm performance. Similar to spin-off duration, one performance measure could be time of firm survival. Further measures could

be number of employees and revenue development.

Overall, this study adds an important perspective to the academic entrepreneurship literature by highlighting the role of specific micro-mechanisms of TTO support during the initial stages of the spin-off creation process.

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Keywords: academic entrepreneurship, technology transfer office, spin-off support, spin-off performance

[202] Juan Aparicio (Centro de Investigación Operativa (CIO), Universidad Miguel Hernández de Elche), Javier Barbero (Oviedo Efficiency Group (OEG), Universidad de Oviedo), Jon Mikel Zabala-Iturriagagoitia (Deusto Business School, University of Deusto) and Jose Luis Zofio (Department of Economics, Universidad Autónoma de Madrid). *Which are the bottleneck that constrain European innovation performance?*

Abstract. Relevance

How to measure innovation at the territorial level is one of the most challenging endeavors in the field of innovation policy, due to the absence of a theory on innovation systems and innovation policy (Grupp and Schubert, 2010). To address this challenge, a plethora of composite indices have been provided, among which the index of the Massachusetts Innovation Economy, the Global Innovation Index, the Nordic Innovation Monitor, the Bloomberg Innovation Index or the European Innovation Scoreboard can be mentioned.

These scoreboards are all based on the use of a composite index that provides a ranking of the countries under study. While the relevance of such composite indices for the practice of innovation policy is low (Arundel, 2007; Mairesse and Mohnen, 2009), they do have strong policy implications, since many political decisions are made on the conclusions drawn from them (Kozłowski, 2015).

Paruolo et al. (2013, p. 610) argue that it is necessary to conduct novel research on the analysis of composite indicators, so as to prevent questionable choices for policy. In order to provide an answer to this claim, this paper aims to contribute to the literature on the performance assessment of innovation systems with a methodology that helps identify the functions of an innovation system that are constraining its overall performance, so as to provide clear guidelines to policy makers on the direction of their interventions (Mazzucato, 2018).

Theoretical framework

The paper relies on the methodology suggested by Acs et al. (2014) to identify the bottlenecks that constrain the performance of an innovation system. This methodology is applied to the 2013, 2014 and 2015 editions of the European Innovation Scoreboard, so as to provide a dynamic evaluation of the main policy needs for each European country. Published annually since 2001, the European Innovation Scoreboard (EIS) is the main instrument used by the European Commission to monitor the results of the Innovation Union. This is one of the flagship initiatives to create an innovation-friendly environment that supports the generation, emergence and diffusion of innovations. It includes statistical information about the set of indicators that are deemed to characterize the performance of innovation systems.

The methodology developed by Acs et al. (2014) was originally designed to measure the performance of national entrepreneurial systems. In this case, the same methodology is extended to the analysis of national innovation systems. Their methodology provides a systemic approach that captures the interactions between the components of a system. The particularity of this methodology is that it applies “penalty bottleneck” for those factors that hold back system performance. Their methodology is based on the theories of the weakest link (Harrison and Hirshleifer, 1989) and the theory of constraints (Tol and Yohe, 2007). These theories argue that the performance of any dynamic system is characterized by interdependencies and feedback loops, as it is the case of innovation systems, and that this performance depends on the element that has the lowest value in the system structure (Acs et al., 2014, p. 482). According to these theories, any system could only improve as long as the weakest link (i.e. the bottleneck that constraints the whole system) is strengthened.

As Acs et al. (2014) discuss, when assessing the performance of a system, it is not only important which is the scale of each constituent, but rather which are the results that can be achieved when the scale of all constituents or subsystems are considered. They illustrate this need for balance through a metaphor that we also deem useful here (p. 488), and which is also in line with Edquist (2011). To bake a cake several ingredients are needed in certain proportions. If we only have one ingredient (e.g. eggs), we may obtain an omelet, but never a cake. Similarly, if we have all required ingredients, but the amount we have for one of them (e.g. flour) is limited, the amount to be used of all the other ingredients should also be reduced in the same proportion. Likewise, an innovation system may have a large intensity in some of its subsystems, but if this "strength" is not complemented with a similar capacity in other subsystems, it cannot be assumed that the performance of the system is likely to be balanced and comprehensive, just as it is impossible to bake a cake with lots of water but no eggs.

If the performance of a system is understood under "the-more-the-better" logic (i.e. the larger the amount of ingredients), we may end up in the trap of having a fragile and unbalanced system (Parsons, 2006) if these inputs are not proportional among themselves. As a result, it seems reasonable to think that the performance of a system should be assessed depending on the balance among the functions that characterize it, and their ability to be transformed into concrete, and also multidimensional, and equilibrized, results.

Data and methodology

Using the indicators provided by the EIS for years 2013, 2014 and 2015, we can build a Global Index decomposed into 3 levels: (1) pillars, (2) sub-pillars, and, (3) indicators.

The methodology to calculate the global scores and the bottlenecks for all countries in the three years considered in the paper is as follows:

Normalization: First, we normalize the value of all the EIS indicators to a range from 0 to 1

Capping: to avoid the effects of potential outliers, we select the 5th and 95th percentile score adjustment. This implies we replace the values for all the indicators that are lower than the 5th percentile with the 5th percentile value for that indicator. The same procedure is also applied for the values that are higher than the 95th percentile with the 95th percentile value. We use the benchmark values from the full dataset, for all countries and indicators.

Average pillar adjustment: we transform our values to equalize the average values of components.

Penalizing: After these transformations, the PFB (The Penalty for Bottleneck) methodology was used to create indicator-adjusted PFB values.

Building of the sub-index: Enablers, Firm Activities and Outputs. The value of a sub-index for any country is the arithmetic average of its PFB-adjusted pillars for that sub-index, multiplied by 100.

Results

As a result of this methodology, we can identify which as the main bottlenecks that limit the innovation performance of each country.

The paper contributes to the literature by evidencing that the performance of innovation systems is to a great extent determined by the weakest link in the system, which acts as a bottleneck, reducing the potential performance the system could have. Accordingly, innovation policies should initially target those bottlenecks, as they would lead to a more efficient and effective systemic performance.

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Keywords: innovation systems, innovation indicators, European Innovation Scoreboard, bottleneck, innovation policy

[203] Matthias Huegel (Friedrich Schiller University Jena), Philip Doerr (Friedrich Schiller University Jena) and Martin Kalthaus (Friedrich Schiller University Jena). *Where it all began: Transfer Opportunity Recognition by Scientists and their Choice of Transfer Channels.*

Abstract. Innovative activity is highly dependent on scientific discoveries. While there are many research results, only a few are translated into commercial applications, because many scientists do not even consider any application of their results beyond scientific use (Dosi, 2006). This is problematic because knowledge and technology transfer (KTT) from academia to economic and societal application contributes to socio-economic problem solving and potentially beneficial ideas do not get exploited. The underlying process of KTT starts with the research conducted and requires the scientist's recognition of a transfer opportunity. Along with the recognition of an opportunity, the scientist has to choose a channel through which she transfers the knowledge into economic application. The three most relevant channels are founding a firm, legal protection of intellectual property or research collaboration with industry to develop the research towards application (DEste, 2019).

Understanding this process of opportunity recognition is crucial to increase engagement into transfer activity. However, so far, scholars focused on the realization of transfer opportunities (e.g. Landry et al., 2010; Abreu & Grinevich, 2013), but not on what determines the recognition of such opportunities. Given the importance of scientists' behavior at the beginning of the process, it is necessary to understand first what characterizes scientists who realize an opportunity for transfer and then why they choose which transfer channel. We contribute to this line of research by explicitly analyzing what determines scientists' recognition of transfer opportunities and the accompanying choice of the transfer channel.

Drawing on the literature of scientists' engagement in knowledge and technology transfer (e.g. Perkmann et al., 2013) as well as on the literature regarding entrepreneurial opportunities (e.g. Ardichvili, 2003), we derive the scientists' academic excellence and their economic experience as preconditions to increase their probability to recognize transfer opportunities. Academic excellence is proxied by the quantitative and qualitative research output, while economic experience is captured by scientist's work experiecne outside academia and their network to industry-actors. Regarding the choice of the transfer channel, we argue that different determinants let researchers with a transfer opportunity choose a specific channel to seize this opportunity. First, we assume that the type of knowledge a researcher generates (basic research or applied research) creates different commercial exploitation options for which a transfer channel may be less or more suitable. Second, we believe that the researcher's willingness to take risks might be a central determinant due to substantially different risk profiles associated with an engagement in each transfer channel. Third, we argue that the environment the researcher is embedded in, influences the likelihood of choosing a specific channel, measured by role models for each transfer channel.

For our empirical analysis, we developed a novel online survey for scientists and conducted it in the German state of Thuringia between December 2019 and January 2020. We sent out the online survey to 7,785 scientists and received 1,412 responses (18,1\%) from which 1,149 are considered in our analysis. Our online-survey consists of a set of questions on the scientists' transfer activities and their involvement in several stages of the transfer process through three research commercialization channels. We considered research collaboration with industry participation, the protection of intellectual capital and the creation of a research spin-off as the most relevant channels for the production of economically relevant knowledge and technology. We included a question regarding the transfer opportunity recognition for each of the three transfer channels to determine the ones who identified ideas for the respective channel in the last five years, e.g. an idea for a collaboration with company participation. We collected information on scientists' characteristics regarding their socio-demographic situation, research activity and personality. In addition to the survey data, we gathered data on the respondents' publication record from the databases Web of Science (WoS) and Scopus.

Since we are not only interested in scientists' recognition of a transfer opportunity, but also in their choice of the specific transfer channel, we use an econometric model that accounts for both. A transfer channel is chosen only by those scientists who recognized an opportunity to transfer research to economic application. This requires an empirical strategy which encounters selection issues to prevent inconsistent estimates (Heckman, 1979). At the same time, we also take into account that researchers with transfer opportunities can pursue them in multiple channels. To address the self-selection as well as the possibility to choose multiple transfer channels, we apply a multivariate probit model with a correction for self-selection issues. The selection equation estimates the scientist's probability to recognize a transfer opportunity while the three outcome equations reflect the choice of the transfer channel for seizing the transfer opportunity. We choose seemingly unrelated regressions (SUR) because if there are meaningful correlations between the error processes of the different relationships between the dependent variables, the SUR estimates will be more efficient than those derived from single-equation regressions (Roodman, 2011).

Our results show mixed evidence for the influence of academic excellence and scientists' probability to recognize a transfer opportunity. While the quantity of research output significantly increases the probability, the qualitative research output significantly decreases it. Regarding economic experience, we can partially provide evidence for a positive correlation, namely between work experience outside academia and transfer opportunity recognition. Regarding the choice of the transfer channel, we find a positive association between the type of knowledge: applied research increases the probability to choose the IPR channel, while basic research does it for the spin-off channel. The scientist's willingness to take risks and is positively associated with the choice of firm foundation as the transfer channel. Channel-specific role models are influential for the choice of firm foundations and the protection of intellectual property, but not for research collaborations with industry partners.

Our research reveals scientists' determinants to recognize a transfer opportunity and the corresponding choice of transfer channel. We thereby complement research that analyzes the end of the transfer process and provides implications for research management and innovation policy.

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Keywords: transfer opportunity, transfer channel, academia-industry

[205] Seyedesmaeil Mousavi (Chalmers University of Technology), Hans Hellsmark (Chalmers University of Technology) and Patrik Soderholm (Luleå University of Technology). *Innovation Policy at the Plant Level: How Entrepreneurial Actors Capitalize on Policy Mixes to Realize Demonstration Projects.*

Abstract. Demonstration projects represent the bridge between research and development on one hand as well as up-scaling and commercialization on the other (Bossink, 2015; Hellsmark, Frishammar, Söderholm, & Ylinenpää, 2016). This stage of the innovation process (demonstration) is critical for proving the market-attractiveness of the new technologies. The innovation system literature emphasizes the importance of uncertainty reduction, and one of the main sources of uncertainty reduction is entrepreneurial experimentation, which implies probing into new technologies and applications (e.g., Bergek et al., 2008). Entrepreneurial actors depend on pilot and demonstration plants in making such experimentation possible. Demonstration plants address not only technical challenges, but also reduce the organizational-, market-, and institutional uncertainties that key stakeholders face in advancing new sustainable technologies (Hellsmark et al., 2016; Hendry et al., 2010).

Failure to support the demonstration and early deployment of the clean energy technologies would mean a waste of resources applied earlier in the innovation cycle for research and development (Åhman, Skjærseth, & Eikeland, 2018). Demonstrating a promising technology at large or full scale involves major costs and risks for technology developers if the technology should fail. Furthermore, knowledge generated through the learning at demonstrations has public-good characteristics, firms will often not appropriate all benefits from their investments. Hence, they are likely to underinvest in learning unless support is provided (e.g., through R&D subsidiaries and technology deployment schemes) (Åhman et al., 2018). This is particularly the case in developing clean energy technologies, where technological complexity and market uncertainty are high. Thus, public support and investment for demonstration plants are a focal point of governmental investments both on a regional, national and supranational-level for strengthening the competitiveness of industry and tackling the barriers that hold back private investment (Hellsmark et al., 2016). Policy action is also argued to be required to remedy various market and system failures (e.g., Edler & Fagerberg, 2017; Edmondson, Kern, & Rogge, 2018).

Few studies have assessed the outputs and effectiveness of public fund instruments for the construction and use of demonstration plants in the context of clean energy technologies (Åhman et al., 2018; Brown & Hendry, 2009; Frame, Hannon, Bell, & McArthur, 2018; Krahé, Heidug, Ward, & Smale, 2013). These studies concluded that public R&D and investment support are important, but as the technology matures, they need to be complemented with purposefully designed market creation incentives and systematic instruments (Åhman et al., 2018; Brown & Hendry, 2009; Hellsmark et al., 2016). Hellsmark et al. (2016) also argue that demonstration programs that reduce technical uncertainties need to be supplemented by policies that ensure that markets are formed. They conclude that relying solely on public subsidies to R&D and investments in a selection of demonstration plants will likely lead to a start–stop approach and will not promote the overall commercialization of energy technologies. This suggests that a mix of different policy instruments are needed for various types of demonstration plants, and policy actions should be matched with intended demonstration plants outcomes more effectively. It is argued that PDPs, particularly when the scale of the project is large and the technology is close to market readiness, are increasingly complex and risky (Åhman et al., 2018; Frishammar, Söderholm, Bäckström, Hellsmark, & Ylinenpää, 2015). Policy mix refers to ‘a set of different and complementary policy instruments to address the problems identified’ in a national or regional innovation system (Borrás & Edquist, 2013: 1514). Thus, for public policy, the main challenge for demonstration and early deployment of the novel technologies then becomes providing the right incentives at the right time so that such a process can be facilitated (Hellsmark et al., 2016).

Bossink (2017) and Hellsmark et al. (2016) also argue that public policy for the demonstration plants cannot be understood at a single level of governance. According to Bossink (2017), next to a national level, there is also a need for coordination of public policies on an international level, for example in the European Union (EU), in order to stimulate the use and construction of demonstration projects for sustainable energy technologies. Hendry, Harborne, and Brown (2010) also contend that the EU needs a comprehensive and general coordination policy, in which all sustainable energy demonstration projects are integrated. In line with these studies, Edmondson et al. (2018) posit that further attention should be paid towards the vertical dimensions of public policy design, spanning multiple levels of government, including implementation of national-level policies at the local scale to reduce conflicts or even increase the synergies. Hence, appropriate policy instruments for the various demonstration plants reside not only within different governmental bodies but also at different levels (e.g., regional, national, supranational). In addition, these may operate under different institutional logics and with partly conflicting goals. Therefore, innovation policy on demonstration plants for clean energy technologies, in general, cannot be understood at a single level of governance (Bossink, 2017). In an effort to bridge the above research gap, it is required to place a central focus on the multilevel nature of existing policy mixes through the differentiation of policy elements and processes at multiple levels of governance (the supra-national, national, and regional levels) and examines their interactive dynamics for the construction and use of PDPs. Accordingly, the literature addresses the need for a more fine-grained insight into how policy mixes influence and facilitate the construction and use of PDPs (Bossink, 2017; Brown & Hendry, 2009; Hellsmark et al., 2016). This limitation also relates to the implications for how to design and implement public policy measures to support PDP activities for accelerating the commercialization of new energy technologies (Hellsmark et al., 2016).

On the other hand, Mavrot, Hadorn, and Sager (2019) argue that the focus on settings and target groups allows for a better understanding of the overall policy mix performance from a policy evaluation perspective. It is at these setting and target group levels that the policy mix concretely takes effect. They show that both the examination of the policy concept (i.e. policy design) and policy implementation are enriched through a better understanding of meso- and micro-level particularities that affect the policy process. The examination of the policy mix is demonstrably more meaningful if the moderating role that settings play between the policy mix as a whole and the ultimate target group is considered. According to Mavrot et al. (2019), within policy mixes a given measure may activate different mechanisms depending on what kind of measures it is combined with. Policy mixes thus provide different sets of opportunities for the target groups to react to. This approach highlights that it is the target group's reaction and behavior to the opportunities provided by the policy that triggers the change (…). Observations at a micro- to meso-level will then allow drawing conclusions for a more general level of policy design. In achieving this, we also aim to get a better understanding of the activities and strategies of key entrepreneurial actors, e.g., technology developers, to make use of different public policies and instruments. This is especially important for policymakers who want to support system builders, e.g., to facilitate the demonstration and early deployment of novel technologies. Accordingly, our main research question is:

How do entrepreneurial actors capitalize on policy mixes to realize demonstration projects?

In light of this background, by drawing insights from policy mix studies (Edquist, 2011; Flanagan, Uyarra, & Laranja, 2011; Rogge & Reichardt, 2016) and the policy feedback theory (PFT) (Edmondson, Kern, & Rogge, 2019; Pierson, 1993), our study provides a multilevel interpretation of the vertical interactions of existing policy mixes in the different governance levels and policy domains. The term 'policy mix' implies a focus on the interactions and interdependencies between different policies as they affect the extent to which intended policy outcomes are achieved (Flanagan et al., 2011). In the last three decades, policy feedback has emerged as a popular concept in policy analysis (Béland, 2010; Jordan & Matt, 2014). Jordan and Matt (2014) argue that since politics create policies, and policies also remake politics, we should make policies the starting points as well as the endpoints of our policies analysis. Feedback from previous and current policies is important in that it helps highlight what policy works and what may not (Edmondson et al., 2019; Kern & Rogge, 2018; Pierson, 1993). Accordingly, the focus of our paper has been on the challenges and implications of innovation policies on the construction and use of demonstration plants to facilitate the commercialization of technologies in the empirical context of advanced biofuel technologies. Three distinctive demonstration plants are studied. The aim is to identify the policy mix dynamics that are active in three cases, and by this, to identify patterns, mechanisms, or processes with analytical and external validity, and contribute to theoretical development in this area (Yin, 2009).

Our aim is to broaden the discussion within the technology and innovation studies literature about the importance of policy mixes and their interaction with the target group. In addition, it provides a point of departure for discussing the challenges of identifying and designing appropriate innovation policy in the PDP context. The main contribution of this study lies in the differentiation of policy mixes at multiple spatial scales (supra-national, national, and regional levels) and the uncovering of their dynamic interactions in realizing the demonstration plants. Furthermore, it helps to derive insights and learn from the policy mixes for further policymaking. In other words, this study contributes to the conceptualization of policy mixes for the construction and use of PDPs by highlighting the verticality of policy mixes, accounting for which configurations will facilitate a more nuanced design of policy mixes. Recognizing the nature of policy mixes in this context is also conducive to the design of more open-ended and reflexive innovation policies. Accordingly, the study provides new insights into the challenges of innovation policy in the demonstration plants context and shows how the development and commercialization of the novel technologies from a policy perspective can be improved.

Keywords: Sustainability transitions, STI policy, Demonstration, Policy mixes, policy design

[206] Benoit Cornet (Ecole Polytechnique Fédérale de Lausanne), Marc-Andre Chavy-Macdonald (University of St Gallen), Jean-Paul Kneib (Ecole Polytechnique Fédérale de Lausanne) and Dominique Foray (Ecole Polytechnique Fédérale de Lausanne). *Defining "innovatization": the case of NewSpace and the changing space sector.*

Abstract. 1. Introduction

In this paper – the first of a series of three companion papers [1] - we aim to characterize the process underlying the transformations currently occurring in the space sector. We propose to name this underlying process "innovatization". With this new term and concept, we intend to describe a great shift of the sector from one mode to another.

In the first mode, space technology projects – e.g. Apollo, the Space Shuttle, the International Space Station (ISS) – are characterized by inattention to costs and consumer preferences, meaning they are not really innovations in the sense used by economists. Indeed, in economics, an innovation is a new product or process that generates economic value in the form of surplus for the consumer or profit for the innovative company. Yet in the first mode, the space sector produces neither surplus nor profit. However, one might argue that space is a sector devoted exclusively to scientific exploration, since science in general produces neither surplus nor profit in the short term. The problem with this statement is that the production of scientific knowledge within the space sector has been relatively expensive when the opportunity cost is taken into account. Furthermore, in most cases, the production of scientific knowledge was not the main objective and was often sacrificed to other imperatives – e.g. diplomacy, "signaling" (MacDonald 2018). Thus, we might say that the sector produces neither consumer surplus, nor producer surplus, and little knowledge surplus – a sector foreign to innovation, but obviously not to technology! These complex technologies and systems simply do not enter the economy to be tested and validated; their designs and production remain free of the laws and constraints of the "normal" economy. We call these technological achievements (TA), as opposed to innovations.

With the term innovatization, we wish to characterize the transition from a mode of technological achievement to a mode of innovation in the economic sense. Such a transition is exceptional and perhaps even unique in history. It causes great upheavals. All the actors of the previous mode - accustomed to certain routines associated with technological achievements - are faced with new constraints, new challenges, and new methods of management and governance. A careful and detailed analysis of this innovatization of the space sector is essential to better understand the way in which public policy must be reinvented to face these transformations.

The goal of this paper is therefore to answer the question "what is innovatization?" with rigorous evidence from the space sector. Here we fully establish the concept (as well as technological achievements), rigorously characterize it and needed theory, and confront it to available evidence in the space sector.

Our approach relies on an interdisciplinary collaboration between researchers in economics, astrophysics, and space technology. This allows a broad understanding of (1) innovation policies, the economics of the space sector and its transformations, but also, of (2) space technologies, which bear marks of these changes in their design and architecture.

[1]: These papers constitute a research project aiming to understand the radical transformations currently occurring in the space sector, and establishing a conceptual framework from innovation economics - innovatization - to analyze them. This framework is intended to be applicable to other sectors (e.g. space, nuclear) with similar transformations. Paper #1, outlined by this abstract, aims at defining this innovatization framework; paper #2 will provide indicators to measure it; paper #3 will include a survey of the Swiss space & start-up ecosystem, and formulate policy recommendations.

2. Relevant background

In the past few years, numerous reports and academic papers have explored the radical changes currently sweeping the space sector. Among them is the emergence of NewSpace, featuring the appearance of entrepreneurs acting independently from government policy. Indeed, they are focused on commercializing space and realizing profits (Peeters 2018 ; Weinzierl 2018), impacting the evolution of the space ecosystem and the role of space agencies like NASA (Mazzucato and Robinson 2018; Lambright 2015).

With the concept of innovatization, we aim to contribute to this literature by providing a conceptual framework to characterize the process underlying the transformations of the space sector. To the best of our knowledge, such a framework has not yet been established. Its goal is to provide economists, policy- and decision-makers with a tool allowing them to identify and understand such a phenomenon, and design public policies accordingly.

3. Data and methodological approaches

In order to establish the conceptual framework for innovatization, we aim to characterize the technological achievement regime, and identify trends and markers of innovatization. To do so, we implement a three-step approach as follows:

1. Analyze the objectives & characteristics of the legacy space institutions and major programs, beginning with Apollo;

- We deep dive with a product archeology study (Ulrich & Pearson 1998), to identify the preferences revealed by the design & architecture of the technical artifacts;

2. Assess input intensity, characterizing the financing for the TA and innovation regimes and other inputs (e.g. human capital);

3. Assess output measures for the TA and innovation regimes (e.g. publications, patents, operations costs such as tonne to orbit, industry revenue and value creation)

The data used comes from economic databases and an extended literature and reports review of US space R&D&I history. This includes research articles, annual reports, grey literature, and government expenditures data, as well as technical data and design histories.

4. (expected) Results

The results provided by this analysis are two-fold. First, we provide evidence on the technological achievement regime and the production of knowledge at a high cost.

The space sector has not been a significant source of patenting (OECD 2014), despite large R&D investments. Indeed, a recent report by the European Patent Office and the European Space Policy Institute (EPO and ESPI 2021) indicates that between 1990 and 2009, the number of new space-related patent families was stable, with 200-300 per year. However, this has changed in the past decade, as the number of space-related patents significantly outpaced sectoral revenue growth. For example, between 2009 and 2017, the number of patents rose by 354% (from 280 to 1270), while the space economy grew by 49% (from $257 Bn to $383.5 Bn).

A deep dive into Apollo's technical architecture is revealing.

The key early design decisions of Apollo have been mapped; these "locked in" most of its later costs and engineering effort. We find a laser focus on the ambitious performance & schedule goal - of landing humans on the Moon and bringing them back before 1970 - with astronaut risk and large cost differentials being the major decision criteria. The choices of technology development pathways - e.g. on-orbit rendez-vous and docking, vs. larger or higher-frequency rocket launches - were made based on these criteria. Similarly, crews were chosen primarily among test pilots; only a single of the 12 moon-walking astronauts was a trained scientist (a geologist). Apollo design choices and path can be reproduced while completely ignoring economic or scientific goals.

Second, we identify trends and markers of innovatization by analyzing current happenings in the sector through the lens of innovation theory. These include:

The creation of consumer and producer surplus thanks to a decrease in costs. The advent of SpaceX and its Falcon 9 rocket have dramatically reduced space launch costs compared to the Space Shuttle (Jones 2018): with the Falcon 9, it costs $63 million to put 22’800 kg ($2’720/kg) of cargo into low earth orbit (LEO), compared to $1.5 billon for 27’000 kg for the space shuttle ($54’500/kg). The gains for NASA are significant. We estimate that in 2009, the cost for NASA of servicing the ISS amounted to $3.36 billion (constant 2019 $); in 2019, this cost was $2.11 billion, representing a 59% decrease. In other industry segments, cost decreases include economies of scale due to the production of large numbers of satellites for constellations, as well as dropping “experimentation costs” due to the rising importance of information and communication technologies (ICT).

The identification of new markets and business opportunities. According to data from the Space Foundation, between 2009 and 2019, the global space economy – consisting of revenues generated by commercial space activities and government investments in space – grew in nominal terms from $261.6 billion to $423.8 billion. Interestingly, a large part of that increase is due to the development of commercial space, which represented 79% of the sector in 2019, up from 67% in 2009. Of particular interest is the development of new segments and business models such as the commercialisation of services using Earth Observation data, and new communications services.

An increase in the total inputs to R&D&I thanks to two elements: firstly, the development of a space innovation ecosystem with increasing human and financial capital. Indeed, universities boost the quality and quantity of engineers by implementing novel nanosatellite-enabled training programs - by tens of thousands more over a decade (Jayaram & Swartwout 2010). The strong network of venture capital funds in the US stimulates the funding of start-ups created by these engineers, notably by decreasing the costs of entrepreneurial experimentation (Nanda and Rhodes-Kropf 2016). According to Bryce Space and Technology (2020), 56 U.S. space start-ups received funding in 2019, compared to 10 in 2009. Secondly, the increase in financial inputs and especially of private capital has also been facilitated by new public private partnerships - e.g. Commercial Orbital Transportation Services types of contracts - and financial engineering - e.g. Special Purpose Acquisition Companies, space funds.

The trends and markers of innovatization provided by this analysis will be formally measured by a range of indicators established in a companion paper (paper #2)[1].

5. Conclusion

This paper is the first step of an ambitious project that aims at providing a framework - namely, innovatization - to analyze the changes currently taking place in the space sector. This approach is interesting for two reasons.

First, it could help economists, policy- and decision-makers design appropriate policies to accompany the NewSpace phenomenon, make it socially responsible and make positive changes sustainable. In particular, in a companion paper (paper #3), we intend to conduct a survey of Swiss start-ups and actors of the ecosystem to assess the readiness of the Swiss ecosystem with respect to innovatization and identify relevant public policy recommendations.

Second, such a framework could also be used to analyse similar transformations that may take place in other sectors based on technological achievements - e.g. the nuclear industry - and be ready to accompany them.

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Keywords: Sectoral innovation, Innovation policy, Space industry, NewSpace, Innovatization, Technological achievement

[207] Dimitrios Pontikakis (Joint Research Centre, European Commission), Ignacio Gonzalez Vazquez (Joint Research Centre, European Commission), Guia Bianchi (Joint Research Centre, European Commission), Marina Ranga (Joint Research Centre, European Commission), Anabela Marques Santos (Joint Research Centre, European Commission), Ramojus Reimeris (Joint Research Centre, European Commission), Solange Mifsud (Joint Research Centre, European Commission), Kevin Morgan (University of Cardiff), Carmen Madrid (Joint Research Centre, European Commission) and Johan Stierna (European Commission, Joint Research Centre). *Partnerships for Regional Innovation Playbook: A concise summary of the full report.*

Abstract. The European Green Deal and the unprecedented European effort to foster socio-economic transformation and build a resilient and sustainable EU bring to the fore an upgraded role for innovation. The ongoing deep transformations of production and consumption systems are a momentous occasion to innovate, build stronger as well as cleaner economies and fairer societies. In this context, the Joint Research Centre (JRC) is developing a new approach to territorial development fit for the green and digital transition.

Partnerships for Regional Innovation (PRI in short) come at a time of growing recognition that all parts of society need to join up forces to deal with the pressing challenges of our time. Striving for innovation in innovation policy, PRI builds on positive experiences with smart specialisation strategies (S3). Some of the features and ambitions of PRI compared to other strategic frameworks for innovation are:

• Overcoming paralysis by complexity through an even greater emphasis on open deliberation, agreement and co-creation. Instead of seeking elusive (and perhaps impossible) consensus around collective strategic priorities, in PRI it is sufficient for coalitions of the willing to rally around goals that are important for them insofar as they can demonstrate that they contribute to long-term societal wellbeing.

• Readiness to use a broader range of policy tools to deliver impact within defined timeframes, recognising that the unique window of opportunity to transform for the better is closing fast. The need for time-critical solutions to e.g. address climate change, conserve specific employment levels or secure Europe’s position in emerging value chains implies greater emphasis on innovation investments that are merely risky (e.g. the adaptation of proven technologies), as opposed to uncertain. Addressing time-critical challenges also implies coordination with policy domains outside R&I that subsidise the diffusion of key innovations and shape framework conditions.

• Broad scope cutting across several policy areas: PRI have a strong focus on Research and Innovation (R&I) policy, but also seek to make strategic use of and inspire relevant industrial, employment, education and social policies, which have so far largely operated in silos.

• Sharp focus on development directions that lead to co-benefits for the economy, society and the environment and, crucially, give preference to pathways that deliver co-benefits in all three dimensions at the same time. Discovering and enabling viable pathways along these directions requires extensive stakeholder deliberation and mobilisation, informed by high-quality strategic intelligence that localises the challenges and opportunities of the transition.

• New ways of working across government departments and levels to deliver impact, ensure stronger coordination across policy silos and to stimulate synergies between stakeholders' efforts. Novel mechanisms seem necessary in light of the inability of current arrangements to facilitate the coordination that is now necessary in view of the profound transitions Europe is facing. Strengthened and extended participatory governance is necessary to engage citizens, identify and legitimise bold transformation goals and co-create transition pathways.

• Introduction of a challenge-oriented approach to innovation policy to accelerate transformative outcomes, such as local goal-oriented partnerships to coordinate actions under a coherent directional logic. Stronger directionality, or clarity about goals, stands to open up perspectives and gather actors (in unusual combinations) around shared objectives. A key feature of strongly directional partnerships would be their ability to explore policy mixes for system-level innovation that include interventions from outside the traditional confines of R&I policy (such as employment, social, fiscal policy and also line ministries in energy, health, transport, waste), promote innovation through regulation (such as 'regulatory sandboxes'), and demand-side policies (such as the creation of lead markets, the creation of innovation spaces during large physical investments, innovation for affordability).

• Firm roots in the EU policy framework, supporting the implementation of the European Green Deal, the EU industrial policy strategy, Horizon Europe, Cohesion policy and the Recovery and Resilience Facility. PRI also address the fragmentation of EU initiatives and funds, ultimately uniting them under the umbrella of integrated partnerships linked to broadly-backed territorial goals. As the PRI approach matures, it can offer a viable path towards simplifying access to different EU frameworks and funds.

As PRI is in an exploratory and experimental phase of its development, a PRI Playbook and a pilot exercise have been developed to provide guidance for experimentation by policy makers, without being prescriptive.

Keywords: innovation strategies, transformative innovation policy, system innovation, sustainability transitions, multiple-value creation, co-benefits

[208] Attila Havas (AIT Austrian Institute of Technology & Institute of Economics, Centre for Economic and Regional Studies), Matthias Weber (AIT Austrian Institute of Technology & Université Gustave Eiffel, LISIS), Susanne Giesecke (AIT Austrian Institute of Technology) and Dana Wasserbacher (AIT Austrian Institute of Technology). *Context scenarios to underpin EU R&I policies.*

Abstract. The "Foresight towards the 2nd Strategic Plan for Horizon Europe" project aims at informing the development of the 2nd Strategic Plan of Horizon Europe by employing a combination of different forward-looking approaches. It explores future changes in the global and EU context for EU R&I policies, as well as emerging developments in research, technological development and innovation (RTDI), in order to identify those topics that might have disruptive impacts on EU's ability to achieve its overarching policy goals. These impacts could be benign as well as threatening, and thus point to differentiated implications for future directions in EU R&I policies.

The Strategic Plans of Horizon Europe explain how the R&I initiatives funded by the framework programme are expected to contribute to the achievement of major EU policy goals as captured for now by the key strategic orientations of the 1st Strategic Plan. However, already during the implementation of the 1st Strategic Plan, the EU is confronted with novel developments that may hamper achieving the initial ambitions of the 1st Strategic Plan, and which should be considered when devising the 2nd Strategic Plan. These novel developments can arise from the global and EU context of EU R&I policies, but equally from RTDI activities. Of particular interest are those developments that may bring with them potentially disruptive consequences – both threatening and promising ones. They will indicate areas in need of particular attention in EU R&I policies, pointing beyond those already identified in the 1st Strategic Plan, and possibly also questioning some of them. In other words, the sequence of Strategic Plans is a means to make the framework programme more adaptive and account explicitly for newly emerging developments, with foresight being an input to ensure that a long-term perspective is taken.

This dual nature of the sources of potential disruptions is reflected in the composition of the project: its first component focuses on existing scenario reports in the global and EU context while the second one is a new horizon scanning activity with respective sense-making in the focus.

The proposed 'speed talk' will focus on the first part of the project that has reviewed a set of recent forward-looking activities, primarily employing scenario methods. The scenarios developed by these activities have been characterised by considering

• Their purpose, rationale, and objective(s)

• The needs of the client commissioning the study

• Their time horizon

• The methods used (expert-based vs. participatory project; STEEPLV, horizon scanning, wild cards, black swans, workshops …)

• The guiding questions for the exercise: thematic coverage vs. a systemic approach (innovation systems, economic systems, political systems, socio-economic systems, environment, …)

• The main features of the scenarios (organising principle(s), the level of analysis, …)

• The main trends, drivers, and key factors underlying the scenarios

• The key likely "developments" in a given future

• The actual use and influence of the report on decision-making

• Critical assessment (novelty of the approach/ methods/ scenario architecture; if any; new or surprising elements/ aspects; relevance for EU R&I policies).

Building on these reviews, a synthesis will be prepared and presented. As this is still work in progress, this abstract can only present the main issues to be discussed in the synthesis.

We will consider the pros and cons of various scenario approaches, namely the types of scenario architectures used in the reviewed reports; other options used in further prospective analyses; as well as three more generic methodological approaches we experimented with in the first part of the project: multi-level scenarios; disruptions as 'starting points' (their likely impacts explored in different contexts); and narratives (short, focussed descriptions of certain developments, as opposed to scenarios offering a more comprehensive picture of a given future). We will identify methodological differences and elaborate on the particularities of context scenarios as opposed to other types of scenarios, and their added value for selecting and framing policy issues.

We will also highlight new or surprising trends, drivers and developments identified in the reviewed reports, with an emphasis on the interlinkages among the key trends and drivers.

The context scenarios will serve to test the robustness of suggested new emerging, and potentially disruptive, developments that may be possibly included in the 2nd Strategic Plan. Further, we will consider what processes and approaches would be appropriate for selecting and framing issues when setting policies. The closing phase of the project will distil policy priorities from prospective analyses (how to tackle the disruptive factors, e.g., how to take advantage of the favourable ones; how to prevent or 'amend' the unfavourable ones; and how to adapt to the unstoppable ones).

Keywords: Context for EU R&I policies, Disruptive factors, Scenarios vs. narratives, Context scenarios, Scenario architectures

[209] Bonno Pel (Université Libre de Bruxelles), Ariane Debourdeau (Te hnische Universitaet Berlin), Kemp Rene (Maastricht University), Adina Dumitru (Universidade da Coruna), Edina Vadovics (Greendependent Institute), Martina Schaefer (Technische Universitaet Berlin), Marianna Markantoni (Maastricht University), Benjamin Schmid (National University Ireland Galway), Frances Fahy (National University Ireland Galway), Aurore Fransolet (Université Libre de Bruxelles) and Karin Thalberg (Jacques Delors Institute). *Energy Citizenship; Ideals, Ideology and Ideal types in the Energy Transition.*

Abstract. The energy transition involves innovations in multiple elements of socio-technical energy systems. The importance of social and institutional innovations has become increasingly evident in recent years. The quest for new institutional arrangements and social relations has been accompanied by the proliferation of new concepts: Energy democracy, energy justice, energy poverty and energy literacy are interrogating and opening up the social relations that carry the energy system. These concepts serve analytical purposes, but they also provide tools for critical diagnosis and transformative action. Scholars, activists and politicians deploy these terms to introduce new social constructions, counter-narratives and imaginaries of energy that is organized more – by certain standards - sustainable and just. A particularly prominent example of these new imaginaries is energy citizenship. Coined originally as an emancipatory concept and as an alternative imaginary of capable and involved citizens, it has also been proven to be vulnerable to ideological appropriation and narrow instrumental interpretations. The tendencies towards responsibilisation, exclusion and reproduced power inequalities are well-known in studies of participatory governance, empowerment and sustainability transitions. This paper argues however that ENCI should not be mistaken for yet another buzzword. Rather than rejecting the concept, it needs to be taken seriously as an emerging governmentality and as a set of ideals that are meaningful to people that try to make sense of the current phase of the energy transition. Our critical-constructive analysis identifies three interrelated clusters of pitfalls in ENCI research: These pertain to 1) the multiplicity of ideals; 2) the performativity of idealizing social constructions and 3) the associated methodological challenges of operationalizing the concept into concrete empirical observables and relevant 'cases of energy citizenship'. This operationalization is arguably a crucial step in the scientific-political-societal co-production of energy citizenship models and best practices.

Keywords: energy, transition, social innovation, citizenship

[210] Thea Jung (University of Cambridge). *Making mission(s) (im)possible? A comparative analysis of policy mixes for decarbonising energy-intensive industries in UK, India and Germany (2000-2021).*

Abstract. As of late, and as part of a broader, 'normative' turn (Schot & Steinmueller, 2018; Weber & Rohracher, 2012), directional innovation policy-making approaches, such as challenge- or mission-oriented innovation policy, have proliferated in the science-policy discourse as potentially fruitful approaches to effectively tackling 'wicked' problems, e.g. climate change (Wanzenböck et al., 2020; Boon and Edler, 2018), and transformational system failures (Weber and Rohracher, 2012). Here, directional innovation policy-making approaches aim to provide a normative direction for transformative change, to mobilise actors to engage in the co-creation thereof, orchestrating the development, implementation and diffusion of social, technological, institutional or organisational innovation in alignment with the desired direction (Hekkert et al., 2020; Wesseling and Meijerhof, 2021).

Existing literature has noted that respective directional innovation policy making approaches do not emerge in a vacuum, but are embedded within context-specific socio-technical configurations, including institutions, policies, infrastructures, actors and their discourses and practices (Köhler et al., 2019; Hekkert et al., 2020; Frenken et al., 2017; Bergek et al. 2015; Markard, 2012). Yet, to date, we have a limited understanding of how prevailing, locally contingent conditions might shape the emergence, development, and implementation of challenge-led innovation policy. What is the role of place-based characteristics in enabling or hindering the effective establishment of directional innovation policy? What sociotechnical configurations, such as existing policy mixes, endowments, infrastructures or actor constellations, might be more or less conducive to identifying and addressing wicked problems?

In this paper, we aim to address respective questions by providing a theoretical and empirical contribution. First, we develop a conceptual framework that allows assessing the interaction between newly emerging directional innovation policies and prevailing context-specific conditions in a systematic manner. Here, we draw on existing sustainability transitions research and innovation policy mix studies (Bergek et al., 2015; Rogge and Reichardt, 2016; Ossenbrink et al, 2019; Markard and Andersen, 2020) to examine in what ways existing elements of sociotechnical systems are aligned with the direction provided by the new policy approach.

Second, we implement the conceptual framework to empirically study the case of climate change mitigation efforts in so-called 'hard-to-abate' sectors (see ETC Report 'Mission Possible', 2018): In particular, we focus on challenge-oriented policies to advance low-carbon technological innovation in energy-intensive industries and the ways in which these interact with place-based characteristics. Our comparative case study analysis includes India, UK, and Germany. We focus on the cement industry, and both supply- and demand-side decarbonisation levers (e.g. energy efficiency, alternative fuels, alternative materials, material efficiency/recycling and CCUS). In terms of place-based characteristics, we include existing policies in both the focal and adjacent sectors (on national level (and EU)), locally contingent endowment (e.g. natural resources), and actor constellations (e.g. industry structure).

Methodologically, we employ process tracing, limiting the temporal scope to 2001-2021, and employ qualitative research methods of document analysis and interviews.

Finally, based on our conclusions, we develop recommendations on designing challenge-led innovation policy in a manner that accounts for existing sociotechnical configurations. This includes, for instance (based on preliminary findings), taking into that developing, implementing and diffusing low-carbon technological innovation requires to put in place or adjust elements in adjacent sectors that are complementary with respective low-carbon technologies, while phasing out elements that are not aligned with the overarching direction.

Keywords: STI Policy, Environmental Policy, Decarbonisation, Energy-intensive industries, Cement Value Chain, Sociotechnical systems transitions

[213] Michael Keenan (OECD). *Transitions in strategic intelligence: developing the knowledge base for STI-enabled sustainability transitions.*

Abstract. Introduction

The twin crises of COVID-19 and climate change call for an ambitious, wide-ranging, disruptive and visionary STI policy agenda. Reforming STI policy so that it better contributes to sustainability transitions, resilience and inclusivity goals may require altogether different policy frameworks and practices from those commonly used today. Reforms will require revisiting STI policy models, visions, targets and instruments with a view to adapting them or displacing them in favour of others. But various lock-ins hinder reforms of research and innovation systems, including in the field's institutions, the routines and capabilities of organisations, the data and knowledge infrastructures on which decisions are taken, and the policy interventions that are commonly used.

The OECD has recently embarked upon a crosscutting project – S&T Policy 2025 – that aims to help articulate the need for reform and transitions, and outlines ways these could be achieved. While many socio-technical transition timelines are long-term (e.g. net zero targets typically aim for 2050), specific measures will need to be put in place now and in the coming few years to ensure STI policy is on track to realise its potential contributions. The project seeks to determine what these measures should look like and what could be achieved by 2025 through an ambitious policy agenda. The project also encompasses the whole of STI policy, drawing together multiple strands (e.g. on STI funding, technology deployment, human resources, governance, etc.) that can be assembled into a crosscutting, overarching schema to provide a holistic overview of the STI policy landscape in transition.

Project objectives

Broadly speaking, the project builds upon and consolidates ongoing and recently completed OECD projects to:

• Provide an overarching guiding vision and framework that help STI policymakers to rethink, redesign and implement a new generation of STI policies that better contributes to sustainability transitions, resilience and inclusivity.

• Translate deep insights from ongoing and recently completed projects into systemic guidance for policy reforms that countries can use when tackling selected STI policy challenges.

• Organise dialogues between STI and other policy domains, with a view to breaking down silos and promoting cross-government cooperation on grand challenges, such as sustainability transitions.

• Prepare various foundational reviews and scoping papers to underpin the project's analysis and guidance, to fill knowledge gaps, and to synthesise the deep insights generated in ongoing and recently completed projects.

• Contribute to the development of a joined-up multilateral agenda for STI, given the international scale and scope of grand challenges like sustainability transitions.

This paper has a dual focus:

1. To outline and justify the project's main products and processes and their expected contributions to a more transformative STI policy agenda.

2. To consider how the provision and use of knowledge and evidence for policy (collectively referred to as 'strategic intelligence') needs itself to transitions if it is to substantially inform a more transformative STI policy agenda.

Focus 1: Providing strategic intelligence that informs transformative innovation policy

Gaps between current STI policy intentions and practices on the one hand, and insights from state-of-the-art thinking and practices on the other point to where practical support to policy transitions might be warranted. This support could take multiple forms, for example, providing models, frameworks, tools, methods, guidance, case studies and other empirical data, etc. to assist policy analysis, design, experimentation, coordination, implementation and monitoring. This is a wide array of analytical and knowledge-based support, collectively referred to as 'strategic intelligence'. A first key focus of the project, therefore, is to generate strategic intelligence of this sort to support STI policymaking and analysis. Specifically, the project is developing the following knowledge resources:

• A guiding vision for STI policy – this is a high-level set of normative ideals/goals that STI policymakers and analysts should keep in mind when formulating, designing, implementing and evaluating policy interventions and governance arrangements. This guiding vision is also the S&T Policy 2025 initiative's "guiding star", providing a reference point for the project's other components.

• Systemic guidance for policy reforms on selected STI policy challenges – this is a bundle of policy analysis and guidance to address specific STI policy challenges. The choice and scope of STI policy challenges is shaped by past, ongoing, and future OECD projects, since these have the necessary granularity to provide deep insights on specific policy problems and possible solutions. Each STI challenge incorporates a vision of a desirable future state, elements of a diagnostic of the current state, and a list of actions that constitute pathways to transition from the current to a desirable future state.

• Sets of megatrends that influence STI policy – these are sets of trends that will be published in 2022 as infographics and assembled around specific key challenges, such as net zero.

• Analyses and fora to promote cross-domain outreach – these range from organising policy dialogues to embarking on joint projects with other parts of the OECD on topics of common interest. Socio-technical transitions are cross-sectoral and cross-government, so STI policy should develop stronger links with other policy domains where it has crucial roles to play.

• A series of foundational studies – these provide insights on the state-of-the-art on selected practices used in the project, e.g. diagnostics and transition pathways approaches, and on specific issues that are central to STI policy contributions to transition, e.g. multilateralism, cross-government coordination, measurement, etc.

• A series of workshops, known as policy dialogues – these aim to inform selected activities above and will involve a mix of country delegates and domain experts.

Focus 2: Exploring transitions in the provision and use of strategic intelligence for policy

A second focus of the project is a reflexive one and asks how organisations like the OECD, but also the wider academic and analyst communities, need to develop the knowledge base, frameworks, institutions, learning networks, and capabilities to inform and deliver an STI policy that contributes to sustainability transitions, resilience and inclusivity. Whether existing strategic intelligence provision and use are well suited to the high ambition of reform agendas is doubtful. Transformative innovation policies demand systemic, transdisciplinary, and inclusive knowledge and processes that support experimentation and learning. These demands may require new or significantly adapted knowledge institutions and infrastructures, as well as new skills and organisational capabilities – essentially a transition of strategic intelligence itself. The S&T Policy 2025 initiative focuses specifically on emerging needs for and provision of strategic intelligence for ambitious STI policy reforms, highlighting, among other things, promising policy practices and arrangements from which others could learn.

The project could also harbour the development of a measurement framework of statistical data, indicators and analysis for monitoring STI contributions to transitions. Monitoring transitions using pathway concepts and intermediate targets and milestones represents a major challenge but also an opportunity to ground abstract concepts into measurable entities. Socio-technical transitions are deep and wide-ranging, and many aspects are not well served by existing metrics and approaches. There is therefore considerable work to do to develop new metrics and improve the timeliness of existing ones, and to deploy existing ones in novel combinations that could provide useful policy insights, as well as coordinate scattered initiatives in a productive fashion. Much of this concerns priority setting, resource allocation and data sharing on the part of policy makers themselves, who are in many cases directly responsible for the generation, upkeep and integrity and accessibility of considerable amounts of administrative data relevant to the monitoring of STI systems and policies.

Keywords: strategic intelligence, sustainability transitions, STI policy, OECD

[214] Jakob Edler (Fraunhofer ISI), Maria Karaulova (Fraunhofer ISI) and Erlend Osland Simensen (University of Oslo). *How do institutional conditions influence research use by policymakers? .*

Abstract. Introduction

The importance of the user perspective is increasingly recognised with regard to the opportunities for research to create impact on policy (Edler et al., 2022). In recent years, science has been called to provide evidence to address pressing societal challenges ranging from the climate emergency to the Covid-19 pandemic (Cairney, 2021, Bremer and Meisch, 2017). In this context, policy needs are again framed as a major justification for scientific activity (Boon and Edler, 2018). It has been suggested that more effort needs to be made to mobilise scientific knowledge and ensure that is considered seriously in policymaking (Nutley et al., 2003, Cairney, 2009, Cherney et al., 2013). Achieving this goal depends on all actors in the policy advisory ecosystem - ranging from individual scientists, to research organisations, funding agencies, intermediaries and policy organisations (Gluckman and Wilsdon, 2016, Mejlgaard et al., 2018, Kenny et al., 2017, de Goede et al., 2012).

This paper considers the role of institutional conditions for research utilization. End users of research are policymakers with their own worldviews through which they interpret evidence, values that determine the importance of science compared to other arguments and reasoning, skills that influence their ability to analyse and interpret information, and resources, which influence their ability to seek, gather and process evidence (Landry et al., 2003, Jbilou et al., 2007, Armstrong et al., 2013, Amara et al., 2004). However, policymaking takes place in organisations. Individual decision-makers are enabled and constrained by the respective organisational dynamics (Scott, 2014). Therefore, a range of institutional processes in policy organisations also influence the ability and willingness of individual policymakers to use research.

Much attention has been paid in recent years to analyse knowledge management practices of public organisations, especially their ability to seek out, collect and use relevant evidence in order to aid policymaking (MacKillop et al., 2020, Walker et al., 2019, Akerlof et al., 2019, Farrell et al., 2018, Donnelly et al., 2018, Ouimet et al., 2017). Some studies have focused on specific strategies and instruments of knowledge transfer and utilization (Belkhodja, 2014). Others problematised the necessary skills and learning needs of individual policymakers (Obermeister, 2020, Amara et al., 2004). More recently, the importance of processes and infrastructures that enable the use of research in policy has been brought to attention (Lawrence et al., 2017, Nutley et al., 2007). Scholars also analysed the scope of influence at different stages of the policy cycles (Strassheim and Kettunen, 2014, Schmidt, 2008). We build on this research by mobilising a previously developed framework that focuses on the role of institutional and organisational conditions that influence policymakers' ideation (Edler et al., 2022). This approach assigns particular significance to sense-making and interpreting as the part of policy deliberation (Edler, 2003) and formulates a number of conditions that influence this part of scientific knowledge uptake.

In this paper, we focus on how policymakers' perceptions about normative and regulative conditions in their organisations influence research utilization. We operationalise and empirically examine the influence of these intra-organisational conditions on research uptake in Norwegian ministries and agencies. The paper contributes to the literature by differentiating between various institutional conditions and then systematically examines their association with two types of research use in policy organisations: the frequency/intensity of use and type of use, subdivided into conceptual, symbolic and instrumental use of research (Amara et al., 2004). Although the influence of certain organisational elements has previously been studied, the relative importance of these various conditions and their influence on different kinds of research use has not been considered.

Conceptual Approach

Our approach brings together the organisational institutionalist approach that captures the ability of policy organisations to seek out, absorb and utilise research with the discursive institutionalist view that uses the ideational lens to examine policymaking dynamics (Schmidt, 2010, Scott, 2014, Edler et al., 2022). In this conceptualisation, we draw a distinction between conditions within policy organisations (intra-organisational conditions) and broader conditions influencing processes in institutional fields (inter-organisational conditions). Further, we suggest that an organisation's background ideational processes can be accessed and analysed by distinguishing between three elements of institutions, which are inter-related in practice: normative, regulative and socio-cognitive.

Regulative institutional elements influence behaviour via a system of incentives and rewards. They are typically explicit and codified within the organisation, for example, formal roles and hierarchies, job responsibilities, laws and internal regulations governing the work of the organisation. Normative institutional elements represent the values and culture that make formal rules legitimate. They represent social obligations and expectations. Socio-cognitive institutional elements represent taken-for-granted habits, routines and scripts. They make up the 'natural order' of things in the organisation. These various institutional elements affect the willingness and the ability of individual policymakers to be influenced by new ideas (Hammami et al., 2013). They can serve as 'filters' that enable some research to be absorbed while other types of research may not pass (Boswell and Hampshire, 2017). They also affect the extent and ease with which knowledge and ideas move within the organisation (Cashmore and Wejs, 2014, Currie and Suhomlinova, 2006).

Due to the limitations of the data , in this paper we explore the influence of regulative and normative institutional elements on research utilization:

Instruction refers to explicit regulations within the organisation that prescribe the use of research in policymaking. Instructions set out extrinsic motivation for policymakers to engage with research, because non-compliance may be sanctioned. Policymakers following instructions would be compelled to always make some effort to seek research evidence.

Finances and infrastructure also represent the basis for research use in policy organisations. They support the ability of policymakers to access relevant information support the access to and uptake of research. These include, but are not limited to, budgets with special research-related spending lines, dedicated research-related management support, access to specialised journals and databases and others. Various previous studies have shown that overall, increased tangible resources are positively associated the policymakers' research utilization (Lawrence et al., 2017, Olmos-Peñuela et al., 2014, Makkar et al., 2015, Belkhodja, 2014). Here we analyse the perceived importance of resources and infrastructure alongside with a number of other institutional conditions, highlighting its relative importance.

Human resources are a particularly important asset in any organisation. With regard to research utilization of policymaking, special role has been assigned to outstanding individuals who can champion research diffusion, such as scientific advisers (Pielke Jr, 2007). Research utilization surveys consistently identify social and human capital of respondents, e.g. advanced degrees or work background in academia, as particularly significant for deeper engagement with research (Amara et al., 2004, Jbilou et al., 2007, Landry et al., 2007). These policymakers would be more likely to seek research and use it as the preferred source of information, adapt it for the needs of their organisation and diffuse it (Holmes and Clark, 2008). They would be able to use the financial resources and research infrastructure efficiently and appropriately. The extent to which the organisation invests in human resources, e.g. by setting up an in-house R&D department and knowledge brokers, recruiting staff with research degrees and offering research training, reflects the long-term organisational strategy and the valuing or research in the organisation.

Organisational culture is the final condition that we consider in this paper. Policymakers working in diverse environments that are overall receptive to new ideas and influences are more likely to use various kinds and sources of knowledge (Hammami et al., 2013). The research-valuing specifically also influences absorptive capacity and learning in policy organisations. For example, Belkhodja et al. (2014) found that research culture, defined as the arrangement where research is a preferred source of information in the organisation, is positively and significantly explained research utilization in Canadian health agencies.

Method and Data

We use the data from a survey of policymakers in the public sector in Norway conducted in 2018-2019 (Thune et al., 2021). 1606 employees with policymaking responsibilities from 21 Norwegian ministries and agencies participated in the survey, illuminating, for the first time and with the high extent of coverage, the practices of research use in the Norwegian policy environment. The survey examined how policymakers access scientific research, how they diffuse it and use it, and their perceptions about various factors that affect their research utilization.

We examine how the respondents' perceptions about various organisational conditions influence their reported engagements with research. We test this relationship by using two dependent variables.

1. Research use intensity, which refers to the frequency with which respondents used research. The survey asked this question directly with the reply options varying from 'never' to 'often'. The descriptive results indicate that almost half of the respondents used research 'often' and a third used research 'sometimes' (approx. monthly), giving a good indication of overall engagement with research.

2. We further distinguish between three types of research use following the classic typology developed in Amara et al. (2004). Policymakers use research instrumentally when they want to inform their decision-making; symbolically when they seek evidence to support their pre-existing opinions and conceptually when they seek to learn about the issue or when they change their mind.

We formulate four independent variables according to the types of conditions formulated above: instructions, human resources, finances and infrastructure, and organisational culture.

Additionally, we control for the respondents' gender, age, seniority and educational level as well as the respondents’ policy areas and organizational affiliation. An ordinary least square linear regression was used to determine the relationships between the variables, which consisted of five-point Likert scales, a factor and dummy variables.

Preliminary results and policy issues

Currently the analysis is ongoing. Some very preliminary results indicate that formal instructions and organisational culture play a far more important role than human or financial resources or infrastructure. Especially when it comes to explore new policy problems and to develop new policies and programs, the organisational culture, the value organisations place on research, appears to be critical.

The importance of instructions and culture hold true even if we control for work type, leadership role and the organisation in which the respondents work. R-squared range from 0,289 for the research use intensity to 0,113-0,180 for the other use variables, except symbolic use where these models have much lower explanation power. Although we need to perform robustness checks to corroborate these findings, the models are stable when including and excluding various control variables. Taken together these results are promising for further development of the paper, its contributions to the literature and ongoing policy discussions about improving research uptake in policy organisations.

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Keywords: research utilization, research impact, research-policy

[215] Kari-Elisabeth Skogen (TIK/University of Oslo), Erlend Osland Simensen (TIK/University of Oslo), Magnus Gulbrandsen (TIK/University of Oslo) and Taran Mari Thune (TIK/University of Oslo). *BUGs in the system – Government officials as brokers, users and gatekeepers of research .*

Abstract.

Objective

What characterises the individuals in public organisations who play particularly important roles in the use of research for policymaking? Who are they, how do they utilise research evidence, and how important is interaction with researchers for research use among these government officials? Prior knowledge indicates that some government officials have a unique role in bridging the research-policy gap through productive interaction with researchers (e.g.Spaapen & Van Drooge, 2011).

In line with the literature on boundary spanning (e.g.Tushman & Scanlan, 1981), we want to understand more about the individuals who occupy such positions and what they do to source and circulate scientific knowledge. To do so, we compare knowledge interaction activities and use patterns among government officials. We are particularly interested in understanding whether the research circulation and use among such individuals can be explained by their holding a PhD (or not), having former research experience, and having formal responsibilities for research use. Overall, this study will contribute to a deeper understanding of different roles in research use as well as individual level use patterns in evidence-based policymaking. Our context is Norwegian ministries and directorates, and the data is a large-scale survey of government officials in these organisations.

We submit this paper proposal to track number one of the Eu-SPRI conference – The role of science for policy: new requirements and new challenges. This paper specifically meets one of the suggested questions to be addressed in this track: "What effects does the engagement of user have on the practical application of research results?"

Background and relevance

We frame our research questions, methodology and analysis within the theory of boundary spanning. Boundaries are defining characteristics of organisations, and there is always a distinction between members and non-members of the organisation (Aldrich & Herker, 1977). Earlier investigations show that there has been a cultural shift towards more evidence-based practices (Jack et al., 2010), and one approach to achieving this is to "span the boundaries" between the organisations that produce, and the ones that use research (Bednarek et al., 2018).

Prior studies have concluded that several individual characteristics (such as educational level, research skills and positive attitude towards research) are positively related to use of research evidence (e.g.Bédard, 2015; Jack et al., 2010; Ouimet, Landry, Ziam, & Bédard, 2009; Purtle, Nelson, Horwitz, McKay, & Hoagwood, 2021). Systematic reviews and empirical studies furthermore highlight that interaction between government officials and researchers is a vital facilitator for research use in policymaking (Innvær, Vist, Trommald, & Oxman, 2002; Skogen, 2022). However, few studies have made detailed analyses of the individuals' different roles in research use. This includes the nature of interactions, circulation, translation and diffusion activities, and individual-level distinguishing characteristics.

A recent review of 32 empirical articles on research use among government officials revealed some gaps in the literature (Skogen, 2022). First, there is a lack of datasets that span several policy areas as the majority focus on health and welfare, and second, the results stem mostly from Canadian and Australian contexts. Understanding more policy contexts and country settings is therefore needed. Lastly, a more fundamental finding is that the literature is highly empirical in its nature, and there is very little focus on theoretical perspectives in both framing of the research questions and methodology, as well as in analysis and discussions of the findings. The two-communities theory stands out as the theory most often applied in these studies, however also sparsely included in many of the articles. The essence of this theory is that policymakers and researchers live in separate worlds with different and often conflicting values, different reward systems and different languages (Caplan, 1979). Many authors stress that this gap between knowledge producers and users need to be bridged through personal contact and relationships (Caplan, 1979). In supporting this theory, the focus on interaction as vital for increased research use among government officials appears to be self-evident.

Boundary spanning, like two-communities theory, focus on boundaries between organisations, and specifically communication boundaries (Tushman & Scanlan, 1981). But where the two-communities theory is mainly a theory to explain non-use of research in policy at the organisational level, the theory of boundary spanning is a better fit for exploring how individuals span these boundaries between policy and research, and thus how they collect, use and diffuse research evidence into the policymaking process.

Through our work, we seek to fill a knowledge gap by including multiple policy areas, and further investigate government officials' research interactions and use patterns. As prior research has found several individual traits that are important for research use in policymaking, we hope to also explore why these traits are important – how they benefit research use in practice and what role different groups of government officials play. Furthermore, we aspire to contribute to a broader theoretical understanding of individuals' patterns and roles in the use of research in policymaking.

Data and methodological approach

This study is based on a large-scale survey carried out in Norway in 2019. The survey targeted government officials in ministries and a few governmental agencies, and their use of research in policymaking. The survey was first piloted and received approximately 300 responses. The main survey was sent to all employees in all Norwegian ministries (except one) and six government agencies. The main survey received approximately 1600 responses. The total response rate was 28%. This study thereby reports from almost 1900 government officials in Norwegian public sector.

To understand and disentangle the relationships between policymakers' interactions with researchers and research use, we present a two-step analysis. First, we have a descriptive part where we show the characteristics of the policymakers that interact a lot with researchers as well as the ones that use research to a high degree. Second, we present a method where we test what type of interactions lead to higher use of research on an individual level. Since our dataset does not cover all respondents in the ministries and since its respondents are not randomly chosen, we use a matched pairs methodology. A matched pairs design imitates experimental design by comparing interacting individuals with similar individuals that do not interact. This way, we can find out whether the 'treatment effect' – in our case a type of interaction – affects different types of research use while all control variables being equal. The strength of such a method is that it is less prone to selection biases while at the same time enabling us to control for individual characteristics such as age, gender, organisational affiliation, and education.

Expected results

Our expectations for the results are that there are distinct types of employees that in different ways connect research and researchers with the policymaking organisations. Although this analysis is not finalised, we observe patterns of highly educated employees that in different ways keep contact with research communities. We wish with this abstract to briefly present parts of the analysis, but also keep open for a discussion and suggestions for how to show and test these characteristics and relationships further.

PhD educated employees are overrepresented among the ones that interact with researchers but more equal to the ones without PhD when it comes to search for research-based knowledge within the organisations. Most of the employees that reach out for research either contact them directly or use the organisations' internal unit for research and analysis. Hence, with this simple cross tabulation, we can identify three types of knowledge search: external search by reaching out to researchers, internal knowledge search within the organisation and the ones that do both these modes. These are interesting results that need to be explored further.

We have made a first attempt at a matched pairs analysis with research uses as dependent variable and various form of interactions as treatment variable. We controlled for age, gender, organisational affiliation and job type. The descriptive statistics on the main variables are summed up in table 1 and 2, while the first results from the matched pairs analyses are summed up in table 3. Table 1 shows that internal interactions are much more common than external interactions and that informal interactions with colleagues about research are highly common.

First results matched pairs and how interactions with research as a treatment variable affects various forms of research use. A green plus signifies a positive and significant effect, the yellow hyphen no effect.

These preliminary results show that most of the tested forms of interactions between policymakers and researchers positively affect uses of research. Our dependent variables cover the use types that Amara et al. (2004) denoted as instrumental, conceptual and symbolic uses of research in policymaking. The most formal and most intense way of interactions with researchers – participating in reference groups or research projects – is the only of these variables that does not affect the research use in a positive way. These results will be further explored and input from the conference will be valuable to point out the direction of the analysis.

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Keywords: Research use, Public policy, Government officials, Research interaction, Boundary spanning, Survey, Matched pairs

[216] Claudia Koch (BAM), Luana Ladu (BAM), Parsa Asna Ashari (BAM), Knut Blind (TU Berlin) and Pavel Castka (University of Canterbury). *Digital maturity in the Conformity Assessment industry: An explorative study from Germany.*

Abstract. Conformity assessment (CA) plays a central role in the governance of digital ecosystems. Conformity assessmnet Bodies' (CABs) services are essential to provide for trust in and safety of digital products and services. Thus, it is vital that CABs are ready to fulfil their tasks also in the digital transformation, having the necessary capabilities and resources. Digital mature CABs can contribute to strengthen digital ecosystems and thus digital innovations in Europe. Our study is the first to comprehensively assess the digital maturity in this industry and to provide some insights on the readiness of the industry to support and at the same time benefit from the digital age. We present first results from our survey among CABs in Germany.

Keywords: Conformity Assessment, Conformity Assessment Body, Quality Infrastructure, Digital Maturity, Digitalization, Digital Transformation

[217] Ewa Dönitz (Fraunhofer-Institut für System- und Innovationsforschung ISI), Björn Moller (Fraunhofer-Institut für System- und Innovationsforschung ISI), Ariane Voglhuber-Slavinsky (Fraunhofer-Institut für System- und Innovationsforschung ISI) and Anna Kirstgen (Fraunhofer-Institut für System- und Innovationsforschung ISI). *Innovation and technology roadmaps as a tool for policy making.*

Abstract. Ever shorter innovation cycles and increasingly interacting innovation systems mean that decision-makers from industry, politics or science are more and more faced with the challenge of considering a high degree of uncertainty. The article examines to what extent innovation and technology roadmaps are suitable as a strategic instrument for policy-making. Methodological principles are analysed and discussed, and the advantages but also the challenges of implementation are shown based on project examples.

Roadmapping is a pragmatic and universally usable tool to support and prepare the planning under considering of future developments, whether on the technology, product or market level. In contrast to most operational planning tools, roadmapping does not originate from scientific theory but was first developed and used by large companies in technology-intensive industries. Common to all roadmaps is a forward-looking perspective, the time-related linking of the outlined aspects and in many cases the work towards a vision or an aspired goal. Thus, a roadmap illustrates developments and events as well as their links over time (Möhrle & Isenmann 2008). This uncovers inconsistencies at an early stage: on the technology side (lack of knowledge of developments), on the market side (lack of knowledge of developments and requirements), and organizational inconsistencies (lack of coordination and communication). Furthermore, in conjunction with a vision, the backcasting method is also used, which clearly defines a desired future and looks back from there to the present to demonstrate how this future can be achieved (Vergragt and Quist 2011; Erdmann et al. 2018).

Generally, the development of the roadmap itself is as important as the result - in the case of roadmaps, often their visual representation (Phaal et al. 2010). By exposing the implicit knowledge of experts and transforming it into roadmap elements, workshops form a central element of a roadmapping process. In this context, interdisciplinary groups of experts make assumptions about future developments based on their expertise and assign a time line or time point to roadmap elements. The analysis of the relationships and influences between the individual roadmap components is particularly important. It serves to reveal the interdependence, for example, of links between drivers (market pull) and technology developments (technology push):

• Technology Push: The relevance of individual technical implementation steps for the fulfillment of strategic goals is identified - Breakdown of technology systems into sub-technologies; evaluation of individual technologies in terms of relevance for achieving goals; identification of necessary technological developments for achieving targeted goals.

• Market Pull: External drivers and barriers are identified and evaluated - Uncovering and examining social, technological, economic, political and infrastructural influencing factors; identifying and evaluating external drivers and obstacles and their influence on strategic goals.

Usually the information in roadmaps comes from expert workshops but also from interviews and surveys. Surveys such Delphi studies are very suitable for this, as they already allow times to be estimated and their data can be taken directly. Actual an estimation of the dependencies between technological developments and environmental factors, shaping the framework conditions, is possible through a personal assessment using expert knowledge and experience.

The involvement of professional knowledge, evaluation and prioritization of the available information as well as the derivation of options for action or concrete activities play an important role in roadmapping. Important process steps that are necessary for this purpose and that generally characterize roadmapping are (Specht, et al. 2017):

• Delineation of reference objects (development of roadmap architecture, i.e. roadmap levels, time horizon, time steps).

• Needs assessment and their projection (identification of trends and drivers, market requirements)

• Potential assessment and its´s projection (identification of relevant technologies and resources)

• Roadmap development (classification of roadmap elements in terms of time and content)

• Completeness and gap analysis as well as consistency analysis (assessment of dependencies between technological developments and environmental factors)

• Derivation of options for action or concrete activities along the time axis

In a business context, roadmapping is a flexible approach designed to support medium- and long-term planning in a company. It provides a structure, usually in graphical form, that shows relationships between different components that are relevant in this special context (Möhrle & Isenmann 2008). These are in particular: Technologies, market developments, products, processes, competencies or organizational structures. Roadmaps enable the bundling of many individual issues and the joint setting of priorities and the creation of processes to achieve the defined goals. Barriers to the implementation of the strategies will be identified and, based on this, proposals for measures to promote the development of market potential and innovations will be designed. In this way, a reliable orientation framework is created for all involved stakeholders. Roadmapping can include scenarios or a vision of possible future markets, products, services, technologies, R&D programs and framework conditions.

This type of strategy consideration has been used as a technique since the mid-1980s. As this concept matured, roadmapping found wider and wider applications. Roadmaps are developed in companies between R&D departments, innovation and strategic planning teams. Typically, this involves graphically depicting the future of a product or product family, incorporating key environmental elements (markets, services, technologies, resources). In the process, attention is paid to ensuring that technical resources and business objectives are optimally linked with further business management approaches. Such a combination was initiated by Motorola in the 1980s (Willyard & McCless 1987) and led to the concept of roadmapping being acknowledged, extended and developed on an industrial level. Following this pioneering application, roadmapping has been used in many companies since the 1990s. Roadmapping is considered a strategic management process used to identify, evaluate, and select strategic alternatives. Although roadmaps originated in the corporate context, and were used in particular as technology roadmaps in strategic business planning, they are also used in policy making at various policy levels.

This is where the following paper takes off: It aims to provide an overview on the different types of roadmaps, when they can be applied, and how they can be used in a methodical and content-related manner. The focus is on innovation and technology roadmaps. We examine to what extent their use as a policy-making tool makes sense so that policymakers can better assess whether roadmaps are the right methodology for their specific issues and goals. In doing so, we look at examples of roadmapping processes that the authors conducted in a variety of contexts: First, in a regional context, to support the strategic orientation of innovation policies of regions. Second, as an orientation framework for European funding of innovative technologies.

In this context, we discuss following research questions: What patterns of roadmapping processes can we observe? Do they depend on general conditions for the considered projects or further specific context factors? Which differences and commonalities can we observe in the roadmapping processes and practices? Which experts were involved in the roadmap development? What role play policy makers? What forms and sources of legitimacy for roadmapping can we observe among the experts? How do they contribute to the process of defining strategic goals or priorities (e.g., visioning, scenarios), policy recommendations, as well as the present and future allocation of resources (e.g., indicators, monitoring)? What are the characteristics of the final product (roadmap visualization)?

Important recommendations for policymakers include conclusions in three areas: (a) process of roadmap development, including multi-stakeholder involvement, (b) structure and content of the roadmap, and (c) roadmap as a communication tool - visualization of the roadmap. The latter plays a major role in reaching consensus. Roadmapping leads to an intensive exchange of participating stakeholders representing different subject areas. The heterogeneity of the team composition is seen as a critical factor to be able to consider technologies and markets at the same time.

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Keywords: Roadmapping, Roadmap, Strategy development, Stakeholder engagement, Participation process

[218] Shubham Sharma (The Hong Kong University of Science and Technology). *Analysing LED Lamp transition in India - A multi-level perspective .*

Abstract. The research in sustainability transition in recent times have focused on the geographical aspect of innovation and the recent experience in India signifies the importance of a globalised view of frameworks like multi-level perspective. Unnat Jyoti by Affordable LEDs for All (UJALA) is a flagship programme launched by the government of India in 2015 to promote the use of LEDs in households and replace incandescent bulbs. In this case, the development of the technology (LEDs) is not domestic, and one of the reasons behind its success is the decreasing global prices of LEDs that helped in overcoming the per unit cost impediment. However, mere low global prices without any policy support cannot drive a transition. Secondly, policy problems and solutions exist together as streams over a period of time along with the related politics, and issues are pushed to the agenda by virtue of a policy window – multiple stream framework. Hence, the politics and national discourse of energy efficiency assumes importance in discussing LED transition in India along with the global technology market.

The programme has since propelled the sale of LEDs in the country that surpassed the sales of incandescent lamps in 2018. It has been touted as one of the few successful zero-subsidy programmes to promote energy efficiency in domestic lighting. The success of the programme and its implementation offers an opportunity to understand sustainability transitions. In India, the scheme was implemented by a government-owned agency that rely on procurement strategies based on demand aggregation to further reduced the cost to customers. The LEDs were sold by the electricity distribution companies which were also responsible for electricity bills and collection in the country. Despite cost reductions, LED lamps were still ten times expensive than the incandescent lamps. Hence the distribution companies reduced the upfront cost and added the remaining cost to the electricity bills of customers as monthly instalments. Consumers were told that their bills will be lesser due to energy efficient LEDs and the new bills despite monthly instalment of the remaining price of LEDs bought will be lesser than earlier bills. The lighting industry in the country welcomed the scheme as it intended to create a new market and assured demand for LEDs in longer term. Almost eight years since the scheme, the market seems to be taking a dominant role with private players manufacturing LEDs in India and sale occurring through usual channels.

In this paper, the landscape is traced through recognition of energy efficiency as an important agenda in policymaking. This has been done by assessing five-year plans published by the erstwhile planning commission (now NITI Aayog). The focus on energy efficiency in India's sixth five-year plan stressed on the need of electrification of railways, conserving of oil. In the process it recognised energy efficiency as a criterion while evaluating new technologies. Subsequent plans continued in the same vein expanding the scope to other sectors – industries, transport, and agriculture. The ninth plan (1997-02) was the first to compare energy efficiency potential of CFLs versus Bulbs, thus discussing energy efficiency in domestic/residential sector. The establishment of Bureau of Energy Efficiency in 2001 was meant to accelerate the process. In the eleventh plan, the labelling of energy efficient appliances by BEE was extended to include CFL and Fluorescent tube lights. The twelfth plan then specifically focused on labelling and standardization and the need of energy efficiency in urban housing discussing super-efficient lights and fans. It also mentioned the national mission on enhanced energy efficiency (NMEEE) which was approved in 2010. The mission was one of the eight initiatives included in the national action plan on climate change which was launched in 2008. Signifying influence of climate change on energy efficiency policymaking. Before discussing regime factors, lets look at the development of LED lamps (niche).

The development arguably started in the late 1960s when Monsanto and HP created red light emitting LEDs. Nichia Corporation (Japan) demonstrated first high brightness blue LEDs in 1994. Few years later the research in China made progress to demonstrate a LED Christmas tree in 1998. Further developments occurred in countries – US, Japan, Korea – that dominated semiconductor chip industries. Governmental support to the nascent technology gained momentum in late 2000s that also entailed standards and certifications. In 2008, Panasonic ceased its research on CFL technology to focus on LED lamps developing 60-watt and 75-watt LED lamps in 2010 and 2011 respectively. By 2010, the global price had reduced considerably that prompted governments and institutions to conducts pilots and demonstration projects.

The greater focus in this paper is on the regime factors, especially the market and private players (industry structure) and their response to government policy which overlooked their participation. The market players or firms in the country remain passive in the transition. The energy efficient products such as LEDs and CFLs were available in the market but their high cost limited them to the consumers in high-income group. The country has a vast rural and semi-urban market whose access to reliable power supply is fairly recent. These large low-income group consumers bought cheaply available incandescent bulbs and firms were happy to supply them. The market did not explicitly focus on reducing the upfront cost of LEDs or CFLs to make them cheaper. It waited for assurance of demand to take-up efforts to reduce cost by scale economy.

Another important factor is that the technological development in the sector has not been very dynamic or volatile. The technology of incandescent bulbs had not change drastically and the domestic firms in the country were not part of global supply chain of newer developments such as CFLs and LEDs. Their non-involvement meant that did not have much to lose with government's intervention.

Additionally, I analyse the jobs offered and manufacturing data from the Annual Survey of Industries (ASI) surveys for the sector and it shows that the transition did not cost too many jobs as firms which manufactured incandescent lamps also manufactured other items that sustained number of jobs it offered howsoever low. At the same time, the sectors contribution to GDP has not been as significant as other sectors (say automobile industry) to cause any significant resistance or disruption.

From the multi-level perspective (MLP), the case offers an interesting insight where the niche is global – development of LED technology and its scale production that drove down its cost; the landscape is political discourse on energy efficiency and climate change, and finally the regime is existing industry structure in India that did not oppose the transition, despite being overlooked and ignored in the implementation of the porgramme. Whether the transition is sustainable or not will depend on several factors such as quality assurance, standards, supply of skilled labour, but the initial push by the government seems to be successful paving way for other under-developed and developing countries to learn from India's experience, and for researchers to consolidate the bridge between sustainability transition and public policy research.

Keywords: Sustainability transition, Multi-level perspective, Domestic lighting, Energy efficiency

[221] Carlos Montalvo (TNO). *The human dimension of transformative innovation ecosystems dynamics.*

Abstract. There is increasing attention to the role of government to steer and speed the direction of social and economic development in order to face the societal challenges of our time. There is the belief amongst the research community in science and technology policy research that change is required innovation can play a major role. The notion of transformative innovation encapsulates the idea that a radical change in practices and behaviour of all actors across society is needed. But who is in position to lead such change? Laudable goals for sustainability exist already for decades. It is clear that short and long terms visions of sustainable development fail to be implemented in practice.

Following Platt (1973) and Constanza (1987) many of the current societal, economic and environmental challenges can be characterised as a social trap. A situation whereby is extremely difficult or impossible to escape from. Such situations are cumulative across time and are the result of short term "local reinforcements" guiding individual and social behaviour that are inconsistent with the long-run, global best interest of the individual and society. This is a common puzzle to ongoing work in transition research. Different streams of research on social and sustainable innovations (Howaldt et al., 2021), sustainable business models (Boons et al., 2013), and transitions (Köhler et al., 2019) are pointing to the need for understanding the underlying social dynamics that limit change towards sustainability. Furthermore, the importance of better understanding the human dimension, for example in the energy transition has been recognised (Steg et al., 2021). Outlined a research agenda with broad questions relevant for transformative innovation: Which factors encourage different actors in sustainable behaviour? Which interventions can be effective to encourage sustainable behaviour of different actors and which factors enhance its effects? Which factors affect public support for policy and changes in systems? For policy design and interventions to be effective, a better understanding of how decisions and the individual level are aggregated at the collective and societal level. Innovation theory as we know it was oriented to support economic growth and helped to make innovative activity more effective but seems unsuitable for the reorientation needed by sustainability. How can we re-orient the preferences and "local reinforcements" that guide decision making within innovation ecosystems? Is this possible within our current institutional system?

This paper offers a framework that was developed to explore, understand and predict human social action in specific contexts. Its main tenet is that that people's emergent social action in most situations can be explained and predicted in structural and dynamic terms. Concerning the structure of action, the individual decision making and behaviour in the short and long-run can be explained in terms of the relative influence of intentions, attitudes, personal and social norms, agency to perform a course of action, emotion and the relational model mediating social interaction. In dynamic terms the emergent action of the individual and the collective is contingent in the asymmetries of structural factors across individuals and the relational model mediating their interactions in a given social setting. The theory guides the identification of factors that facilitate the prediction of likely emergent action at the individual level and the conditions for the collective to converge or diverge to specific societal, economic or environmental actions and goals.

In specific innovation ecosystems, following Schlindwein and Montalvo (2022) these actions and goals manifest differently across different types of individual and collective or institutional actors (i.e., consumers, prosumers and prosumagers, participants in protests and movements, policymakers, communities and business entities). Therefore, their engagement in transformative innovation has a different structure of incentives and disincentives. the model proposed for this aim enables the understanding of engagement and emergence of transformative innovation at three levels of analysis in:

Following (Montalvo 2022) Testing for transformative innovation emergence is therefore analysed in three stages. A three-stage model enables the identification of bottlenecks transformative innovation emergence whether this resides at the individual or the collective level. It will enable also to identify in detail the sources convergence to common sustainability goals. In addition, this serves as the primary input for the exploration of the nature of new social contracts as well as broad redesign of policy approaches targeting specific but also generic aspects of the behavioural change required in transformative innovation.

STAGE 1: Following Montalvo (2022), a throughput model that considers inputs (perceptions), throughput (appraisal or situational evaluation) and output (intention and behaviour) is here conceptualised to integrate the different constructs of the theory of planned behaviour (Ajzen 1991) and the norm activation model (Schwartz, 1990). The structural features of the relationships between constructs are organised around an interplay between the three phases of the decision making model depicted in Figure 1 (left side). The model proposes that in an input phase at any given time and context an individual perceives its reality, this generates in the first instance attitudes, confrontation of internalised values in moral norms, the pressure from peers and social context, as well as his/her degree of agency with respect to resources and options, goals and target behaviour or action in mind (e.g., energy generation, storage, usage, etc.). Then in an evaluation phase, the action in turn is appraised in reference to: potential outcomes of actions supporting transformative innovation generating attitudes, the peer and social norm (pressing or not for innovations) present in a given relational model that might generate pressure to comply with prevalent norms, the personal moral norm congruence with the current relational model, the level of individual agency on time and resources to actually carry out the behaviour and congruence and appropriateness of the behaviour within the operating relational model between people and institutions. High levels of congruence with the reference goals (own or external), attitudes, moral and social norm as well as sufficient degree of agency will generate positive emotion whereas high levels of dissonance can be expected to generate negative emotion. Negative or positive emotion must not be understood here as an adjective but as the numeric valence of any type of emotion generated in any situation. Given the above, this implies that the appraisal of a course of action and behavioural activation of energy citizenship engagement can be started by any of the constructs in the model.

In the output phase, intentionality, actual action and the corresponding perceived outcomes come to retrofit the previous two phases reassessing the reactive behaviour of others and the effect on the individual condition and the welfare of others. In the first place, emotion is moderated depending on behavioural outcomes as well as the effect on the disruption or permanence of the operating relational model. In turn a new phase of inputs restarts. Here it is important to highlight the expected strong relationship between agency and the mediating relational model with the performance of actions supporting transformative innovation.

STAGE 2: The model stage two highlights that, despite having a common overarching societal goal, different actors might not confluence to performing transformative innovation actions (Figure 1 Centre). The potential mismatch between both actors (i.e., citizens, business and policymakers) arises from diverse sources: i) the actors might be targeting immediate different goals and follow different rationales (for example, citizens might have the goal of extending the life cycle of a durable good with a low energy efficiency while the policymaker might want to increase aggregated energy efficiency in a given region by promoting investments by citizens accompanied with subsidies); ii) even when there are behaviours that match at the goal levels, the underlying determinants might bring mismatches between the two actors (for example, citizens despite having a positive attitude and pressing sustainability values and norms might have limited resources to invest in new more efficient durable goods). Similarly, the policymakers might have a very positive attitude towards a policy initiative giving monetary incentives but have no support from higher government or parliament to enact subsidies for energy efficiency due to budgetary restrictions or partisan preferences. The mismatch between drivers and barriers is likely to derive in a lack of convergence in a given point in time towards a common goal. Attitudes, norms, agency and intentionality might evolve over time across diverse actors. In turn the interdependences between actors are likely to change as well. Depending on the changes in such predispositions the aggregated behavioural patterns are likely to evolve, too.

STAGE 3: The model stage three builds on the central assumption that relationships are patterns of coordination between people. The unit of analysis here, in contrast with most models to analyse decision making focusing on the individual, focuses on behaviour in a relational context. According to Fiske (1992), four structures operate when people interact (e.g., transferring things and ideas, bilateral exchange, contribution, distribution, etc.) and set the primary standards of social justice and influence. In addition, all social relationships can be understood and organised by the combination of these four models and that over time one archetypical relation can evolve, combining models or mutate from one model to another (Fiske, 1992). These modes of interaction are: Community sharing (CS) relationships are based on a conception of some bounded group of people as equivalent and undifferentiated. In CS relationships, resources (e.g., food, land, capital, durable and non-durable goods, information, expertise, etc.) are regarded common rather than individual property. In authority ranking (AR) relationships resources exchanges are motivated by power asymmetry underpinned by a sense of duty, honour or fear. In equality matching relational models (EM) people are primarily concerned whether an interaction is balanced, keeping track of any asymmetry. The underlying principle is that each person is entitled to the same amount as any other person in the relationship, the direction and magnitude of an asymmetry are meaningful. In market pricing relational model (MP) what matters is how an individual in proportion to other and the social value of an exchange is defined by the ratio of what is given and received (e.g., prices, wages, commissions, rents, interest rates and any other exchange organised in terms of cost-benefit and rational calculations of efficiency or expected utility). Figure 1 right side indicates that there are a myriad of relational models in place and the dissonance between them across people and groups operating with different relational models are likely to generate divergence in common societal goals like transformative innovation.

From the above it can be stated that relational models are a likely additional source of mismatch and asymmetries between the individual and the collective action towards common goals in transformative innovation. Such potential mismatch originates from differences between the individual rationality and the collective aims between actors or groups of actors operating with an implicit or explicit assumption of differentiated relational models. each relational model implies different assumptions of what is or should be the rules in operation in any exchange and relationship in a desirable new social contract that supports the emergence of energy citizenship. The most salient example of such mismatch between relation models for interactions are between community sharing and market pricing. Many would argue that resources like water, air, fisheries and forests provide values to the commons of earth but the cost of their exploitation is socialized while the revenues and often privatised. The model presented above provides tools for analysis that makes transparent the rationales in different stakeholders while identifying the models that would support best transformational innovation and the conditions for its emergence.

The above framework provides tools for the analysis of the sources of convergence to common goals that underpin the notion of transformative innovation. It starts with the structure and characterisation of drivers at the individual level, the enables the identification of asymmetries across actors in an innovation ecosystem. Then looking into the dynamics links the micro motivation of individuals to the possible form and modality of interactions between different actors. Last, it enables the identification and disambiguation of the implicit social contract ruling the interactions underlying or limiting potential transformative innovations.

Keywords: emergent behaviour, collective action, social innovation, transformative innovation, relational models, innovation and behaviour, new social contracts, sustainable behaviour, behavioural insights for policy

[223] Julino Soares (University of São Paulo, CEPEDISA), Claudio Cordovil (Fundação Oswaldo Cruz (FIOCRUZ)), Marina Borba (University of São Paulo, CEPEDISA) and Fernando Aith (University of São Paulo, CEPEDISA). *Civil Society in the Public Policy Arena: meetings and disagreements of organizations representing patients with rare diseases in Brazil.*

Abstract. Civil Society in the Public Policy Arena: meetings and disagreements of organizations representing patients with rare diseases in Brazil

PROBLEM: Patient Representative Organizations (PRO) emerge around the world as new spaces for social participation, using innovative interventions to promote the rights of people with health needs, promoting and organizing national and transnational coalition platforms, as well as acting in areas previously reserved for researchers and health professionals . However, few studies have evaluated how different PROs occupy spaces of participation and how dispute processes between these actors take place. Thus, it is necessary to understand the challenges of PROs in the construction of representation legitimacy, in the formation of networks, in performing advocacy and in the transparency of their actions.

OBJECTIVE: To describe the profile of coalitions and Patient Representative Organizations in rare diseases in Brazil, as well as their main characteristics and the impact of their actions on public policies.

METHOD: This is a qualitative research with an exploratory-descriptive approach, carried out from the survey of scientific publications, gray literature and field notes. PRO data were collected in September 2021 from the following sources: Lima ; Map of Civil Society Organizations of the Brazilian Institute for Applied Research (IPEA); Facebook and on the PROs websites.

RESULTS: 518 PROs registries working on rare diseases in Brazil were identified. The rare diseases with the highest number of PRO records in Brazil are Gaucher disease, with 54 records, followed by multiple sclerosis (46), cystic fibrosis (44), mucopolysaccharidosis (39), tyrosinemia type 1 (31), hemophilia and Von Willembrand disease (31 records) and muscular dystrophy (23). These seven diseases account for 52% of PRO records. The priority rare diseases in Brazil with the highest number of PRO records are Congenital Anomalies or Late Manifestation with 10 records; Chromosomal Anomalies and malformative complexes with 5 records; followed by Intellectual Disabilities with 9 records. Five PRO coalitions were identified in rare diseases operating in Brazil, joining between 17 and 532 PROs. The search for information on the websites of these coalitions and the respective PROs of their executive directors indicates the following skills: ability to dialogue and mobilize influential political actors in the various spheres of power and levels of government; dialogue with regulatory agencies in Brazil and other countries; organization of technical and scientific activities bringing together actors from the public and private sectors; construction of first comprehensive care and training center for rare diseases in Brazil; and occupation of strategic public positions in the health area. However, the report on the activities of the PROs consulted for the year 2021 and the declaration of conflicts of interest was not found in their respective websites. Only one coalition cited the presence of pharmaceutical companies among the initiative's collaborators. We emphasize that there were no mentions of joint activities between these coalitions or even cross citations of the coalitions on the websites consulted, suggesting, at least, the absence of dialogue.

DISCUSSION: We can list important public policies advances for patients with rare diseases in Brazil in recent years, but we did not find any official mention of PRO participation in these initiatives. Despite the institutionalization of certain spaces for social participation, these are not enough to guarantee the effective participation and influence of social actors in the decision-making and public policy-making processes, due to conflicts of interest, social and knowledge asymmetries . The high concentration of PROs for some rare diseases and the low overlap of this representation for the priority rare diseases in Brazil may indicate the existence of inequities in the participation process; the overload for coalitions to represent the multiple demands of patients; or the underrepresentation of demands of these patients. Social participation can contribute to the reduction of inequities in health, but this contribution is less determined by the quality of the participatory process and more by the character of political alliances and mobilization processes carried out by civil society .

Certainly, the inter-organizational character, of a social and political nature, of PRO coalitions cannot be understood in a dissociated way from their strategic and institutional context. However, the data suggest that the absence of dialogue or even disputes over the legitimacy of representation could compromise the formation of public policy networks with greater capacity for incidence.

CONCLUSIONS: The number of PROs for patients with rare diseases in Brazil indicate a positive democratic movement for these patients' health rights protection. The strategy of gathering different PROs in coalitions is legitimate and necessary, considering the challenges regarding the access to treatment and the complex negotiations among different public and private spheres of power. In this sense, cooperation between PROs and its coalitions seems to be the better path for greater effectiveness of social participation in public policy decision-making processes.

Keywords: Health Policy; Rare Diseases; Community Participation; Organizational Innovation; Health Advocacy

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[224] Joanna Grudowska (Nicolaus Copernicus University) and Piotr Stankiewicz (The Łukasiewicz Research Network - Center for Technology Assessment). *How Polish innovation system response to the challenges of sustainable development?*

Abstract. The paper aims to present and evaluate, using the example of the Łukasiewicz Research Network, how the Polish innovation system responds to the challenges of sustainable development.

The Łukasiewicz Research Network was established in 2019. After Fraunhofer-Gesellschaft and VTT Technical Research Center of Finland, it is the third-largest research network in Europe. As part of the Polish innovation system, Łukasiewicz is responsible for carrying out R&D in strategic areas for the state and supporting economic policy. Łukasiewicz was established to integrate a dispersed group of research institutes and coordinate the public R&D system in response to the challenges facing the Polish economy and society.

Łukasiewicz should be placed in contexts of science and the entrepreneurial state. In the context of science, it is important to determine how Łukasiewicz fits into the Responsible Research and Innovation (RRI), mission-oriented research and mission-driven approach. These are policies to exploit scientific and technological work for the needs of the economy and society. An entrepreneurial state can take risks with the riskiest areas of science and technology. Łukasiewicz, as a public institution, takes such risks in R&D projects because it has resources and capabilities beyond the capabilities of a significant part of actors in the Polish economy, i.e. SMEs.

As a global and european community, we are facing huge challenges defined by the Sustainable Development Goals (SDGs), European Union Green Deal, Fit for 55, or Taxonomy. For example, the energy and climate transformation will cause profound socio-economic changes in all areas. The agricultural sector will change, in addition to the availability of products, consumer habits, the situation of farmers, food culture, etc. Changes in the energy sector are associated with: the need to reduce emissions, increase prices for ETS, creating energy innovations, or build a hydrogen economy. These challenges are solved on political and economic grounds, but also by the national innovations system (NIS). Łukasiewicz is one of the key actors of the Polish innovation system. His role and position in the NIS set the horizon of potentialities related to supporting the solution of the mentioned challenges. Łukasiewicz is not only an R&D actor but also involved in the public debate, political activities and is active in the economic field.

As a young actor, Łukasiewicz pursues ambitious activities with great potential to transform the Polish innovation system. But is its activity rooted in a mission-driven approach and RRI? Does Łukasiewicz work to support sustainable development and solve the challenges facing the Polish economy and society? How does Łukasiewicz do this and how does it succeed? What it makes not do so: what internal and external mechanisms and phenomena cause it not to support solving sustainable development challenges? This is an introduction to the question about the Polish innovation system: is it systemically supporting solving social, economic, and environmental challenges. What determines this state of affairs? It is also an introduction to the question of Poland's readiness to solve challenges connected with sustainable development.

Paper is based on preliminary results of two qalitative research conducted in Łukasiewicz Research Network. First is concered espcially what engineers know about the SDGs and how the incorporate them in they R&D work. Second is about what Łukasiewicz Research Network - as an specific B+R organisation in Poland - is doing to support the realisation of sustainable challenges.

Keywords: polish innovation system, sustainable development challenges, research and development

[225] Enza Lissandrello (Aalborg University), Rasmus Nedergård Steffansen (Aalborg University) and Lasse Schytt Nørgaard (Aalborg University). *Knowledge Co-production on Air Quality – The Role of Planning Research in Participatory, Healthy, and People-Centered Cities.*

Abstract. Air quality is a growing topic in urban planning as it becomes increasingly apparent that sustainable urban planning is not feasible without considerations regarding air quality. In Europe, pollution levels that exceed the WHO's guidelines expose up to 90% of the people living in cities to poor air quality, cause thousands of premature deaths every year and generally reduce urban liveability. However, in urban planning and public policy, air quality is mainly discussed only when excessively warning conditions occur. There is a shared opinion among citizens and policymakers in the Nordic countries that air quality is generally reasonable. Research on air quality is developing in discussions on innovative city technologies, which are increasingly becoming part of knowledge-based planning. In the last decade, citizens-science has developed as a strand of research in itself by exploring how citizens can be equipped with tools to understand – or measure - their local environments. In research on urban air quality, citizens engagement through sensors has underlined a twofold purpose: on the one hand, the high flexibility of the citizens' data collection across large areas; on the other hand, the active involvement of citizens in capacity building and raising public awareness on the importance of the air quality for the liveability and sustainability of the urban environment. Nevertheless, planning actions to improve urban air quality locally remain critical on how data can be understood, monitored and interpreted differently. The question remains if improving air quality can become a strategic goal for planning (more) sustainable and healthier cities for the future.

This question has been a starting point in a research project on urban air quality in the Nordic countries called NordicPath, funded by NordForsks (2020-2023). Air quality sensors as a form of citizens' engagement are significant to smart and sustainable urban planning in Nordic countries. The Nordic welfare state system is well-known for its sensitive approach to public participation and a high level of digitalization. The NordicPATH project is a partnership among universities and researchers in Nordic countries with empirical fieldwork research in four municipalities (Aalborg (DK), Kristiansand (NO), Gotenburg (SE) and Lapperranta (FI)). The Urban Living Labs (hereafter ULLs) method focuses on knowledge co-production with citizens engagement through low-cost permanent and mobile sensors and Participatory Geographical Information System (PGIS). Researchers are driving a process of facilitating knowledge co-production on urban air quality with citizens and communities, not just as passive 'users' but as active agents for the visualization and interpretation of data.

Furthermore, researchers facilitate dialogue among policy actors in the respective municipalities to engage in discussions on public participation, air quality and urban futures of Nordic cities. Policy actors are encouraged to critically interpret air quality data as possible triggers of sustainable urban transitions. Reflections across the local contexts aim to identify specific actions to improve urban air quality as a strategic driver for planning (more) sustainable and healthier Nordic cities.

Urban Living Labs (ULLs) presented a novel method to co-produce knowledge through citizens' and communities' engagement. In the NordicPATH project, the concept has served as an interdisciplinary focus among researchers from diverse fields of knowledge (e.g., air quality scientists, citizens-science scholars, environmental monitoring experts, urban planners). ULLs have identified diverse geometries of ecosystem learning among diverse fields of knowledge at the crossroad of situated knowledge on air quality, public participation, and urban planning. Intertwining these fields of knowledge has also created a new ecosystem learning that connects macro-scales societal problems as the air quality to micro contextual problems connected to diversified sources of pollutions as well as the institutional set of ambitions of urban planners in municipalities, or the opportunity of researchers to deliver not just data on air quality but also to include actors and stakeholders than traditional processes.

Understanding urban air quality as a driver to co-produce knowledge and expand the local scope of ULLs, the paper demonstrates how researchers and practitioners can engage citizens on a co-production of knowledge by sensor-ing, measuring, and giving value to their perception of air quality qualifying their living environment. Both technical aspects of flows, movements and causes of deteriorated air quality, and more qualitative concerns of local perceptions of certain areas (good and bad) are brought together on equal footing in discussing the city's future. Conceptually, urban air quality is easy-to-grasp but hard to master as a topic: it concerns all of us and the quality of the cities we inhabit, but the sheer complexity can make it overwhelmingly. The topic can potentially impact future planning strategies and urban political agenda at multiple levels and scales. The paper frames public participation to enhance understanding of public problems, and explore and generate potential solutions; produce policies, plans, and projects of higher quality in terms of their content; generate support for decisions and their implementation; manage uncertainty; create and sustain adaptive capacity for ongoing problem solving and resilience. Participation and engagement are also two ways for planners and citizens. Planners come to acquire locally specific knowledge and learn about local processes and issues, and citizens become involved in knowing the stakes of decision-making and the surrounding processes. In addition, collaborative planning can lead to new (citizen) networks emerging, allowing the public to significantly influence the planning process. In other words, the end goal of public participation and collaborative planning is to foster conditions under which "(…) policy [can] be designed, not for citizens, but by citizens in their role as policy 'users'." [Brand & Gaffikin 2007, p. 290]. In the last two decades, the way to understand public participation has developed according to diverse practice models implemented in local contexts often termed as Urban Living Labs (ULLs). ULLs have become an umbrella term to define a way to develop urban innovation by mobilizing a local context of citizens and communities. ULLs models often aim to test or experiment in a situated local context with citizens, either a technology, a policy, or a new form of partnership, which could produce a new 'outcome' intended as a product, a process or a service. ULLs are also specific fields of experimentation with research institutions testing a particular view of future deliberation for eventually triggering new policies to be received by existing governance structures to mobilize multiple actors and interests. In NordicPath, ULLs approaches have been a starting point to develop a Nordic Living Lab perspective that draws both on existing literature - analyzing and problematizing the contemporary challenge of existing participatory urban planning practice in Nordic cities. By exchanging cities' existing practice of public participation, through the voice of policy actors and sharing knowledge on urban air quality in their local contexts, the Nordic Living Lab builds step-by-step strategies for integrated urban planning processes connecting policy actors and researchers and assembling knowledge about urban air quality as a driver for a sustainable urban transition. The Nordic Living Lab moves from a plain air quality assessment as environmental impacts to a strategic and process-supporting urban transformation co-produced by citizens, researchers, and policy actors through permanent and mobile air quality sensor/ing and a PPGIS platform.

The Nordic Living Lab includes diverse phases of implementation across:

1. the engagement strategies and knowledge assemblages among citizens, policymakers and researchers and their existing challenges in the participatory endeavour,

2. the co-production of a new ecosystem learning intertwining existing fields of knowledge among participation, air quality, and urban planning by connecting policymakers/researchers/citizens in the sense-making of the interplay among these fields,

3. the co-design of planning strategies and new urban policy can integrate living participatory processes on urban air quality to shape more tangible goals for future healthy and liveable cities and smart communities.

Within the Nordic Living Lab perspective, the data collected through air quality sensors and PPGIS surveys and initiatives engage different urban actors (researchers, policy actors, citizens) in producing quantitative data (and awareness about data meanings) and qualitative data (opinions about air quality in diverse urban areas and by diverse groups of citizens) that contribute to sensitize, involve, and redesign policy efforts in shaping future healthy, liveable, and sustainable smart cities.

NordicPATH's overall objective is to establish a new model for citizens' participation and collaborative planning in four Nordic cities to create healthy and people-centred urban environments. The project is tackling complex environmental impacts such as air quality and is developing a method targeted explicitly to the governance conditions of the Nordic countries with potential replicability and scalability to other countries. The Nordic Living Lab approach developed through a period of lock-down and isolation – intersecting the diverse meanings of ULLs in contexts. The content lies at the intersection among public participation - involving policy actors of municipalities, but also citizens and communities through sensor-ing engagement and urban planning (understood as the actions to move ideas of urban futures).

Policy actors municipalities have found that there is a need to use several methods to combine these diverse forms of knowledge in the local context. For example, air quality cannot directly influence planning strategies; this is only possible through a solid commitment to public participation. Public participation includes diverse methods often explored directly in urban planning practice. Policy actors highlight the need to reflect further on how and when public participation is useful to the planning process, consider the expectations that might arise.

Through the NordicPath experience of researchers, the paper demonstrates the effort to build an understanding of public participation as a vital part of transitioning to a low-carbon society. Municipalities need to think of how to mobilize and engage citizens in the co-production of knowledge on complex issues, such as air quality. The sustainable urban transition is more than just thinking of urban transformation as a physical space. It requires change on a societal level. NordicPath researchers have learned that high-quality engagement is essential to understand the pathway to a low-carbon society, but also just possible by establishing solid partnerships among municipalities' policy actors and researchers in a respectful and open co-production of knowledge with an open end. An open-end might mean imagining and planning future processes inclusively of many partners, citizens, neighbourhood communities, students. Nordic cities play a role model for public participation and collaborative planning as catalysts for global change. In the context of this paper on the NordicPath experience, Nordic countries show a comparatively advanced approach to public participation, but there is still little work on examining it as a 'Nordic model'. Learning from the NordicPATH experience, this paper shows that the transition to a low-carbon society requires smarter and sustainable cities. It would depend mainly on the opportunities to share common practices, to reflect on the barriers and constraints of public participation beyond the legal requirements of public hearings. The NordicPath research effort to co-produce knowledge for improving a culture of participation has identified some barriers and opportunities. A Nordic Living Lab that restructures the ULLs in a network of micro-level specific contexts would help overcome the mindset of institutional constraints and offer a space to think broader as research and policy can interact and align together on the societal challenge of planning future more sustainable, healthier cities. The lessons learned from air quality knowledge co-production in the context of making the Nordic Living Lab are that:

1. integrated approaches through data open possibilities for engagement, education and sensibilization to understanding the urban environment as a whole,

2. the situated connection with existing urban policy and planning processes offer challenges but also opportunities,

3. the role of research is to encourage connection and assemblages between and among policy actors and local experiences with citizens to avoid isolation of experiences, 'niche traps' and solitude of actions.

In conclusion, the NordicPath experience shows that research and policy can improve understanding on how air quality data can trigger public participation, establish possible pathways to drive new urban policy (and planning) and planning a sustainable urban transition with citizens and communities.

Keywords: urban planning, public participation, low-carbon transition, citizens science, data, air monitoring

[226] Yana Zabanova (Institute for Advanced Sustainability Studies) and Rainer Quitzow (Institute for Advanced Sustainability Studies). *Geoeconomics and the transition to climate-neutrality: towards a conceptual framework.*

Abstract. The geopolitics of energy transition has been the focus of a growing body of research (cf. IRENA 2019, van der Graaf et al 2020), yet the concept remains undertheorized. Moreover, geopolitical analyses of the energy transition tend to focus on how a future net-zero world would be different from the world today. For instance, scholars have reflected on how an energy system dominated by renewables and, more recently, one that incorporates large shares of climate-neutral hydrogen might redraw the geopolitical map and how it might change the relative power and influence of traditional energy exporting and importing countries. A number of scholars have engaged in a debate on whether the transition to renewable energy would result in a reduction in conflict in the international system compared to the current system dominated by fossil fuels.

A smaller number of contributions explicitly discuss the geopolitics and geoeconomics of the highly contested, multi-speed transitions unfolding at present, i.e. the ongoing global process of structural change and how it is being tackled by different actors. One exception is the contribution by Goldthau and Westphal (2019), which discusses transitional strategies of fossil-fuel producing countries and their geopolitical implications. Another important area for research relates to the geoeconomic rivalry between major countries and economic blocs vying for leadership within the context of the transition to climate neutrality. This raises questions regarding the role of geoeconomics in shaping the transition to a climate-friendly economic system and, conversely, how this transition is reshaping geoeconomics. In this context, a particular salient question revolves around the increasing tension between competition for a leadership role in a future climate-friendly economy, on the one hand, and the need for enhanced cooperation to confront the challenge of climate change, on the other.

In this paper, we focus on a discussion of this latter set of questions. Following a review of existing literature (e.g. Kim 2021; Grevi, 2011; Luttwak, 1990), we first seek to disentangle conceptual boundaries between traditional geopolitics and the concept of geoeconomics. While the former focuses on more overt political strategies, buttressed by military and/or economic power to secure geostrategic influence, the latter focuses on more subtle or indirect interventions focused on exerting economic influence.

Against this background, we then develop a focused analytical framework for analyzing the geoeconomics of the global transition to climate neutrality. For this purpose, we define geoeconomics as the field of study concerned with the engagement of governments in exerting influence – or building the capacities to do so - by shaping international markets and related global production networks (see Wigell, 2016 for a similar conceptualization). This can have both an inward-oriented and outward-oriented focus. The former involves increasing the resilience of the domestic economy, for instance, by reducing reliance on imports of critical resources and technologies (i.e. reducing one's asymmetric dependency on others) and by containing external influence within the domestic economy. The latter consists of actively building geoeconomic power by actively shaping the global economic system or other domestic or regional economies in order to exert influence over strategic elements of relevant markets, networks and infrastructure systems. This includes, for instance, activities aimed at positioning domestic industrial clusters as important hubs within global production networks (i.e. increasing others' strategic dependency on oneself).

Based on this general framing, we propose a more detailed analytical framework for the study of geoeconomics in the context of a transition to climate neutrality. This analytical framework distinguishes two basic dimensions:

- Resources and technology
- Markets, networks and infrastructure

Resources and technology refer to goods and services that are either directly energy-related or subject to energy-intensive production processes, such as basic materials like steel, cement or chemicals. These goods and services represent the main targets of decarbonization policies and are subject to the most far-reaching changes in the transition to climate-neutrality. As a result, they are also potential targets of geoeconomics competition as countries and economic blocs devise strategies to secure positions of economic power in a future climate-friendly economy. Ultimately, geoeconomic influence hinges on controlling or influencing control over these assets. The transition to climate-neutrality is leading to three major changes in relation to the role that resources and technology are playing in the energy system and hence their relative importance in terms of geoeconomics. Firstly, it is leading to a relative decline in the role of natural resources vis-à-vis technology. Secondly, there is shift in importance from fossil-fuel resources to renewable energy resources, mineral resources for the production of climate-friendly technologies as well as natural sites for the storage of CO_2. Thirdly, data for managing the CO_2 footprint of production processes and service delivery is gaining in importance as a resource in the energy system. Enabled by the parallel process of digitalization, it represents a factor of growing importance in the geoeconomics of decarbonization.

Markets, networks and infrastructure represent the key arenas in which resources and technologies are produced and exchanged. Although influence over them does not represent an end in itself, they offer strategic entry-points for controlling access to energy-related technologies and resources. They include both tangible and intangible infrastructure and networks that connect economic actors and facilitate economic exchanges in the economy. Given the transition to climate-neutrality, the build-up of new markets, networks and infrastructure as well as the conversion and adaption of existing ones are hotly contested. This in turn offers opportunities for shifting the broader distribution of economic power across countries and economic blocs.

Building on this basic framework, the paper discusses the channels for governments to exert geoeconomic influence. In the most general sense, this encompasses four basic modes of intervention (Hood, 1983; Blackwill and Harris, 2016): the development of organizational capacities within the public sector, the use of public financial resources to incentivize action by external actors; the coordination of external actors by providing informational resources or platforms for their exchange and, finally and possibly most importantly, to set the rules of the game. Drawing on recent literature innovation policy, socio-technical transitions (e.g. Wittman et al. 2020; Borras & Edler, 2020; Mazzucato et al. 2020) and the governance of global production networks (e.g. Werner, 2020), the paper discusses how these different modes interventions may interact and modulate developments within a transition to climate neutrality.

Following calls by geoeconomics scholars (Kim 2021) to better conceptualize the role of non-state actors, the paper also addresses the activities of different types of actors in the transition to climate-neutrality, drawing on insights from the literature on global production networks (GPNs), which has developed an apparatus for analyzing the various roles of both lead firms and states across GPNs (e.g. Horner 2016). This includes a discussion of the relationship between public and private actors in exerting geoeconomics influence, in particular when it comes to managing the tension between the valorization of assets within the still dominant fossil-based energy system and the promotion of new assets within a climate-friendly system.

The paper concludes with a reflection of potential contradictions and trade-offs inherent in the ongoing transition to climate-neutrality. This can stem from the occasionally conflicting logics of geopolitics and geoeconomics or be rooted in the simultaneous need to achieve geoeconomic leadership through competition, on the one hand, and the need for cooperation on climate as a collective action dilemma, on the other.

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Keywords: geopolitics, geoeconomics, climate neutrality, energy transition, global producton networks

[227] Ivan Nechaev (Aalborg University Business School) and Daniel Hain (Aalborg University Business School). *Methodology of extraction of social effects reflected in CSR reports.*

Abstract. Modern companies operate simultaneously in economic, social, and environmental realms. It is vitally important to capture and understand the causes, links and consequences of effects the company produces in each dimension. In our current study we are focusing on social dimension.

Social impact can be defined as the attribution of the activities of an organization to the overall social results of the longer term (Cerioni & Marasca, 2021). Various concepts and frameworks trying to tackle social effects have emerged through the recent decades. In the study Clark et al. (2004) identified three categories of social impact assessment by their major function: process methods, impact methods and methods of monetization. In Clark et al.'s classification we utilize results of process methods to capture social impacts. We analyze non-financial statements or corporate social responsibility (CSR) reports of companies to retrieve their reflections on the effects they produce in social sphere.

Well-deployed CSR activities create a good reputation and a nice social and eco-friendly brand image, improve employee commitment and retaining, establish better relations with major stakeholders (consumers, employees, governments, non-governmental organizations (NGOs) and the community), reduce costs and avoid regulatory sanctions, which all in all can provide a company with a competitive advantage and result in higher profitability (Uyar et al., 2021; Wasiuzzaman et al., 2021).

There are many frameworks for preparing a non-financial statement all over the world. In the European Union reporting rules are set by Non-Financial Reporting Directive (Directive 2014/95/EU) and several other legislative acts. Recommended reporting frameworks include Eco-Management and Audit Scheme (EMAS), the United Nations (UN) Global Compact, ISO 26000, the Global Reporting Initiative and some others. The abundance of frameworks in practice turns out to cause serious hindrances to reporting transparency, information credibility and objectiveness, third-party assurance ability, cross-company/industry/country comparison of social or environmental effects. There is no unified format of information representation which makes analysis on a scale of more than several companies very difficult. There is a distinctive need of easily accessible mechanisms that can evaluate the CSR performance of a company, can assure that the information disclosure reflects CSR activities unambiguously and can propose and introduce changes to further revisions of standards (Olanipekun et al., 2021).

This work studies the problem of social effect extraction and comparison through different reporting frameworks. We propose the following research questions:

RQ1. How can we extract social effects that are reflected in CSR reports independently of their framework on a large scale?

RQ2. What kind of effects on social sustainability do companies self-report?

One of the most fruitful methods to investigate the contents of CSR reports is natural language processing incorporating machine learning tools. In current literature contributing to the same problem there are two distinguished approaches to CSR reports analysis irrespective of the initial framework. First one uses topic modelling tools (namely Latent Dirichlet Allocation — LDA). The second one utilizes various researcher-predefined thematic dictionaries. Our study proposes the third type of analysis that is based upon classification techniques of social impacts with further dependency parsing for extracting and analyzing report prepared in different types of frameworks.

By the means of LDA analysis Goloshchapova et al. (2019) identified the most common topics among more than 5000 reports, namely: “employees safety,” “employees training support,” “carbon emission,” “human right,” “efficient power,” and “healthcare medicines”. Study of Ning et al. (2021) supports the idea that the aim of sustainability reporting is to manage firm's reputation with customers. Authors also find that sustainability initiatives on environmental issues can increase firms’ financial performance. Lee and Huang (2020) applied fuzzy rough set theory and extreme learning machine on top of topic modeling and found that specific CSR dimensions are highly related to corporate financial performance and that including CSR related ratios as explanatory variables in a forecasting model would provide it with higher forecasting capability.

To make a predefined thematic dictionary Pencle and Mălăescu (2016) analyzed the major reporting frameworks (GRI, UN Global Compact, IIRC, MSCI KLD and ESG) and identified most similar dimensions: employee, social and community, environment and human rights dimension. Based on this approach authors find correlation between estimated indicators based on the vocabulary and the size of the IPO (initial public offering) in terms of the offering price and the total number of proposed shares, as well as underpricing on the first day of trading. Uyar et al. (2021) discovered that European reports cover more sustainability topics than other regions: they are richer in their keyword usage and they are better at meeting stakeholders’ expectations. Authors also denote that GRI based reports more condensed and cover a greater scope of topics than free format reports; GRI reports better address specific stakeholders. Kumar and Das (2021) found that through the period of 2008-2017 sustainability performance was improving.

Topic modelling can provide a comprehensive overview on the main themes covered in given set of texts but has certain limitations when interpreting results on a narrow level of identifying particular impacts. Predefined thematic dictionary approach has more potential for particular impact identification but is limited due to its rigid predefined topics: such an approach won’t be able to pick up new trends that appear in new text sets as soon as the dictionary remains the same. To answer the first research question, we propose a new method of CSR report analysis based on classification of impacts in accordance to Global Reporting Initiative framework. This approach can provide a focused analysis of impacts as well as adjustability to new revisions of GRI framework..

We propose the Global Reporting Initiative (GRI) framework as a reference point for several reasons. Reports that were using standardized framework (such as GRI) tend to be more credible than those that don't (Lock & Seele, 2016). The scope of topics covered within the GRI framework is wide and exceeds the scope of free-format reports (Kumar & Das, 2021). One of the major technical reasons for choosing GRI framework is that every non-financial domain in this framework is codified and all reported effects are bound to a certain GRI code. So, we can regard GRI reports as a source of labelled data. Hence, we are able to solve the classification problem in the field of supervised machine learning: predict the impact type of a given text. Trained model can be applied to reports prepared in accordance to other frameworks, thus comparing the effects of all companies that disclose their non-financial information.

We obtained the list of companies that report in accordance to GRI framework from globalreporting.org, the official Global Reporting Initiative website which included 2750 companies worldwide. This list contained links to CSR reports in pdf format that were downloaded and processed further. The time span covers 2017—2020 of reports being published.

On the first stage we generated labelled dataset by manual identification of page numbers with GRI codes. Our final dataset contained 72 reports from 60 companies. On the second stage we used text mining packages in R to automatically extract text from the specified pages (corresponding to a certain GRI code). For training and testing the classification model we obtained around 1250 observations of unique ‘GRI code—text’ pairs. Among basic 19 codes from Social sector of GRI framework (codes and subcodes ## 401 to 419) the most reported codes are: 401—Employment, 403—Occupational Health and Safety, 404—Training and Education, 405—Diversity and Equal Opportunity, 413—Local Communities.

For classification model we chose Random forest as one of the most commonly used and effective machine learning methods. Random Forest operates by building multiple decision trees. As vectorization technique we utilized ‘term frequency — inverse document frequency’ (TF-IDF). This combination (Random forest on TF-IDF) showed better results than regression models or combination with hashes instead of TF-IDF. The accuracy characteristic of random forest model run on the train data was estimated as .94 and on the test data as .65.

Suggested method of impact extraction from non-financial statements combines the flexibility of LDA approach and a rigidity of pre-defined topic dictionary approach. In case standards are being changed training the model on new text datasets will ensure that it retains sufficient accuracy. This methodology can be used for compliancy check of reports, making the process more transparent and affordable if other dimensions of GRI standards are also included in the dataset. To answer the second research question, we combine the above suggested approach with dependency parsing. Such a combination provides specific insights into particular effects companies report. Results obtained during dependency parsing bring cross-company/industry/country comparison of reflected social impacts to a highly focused level. Preliminary results can be found on Figure 3.

There is a need of accessible mechanisms to check the compliance of the reports with the frameworks, to check information revealed to actual CSR performance and to influence the development of next generation of standards. Our proposed method of analysis can help get better insights into the reported effects, compare them across different frameworks and can serve as one of the elements for such a mechanism. We use machine learning methods to train a Random Forest model. After training the model we can predict types of social effects in any CSR report. Dependency parsing helps to extract particular impacts from the set of reports. We are focusing on social dimension but for further research the proposed pipeline can be easily enhanced to cover environmental and governmental dimensions.

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Keywords: social impact, CSR reports, Global Reporting Initiative, text mining, random forest

[229] Xiao-Shan Yap (Eawag; Utrecht University) and Alison Coyle (Utrecht University). *Anticipatory governance on the rise of satellite constellations in Space: insights from a socio-technical configuration analysis.*

Abstract. The Space sector has experienced tremendous growth since the last decade, strongly driven by technological innovation and commercialization (Robinson & Mazzucato, 2019; Yap & Truffer, 2021). In particular, billionaire companies have proposed to set up Internet satellite constellations in Earth's orbit, which promise to reach populations that previously did not have access to the Internet with traditional infrastructures. Several Internet constellation projects are already under construction in Earth's orbit by companies like SpaceX, Amazon, and OneWeb. These projects, despite bringing opportunities for sustainable development, are in effect causing new environmental challenges such as the increasing congestion of Space objects or debris in the orbit. More specifically, there were about 4,500 operational satellites orbiting the low-earth-orbit as of 2021 but this number is expected to increase to about 50,000 by the end of this decade if all current satellite constellation proposals materialize. An unsafe orbital environment may prevent existing satellite infrastructures from functioning well; therefore severely disrupt daily activities or critical services on Earth.

The Space sector currently still follows the Outer Space Treaty 1967, which has been argued to be insufficient when dealing with these rapidly evolving development trends (Jakhu & Pelton, 2017). The future environmental sustainability of Earth's orbit is therefore highly uncertain, given that these spacefaring companies operate under a weakly governed regime. A major challenge lies in whether the emerging Internet satellite constellation sector could indeed help minimize the digital divide while maintaining orbital sustainability. At the moment, the Internet satellite constellation sector consists of a diverse set of actors, the majority of which are driven by differing interests. Anticipating future developments of the sector is challenging, let alone designing the right policy tools for addressing its sustainability challenges.

To address the abovementioned problem, this article seeks to integrate insights from the fields of sustainability transitions and anticipatory governance. Sustainability transitions research has offered important conceptual and analytical frameworks to understand long-term sectoral transformations. This field of research perceives technological change as deeply intertwined with social and institutional elements. In particular, a sector's development is shaped and guided by its 'socio-technical regime'; understandable as a semi-coherent set of rules that orient or coordinate actors' activities leading to the reproduction of elements within the socio-technical system (Geels, 2011). Analyzing the composition of the socio-technical regime of the Internet constellation sector will therefore enable us to better understand the drivers, rules, and institutions shaping the rapid growth of the sector. However, transitions studies have been argued as frequently adopting a fire-fighting approach to environmental challenges (Markard, Van Lente, Wells, & Yap, 2021), hence lacking a precautionary approach to newly emerging environmental challenges - which in this case the unsustainable growth of Internet satellites in orbit.

To address this limitation, we will borrow insights from anticipatory governance studies, which focus on for instance identifying which development trajectories to be promoted or restricted and for what purposes (Gupta & Möller, 2019; Gupta et al., 2020). Anticipatory governance, meanwhile, can benefit from engaging with transitions concepts, given that the emergence of socio-technical configurations in a new sector provides a glimpse into actors' interests, business strategies, policy preferences, etc., which may be a blind spot in governance studies in general. We therefore expect this article to bring some fruitful conceptual synergies between the two fields.

To achieve its objective, we will first analyze and map the socio-technical regime that has been shaping the rapid development of the global Internet constellation sector. We will apply the recently proposed socio-technical configuration analysis (STCA), which is a discourse-based network analysis that uses text data from newspapers and government documents to map and measure socio-technical alignment processes across time and space (Heiberg, Truffer, & Binz, 2022). Given that the sector is only in its infancy, we aim to focus on the various value orientations, motivations, and rationales of actors that drive the sector's development. We will operationalize the mapping of actors' value orientations by using the concept of institutional logics, which argues that actors tend to subscribe to one or a limited number of ideal type institutions, being: family, community, religion, profession, the state, the corporation, and the market (Fuenfschilling & Truffer, 2014; Thornton & Ocasio, 1999). This is in line with the recent proposition that understanding actors' value orientations helps inform the directionality of socio-technical systems (Heiberg & Truffer, 2022).

In terms of data sources, we will analyze approximately 200 newspaper articles and 50 government documents over three periods from 1997 to 2021. The data will be coded using Nvivo, which is a qualitative content analysis software. The coding scheme for institutional logics and the related elements of socio-technical configurations will first be developed deductively based on existing literature. The scheme will be expanded and revised inductively throughout the coding stage. This process will be repeated in an iterative form until we arrive at a final coding scheme. The coded data will subsequently be visualized using the Visone software to identify clusters of actors based on shared interests or value orientations (Heiberg & Truffer, 2022).

We posit that strong market interests may have already dominated the socio-technical regime of the sector, be it commercial actors seeking to profit from the sector or policymakers seeking to create new domestic industries. Under such conditions, we expect to identify three potential development trajectories of the Internet constellation sector driven by: i) a market-based logic consisting of actors that highly center profits and mainly take advantage of the under-regulated sector; ii) an ecology-market logic consists of actors interested in simultaneously strengthening regulations for orbital sustainability and promoting commercialization of the sector; and iii) a community-market logic consists of actors that actively shape discourses about the role of the sector in bringing Internet access to the less privileged. We furthermore analyze how these institutional logics may shape other elements of socio-technical configurations, including different policy preferences, business strategies, or collaboration models among actors. Using these insights, we will be able to identify points of policy intervention in terms of anticipatory governance, e.g. which future development trajectories are to be promoted or restricted, and for what purposes. We argue that anticipatory governance for the Internet constellation sector has to simultaneously consider promoting sustainable development opportunities for the less privileged, preventing the rich and advanced from causing social injustice, as well as maintaining orbital sustainability.

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Keywords: outer space, socio-technical, institutional logics, network analysis, anticipatory governance

[231] Harro van Lente (Maastricht University). *Space for tourists: exploring needs in innovation .*

Abstract. One of the salient aspects of the transformation in the space sector is the rise of space tourism. Several operators now offer space travel for private persons, or, at least, promise to organize such travels on a regular basis in the near future, with dropping costs. In their attempts to define and inhabit the prospective market for space tourism, these operators bring forth particular visions of the future of space tourism.

The prospects of space tourism raises various questions and has spurred a debate on the desirability. While some point to the unfortunate and dismal environmental effects of space tourism, others point to novel markets or the inherent curiosity of mankind to go beyond existing borders. Elon Musk even sees space tourism as a stepping stone for an imminent multi-planetary existence of homo sapiens. In the evaluation and appreciation of space tourism the notion of 'need' is ambiguous and key. It is ambiguous, as it is not easy to claim that the endeavor of space tourism is simply addressing a given need. Yet, there are also traces of needs-in-the-making – and once needs have settled, they will not easily go away.

In this paper I will investigate the contested case of space tourism and the various ways in which new needs are mobilized. This investigation is both empirical (How do needs emerge in a new domain like space tourism?) and conceptual (What is understood by needs and what moral and political distinctions does this bring?). The paper, therefore, follows three steps: a case study of space tourism; a review of perspectives on needs in innovation studies; and a reflection on how the empirical and the conceptual explorations meet and what this implies for innovation theories and policies.

First, I will investigate the unfolding of needs and the mobilization of publics in space tourism. Clearly, space tourism is an interesting case, as travelling to space for leisure is not yet seen as a need, but such needs are already tentatively constructed. Data are drawn from newspaper articles (2010-2020), websites of operators (SpaceX, Blue Origin, Virgin Galactic), market reports, popular books on space travel and governmental documents.

The empirical exploration of space tourism traces five routes of needs construction. First, needs follow from value-rich umbrella terms, or 'ideographs', like democracy, freedom or progress. Virgin Galactic, for instance, sees space tourism as a matter of democratization. The argument is that only hundreds of humans have travelled into space, whereas billions have not had this opportunity. Second, needs follow iconic and desirable images, like the pictures of the blue earth and the 'earthrise'. Third, needs follow the competition and innovation races between companies and countries. When it spurs such fierce competition, it must be desirable after all. Fourth, needs in the making draw from banalization: the speculative possibilities of space tourism are described as if they are real. Prospective clients are instructed what to bring, what to wear and how to eat in space. The final route of needs construction is the anticipation of rights. When space tourism is a possibility, how can we deny individuals the right to opt for it? Together, the five routes bring tentative statements of the needs of space tourism.

The second step in the paper is to acknowledge the question of needs as a perennial question in innovation studies and policies. What comes first, need or technology? Are needs first and are new technologies a response to that, or do needs only arise after a technology is used? The popular image sees the design and use of technologies as to solve problems and to satisfy needs: needs are first, technologies follow. This order is important for the self-image of engineers who see themselves as solvers of given problems in society. The order of technologies following needs also helps companies to justify new products and systems: after all, they now can claim that products are simply there because there is a need, or demand for it. The idea of needs being addressed by new technologies is also important for innovation policies, ranging from targeted needs in mission-oriented policies to the generic needs in grand societal challenges. Yet, innovation studies have challenged the standard notion that technology is developed to fulfil pre-given needs. Empirical studies point to co-production: when technologies are promised, developed and used, many things change in the same movement, including needs and, eventually, rights, when new needs have become self-evident.

How, then, is the tension between needs and innovation addressed in innovation theories? In the paper I will review (i) how innovation theories conceptualize 'need'; (ii) the role of needs in the explanatory schemes of innovation theories; (iii) how in innovation theories needs bring along suggestions for improvements and inform socio-technical futures. I will contrast three groupings of innovation theories: evolutionary economics, including the national systems of innovation approach; socio-historical theories; and transition theories. The analysis is based on a conceptual analysis of core texts and their scholarly use.

The third part of the paper will compare the findings of the case study and the review of innovation studies. In the comparison I will focus on key moments of innovation: the production of novelty; experimentation and learning; domestication and appropriation. The review shows how needs in innovation theories may be articulated as 'preferences', 'demands', 'wants', 'desires' and 'rights'. Such articulations occupy different innovation discourses, and have different epistemological and moral significance.

The paper concludes that when needs are not pre-given, but dependent upon socio-technical configurations, and, in fact, both cause and effect of technological change, the question about desirable techno-scientific futures has to rephrased. The malleability of needs raises intriguing questions about how novelty and needs are co-produced and whether such changes can be anticipated. Also, when needs are not pre-given, but dependent upon socio-technical configurations, and, in fact, both cause and effect of technological change, the question emerges what desirable directions are. When needs are seen as pre-existing, a new development like space tourism appears as inevitable and the discussion on the desirability of space tourism is paralyzed. If, on the other hand, needs are considered as a result, we are encouraged to pay more attention to how new needs emerge.

Keywords: space tourism, needs, innovation theories

[232] Javier Ortega-Colomer (University of Valencia), Oscar Llopis (University of Valencia) and Julia Olmos Peñuela (University of Valencia). *Scientists' engagement in knowledge transfer activities: the role of SDG-inspired research agendas.*

Abstract. Introduction and objectives

The United Nations (UN) Sustainable Development Goals (SDGs) are aimed to tackle the grand challenges of our era. Global problems that are difficult to face at a country level, such as environmental degradation or socio-economic inequality, have now a common framework of action since 2015, when 193 countries agreed the 2030 Agenda (United Nations, 2015). Although this collective plan has not been free of criticism mainly by ecological economists and critical political scientists (Brissett & Radhika, 2017; Swain, 2018; Heleta & Bagus, 2021), it has been extensively agreed by many relevant actors, including businesses, governments, and universities, among others. The SDGs have been the result of a great effort of participation and consultation to formulate policies at both national and local levels towards sustainability. This effort was materialised in September 2015 in 17 main objectives to be reach by 2030, subdivided into 169 sub-objectives (United Nations, 2015, 2021), which can also be grouped into 5 key areas (people, planet, prosperity, peace and partnerships) coping with the economic, social and environmental sustainability.

The societal goals embodied in the SDGs have critical implications for the public university system and the role played by academic scientists. Specifically, they boost the transition from traditional university research and knowledge to a mission-driven demand for knowledge and solutions. This perspective has been already underlined by several related conceptual frameworks: the triple helix model (Etzkowitz & Leydesdorff, 1997), mode 1 and mode 2 of knowledge production (Gibbons et al., 1994), the entrepreneurial university (Clark, 1998), and more recently, the mission-oriented innovation model (Mazzucato, 2018). Furthermore, the outside-in approach to universities to address the SDGs stimulates interdisciplinary solutions (Rafols et al., 2021) or even transdisciplinary research (Marques, 2019), which brings practitioners as active participants into the projects (Schaltegger et al., 2013). Consequently, universities are increasingly pushed to reach a new balance among its three primary missions (namely, teaching, research, and knowledge transfer). Thus, for universities, this governance challenge implies a closer cooperation not only with their internal stakeholders (e.g.: faculty members, administrative staff, and students), but also with their external ones.

Against this background, most of the existing research exploring the influence of the SDGs on the university system has constrained their analyses to the macro-level (e.g.: regional or institutional). Our study adopts an individual-level approach to explore the extent to which the SDGs discourse and initiatives have influenced university scientists' (hereafter, scientists) practices. Specifically, this paper offers two main contributions. First, we identify groups (clusters) of social sciences and humanities (SSH) scientists based on the extent to which the SDGs influence their research agenda. This allows us to characterise and describe scientists in terms of diverse personal and professional characteristics. Second, we explore whether scientists whose research agenda is most inspired by the SDGs tend to interact more with non-academic actors, distinguishing between different forms of knowledge transfer activities. The empirical study relies on an original dataset of more than 600 SSH scientists affiliated to four public universities localized in the Eastern Spanish region of Valencia.

Data

This study is part of a broader research project aiming at exploring openness in academics' research and scientific creativity and the extent to which these two factors are related to knowledge transfer activities. We restrict our analysis to scientists employed in four public universities located in the Valencian Region, as higher education competences in Spain are transferred to regional governments.

Data was gathered through a survey directly addressed to all scientists affiliated to SSH departments from all four universities. The population was identified through the institutional information publicly available in universities' websites. The survey was developed from a literature review on the production of societally relevant research and academic engagement (Abreu & Grinevich, 2017; D'Este et al., 2017; Olmos-Peñuela et al., 2015; Perkmann et al., 2013). Data was gathered between December 2019 and March 2020. We ended up with a final sample of 614 scientists. The response rate was 20.7%, being representative of the population of study in terms of university affiliation, field and sex.

Measures

To capture scientists' degree of engagement in knowledge transfer activities, respondents were asked to evaluate, in a scale from 0 to 4, their participation frequency in different activities associated to knowledge transfer, during the last 3 years. These activities were highly heterogeneous, including practices such as academic consulting or contract research.

To measure SDG-oriented research, respondents were asked to evaluate, in a 7-points Likert scale, the extent to which their research agenda is inspired by each of the following categories associated to the SDGs: prosperity, people, peace, planet and partnerships.

The survey included additional indicators associated to the professional and personal characteristics, such as academic position; university to which they belong, department field, gender, PhD year, experience inside and outside academia or time distribution across academic activities (teaching, research, knowledge transfer and management).

Analysis and preliminary results

First, we performed a cluster analysis to obtain a typology of scientists according to the extent to which their research agenda is inspired by the SGDs. We used a two-stage procedure approach. First, we run a hierarchical agglomerative procedure based on the Ward's method using squared Euclidean distances. We use the clusters centroids obtained from this first hierarchical procedure as initial seeds to run a non-hierarchical analysis with k-means (Steinley, 2006). We obtained a two-cluster solution, which shows that cluster 1 is formed by faculty members that reported a low engagement in SDG oriented-research (C1=Low SDG-oriented research, n=338) and a second cluster with faculty members that reported a high engagement in research related to SDG (C2 = High SDG-oriented research, n=276).

Second, we assessed whether there were differences across clusters for each of the defining (SDG-oriented research) and associated (personal and professional) variables by means of t-test analysis for continuous variables and Chi-Square statistic for categorical variables. Differences across clusters were found in all the defining variables, but also in some associated variables such as fields or time distributions.

Third, we assessed the relationship between SDG-oriented research agenda and knowledge transfer activities through a multivariate regression. We performed a factor analysis to reduce the broad set of knowledge transfer activities into a smaller number of latent factors and we retained nine activities, which generated two factors (our dependent variables) explaining 64% of the original variance: market-mediated activities and non-market mediated activities. Our key independent variable was the binary measure obtained from the previous cluster analysis. We also introduced a set of control variables to account for alternative personal and professional characteristics of scientists that might influence their degree of engagement in knowledge transfer activities. Our preliminary results suggests that overall, scientists whose research agenda is mostly inspired by the SDGs exhibit greater levels of engagement knowledge transfer activities. We also find that this positive relationship is stronger for market-mediated activities, as compared to non-market mediated activities.

Final considerations

This study aims first at exploring to what extent the alignment of SSH scientists' research to the SDGs differs from those scientists whose research agenda is not (or little) influenced by the SDGs. Given the importance of the challenges that SDGs pose to all 193 countries that agree in 2015 to support them, our study opens up an interesting research avenue. Despite not having any explicit incentive to do so, a large part of our sample of scientists have aligned their research agenda towards the SDGs. Moreover, two patterns of scientists have been identified, according to their level of engagement with the SDGs. Interestingly, our results suggest that a greater research alignment with SDGs implies a more active engagement with non-academic actors. Specifically, scientists whose research is SDG-oriented seems to participate more actively not only in market-mediated activities, but also in non-market activities. This has important implications for university policies; therefore, should universities aim at promoting societally relevant research and its uptake by societal actors, more coordinating efforts will be needed to strengthen the current top-down approach and its effect on scientists' academic practices.

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Keywords: Sustainable development goals, Research agenda, Knowledge transfer, University

[233] Leticia Müller (Zurich University of Applied Sciences) and Jochen Markard (Zurich University of Applied Sciences). *Analyzing net-zero policy mixes from a sustainability transitions perspective.*

Abstract. In sustainability transitions the role of policies and policy mixes that address both innovations and sustainability challenges are central to the field. Sustainability transitions are fundamental transformations of socio-technical systems (e.g., around energy supply, transport or agri-food) toward more sustainable modes of production and consumption (Köhler et al., 2019; Markard et al., 2012). In sustainability transitions, innovation is key: the underlying rationale is to replace established technologies and practices that are unsustainable with new ones that are more sustainable. Another important element is guidance: Policymakers typically formulate long-term targets (e.g., in relation to a specific sustainability dimension such as CO2 emissions or with regard to the diffusion of a specific technology such as electric vehicles) for a socio-technical system or sector. Policies and policy mixes are therefore crucial both for stimulating and guiding innovations (e.g., through R&D programs or mission-oriented innovation policies) and for addressing sustainability challenges (e.g., through emission regulations, technology performance standards, or phase-out policies).

Given the complexity of sustainability transitions and the wide array of policies that are typically involved, it is important to understand how well policies and policy mixes align with sustainability goals and the agenda for transformative change toward sustainability. Earlier studies have analyzed, for example, how different policies compare in terms of sustainability targets, e.g. whether they have high ambitions or not, and the level of transformation, e.g. whether they are more disruptive for established systems or not (Lindberg et al., 2019). Scholars have also examined coherence and consistency of policy goals and instrument mixes to analyze policy mixes in energy efficiency (Kern et al., 2017), and combined socio-technical systems with policy feedback literature to outline the co-evolutionary dynamics of policy mixes and socio-technical systems (Edmondson et al., 2019).

In the light of recent debates of e.g., how Covid-19 recovery programs can also be used to advance sustainability targets (Geels et al., 2022; Rosenbloom & Markard, 2020), or what policies should be mobilized for decarbonization (Baranzini et al., 2017), scholars have started to develop transition policy principles to guide transformative policy making (Markard & Rosenbloom, 2020; Rosenbloom et al., 2020). They argue, for example, that it is important to address both innovation and decline (Kivimaa & Kern, 2016); to develop more sustainable alternatives (through innovation policies) and, at the same time, to destabilize established systems and deliberately phase-out unsustainable practices (through decline policies).

In this paper, we work toward developing tools that can be used to analyze transformative policies and policy mixes from a sustainability transitions perspective, with the intention to better understand the strategies and pathways different jurisdictions (e.g. countries) pursue. We first seek to understand what constitutes as transformative policy based on empirical policy data. Then, we seek to schematically delineate them by e.g. finding common characteristics, and in a third step, analyze them, e.g. in terms of comprehensiveness, consistency, transformative orientation, or their potential to garner broad societal and political support. We will apply these tools to three selected countries as well as the European Union.

Our field of inquiry are net zero policies and strategies at the national and regional (European) level. In recent years an increasing number of countries have framed decarbonization challenges and ambitions around net zero, carbon neutrality, or binding vast emissions reductions. Through these new approaches, a shift in climate policy is visible and the importance of transformative policy approaches has come to the fore. In our study, we focus on net zero targets and policies as the currently most ambitious concept.

Our conceptual starting point are recent ideas around sustainability transition policy principles, which highlight that transitions policies should i) have a transformative orientation, ii) address innovation as well as decline, iii) prioritize effectiveness over efficiency, iv) be context sensitive, v) be just, vi) be tailored to transition phases, vii) be flexible and adaptive and viii) acknowledge and handle the importance of politics (Markard & Rosenbloom, 2020; Rosenbloom et al., 2020). We also build on existing concepts of how to analyze policy mixes for sustainability transitions, including policy targets and policy strategies but also general characteristics such as consistency, coherence, or comprehensiveness (Kern et al., 2019; Rogge & Reichardt, 2016). Finally, we mobilize insights from recent reports and analyses by think tanks that have suggested assessment criteria and rankings for net zero approaches in different countries (Hale et al., 2021). Examples of criteria include i) whether all greenhouse gas emissions are included in the target, ii) whether emissions from shipping and aviation are covered, iii) details about a review plan, iv) questions of fairness, and v) whether a country has separate CO2 reduction and removal targets.

Empirically, we start by focusing on countries that either have advanced targets (UK, Germany) or are frontrunners in decarbonization (Norway). We also look at the European Union due to its ambitions of the EU Green Deal to become the first carbon neutral continent. We first seek to understand transformative policy empirically in the context of net zero in the selected countries. To do so, strategy documents and policies from databases like the EEA database (2021) are reviewed and coded to understand the commonalities between their varying net zero approaches. We code the sectors, general solution strategies that are mentioned, and the specific targets to gain an overview of each country's approach.

Together the developed criteria for transformative policy that set the empirical scope and the transitions principles based on the literature will be synthesized and form the tools used to further analyze sustainability transitions policies like net zero policy mixes or Covid-19 recovery packages. In addition, we investigate how countries measure their performance and consider indicators such as carbon intensity of different sectors, and CO2 reductions and removals from their set baseline. For these indicators, we will rely on official sources like Eurostat (2021), and the IEA database (2021).

First findings suggest that while the countries have committed to net zero with different goals and milestones, they appear to have a shared understanding of the different sectors and strategies used to decarbonize these, as well as the need to go beyond supply-side policies and adequately address energy demand to reach ambitious policy targets. In further steps, tools for analyzing transformative policies will be further developed and refined to contribute to transition policy principles.

Keywords: net-zero policy, policy mixes, transition policy principles

[234] Camille Bellet (University of Manchester) and Barbara Ribeiro (University of Manchester). *Digital sensing technologies and knowing practices in cattle farming.*

Abstract. 1. Introduction

Digitalisation is framed as a solution to immediate and long-term challenges faced by agriculture and animal farming. Regarding the latter, the use of automation and data analytics supported by sensor technologies has increased in animal farms worldwide (Halachmi et al., 2019; Neethirajan and Kemp, 2021). In Europe, these have particularly focused on addressing a decline in workforce and skills shortage, while seeking to improve quality, efficiency and productivity in farms with growing herd or flock size. At the same time, digital technologies are expected to support a form of 'sustainable intensification' of animal farming, delivering against key policy objectives such as climate change, public health, and animal welfare (Lajoie-O'Malley et al. 2020).

Farms are spaces where knowledge about animal health and illness is co-produced through practice between farmed animals (e.g. cows, pigs, chickens), farmers, veterinary experts (including researchers), technology developers and other nonhuman actors such as technological artefacts. Scientific and clinical knowledge transcends the boundaries of formal scientific organisations, such as the veterinary school, to incorporate insights from and inform practices performed at the farm. In this paper, we adopt a posthumanist, practice-oriented sociological lens (Gherardi, 2019) to investigate how digital technologies reconfigure the everyday management of cow health in farming. We draw on the idea that knowing – regardless of where it is performed and by whom – is a sensory, tacit, material, embodied and affective practice which is better understood as situated in a sociocultural context and community of practice (Knorr-Cetina, 1999; Sandell, 2010; Friese, 2013; Maslen and Harris, 2021).

Based on a qualitative study of cattle farming in France and the UK, we examine how sensor technologies affect knowledge production about cow health and illness when they are brought into clinical practice at the farm. We pay attention to the temporal and spatial dimensions of the impact of digitalisation on everyday practices to ask the following research questions: how are the individual and collective practices of veterinarians, farmers, cows and related actors affected by the use of sensor technologies? How are sensor technologies reconfiguring the organisation and objectives of animal healthcare in farming? What are the implications for innovation management in cattle farming and policies that support its digitalisation?

2. Methods

We draw on empirical research conducted in dairy farms in France and the UK, which are two of the largest cattle producers in Europe and global investors in technology development for the food industry. Our data comprises 43 interviews with cattle farmers, veterinary surgeons, veterinary educators, technology developers, and researchers, as well as more than 200 hours of ethnographic observations of four dairy farms in France and the UK. Data analysis (in progress) is based on an inductive approach, informed by grounded theory methods (Charmaz, 2009).

3. Results

3.1. Digitalising everyday practices in cattle farming

Changes in levels of regular activity (such as eating and drinking), movement, and body condition are important early warning signs of a cow's deteriorating health, which may lead to a reduction in the productivity of dairy farms. These signs not only make it possible to draw the attention of the farmer and the veterinarian to potential dysfunctions or discomfort experienced by the cow, but also inform how her clinical auscultation will be conducted, contribute to the construction of clinical hypotheses and, ultimately, to the establishment of a diagnosis.

The practice of diagnosing cow illnesses, therefore, exists at the intersection of knowledge produced by farmers – who are in close and constant contact with the animals and who have expertise in conducting certain clinical procedures; veterinarians – who regularly visit farms to conduct routine checks, support and collaborate with farmers, and who are also connected to formal sites of knowledge production on animal health, such as research institutes and universities; and the knowledge produced by cows themselves, who learn how to adopt specific routines (e.g. milking, receiving medication) in collaboration with farmers and veterinarians and in the presence of farm technologies (e.g. milking machine).

Historically, information on a cow's health was mainly gathered by direct visual and manual inspection before and/or during the visit of the veterinarian to a farm, in communication with farmers and based on their appreciation of changes in the animal's routine or appearance. Today, their activity levels, movement, and general body condition are increasingly and continuously accessible remotely by the use of sensor technologies attached to the body of the animal. Data collected by the sensors become available daily on computers, mobile phones, or tablets to farmers and veterinarians. Sensor technologies directly attached to the cow's neck, leg or ear and cameras installed in transit areas record and trace in real-time any (ab)normalities which, following automated analysis by dedicated software, are then reported on the system.

3.2. Calibration, triangulation and translation practices

Our study identifies new forms of sensory work afforded by digital sensor technologies and shows how they become embedded (or resisted) within the everyday routines of farmers, veterinarians, cows and other actors as they engage and co-produce knowledge about cow health and illness. As the routines change on the farm, different actors get involved in three types of knowing practices that are entangled with digital sensing technologies. We outline them below.

Calibration practices. Sensor data informs important decision-making processes in farms and therefore require calibration. Calibration work is one of contextualisation and regular comparison, which usually requires in-person validation (i.e. it cannot be conducted remotely). In calibration work, veterinarians learn about contextual elements of a cow's routine that are known to the farmer; at the same time, farmers learn from veterinarians what types of data are important and how to interpret them to inform clinical practice. Despite the codified nature of sensing data, calibration work is also dependent on tacit knowledge. That is, sensor data is 'calibrated' against knowledge based on recent or past experience with animals. Farmers and veterinarians learn how to "know their cow" through regular comparison and observation, with an important temporal dimension to tacit knowledge. On the one hand, these actors rely on their past experience with individual cows well-known by them. For example, a cow that has, for many years, regularly displayed a specific type of behaviour – such as particularly high activity when out on the grass for the first time in the year – that could be identified as deviant (and, therefore, trigger a warning) by the sensing technology. On the other hand, they also rely on recent contextual analysis. For example, if the barn where the cows eat and rest has been recently cleaned, sensor technologies would also show higher levels of activity, but this is because cows would be moved between barns (during the cleaning process).

Triangulation practices. Farmers and veterinarians also engage in triangulation practices, which are defined as the integration of different data sources to inform the clinical analysis. Here, the history and background of the cow (as it is the case with human patients) is integrated with other data sources, such as sensor data on milk production or volume, the number of failed inseminations, the cow's age, as well as comorbidities, such as common diseases like mastitis (udder inflammation) or lameness (limping). In triangulation work, digitalised data coexists with information that may be entered manually, either by the farmer or the veterinarian, but the two need to make sense together of which data sources to use and how data should inform clinical practice.

Translation practices. Translation practices refer to the use of data to inform action or the translation of observations and data analysis into action (e.g. decisions on artificial insemination). For example, cows may receive a lameness score based on a combination of body condition and mobility scores measure through the collection of different data from cameras placed in areas like milking spaces. A recommendation from the software is then issued and a cow may be identified for treatment, which potentially demands the identification by farmers and veterinarians of other specialists, such as foot trimmers to treat conditions such as lameness. A range of factors may affect translation work, including resources in terms of staff, space and time availability; or the opportunity to take advantage of expertise and knowledge available at a given time (e.g. the presence of the veterinary when they come for their routine visit). Finally, translation work also depends on the balance between the needs of farm settings, the capabilities of technological systems to deliver on them, as well as the validation between what is observed in the farm setting by researchers and what becomes codified in software by developers and data analysts.

4. Preliminary conclusions

This paper contributes to furthering our understanding of the complex relationship between digital technologies and everyday practices. We put forward three sets of sensing practices that demonstrate the entanglement between human and nonhuman actors in producing knowledge that is of relevance to the management of animal health and illness. We argue that the successful implementation of digital technologies in farming depends on how these three sets of practices unfold as sensors and AI-related methods such as machine learning become embedded in farming routines. We also highlight several factors of relevance to policy-making in European countries and the UK, which affect a broader project of digitalisation of farming practices, such as the need for human resources to make sense of big data and to conduct essential transdisciplinary (or translational) work.

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Keywords: Digitalisation, Sensor technologies, Knowledge production, Practice, Farming

[235] Max Meier (Centre for R&D Monitoring (ECOOM), KU Leuven). *Exploring the (inter-)disciplinary pathways of and towards grand societal challenges.*

Abstract. Collaborations across cognitive, social, institutional, organizational, and geographical borders have increasingly been recognized as a means to tackle the complexity of today's societal challenges. Among the many hopeful prospects of such collaborations, interdisciplinary research (IDR) has become a priority among several scientific funding organizations in the world. The underlying rationale can be described as twofold: first, that valuable scientific progress can be derived from combining multiple disciplines towards a research problem and second, that in the absence of specific incentives, the barriers for such interdisciplinary research collaborations might be too high (Hackett et al., 2021; Ledford, 2015).

With the increased attention for IDR, much academic research has been devoted to better conceptualize, delineate and measure the phenomenon. While this is of particular importance to the research on the SDGs, to which extent these efforts are successful has been contested. On the one hand, on grounds of the consistency and validity of the proliferated measures, even among supposedly similar indicator dimensions (Wang & Schneider, 2020). On the other hand, on the basic premise that the quantity of subject or field categorical combinations, such as the number of WoS subject categories in the reference list of publications, can provide insights into the pathways and manifestations of the (inter-)disciplinary phenomenon (Rafols in Sanders et al., 2021). This also relates to the apparent disconnect between the boundary work of conceptualizing and defining the types, degrees and definitions advanced by (i.e. Huutoniemi & Rafols, 2017; Klein, 2017) in capturing IDR, and the lack of such similar efforts in relying on the more bibliometric tradition, with some notable exceptions (i.e. Marres & de Rijcke, 2020).

In this spirit, the idea is to discuss a research approach that might be better able to reflect differences in (inter-)disciplinary pathways of and towards grand societal challenges. The assumption advanced here and to be tested is that the sections of where those references occur and co-occur in a publication can be informative as to the type of knowledge integration reflected in the publication. These can be observed by exploiting the information in full-text databases and identifying section headings, alongside the in-text references and connecting them to the bibliographic databases that contain the metadata related to a given publication. Possible distinctions could be drawn between i.e. empirical, methodological and theoretical interdisciplinarity (Huutoniemi et al., 2010), depending on the distribution of the observed categories across those sections of the paper. Both the knowledge integration as well as knowledge diffusion (Liu et al., 2012) of a focal paper could be traced and reflected against the type of knowledge integration that has taken place. Some guiding questions could include:

- Is it the fusion, the displacement or combination of concepts/ theories/ methods in (dis)connected fields that characterizes the (inter)disciplinary nature of a societal challenge?

- Is there a limit as to how many references can be considered key or only ancillary to the resulting type of knowledge integration? Can this inform currently used indicators, such as variety, balance and disparity that only rely on the full reference lists?

- To which extent do the same or closely related reference categories co-occur in a given section? Could those be reflective of multi-or interdisciplinarity?

- Are there observable differences across societal challenges addressed by the SDGs related to the types of knowledge integration?

- Are there observable differences between the knowledge integration and the knowledge diffusion dimension (i.e. does theoretical knowledge integration result in the publication being used as theoretical input in all of the integrated fields?)

Reflecting such a research approach in the context of the STEPS research project and more broadly among research on SDG can be particularly important due to the conviction among policy-makers and science-funders that interdisciplinarity is an important element in contributing to their success. Moreover, research on interdisciplinarity can benefit from a more careful assessment as to the representativeness of its science categorization schemes which is within the scope of relating the SDGs to specific research areas.

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Keywords: Interdisciplinarity, SDG, Pathways

[236] Katherine Lovell (University of Sussex). *Digital Twinning for infrastructure transformations: opportunities for policy and sustainability?*

Abstract. The idea of the digital twin is a key meeting point for fast emerging Industry 4.0 capabilities and the relatively slow and steady world of the developing built environment. Although longer established in product and manufacturing sectors, digital twinning is currently an area of intense interest and discussion within the built environment sector. Increasingly these interests and justifications around digital twin development are being connected to sustainability, resilience to a changing environment and decarbonisation. How well can digital twinning be applied, beyond a management tool for new buildings, to provide tools for policy and design to work together in transforming cities and established infrastructure sectors for sustainability?

A digital twin provides a virtual replica of a physical asset or built system using system data to generate a representation of the asset or system in operation. Important early uses of digital twins have included NASA's use of simulators in the Apollo 13 rescue and within the power by the hour business model for aircraft engines. However, advances in sensor technologies and continuing developments in communications, such as the Internet of Things (IoT) are opening up possibilities for digital twinning. In the built environment the development and use of digital twins built initially from developments in Building Information Modelling (BIM) and, like in manufacturing sectors before it, develops a link between design/innovation and operation in the sector. However, the built environment is also a sector with longer lifecycles and path dependencies and with broader societal requirements than many manufacturing sectors. In this context digital twinning (and its potential influences on innovation and change (Purdy et al., 2020)) could have the potential to address a different type of challenge by forming the basis for communications and co-ordination for transformation of complex and embedded systems for sustainability.

The case of the UK presents two areas of policy development that provide a setting to consider digital twinning contributing to co-ordination of infrastructure transformations for sustainability. The first is the creation of a legally mandated 2050 Net Zero target for carbon emissions across the UK economy introduced in 2019. The second is policy steps supporting the development of digital twinning in infrastructure. Developments towards digital twinning for infrastructure include the 'National Digital Twin programme', set up in 2018 in response to work by the National Infrastructure Commission (2017). This national level stream of work brings has been set up to include considerable levels of industry engagement and work considering values for uses of data associated with national initiatives (see the Gemini Principles (Centre for Digital Built Britain, 2018). It also prompts a connection to national policy issues, such as the Net Zero target; for example, The Royal Society (2020, p6), considering digital twins applied at a systems level refer to "rich data flows enabling a 'control loop' for the planet's emissions". These developments highlight the additional demands for digital twins in this context and upon the involvement and influence that might be required from policy actors in framing digital twining within processes.

This research considers the potential for digital twinning in the built environment as a space for interactions with policy actors and to contribute to decarbonisation, beyond individual buildings and new build sites, at city scale and national scales and through opening up understanding for transformations in established infrastructure systems. The case study traces developments in digital twinning for infrastructure connected to policy in the UK. Theory of innovation processes in socio-technical systems is used to better understand potential additional demands and challenges on processes of digital twinning for infrastructure transformation and to reflect upon opportunities and barriers for digital twins to contribute to co-ordinating responses to the policy challenge of Net Zero.

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Keywords: Infrastructure, Digital Twin, Sustainability Transitions

[237] Conor Douglas (Department of Science and Technology Studies, York University (Toronto)), Fernando Aith (Universidade de São Paulo - FSP/USP), Claudio Cordovil-Oliveira (Escola Nacional de Saúde Pública Sergio Arouca Fiocruzr), Wouter Boon (Copernicus Institute of Sustainable Development (CISD), Utrecht University), Liliana Doganova (CSI, ARMINES), Rob Hagendijk (AISSR/Political Science, University of Amsterdam), Janrno Hoekman (Copernicus Institute of Sustainable Development (CISD), Utrecht University), Tineke Kleinhout-Vliek (Copernicus Institute of Sustainable Development (CISD), Utrecht University), Ellen Moors (Copernicus Institute of Sustainable Development (CISD), Utrecht University), Alexandre Mallard (CSI, ARMINES), Florance Paterson (CSI, ARMINES), Shir Grunebaum (York University) and Vololona Rabeharisoa (CSI, ARMINES). *Social pharmaceutical innovation: Towards a interdisciplinary research agenda for drugs for rare diseases .*

Abstract. RELEVANCE & RESEARCH QUESTION

The area of rare diseases presents a number of societal challenges that are troubling science and innovation scholars and health policy makers alike. These relate primarily to the access and availability of treatment for rare disease patients, which maps onto issues of social justice and health care system sustainability. Today, there is considerable unmet treatment needs with 7000 currently identified rare diseases only having 564 orphan products approved by the US Food and Drug Administration (FDA) to treat about 11% (or 838) rare diseases (Commissioner, 2020; Hurron, 2021). As a consequence millions of patients still go untreated. While some challenges facing R&D in this space are scientific and technical, there are also a number of issues more associated with policy issues related to social, economic and political (regulatory) factors. For instance, patents and secrecy stifle cooperation and collaboration that is critical in rare disease research. The price of treatments is also an issue with many of the most expensive drugs in the world being for rare diseases (Luzzatto et al., 2018). Finally, there is a stark evidentiary mismatch between industry submissions and the existing regulatory and HTA structures that lead to delayed access to medicines, and can lead to poor coverage decisions. While not an exhaustive list, it is evident that there are constraints on the current system to deliver on the needs of rare disease patients. While challenges are experienced differently globally (i.e., North-South), many are also being expressed transnationally, which suggests systemic issues.

In the face of these challenges our consortium is observing a growing number and variety of initiatives in the rare diseases field that are of significance due to the role they are playing in addressing some of the challenges of access and availability of treatments for rare diseases, and because they are doing so in ways that depart from the traditional industry-led model of innovation (Rollet et al., 2013). The initiatives in question have in common that they involve several societal stakeholders, explicitly address a higher societal goals, or both.

In this paper we ask how scholarship and practices within social innovation can help us make sense of these developments? In addressing this question we construct an interdisciplinary research agenda and analytical framework to make sense of these emerging practices and processes that we are terming social pharmaceutical innovation (SPIN)? Through this framing how might we contribute to SPIN – both through policy initiatives and otherwise.

THEORETICAL FRAMEWORK

The novel practises we are observing across the R&D life-cycle of rare disease drugs are creating opportunities for re-envisioning pharmaceutical innovation through what SI scholars refer to as the "adjacent possible" (Johnson, 2011; Kauffman, 2000; McGowan & Westley, 2015) in which "the range of alternative social arrangements [is] just beyond the horizon of prevailing practice" (McGowan & Westley, 2015). We are proposing this heuristic device of social pharmaceutical innovation (SPIN) that can help us to both more fully understand this "adjacent possible" in drug development, as well as contribute to its further progress. We understand SPIN as novel forms of collaborative processes, programs, policies, procedures and/or designs involving diverse sets of actors that break with conventional pharmaceutical innovation practises for the production of safe, effective, and accessible interventions that address unmet societal needs of rare disease patients that are not primarily market-driven. Similar to SI, we see SPINs pertaining to both transformations in processes as well as in novel outcomes; however, these two concepts differ in the respect that we see SPINs as an emerging techno-social phenomenon and research object rather than an analytical perspective. We see SPIN as a 'working concept', both in terms of the work it carries out as a heuristic device that aids in framing research and asking pertinent questions concerning transformations in pharmaceutical R&D, and in terms of being a concept 'in work' in terms of its evolving nature. As such, we anticipate our definition of SPIN to develop in an iterative manner through further empirical investigations, conceptual elaboration and engagement with stakeholders.

DATA AND METHODOLGICAL APPROACH

As a consortium we are critically assessing the content, processes, and outcomes of three types of such social pharmaceutical innovation that cover the lifecycle of pharmaceutical innovation. The first form of SPIN that we are interested in are novel R&D partnerships across the public, not-for-profit and private sectors. For instance, in the context of drugs for rare diseases these partnerships may concern the development of new drugs, as well as the re-purposing of existing drugs. Central questions raised in understanding this form of SPIN concern the nature of multi-sectoral partnerships in question, in terms of what they actually do and what they aim for? Also critical is describing how the various actors involved frame the problems and causes they seek to address (e.g., rights to health, social justice, unduly high profits for companies).

A second form of SPIN we have started to study is the development of alternative forms of provision and licensing. These include magisterial preparations (i.e., medicines prepared by pharmacists, based on prescriptions for unmet needs, etc.), public sector manufacturing (e.g. when the state or a public-private partnership takes the lead in producing a treatment in their own facilities), off-label use (e.g. the use of a drug, which is on the market, but for an indication other than the one for which market approval is given), early access schemes (Ali et al., 2018) and compassionate use (e.g. the provision of promising treatments before they get market approval), and adaptive pathways (e.g. iterative drug development plans and progressive provision before and after market approval). Critical here is understanding how evidence is debated between the various actors involved. Another question is whether and how actors from different institutional backgrounds (e.g. public, private, community) are able to align their incentives and activities in novel collaborative arrangements.

The third form of SPINs studied are alternative regulatory frameworks for coverage. This includes initiatives for new medico-economic Health Technology Assessment procedures that consider the social value of drugs for unmet needs (Baran-Kooiker et al., 2018; Lasalvia et al., 2019), as well as new pricing (Hollak et al., 2021) and reimbursement schemes negotiated between companies and public authorities to lower the prices of certain drugs, are some examples (Holleman et al., 2019; Klemp et al., 2011; Zaric, 2021). Here the focus is on the nature of regulatory and institutional change that SPIN contemplates, or drives.

Explorations into the different types of SPIN discussed above necessitate analysis on at least three cross-cutting issues. The first is an understanding of the diverse problem-framings and goals of SPIN initiatives. This includes the national and transnational debates surrounding drugs for rare diseases, as well as how these debates are framed, and through which media they play out. The second key cross-cutting issue is processes: how are SPIN constituted and through what processes and factors are they adjusted and actually carried out? What role does the decentralised and distributed character of these SPIN processes play is this, and how are collaborations organised and managed? Careful consideration must be given to when, where and how multi-sectoral partnerships emerge, and particularly when patient organisations intervene and/or are mobilised for the design and conduct of SPIN. Finally, SPIN must also be examined and held to account for its outcomes and/or products. Critical questions must be asked of the extent to which SPINs are delivering on their promises: What successes may be claimed? What can be learned? How to improve the track record of SPINs in targeting rare diseases? How and where have SPINs reorganised work and activities relative to the medical, practical, regulatory and politico-economic environment? When and how can activities be aligned better and sincere collaborations be stimulated? In setting up partnerships, what obstacles do SPINs face? Through these three cross-cutting lines of inquiry we may begin to think about ways of systematically analysing, assessing and ultimately understanding the different types of SPIN.

RESULTS / EARLY POINTS OF DISCUSSION

Through the framing of examples of SPIN in the rare disease space important differences are emerging between seemingly identical cases and across contexts and constituencies. The first type of difference relates to the diversity of initiatives. SPINs can not easily be divided up in discrete sets of practises, but rather amount to series of distinct and different initiatives and dialogues ranging from more inclusionary forms of research and development to policy changes at the regulatory or health systems level. This offers significant opportunities to learn how different constituencies are engage with and address challenges relating to drugs for rare diseases. This diversity prompts social scientific methodological reflection in terms of what we engage with (i.e., studying actions, processes or discourses). Related to this point of diversity of SPIN is the fact that writ large differences exist depending on global, national or even regional contexts. The capacities for collaborative research and development initiatives differ between the Global South versus North. Political stability, economic and industrial development, social inequalities, corruption, among other factors, have a direct impact on the country's capacity for social pharmaceutical innovations. At the same time, inequalities and hurdles also can be a factor for creative social innovation in the Global South. Furthermore, constitutional and policy arrangements of individual countries are also proving to be significant mitigating factors in the success of – let alone possibly for- some forms of SPIN.

The second point is the nature of participatory research activities in terms of who is included in such endeavours, who is left out, who decides who participates, and to what end? Similarly why are some kinds of SPIN undertaken rather than others? To be sure, scientific and technical features figure into the answers to some of these questions, which our consortium considers alongside socio-cultural and political-economic drivers. How do such features and drivers relate or get related?

The third point raised in our analysis of SPIN has to do with the extent and degree of change they enable. Within the SI literature, it is argued that "[t]o achieve broad, lasting change, social innovations must cross multiple scales" (McGowan & Westley, 2015). We are observing scale-up difficulties in some instances of SPIN (e.g. with hospital-based or public sector manufacturing of cell therapies). This raises broad strategic questions for stakeholders about outcomes, success, and possible failure. How to challenge and change the system and how radical system change may be achieved. Is it the case that SPIN must have lasting system impacts if -for example- they are able to secure medicine for a patient(s) that might not otherwise be treated? How does one evaluate more micro-level interventions that might be transitory against endeavours that seek more system-wide change?

CONCLUSION AND POLICY ISSUES

We are observing a number of broader fields of change taking place around rare diseases, which we have termed here social pharmaceutical innovation (SPIN). Building on research and practice in social innovation, our perspective on these developments seeks to add explanatory value of what is taking place from a broader socio-technical perspective, comparative value of what has and has not worked in other contexts including experiences with challenges and barriers within and between lower, middle, and higher income countries, and evaluative value concerning the outcome of these initiatives and what they have been able to achieve vis-à-vis their goals and impacts on dominant pharmaceutical R&D practises. By formulating these developments in terms of SPIN critical research questions emerge about the problem-framing and the goals through which SPINs work as well as the nature of SPIN processes and outcomes. We see these questions as part of an ambitious agenda for future research that we want to contribute to and with which we hope to draw in others to do the same. Furthermore, by framing these activities in terms of social pharmaceutical innovation we not only seek to ignite further interest in these questions but also hope to actively contribute to them. We will organise an outreach event in 2023 to share our preliminary findings and receive feedback from stakeholders in this space on the policy recommendations we are developing in support of SPIN.

Keywords: social innovation, social pharmaceutical innovation, rare diseases

[238] Sergio Salles-Filho (University of Campinas), Kleinsy Bonilla (University of Campinas, Brazil.), Adriana Bin (University of Campinas, Brazil.), Nicholas Vonortas (George Washington University), Laurent Bach (University of Strasbourg), Marie-Louise Eriksson (ML Impact Consulting AB, Sweden), Carlos Henrique de Brito Cruz (Professor Emeritus of the Physics Institute of Unicamp) and Yohanna Juk (University of Campinas, Brazil.). *Planning and orienting funding agencies: international evidence and trends.*

Abstract. Introduction

This study reports an ongoing project that aims to identify and synthesize the main trends and strategic and operational drivers of Science, Technology and Innovation (STI) funding agencies.

Public and private not-for-profit STI funding agencies are organizations that constitute an essential pillar for policy design and implementation. (Braun, 1997). A preliminary literature review highlights trends in funding agencies, such as the need for qualified information on the effects (impacts) of funding for basic and applied research, in many dimensions, sectors and matters of general or specific interest nature. Based on these discussions, funding agencies have invested in experimental and observational studies (Buckley-Woods & Wilsdon, 2021; Barnett, 2016; Brock, 2019; Veletanlić, 2020) - such as randomized or quasi-randomized experiments, simulations, and longitudinal studies - to rely on data and evidence for its planning and institutional learning and also to demonstrate its relevance as an organization promoting development, render accounts and present its impacts to society and advocate in favor of resources. (Azoulay et al., 2015 e Li et al., 2017).

Nowadays, we can say that they are a sort of compass of STI policies to the extent they reflect, and influence, the design and implementation of programs and funding instruments.

The general underlying question is that, given the common environment in which different STI funding bodies operate, could we observe common trends as regards to objectives and organization across funding agencies? For this we look for evidence from country case studies and a comprehensive literature review.

This role has been particularly visible in the past ten years because of two main drivers: a) the increasing pressure to show societal, environmental and economic impacts; and b) to engage to national, regional and local development policies. These drivers have led funding agencies to systematically implement strategic planning and to professionalize planning and management departments in their organizational bodies.

Methodology

This study reports cases of funding agencies from the following countries:

• China (National Natural Science Foundation of China)

• France (Agence Nationale de la Recherche)

• UK (British UK Research and Innovation)

• South Africa (South Africa National Research Foundation NRF-AS)

• Sweden (VINNOVA and Swedish Foundation for Strategic Research)

• United States of America (ARPA-e, GRA and NYSTAR)

The methodological approach was based on collecting primary and secondary data of the identified funding agencies employing literature review, desk review of official documents and websites, and interviews with managers from those agencies.

The main topics we are looking for are: i) common strategic trends; ii) planning strategies; iii) main funding trends; and iv) operational drivers.

The case studies followed a common outline structure:

i) Description of the recent strategic planning, including:

a) Description of the scope, main issues and concerns, time horizon of the strategic plan/document.

b) Description and analysis of the leading institutional goals and drivers established by the plans for the short, medium, and long-term.

c) Description and analysis of how agencies have been defining and implementing their institutional priorities.

d) Description of the main programs and funding instruments resulting from the strategic planning, with a focus on:

1. Research for innovation

2. Support for habitats of innovation (as for ecosystems of innovation and similar approaches), and

3. Research for social and economic impacts.

e) Other complementary topics such as new sources of funding, how agencies are facing challenges related to increasing gender and ethnic diversity in RDI and incorporating the Sustainable Development Goals.

Below we present a very brief description of issues being developed in the selected funding agencies and that will be completed and detailed in the full paper:

i- China - National Natural Science Foundation of China (NFSC)

China has five leading organizations that fund science projects, NFSC is the major funding agency. Since its establishment in 1986, NSFC has introduced and implemented a merit-review system, with researchers as main users. Its mission centers around supporting basic research, fostering talented researchers, developing international cooperation and promoting socio-economic development.

The NSFC is enforcing the Reform Plan on the Funding System of the National Natural Science Fund which was approved at the first Plenary Meeting of the 8th NSFC Committee. The organization uses this instrument as a roadmap for five to ten years. Three major reform tasks have been highlighted: a) identifying funding categories, b) establishing category-specific review systems, and c) optimizing the layout of research areas.

As for “identifying funding categories” the objective is to play a guiding role in the research and behaviors of applicants. Support truly new ideas and concepts which provide concrete solutions to meaningful scientific problems. Distinguish basic research with different scientific attributes. They divided scientific research activities into four categories according to the attributes of scientific issues:

i. research of creative and timely ideas,

ii. research focusing on frontiers of science in unique ways,

iii. application-driven basic research, and

iv. transdisciplinary leading-edge research.

ii- France - Agence Nationale de la Recherche

The French National Research Agency (ANR) is a public administrative institution under the authority of the French Ministry of Higher Education, Research and Innovation (MESRI). It was founded in 2005 to promote French project-based research and to stimulate innovation by promoting the emergence of collaborative multidisciplinary projects and encouraging collaboration between the public and private sectors. The ANR is now the main French public agency funding project-based research carried out by public operators cooperating with each other or with private companies. Its primary mission involves ANR in the implementation of the National Research Strategy.

The analysis indicates that the ANR has progressively gained organizational maturity, structuring planning and strategic orientations, and a willingness to develop evaluation ex-ante and ex-post, advanced project management practices, and data collection and dissemination. Evidence also suggests that ANR activities reflects the research work carried out by France to help the society to address the major challenges it is facing, in connection with the European Commission's “Horizon Europe” and the United Nations “Sustainable Development Goals” (SDG).

iii- South Africa - South Africa National Research Foundation NRF-AS

The NRF promotes South African research and innovation interests across the country and internationally. It is the main organization in the country responsible for promoting the national research enterprise and is the primary public funding of postgraduate students and researchers. The most recent strategic planning pointed to the TIES conceptual framework: Transformation, Impact, Excellence and Sustainability.

Transformation is interpreted to go beyond demographic representation to include the transformation of institutional cultures, including curriculum reform. Within this context, the NRF has identified the need to accelerate the transformation agenda across universities and research institutions to ensure diversity, taking into account race, class, gender and disability. In response, a comprehensive Transformation Framework has been developed.

Impact refers to the societal and economic (innovation) impact. This anchor is interpreted to include both the impact of the NRF and the impact of the research enterprise supported by the NRF. Start with the needs and demands of society, and, working backward, seek specific research-based solutions to societal challenges. The need to balance ‘curiosity-driven’ and ‘challenge-led’ research has been recognized

Excellence is one of the main parameters of research evaluation. The NRF has a well-developed process for assessing the excellence of individuals and research proposals. The value of excellent research has always been considered self-evident based on the assumption that most of the curiosity-driven research would reap benefits in time.

Financial and human sustainability, both internally to the NRF and externally.

iv- Sweden - VINNOVA and Swedish Foundation for Strategic Research

There are four large public research funding bodies in Sweden: the Swedish Research Foundation, FORMAS, FORTE and Vinnova. The largest public funding body in Sweden is the Swedish Research Foundation, with an annual budget of approximately € 670 millions. The Swedish Research Foundation funds mainly basic research. The best research ideas are selected in open calls, in competition, and after in-depth peer review and prioritisation. Vinnova is the Sweden innovation agency and invests approximately € 287 million per year in research and innovation projects and building the innovation eco-system.

Although different in nature, both agencies have implemented frameworks to drive research towards strategic research, solving societal challenges, and promoting cooperation between either different disciplines or actors from several sectors. There is also an increasing emphasis on creating synergies among programs and projects with the aim to make the best use of money.

The growing focus on societal challenges, however, is not without problems, as there always lies a risk in defining what a challenge is and to whom. Thus, the Swedish Government has in its latest Research and Innovation Bill also included a theme of democracy. It is also emphasizing the importance of protecting free research. The promotion of basic research and a free academic context in which researchers can focus on research issues that might not answer to a current societal problem, and which has a long way to be “commercialized” has proven important in an era of uncertainty. There must be a balance between curiosity- and needs-driven research.

v- United States of America - ARPA and the National Science Foundation

The Advanced Research Projects Agency-Energy (ARPA-E) is a relatively new U.S. agency, which applies the Defense Advanced Research Projects Agency (DARPA) model to the energy technology sector. The agency’s mission is to advance high-potential, high-impact energy technologies that are too early for private-sector investment.

ARPA-E issues periodic Funding Opportunity Announcements (FOAs), which are focused on overcoming specific technical barriers around a specific energy area.

A key element of ARPA-E's mission is preparing for eventual transfer to market, termed "technology-to-market," or "T2M"; ARPA-E helps move technologies down the innovation pipeline to the prototype or small-scale demonstration stage. It has continuously evolving system to aid project teams for the eventual development of their technologies into commercial products. ARPA-E is characterized by institutional independence and a flat organizational structure, and it can quickly initiate and terminate projects based on performance.

Final remarks

Investigating trends in STI funding agencies can aid the development of new policies and practices for hiring, promotion, and funding decisions. Some preliminary findings show common trends for new methods of priority setting and decision making (including randomization); adoption of strategic planning followed by monitoring and impact evaluation; applying a broader concept of excellence, considering inclusion, societal impacts, knowledge transfer instruments, and SDG; interconnections with higher-level development policies; among others that are now being detailed and completed.

Our proposal intends to contribute to the theme 02 Forward-looking activities (FLA) for STI policies.

Next steps

Data analysis is now being conducted to identify and compare international evidence and trends.

Keywords: funding agencies; science, technology and innovation trends; international trends.

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Keywords: funding agencies, science technology and innovation trends, international trends

[239] Emil Ahmadov (Nova Information Management School), Bruno Damásio (Nova Information Management School) and Sandro Mendonça (Instituto Universitário de Lisboa (ISCTE-IUL) – Business Research Unit (BRU-IUL), Lisbon, Portugal). *Big Tech shadowing the science system: An analysis of direct and indirect support strategies by the very large digital platforms.*

Abstract. The academic influence of the large digital economy players (Big Tech) is a little understood issue. By drawing on 130,000 academic papers for which there is evidence of support by the Big Tech, the present work applies bibliometric approaches (on the metadata) and textmetrics techniques (on the contents) to derive a set of stylised facts. In particular, we take into consideration research funding (direct strategies) and conference sponsorships (indirect strategies) to empirically explore this relatively unexplored side of Big Tech's massive role in contemporary society. While developing the analysis a key limitation was the scarcity of prior work exploring the connections between digital platforms and the scientific enterprise. We find that conference sponsorships rise after the year 2000 while financing to published papers follows suit after 2005. There are several patterns that come to light, a major stylised fact being that research supported by Big Tech companies gives much more weight on the technical perspectives (like machine learning or artificial intelligence) than to reflexive (say ethical or environmental) dimensions of innovation. These findings may stimulate further inquiries into why, where, how and how much and what risks are generated from the direct and indirect that steered toward academia by corporate informational giants. The causes and consequences of this non-market activity by companies with huge market power may warrant the attention by regulators and policy-makers.

Keywords: Big Tech, Digital Platforms, Research Funding, Science Policy, Regulation

[240] Maria Tsouri (Mohn Centre for Innovation and Regional Development) and Ron Boschma (University of Utrecht). *The importance of science for the development of new PV technologies in European regions.*

Abstract. Climate change and its economic, social and environmental consequences, constitutes one of the most pressing problems of our time. Reducing climate change's rippling effects demands a fast transition to new technologies. This transition is particularly important for the energy production sector, where innovation in renewable energy technologies (RETs) is crucial for both sustainable development and economic competitiveness. There is broad consensus that new technologies do not emerge out of the blue. They build on existing technologies and science, combined in different ways (Boschma et al., 2015; Mazzucato, 2018; Rigby, 2015). The importance of the linkage between science and technology has been extensively studied, stressing out that the interactions between academia, industry and state constitute the institutional context fostering innovation, knowledge economy and economic development (Leydesdorff & Etzkowitz, 1998). The innovative activity and knowledge economy development in Europe is supported and reinforced by supranational, national and regional policies (e.g. EU frameworks).

The innovative activity in RETs is highly dependent on the advancements of science and technology. Innovative patenting activity in RETs is subsequent to scientific knowledge providing innovative marketable applications in the field of energy transitions. However, despite the large research strand on the linkage between science and technology, there is still scarce evidence on how well scientific knowledge is transformed into technology in regions. Using the relatedness framework, Balland and Boschma (2021) investigated link scientific and technological capabilities of European regions in specific domains, based on patent and publication data. Both scientific and technological knowledge in RETs tend to show their own geographies, and there is not necessarily an overlap between the two (Balland & Boschma, 2021). Moreover, regional capabilities seem to be very important for regions to diversify into green technologies (Santoalha & Boschma, 2021), a topic that has not yet caught too much attention in the transition literature

The aim of this study, therefore, is twofold. The first objective is to construct a measurement of relatedness between the scientific fields from which RETs source their scientific knowledge base. The second objective is to understand how well this scientific knowledge is transformed to regional technological capabilities, enabling regions to pursue new technological directions in RETs.

To do so we use the solar Photovoltaic (PV) technology. PV is one of the principal RETs that leads towards sustainable energy production. In particular we focus on PV technology because: (i) several European policies were introduced to boost its development, (ii) it is a technology reducing climate change, and (iii) it consists of components and materials that may be considered of different diffusion (Kalthaus, 2019). Thus, we find particularly important to understand how the scientific and technological knowledge affects the geographical distribution of each type of PV technologies having an impact on the development of technological capabilities of regions in this RET industry.

Empirically, we have identified all patents granted on photovoltaics for twenty years (1998-2015). We used the PATSTAT database to identify all patents with a cooperative patent code (CPC) on photovoltaics (Y02E10/5*) and at least one inventor located in a European country. We identified twelve distinct types of PV technologies within this domain, noted by different CPCs. We geolocated all Europe based inventors in NUTS2 level, assigning patents to NUT2 regions. We extracted all the scientific publications as well cited in these patents, assigning each one of the publications to one or more scientific fields. The scientific fields were attributed to the publications through the journal they were published (Scopus journal classification). In this way, we defined the link between technological and scientific knowledge as the citation a publication by a patent.

Additionally, we used Scopus publications on PV technologies for the same period of twenty years, to define the scientific regional capabilities. In this way, we have the regional technological knowledge capabilities measured by patents, the regional scientific knowledge measured by publications, and the link between the regional technological knowledge and the scientific knowledge regions source from outside the region measured by the academic citations of patents. We divided the period of twenty years in seven-year windows.

For each seven-year window, we expressed the relative specialization on a type of PV technology of a region, calculating the revealed technological advantage (RTA) that a region presents to a specific type of PV technology. RTA is defined as the share of a technology in a region's overall patents divided by the all-region share of this technology in all patents. To explain the relative specialization of a region on a type of PV technology, we employed four main relatedness matrices. The first one expresses for each type of PV technology its relatedness to the rest of PV technology types, the second one the relatedness of each PV technology to the rest of technologies, the third is the relatedness of each type of PV technology to the scientific knowledge external to the region, and the fourth is the relatedness of each type of PV technology with the scientific capabilities of the region. In this way, we were able to measure how much a region (NUTS2) was diversified in terms of PV technology types, the rest of technologies and scientific fields.

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Keywords: green diversification, technological capabilities, scientific capabilities, relatedness, European regions, Photovoltaic (solar) technologies

[241] Markus Trunschke (ZEW-Mannheim/KU Leuven), Bettina Peters (ZEW-Mannheim/University of Luxembourg), Dirk Czarnitzki (KU Leuven) and Christian Rammer (ZEW-Mannheim). *COVID-19 and Innovation: Long COVID for German Innovation Activities?*

Abstract. The COVID-19 pandemic combined with measures to prevent health care systems from breaking down has negatively affected economies worldwide. Since the pandemic, numerous companies have had to cope with temporary lockdowns, social distancing measures, and disrupted supply chains. Therefore, in an effort to stay in business until the end of the pandemic, firms had to adjust their strategies, resulting in the reallocation of resources to the most urgent issues. Innovation activities have likely been reduced in this process because they only provide performance benefits in the future. However, innovation is a primary driver of economic growth and is highly important for firms to stay internationally competitive. Even though reducing innovation activities might allow firms to survive the COVID-19 pandemic, it can negatively affect their future performance. Therefore, a reduction in innovation activities during the pandemic can impact economies negatively in the coming years.

This paper focuses on the innovation response of German firms that are negatively impacted by the COVID-19 pandemic. Our analysis uses information from the two most recent waves of the Mannheim Innovation Panel (MIP), a representative survey of German firms. The MIP represents the German contribution to the Community Innovation Survey (CIS), a European-wide survey on firm innovation behavior guided by the Oslo Manual. Our final sample consists of 2565 firms from manufacturing and service sectors that we observe over both survey waves.

We employ a Difference-in-Differences design not just to evaluate the immediate innovation response of affected firms in 2020 but also their expected innovation expenditures in the following years. We balance treatment and control groups by weighting observations using an entropy balancing procedure to minimize a potential selection bias in the analysis.

We find that firms that are negatively affected by the COVID-19 pandemic show an immediate strongly negative response in R&D activities in 2020 compared to less affected firms. They decreased their total innovation expenditure in 2020 by about 10.3% more than the control group. R&D expenditures (which exclude investments in innovation capital) are lowered by about 4.7%, and investment in R&D capital (e.g., machinery or buildings) is decreased by 9.8%. However, further results show that this immediate response is followed by long-lasting adverse effects on innovation activities in the following years. We find that negatively impacted firms also planned to reduce their innovation expenditures in 2021 even further by 3.2%. Even in 2022, the same firms plan to continue reducing their innovation expenditures compared to 2021 by 1.5%. Analyzing the impact on innovation expenditures from 2019 to expected expenditures in 2022 negatively impacted firms plan to reduce their innovation expenditure by 8.8%.

These results show that COVID-19 negatively influenced innovation behavior as an immediate response in 2020. However, we also find that this negative effect is still present in the following two years. Especially because innovation is a main driver of firm performance, it is likely that a continuing decrease in innovation activities of already negatively affected firms will further harm their competitiveness. This highlights the importance of policies aiding firms that were strongly negatively affected by the COVID-19 pandemic.

Keywords: COVID-19 pandemic, Innovation activities, ifference-in-Differences, Mannheim Innovation Panel

[243] Peter Biegelbauer (AIT Austrian Institute of Technology), Petra Wagner (AIT Austrian Institute of Technology) and Katharina Berger (AIT Austrian Institute of Technology). *Experiences with institutionalizing responsible research performing and funding.*

Abstract. Current debates in both Transformative Innovation Policy and Responsible Research and Innovation (RRI) discourses shed light on the relationships between technology, innovation and society and the responsibilities of key actors such as scientists, innovators, business and the state. It also implies significant changes to these relationships and responsibilities which, in turn, imply significant changes to organisational logics, norms and practices within research funding and research performing organisations (Owen et al 2021). There is a strong need to build experience and capacities and experience for the institutionalization of responsible research and innovation (RRI) through relevant policies, governance mechanisms, methods and organisational changes via transformation related initiatives and projects.

For arriving at an ecologically, economically, and socially sustainable future we suggest a productive exchange between institutional and societal levels, connecting responsible research and innovation (RRI) with transformative capacities. Our research question is: How can we build capacities for RRI-inspired and transformation-oriented experimentation at organisational and societal levels?

Methodological approach and theoretical framework

This paper is based on the work ongoing in the EU-funded three-year project Co-Change with its eight collaborative labs in research promoting and research funding organisations across Europe. Within the project, we have built organisational spaces of experimentation in order to support RRI-inspired institutional changes along the lines of four RRI dimensions, i.e. anticipation, reflexivity, inclusion and responsiveness (Stilgoe, Owen, & Macnaghten, 2013). The labs are configurations of substantive and procedural focus areas, addressing sub-organisational, organisational, trans-organisational, ecosystem and societal levels in the areas of research ethics, sustainability, citizen engagement, science education, gender equality, and open access.

The overarching goal of Co-Change is to produce adaptive institutional changes with the ambition of aligning research and innovation practices and governance with societal values (Novitzki et al 2020) by building adaptive capacity towards transformative capacities for transformation-oriented system change. To guide the Co-Change labs for institutional change, we have used the concept of transformative capacity (Wolfram 2016). It refers to the collective ability of all actors in an ecosystem to be aware of, to prepare for, initiate, and carry out change at organization and (societal) system levels. Developing capacity for transformation in and across organizations needs to attend to (a) create communities of practice with transformative leadership and governance (→ agency and interaction); (b) work across levels and scales (→ relations) while observing the RRI principles of anticipation, reflexivity, inclusion, responsiveness; and (c) move along a learning cycle from initial system awareness and analysis to future outlook, then experimenting with promising pilots to eventually embedding these innovations as institutional changes (→ processes).

Interim Results and Experiences

Drawing on our various experiences and Co-Change's activities and outputs, we would like to situate these within our theoretical framework grounded in RRI and transformative capacities and reflect on its contribution to build capacity for RRI-inspired and transformational experimentation at organisational and societal levels.

Experiences from various RRI projects show that it is possible to create institutional spaces as (living) labs in which experimentation can take place - even if institutional environments are not necessarily conducive to changes (e.g., New HoRRIzon, JERRI projects). It is, however, less clear in which ways the experimentation results can successfully be transferred towards other parts of the organization in which the labs are embedded. Moreover, there have been debates about the sustainability of institutional changes, e.g., once the project creating the lab has ended and the experimental institutional space itself is running the risk of being dissolved.

Co-Change aims to support transformative agency and leadership by forming change coalitions ('deep institutionalization' as proposed by Randles 2017) within and beyond single entities (organisational level). Therefore, the project community has been set up to also actively engage with the organisation's environment, i.e., the innovation ecosystems of the labs (societal level). After two years into the project, experiences show that if a change coalition includes key strategic actors, it is possible to have an impact on organisational level, even in the innovation ecosystem. Such coalitions may include top management (thus easing institutional changes considerably) or consist of actors relevant for a specific unit or function across hierarchical levels - not necessarily including the CEO.

Due to the complex nature of institutional change, mutual learning across labs is of key importance. To this end, we have created forums, i.e., community of practice meetings in the form of two-day events involving labs, RRI experts, ecosystem actors and other interested quadruple helix partners. Since all these events were planned online due to the Covid pandemic, a series of different formats was carried out, e.g., visioning, science-fictioning, road mapping, elevator pitches, lab clinics, surveys, discussions in reflexive settings as small and large group exercises (see also the methodological approach above). On average these have been highly rated by the participants and have regularly had a direct effect by stimulating the change-oriented work of the labs.

Pilot activities for RRI inspired institutional changes in Co-Change include the institutionalisation of ethics training for researchers and civil servants in several organisations, the development of organisational responsibility programmes, the application of responsibility by design standards, the development of an AI tool identifying stakeholders to be included in the processes of a national standardisation organisation, the institutionalisation of a gender equality board and plan, the adoption of a code of ethics for consumer engagement in food research and data analytics, the adoption of a regional funding plan for supporting RRI related measures, the support of a company providing CSR and RRI related services to corporations and the development and adoption of funding guidelines for research funding organisations.

Conclusions and Outlook

The Co-Change project tackles change primarily through a bottom-up mechanism, as represented by the Lab approach. Nevertheless, the Labs recognise the diversity of different stakeholders and relations at organisational and societal levels. Through reflection and learning within the wide range of settings and formats, the Lab opens to the organization and system level in a very specific and tangible manner. Thus, Co-Change has been able to contribute to the formation of meaningful change processes with the potential of resulting in even more substantial transformation pathways.

Furthermore, we can see in several examples that R&I ecosystems are moving to 'co-change' to address societal challenges with RRI. Co-Change thus represents not only a space about how to institutionalize more RRI practices, but also a space for deeper reflection and learning about how different policies and governance mechanisms at the (eco)system level affect the organizational level. For instance, it seeks to understand how regulatory processes can be made more porous, which impacts this has on the design of regulations and policies, and which stakeholders should be involved in this process from the beginning.

Promises of transformative change and innovative solutions, many RRI related, seem abound. In the remaining project period, the Co-Change project will also critically look into the interplay of RRI and TC with the current discourse in organizational sciences to shed further light on how the organizational institutionalization of RRI have an impact on transformation-oriented policies, and vice versa.

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Keywords: organisational institutionalization, transformative capacities, labs, ecosystems, societal values

[246] Ron Boschma (Utrecht University). *Designing Smart Specialization Policy: relatedness, unrelatedness, or what?*

Abstract. From its very start, Smart Specialization policy aims to select and prioritize new domains in regions (Foray et al. 2009). Regions should focus on their own capabilities because they provide diversification opportunities but they also set limits to what can be achieved in this respect (Camagni and Capello 2013; Iacobucci 2014; Radosevic et al. 2017). S3 follows the basic principle that regions should not start from scratch when developing new domains (for example in AI) in which they have no relevant capabilities whatsoever. In particular, regions should target those domains in their S3 that could build on related variety (Frenken et al. 2007), as this would promote the cross-fertilization of knowledge and ideas across domains. In the EU guidelines for S3 design, explicit emphasis was put on relatedness as a key dimension to identify and choose future domains of specialization (Asheim et al. 2011; Foray et al. 2012; Boschma 2014; Valdaliso et al. 2014; Foray 2015; McCann and Ortega-Argilés 2015; Iacobucci and Guzzini 2016; D'Adda et al. 2019b; Santoalha 2019; Whittle 2020).

Scholars have also pleaded for S3 focusing on unrelated rather than related diversification, to avoid regional lock-in, and to promote radical change in regions (Frenken 2017; Grillitsch et al. 2018; Asheim 2019; Janssen and Frenken 2019). We outline and discuss the pros and cons of the two types of S3. We argue it depends on the specific regional situation whether S3 should purse related or unrelated diversification policy. While there are good reasons to promote related diversification in regions in general, regions may also become too specialized or trapped in a low-complex economy that might warrant a S3 focus on unrelated diversification. This will be further clarified by discussing S3 options of three stylized types of regions. The theoretical arguments will be backed by empirical findings on diversification processes in regions in the European Union.

Keywords: Smart Specialization policy, regional innovation policy, related diversification

[248] Magdalena Wicher (Institute for Advanced Studies, Vienna;), Richard Woolley (INGENIO (CSIC-UPV) Universitat Politècnica de València), Jordi Molas-Gallart (Universitat Politècnica de València) and Shauna Stack (Institute for Advanced Studies, Vienna). *Transformative Innovation Policies (TIPs) in translation from theory to practice.*

Abstract. Objectives and research question

The background of this paper is an ongoing evaluation of the European transnational funding Call SOLSTICE on Enabling Societal Transformation in the Face of Climate Change, initiated by JPI-Climate (Joint Programming Initiative "Connecting Climate Knowledge for Europe"). The main objective of the Call, which was launched in 2019, is to engage the Social Sciences and Humanities (SSH) in an interdisciplinary collaboration on climate change to generate new and fruitful knowledge that has been lacking so far. Ten European countries joined the initiative, which resulted in seven funded projects.

In our contribution, we aim to explore the potential of the Call SOLSTICE, which has the goal of enabling societal transformation on climate change as an example of transformative innovation policy. The question we want to investigate is how ideas (on the side of policy and funders) about transformative research and innovation policies are created and then translated into practice (of and by researchers). We want to develop further evidence on the expectations policy makers and funders have about the transformative potential of funding Calls they design. We wish to better understand how ideas about new and experimental approaches are foreseen to create new knowledge, how researchers translate funders' expectations and their own innovative ideas to try and change attitudes and practices, and what outcomes they seek to achieve.

Relevance

Linking SSH to climate change is quite new, as mission funding in this area has tended to focus mainly on natural and technical sciences and engineering research on climate change mitigation, anticipation, adaptation, and sustainability. Under the SOLSTICE Call, SSH are seen as critical to "accelerating positive change"1 at multiple scales. SSH are also viewed as contributing to the advancement of transdisciplinary approaches in the Call.

1 See page 5 of the Call text: http://jpiclimate.eu/gfx_content/documents/solstice%20guidelines%20for%20applicants.pdf

With its focus on societal transformation, the Call concentrates on three themes: (1) social justice and participation; (2) sense-making, cultural meaning, and risk perception; and (3) transformative finance and economy. In addition, principles of sustainability and Responsible Research and Innovation (RRI) are key in the development of the Call and its assessment approach, and are expected to be reflected in the implementation of the funded proposals. Successful applicants are expected to implement their research in interdisciplinary teams that adopt at least one of the following perspectives: (1) operational upscaling; (2) deliberating norms; and (3) a systemic approach. Within the procedure for evaluating the

submitted proposals, scientific quality and scientific and societal impacts of the proposals received a double weight to emphasize the importance of those two criteria.

Our investigation will allow us to contribute to understanding of the mechanisms of

transformative innovations policies, on a topic that is of major societal relevance. We follow a long chain from the drafting and design of the Call right through to the implementation of the selected projects, giving us a full picture of how ideas and expectations come about and how they are translated into the interdependent practices of policy makers, research funders, researchers, and those societal stakeholders connected to the projects.

Theoretical framework

Research and innovation policy has been described by Schot and Steinmuller (2018) as

moving through three frames. The first frame linked inputs to outputs in linear models, whilst the second sought to leverage system complexity by involving societal stakeholders in new modes of knowledge production and by boosting the scale, scope, and quality of interactions between them. The third frame extends policy focus to science and technology outcomes, seeking to modulate the direction of R&I toward environmental & societal challenges, particularly in the face of challenges such as climate change. Through experimentation and scaling-up the idea is that transformative innovation policies (TIP) promote transformative dynamics that drive long run changes in existing conditions.

TIPs also require new evaluation approaches. Formative evaluations can support changing and shaping the research and innovation policy process through hands-on, real-time adaptation. This includes the engagement of different stakeholders throughout the whole course of the evaluation (Kuhlmann 2003, Molas-Gallart & Davies 2011). All participants of the TIP should also be part of the evaluative process in order to secure inclusiveness as well as reflexivity and (first and second-order) learning of all people through constant feedback into the system (Molas Gallart et al. 2021). Using a theory-based approach (Theory of Change, ToC) enhances transformation and learning. As TIPs are seeking for deep changes in socio-technical systems, we think that the example of SOLSTICE is well suited to search for patterns in these changes. The Call wants to contribute to enabling transformational change

through interdisciplinary collaborations affecting all levels of society and stakeholders and learning through "(d)ifferent perspectives on levels and domains of climate-related governance".

Data and methodological approaches

We base our work on empirical material collected at different stages and using different approaches, as part of a case study conducted for the Horizon 2020 project SuperMorri. Data are being collected as part of a formative evaluation established to assess the development and implementation of the SOLSTICE Call. First, data is collected through document analysis, interviews and workshops with actors involved on all levels. This includes the level of policy and funding (the creation of the policy idea and development of the Call) as well as the level of implementation of projects (translation of the Call into proposals, implementation of

projects). Second, the formative evaluation is based on activities that have been co-created, including tailoring the ToC to capture stakeholder expectations and adaptation to possible changes during implementation. These adaptations are anticipated to relate to the Covidpandemic and to shifting objectives including cognitive, technical, and institutional aspects.

Initial data analysis has been based on thorough document analysis of the materials used to develop the Call (e.g., preparatory texts, a White Paper2), the evaluation process and content related parts of the funded applications. There, we are mapping patterns on goals, objectives, research contents, the outcome base and potential of scaling up of the projects. In a second ongoing step, interviews are being conducted with people involved in the development of the Call and the evaluation procedure (on the policy and funder side) and with actors involved in the development of proposals and their implementation (on the project side). These interviews serve to gain deeper insight into the processes of change and to validate and complement the data from the document analysis.

Expected results and conclusions

The SOLSTICE Call was not designed explicitly as a transformative innovation policy. Rather the SOLSTICE Call is an example of a policy designed with transformative objectives that has several elements consistent with those defined as characteristics of the third wave of innovation (Schot and Steinmuller 2018). In our work we are able to study how such a policy emerges and intervenes in the research and innovation (R&I) landscape and particularly the climate change mitigation mission. Our results will enable us to develop some important insights into the relationship between the theory and practice of transformative innovation policy initiatives.

The basis of the SOLSTICE Call was the idea that SSH can make an important contribution to promoting societal transformation in the face of climate change. Certain ideas on how this transformation could be done and the types of expected outcomes were inscribed in the Call text, whilst also leaving open crucial questions. How should (inter/transdisciplinary) collaborations be organised to generate transformative outcomes? In what form should knowledge be created and scaled-up in order to foster real change? The answers to such questions depends on how specific projects were designed, how narrow or broad were their ambitions, and their relevance to stakeholders and citizens. This inevitably also made the assessment of applications a challenging and complex process.

Our initial results suggest that the "how" of the implementation of the transformative change or changes are largely left to the innovative ambitions of the projects themselves. The Call themes and guiding perspectives provided a framework for the projects, but left

2 See: https://www.researchgate.net/profile/Asa-Gerger-

Swartling/publication/336179488_Operationalising_knowledge_on_and_for_societal_transformations_in_the_

face_of_climate_change_JPI_Climate_White_Paper/links/5d937bc0299bf10cff1f1e39/Operationalisingknowledge-

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considerable latitude and freedom for applicants to interpret how the Call might be

responded to in a valid way. This included critical elements related to how the projects should design and credibly demonstrate their potential for effecting societal transformation within the ambit of the Call. The paper will include details of our analysis of all the concrete elements of designing and implementing the SOLSTICE Call, including our co-creative work to define a generic ToC at the SOLSTICE Call level and our analysis of and interaction with the funded projects. This serves to assess how these diverse interventions, which are heterogeneous in terms of knowledge bases, interdisciplinarity, technologies, and planned outcome bases, map onto this programme/call theory.

Policy relevance

In the context of our study, we are currently concerned with three main lines of policy thinking. First, the work of JPI-Climate and the SOLSTICE funding Call provide insights into the challenges of building EU-level initiatives to confront global challenges. It also provides pragmatic lessons relevant to the ambitions of the European Commission (2020) and the Council of Europe (2021) to deepen and widen the European Research Area (ERA). Different types of challenges arise when a policy intervention requires transnational efforts to be relevant and effective in promoting change. Such an intervention must be adapted and embedded into often very different national funding schemes and technical requirements. SOLSTICE provides policy insights into the variety of challenges and complex professional collaborations required to translate ambitious ideas into the common ground that make an innovative funding initiative possible.

Second, the paper provides substantive insights into the types of research activities that can drive or support societal transformations in relation to climate change action. These insights include evidence of the effectiveness of different approaches and methods designed to scale-up and diffuse transformative project outcomes. The process of our own formative evaluation (which falls short of being a fully transformative evaluation, Molas-Gallart et al. 2021) may also provide policy-relevant information on how a deeper co-evaluation process involving funders, researchers, and stakeholders can itself potentially contribute to unlocking the transformative potential of funding programmes/calls and projects.

Third, the SOLSTICE case highlights tensions between the theory of transformative

innovation policy and the practice of implementing policy designed to impulse

transformations in societal attitudes and practices from a pragmatic perspective. The question of how specific policies can translate the sweeping historical arc of 'transitions' thinking to the specific time and place bound contexts of living societies remains difficult to envisage. Our results suggest that a significant gap remains between the theory and practice of transformation-drive policy making, and that questions remain regarding which contexts 'jumping the gap' into fully reflexive TIPs-style policy design, implementation, and evaluation - essentially installing TIPs as a coordination method - would be the optimum approach for

policymakers.

Keywords: Social Sciences and Humanities, Social Transformation, Transnational funding

[249] Roger Strand (University of Bergen). *Transformative Translations?*

Abstract. The convenors of this track asked: «how are transformative innovation policy and RRI institutionalised in structures, processes and practices of research funding and research performing organisations?»

We, the group of authors of this paper, have been part of a dozen EU-level projects and policy initiatives and numerous national and local initiatives where RRI has been invoked with transformative ambitions, going back to the introduction of RRI and also in some sense before, if we see «ELSI», «ELSA» and «integrated ELSA» as precursors of RRI. In all of these initiatives, we have had hybrid roles: as participants and observers; as RRI researchers and RRI change agents; as insiders and outsiders to the system or entity that was supposed to be transformed. The initiatives vary from the European attempts at creating indicators and monitoring frameworks for RRI; the attempt to «infuse» a basic research centre (funded as a Norwegian Centre of Excellence) with ELSA/RRI; the merging of Smart Specialisation agendas with RRI; and the creation of the Centre for Digital Life Norway, with the ambition of transforming Norwegian biotechnology.

This paper will not rehearse all our results from these experiences, and the challenges related to our double roles of insiders and outsiders in RRI initiatives. Rather, we propose a lens for analysing and discussing these matters that shifts the discourse away from «implementation» to the STS usage of the notion of translation. In the course of these years, we never encountered that RRI was «implemented» according to plan and with the expected result. RRI – as much as we promote and defend it ourselves – originated as a policy concept. It is predicated on ideas about the transformation of the R&I system at a level of abstraction and idealisation that allows for «implementation» in the concrete case in ways that are little more straightforward than the desire to implement virtue ethics in real estate markets. An empirical indication is the plethora of STS and applied ethics papers in which the authors state that things did not go according to the RRI plan.

Things do not go according to plan but still things happen. A philosophical idea may be “misunderstood” and translated into a workable operationalisation. A set of “RRI keys”, originating in little more than administrative coincidence in the organisation chart of the European Commission, may take on new meaning and give inspiration to local innovators. The confusion in a group of university researchers about what RRI really means may lead to a profound consideration of anticipation and reflexivity. And so on. In the paper we shall present some examples to show how both processes of hermeneutics and institutional operationalisation work to translate RRI and sometimes perhaps even achieve transformative effects.

Our main motivation for focusing on translation thus is to productively think about what is commonly referred to as “implementation”. The main problem with the term implementation is, that it assumes that there is one right way of doing RRI, an essence of RRI or a core set of principles. These principles can then either be followed the right or the wrong way, you can thus succeed or fail in implementing RRI. There is no single valid definition of RRI, it is a moving target. There are different RRI keys and there is the AREA framework, but none of the elements in these frames are exclusive to RRI, nor do RRI projects apply all of the keys or principles.

Translation as a concept comes from literature and refers to the transfer of a text from one language into another. The main advantage of this term is that it doesn’t assume an essence of RRI, it is a relational concept. This is expressed in John Law’s definition of the term as the combination of “traduction/trahison” (Law, 2003); or in Andrew Barry’s way of thinking about translation as a process of replication through imitation and differentiation (Barry, 2013). So, translation focuses on both similarity and difference simultaneously: “When public participation instruments are situated in specific local contexts, however, their ideas, values, formal rules, and tools become remixed, giving rise to new meanings.” (Soneryd, 2016)

Looking at translation provides a good way to understand how exactly ideas – or policy concepts like RRI – travel and materialize in ever new forms. This is especially relevant in the SwafS – Science with and for Society – projects, that are precisely about the idea of RRI travelling from a transnational context to regional or territorial scales, and across different sectors in the quadruple helix. In these processes of translation and travel, RRI itself gets transformed and assembled in new ways. Over the last years for example, RRI is increasingly translated as different forms of citizen engagement or deliberative democracy.

What this leads us to, is a reflection on a possibly hidden dimension of “top-down governance” in discourses on transformative innovation policy and RRI. Yes, the leading authors in these fields are very well aware of the distinction between governance of complexity and governance in complexity, and about the illusory status of the Cartesian dream of prediction and control. Indeed, the concept of ‘governance in complexity’ was developed by authors in the field. This is why the literature is ripe with considerations on bottom-up agency, network governance, knowledge coproduction and so on. However, the problem is still that the very purpose is set from above: To achieve transformation, to achieve RRI, that is, to achieve processes or results that are identifiable from the top-down policy perspective as fit for the defined purpose. Beneath the surface, there may be a remnant of intervention logic and a desire to plan the future that becomes evident every time an analyst or a policymaker is disappointed with the results in a concrete case.

Our solution is not to let go of the normative ambitions of transformation, responsibility or sustainability. Not the least for those of us who have been asked to define RRI indicators, however, we observe and participate in a field where attempts at describing are overloaded with normativity and eagerness to do good. If there is no immediate alternative to the presence of people such as us, that is, scholars who make careers on describing the same thing that we try to promote (a position that comes with its very own sets of problems as pointed out be Alfred Nordmann already back in 2007), at least the conceptual frameworks of descriptions should try to offload some of the normativity. Moving from “implementation” to “translation” would be one step in that direction. Developing the understanding of what governance in complexity entails, could be a next step. In the full paper, we will employ our own experiences to try to indicate such an understanding.

Keywords: Translation, Governance in Complexity, RRI, Implementation

[250] Roger Strand (University of Bergen). *Translating tools and indicators in territorial RRI .*

Abstract. "No object considered purely in and for itself, in terms of its intrinsic attributes alone, can be a tool. To describe a thing as a tool is to place it in relation to other things within a field of activity in which it can exert a certain effect. Indeed we tend to name our tools by the activities in which they are characteristically or normatively engaged, or by the effects they have in them. Thus to call an object a saw is to position it within the context of a story such as the one I have just told, of cutting a plank. To name the tool is to invoke the story. It follows that for an object to count as a tool it must be endowed with a story, which the practitioner should know and understand in order to recognise it as such and use it appropriately. Considered as tools, things are their stories. (Ingold 2011, 56)

The beauty of this quote from social anthropologist Tim Ingold lies in the fact that he takes the most toolish of tools – a mundane saw – and casually proceeds to deny it its essentialist qualities as a saw. Instead, he argues that what lends the saw its sawiness are not inherent qualities or attributes but narratives and relations. Stories about what the saw does or what is done with it and about the relations it creates. What is true for a saw, we argue in this paper, also has some value for thinking about RRI and its evaluation.

Over the last decades we have witnessed a growing interest in the concept of Responsible Research and Innovation (RRI). RRI grew out of policy debates and resonates with longstanding concerns about changing ways of producing and circulating knowledge both diagnosing and calling for changing relations of science, society, politics, and innovation as well as with the aim to find more socially robust way of assessing and governing emerging technologies.

Especially in the Horizon 2020 Science with and for Society programmes, the idea of a cultural shift in our collective ways of engaging with technology and innovation and creating stewardship for our shared futures hast developed into an endeavour of creating tools for locally implementing RRI.

We are interested in precisely these multiple territorial translations of RRI, the organizational and institutional orderings with which they co-emerge and in the challenges that come with these translations. Furthermore, we are interested in translation processes that are connected to the implementation of RRI as a set of tools (e.g. for engagement of citizens in regional development and awareness raising projects)

• How is RRI translated when it travels from the transnational world of EU policymaking to national and regional context and across different sectors?

• How are these translations shaped by territorial innovation ecosystems?

• How are RRI tools embedded within regional research and innovation stories/narratives?

• How to evaluate the performance of RRI as tools in territorial contexts?

To address these questions we bring together work from the field of Science and Technology Studies (STS) with approaches from evaluations studies and practice.

The concept of translation - brought into STS in the early years of ANT - has been used to tackle simplistic notions of technology transfer (Akrich, 1992) and to explore implementations of engagement activities (Soneryd and Amelung, 2016) framed as "technologies for elicitation" (Lezaun and Soneryd, 2007). Originally coming from the realm of literature where it refers to the transfer of a text from one language into another, the concept challenges essentialist and technocratic notions of engagement and instead directs attention the shifts in meaning of concepts like responsibility, participation, citizen, or expertise, and to the making and re-making of links between different entities and agents. Such a relationalist understanding of RRI allows us to focus on how it is practiced in the three different TRANSFORM pilots. The main advantage of this term is that it doesn't assume an essence of RRI, it is a relational concept. This is expressed in John Law's definition of the term as the combination of "traduction/trahison" (Law, 2003); or in Andrew Barry's way of thinking about translation as a process of replication through imitation and differentiation (Barry, 2013). So, translation focuses on both similarity and difference simultaneously and directs attention to the regional specificities when applying tools that are to some extent standardized on different scales: "When public participation instruments are situated in specific local contexts, however, their ideas, values, formal rules, and tools become remixed, giving rise to new meanings." (Soneryd, 2016).

Looking at translation provides a good way to understand how exactly ideas – or policy concepts like RRI – travel and materialize in ever new forms.

To get a hold of the organizational, institutional and political context in which the RRI tools are used we use the concept of "ecologies" as developed by Jason Chilvers and Matthew Kearnes (2015). This means assessing RRI practices not in isolation but as part of particular institutional-organizational settings and issue spaces as well as embedded in certain legal frameworks, infrastructures, collective imaginaries, established social practices, and collective forms of public reason.

What this allows us to focus on in our evaluation of the TRANSFORM activities is on a double movement of translation, in which RRI is translated in specific ways in the clusters (as a tool through different methods/approaches) which in turn means that (2) also different methods are translated as RRI in specific ways.

In this paper we present a comparative analysis of three different RRI-pilots within the Horizon 2020-funded project TRANSFORM. In these pilots RRI takes the shape of citizen science projects, participatory agenda setting and (plans for a) citizen assembly. Thus, we see different translations of RRI steered by diverse actors.

The analysis builds on material gathered in the project TRANSFORM. The core material consists of interview data from 12 semi-structured interviews with 15 project partners working in the different territorial RRI pilots of the TRANSFORM project. The interviews were transcribed and coded according to , In addition to that, project documentation and relevant policy documents have been also analysed using the same coding framework.

This paper carves out a range of different translations of RRI in territorial pilot projects in the three TRANSFORM clusters in Lombardy, Catalonia and the Brussels-capital region while also directing attention to the organizational and institutional ecosystem that both enables the pilot projects' work and also shapes how it plays out in practice. Through describing these translations we will also draw some conclusions on how to "measure" the success of the various tools for territorial RRI and what it means to think about RRI in terms of tools. We point to approaches that propose to focus on "indicating" (Marres and de Rijcke, 2020) and "evaluative inquiry" (Fochler and de Rijcke, 2017) to better grasp "the epistemic missions, frictions and resonances of the work under scrutiny" (ibid.).

Keywords: RRI indicators, regional RRI, Smart Specialisation, Translation

[251] Carlos Montalvo (TNO). *Innovation social value optimisation: Behavioural additionality, impact assessment and policy roadmapping.*

Abstract. The current document is based on the work and related results stemming from the study entitled Scientific support to the development of a methodology to assess the potential social and economic impacts of the use of Artificial Intelligence to support public services commissioned by the European Commission Joint Research Centre (JRC).

Introduction: The transformative capacity of innovation can hardly be under discussion. The issue of policy design concerns the intentionality and directionality of technical change (ref). The recent advances in new technologies applications (e.g., artificial intelligence, quantum sensors, block chain, digital platforms, social robots, smart factories, E-government, etc.) give indication of transformative changes in industrial al commercial organization. The question here is whether policy (governmental or corporate) can steer the direction and intensity of innovation impacts to optimise public value. The full impact of these technologies still remains in the future. In order to steer change with efficacy decision makers in government and the corporate need tools that enable: 1) the ex-ante assessment of potential impacts; 2) to incentivise the appropriate behavioural additionality in key actors in an innovation ecosystem towards common societal goals. The later requires new methodologies that not only identify potential impacts but also facilitates the understanding of heterogeneous rationales of key actors that enable the use and deployment innovations. This paper aims to contribute to the closing of this knowledge gap by applying a novel approach that links heterogeneous preferences and behavioural additionality, adoption drivers, propensity to use to expected impacts and the meso and macro levels. Although the methodology was developed to assess the potential social and economic impacts of the use of Artificial Intelligence to support public services, its theoretical underpinnings and approach are valuable in other policy realms.

Background: Traditionally, ex-ante impact assessments are undertaken to gauge the likelihood of a particular policy intervention to achieve specific goals. Results of the ex-ante assessment are used to steer or redesign the interventions (both in scope and scale), as well as its instruments and governance. Similar efforts can be conducted in the case of ongoing or finalized intervention programmes, in order to assess if their original aims were/are achieved or to assess the scope and scale of their effects. Two basic assessment frameworks in particular enjoy wide use: the so-called intervention logic model (focusing on the specific outcomes to be achieved) and, more recently, the Theory of Change (focusing on inputs, activities, outcomes). Criticism of the two frameworks often refers to their simplistic approach to complex intervention programmes, especially where the counterfactual of effects and the leverages to achieve desired outcomes are not trivial (Moore and Evans, 2017; Maine, 2017). This and other shortcomings of the basic models of impact assessment have led to the emergence of a myriad of alternative approaches (Branch 2019). Recent reports and literature on social impact assessment and evaluation compare and review the tenets of these approaches (Florman, et al. 2016; Karami et al., 2017; Calvo et al., 2020; Bice and Fisher, 2020). They reveal a number of advantages as well as shortcomings of these approaches.

The methodology here presented overcomes some of the following shortcomings:

a) Data availability. The modelling of technology diffusion is generally done based on data such as volume/value/type of services provided, levels of investment for a specific technology during a given period of time and within a specific geographic area. When such data are available, it is possible to estimate rates of diffusion and economic effects (Rogers 2010). However, for the diffusion of innovation is a specific sector of application does not exist requiring the foresight of effects and must be estimated by the elicited preferences of experts, users, developers, citizens, etc.

b) The systemic character of human activity. In general, system analysis approaches

emphasise the need to examine the systemic character of any realm of human activity.

Here there is no consensus on the limits and boundary conditions of the system. In

general, the boundaries are set in an ad-hoc manner. For example, public services

provision involves many agents but in principle they are divided into the provider (the public sector) and the recipients of the service (citizens and businesses). In addition, much attention is paid to the dynamics and feedbacks of influences of the agents included in the analysis. Such attention is indeed necessary, but in most studies, this is done at the expense of a proper understanding of sources of heterogeneous behavioural preferences of the agents1 included in the modelling (Trajkovsky and Collins, 2009). The problem of untangling and understanding the effects and influences of different actors has been acknowledged as a major challenge in policy analysis and program evaluation (Mayne, 2015;). It has been suggested that a step forward is to understand the different perspectives of various stakeholders by looking at their perspectives, rationales and reported outcomes and impacts (Maine 2017). The later to map different paths of influences from inputs to impacts and accordingly develop roadmaps for intervention actions. A sound method for the analysis and thorough understanding of the differences in rationales is still lacking in these approaches.

c) A third shortcoming refers to the format of models and tools. It has been acknowledged that particularly the stylised form of such models and tools, combined with a limited availability of data, has hampered their use in policymaking practice. In exercises simulating behavioural additionality (for example the adoption of AI in the delivery of public services) and while considering the system, the models normally build on assumptions formulated by experts about expected preferences, beliefs, and values of the relevant actors in a given adoption context.

d) A further shortcoming refers to the parameters used in modelling. One of the major challenges in scenario development is the reliability and validity of the parameters used as initial conditions of the variables of interest. This is true for systems dynamics (e.g., Weisbuch, 2018; Senge, P. M., & Forrester, 1980), actor network (e.g., Carrington et al., 2005; Contractor and De Church), agent-based modelling (e.g., Trajkovski and Collins, 2009) well as in general equilibrium modelling for macro-economic forecasts (e.g., Di Bartolomeo & Saltari, 2016). Where no data are available (e.g., panel or time series data) to calibrate the parameters of a model, generally the approach relies on expert opinion on the size and direction of the likely effects (i.e., achieving face and concurrent validation).

An additional step to ensure the reliability of the parameters to be used in the scenario modelling is to strive for structural validation. This means that the relationship between variables is confirmed by means of statistical analysis indicating the strength and direction of the relationship between the variables of interest. Often this step is not achieved.

e) One additional drawback concerns the aggregation of disparate sources of influence on the variables of interest (drivers of adoption, adoption levels, social impact, employment and jobs) into a coherent set of relations that can be reliably tested. In this area, most available theories for modelling do not fare well.

Scientific contribution and impact

The scientific contribution of this paper is driven by using a behavioural approach for: 1) the quantitative assessment heterogeneous preferences and drivers at the organisational and decision maker levels, and 2) linking the reported behavioural preferences to meso and macroeconomic effects. The approach adopted further makes it possible to reflect critically on preferences, opinions expressed by experts, citizens and policymakers concerning the likely effects of new technologies in increasing social value (in this case the use or artificial intelligence in the provision of public services). The basic behavioural model proposed here has already been applied in the testing of the structure of digital technologies adoption in government for the provision of services (e.g., see Ozkan and Kanat, 2011; Ozen et al., 2018; and Kanat and Ozkan 2009).

The approach proposed advances the field of impact assessment and evaluation for the following reasons: i) enables the integration a variety of insights technology likely adoption and use for the quantitative testing of hypotheses about the variance in drivers and in perceived impacts and benefits of new technologies. ii) In turn, this enables gauging the soundness and completeness of the variables and factors used to construct the impact assessment model; iii) testing the reliability of the impacts reported; and iv) the creation of scenarios based on a quantitatively validated structural model of impacts. vi) The approach adopted builds upon a human behavioural model that has been widely tested in many different situations and contexts explaining up to 90% of variance on intentionality and behaviour (Armitage, 2015).

The approach facilitated the translation of perceptions, opinions, and judgements into numerically validated indicators of propensity and adoption and use of AI in public services. The ability to quantify behavioural indicators has the advantage of making the qualitative analysis suitable for a complimentary quantitative output-input econometric analysis of extended impacts on economic aspects, (employment and aggregate demand). In this last analysis the propensity to adopt QST is used as a multiplier affecting economic, social and environmental performance of a country or region. By following this approach, the new methodology proposed here can improve impact assessment practice, using behavioural insights to understand the engagement of governments, business and citizens in the adoption and use of new technology applications and their impact in society and the economy. Additionally, it should provide better support and guidance for the design of better policy (instruments) in support of the deployment of QST to achieve societal and economic goals.

The paper is based on a study report conducted on behalf of the European Commission JRC. In the elaboration of the report the authors would like to thank the following reviewers and the advisory group for their valuable input: Evgueni Poliakov (TNO), Hattie Bouma (TNO), Gabriela Bodea (TNO), Gianluca Misuraca, Lorenzino Vaccari, Marina Manzoni (JRC-Ispra), Colin van Noordt, Francesco Molinari, Francesco Niglia, Anys Boukly, Lorena Hernandez Quiros, and Rony Medaglia. Part of the questionnaire and of its structure was developed in collaboration with some of them, namely: Rony Medaglia, Colin van Noordt and Francesco Molinari.

Keywords: behavioural additionality, impact assessment, transformative innovation impact assessment, program evaluation, artificial intelligence, E-Government, theory of planned behaviour

[253] Stefano Bianchini (Université de Strasbourg). *Artificial Intelligence in Science: An Emerging General Method of Invention.*

Abstract. This paper offers insights into the diffusion and impact of artificial intelligence in science. More specifically, we show that neural network-based technology meets the essential properties of emerging technologies in the scientific realm. It is novel, because it shows discontinuous innovations in the originating domain and is put to new uses in many application domains; it is quick growing, its dimensions being subject to rapid change; it is coherent, because it detaches from its technological parents, and integrates and is accepted in different scientific communities; and it has a prominent impact on scientific discovery, but a high degree of uncertainty and ambiguity associated with this impact. Our findings suggest that intelligent machines diffuse in the sciences, reshape the nature of the discovery process and potentially affect the organization of science. We propose a new conceptual framework that considers neural network methods as an 'emerging general method of invention' and, on this basis, derive its policy implications.

Keywords: Scientific Practices, Automation of Science, Artificial Intelligence, Economics of Science

[254] Tobias Buchmann (ZSW), Patrick Wolf (Center for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW)), Matthias Mueller (University of Hohenheim), Michael P. Schlaile (University of Hohenheim), Marion Dreyer (Dialogic), Frank Dratsdrummer (DIALOGIK – non profit institute for communication and cooperation research) and Bianca Witzel (Dialogic). *An RRI Indicator System for Supporting Renewable Energy Innovation.*

Abstract. Political and diplomatic efforts have so far hardly led to significant reductions in global greenhouse gas emissions. Accordingly, hopes rest on energy transition innovations that are effective, experience a high level of social acceptance and can thus be implemented widely in order to successfully advance the energy transition process. We delineate acceptance as the passive or active socio-political and community acceptance of (mostly) largescale energy technologies or related policy strategies, i.e. the public's passive or active approval (based on subjective valuation rather than scientific expertise) of decisions by others (Bertsch et al., 2016).

Our core assumption is that it is possible to increase the likelihood of innovations for being accepted if they are aligned more closely with societal values and needs. This will reduce the risk of energy transition innovations being developed that are not widely adopted because they contradict societal values and guiding principles, as shown, for example, by the multi-layered debate on biofuels and CCS (carbon capture and storage). Impacts of new technologies are often only identified, then regulated and mitigated after large-scale production and diffusion has started. That is, research and development (R&D) processes are often not anticipatory and are lacking the integration of, for instance, environmental and social research. In order to reduce the likelihood of unintended consequences of R&D processes, we argue for the application of an RRI indicator system. Thereby, concerns that may – directly or indirectly – affect the acceptance of a resulting innovation can be anticipated during the technology development process. Moreover, an RRI indicator system provides important guardrails to improve the innovation process and thereby informs R&D decision-makers to potentially reorient innovation processes.

In fact, technology development and diffusion cannot be viewed as an isolated process. Rather, successful technology development takes place in a systemic context in interaction with societal actors and ideas. The energy transition (in German: “Energiewende”) should thus be understood as a transformation process involving society as a whole (WBGU, 2011; Schneidewind, 2018), which is characterized by a high degree of complexity and extends beyond the implementation of purely technical solution concepts. We consider RRI a possible element of the solution for the raised problem, as also Owen et al. state: "The aim of RRI policy is that research and innovation should have a societally beneficial impact" (Owen et al. 2012).

While the central idea of RRI – to take the normative dimension of research and innovation processes more seriously in the face of wicked problems and global challenges – is relatively unchallenged in the innovation and policy research community, questions regarding the actual application of the concept in a policy, research, and business context remain opaque. Recently, different research projects have delved more deeply into the question of how RRI can be applied as a toolkit to help policy makers, scientists, and businesses (e.g., see https://rri-tools.eu/ or https://www.v4innovate.de/). Thus, guidelines and indicator systems are being developed and applied as an orientation for the development and diffusion of more (societally and environmentally) responsible technologies (e.g. van Mierlo et al., 2010; Wickson and Carew, 2014; Meijer and van de Klippe, 2020).

However, the literature is still driven by ongoing debates addressing various unresolved issues around RRI. To mention just a few, traditionally, RRI has been applied to potential breakthrough technologies such as biotechnology, genetic engineering, and quantum computing. RRI, thus, arguably neglects innovation as a systemic phenomenon emerging in complex adaptive innovation systems (e.g. Owen 2019). In a similar vein, one could argue that the scope of RRI must be even further extended in order to adequately address social-economic transformation processes, for example to tackle Grand Societal Challenges such as the transition of the energy system towards carbon neutrality (e.g. Owen et al., 2013).

For our paper, we develop an indicator system concept which takes the process as well as the product dimension of innovation into account. We believe that, though challenging, the product dimension is as relevant as the process dimension since it reveals potential problems of an innovation that can be tackled by adapted innovation processes. Keeping this in mind, we have a similar broad understanding of the notion of innovative products as van de Poel (2019) for whom a product is “any kind of output that can be used by another actor for another end” which also includes new knowledge and not only artefacts. Moreover, an innovation needs to be the outcome of a deliberate knowledge generation process which is typically an R&D activity.

Often regulation lags behind the related development of a new product and RRI was also developed to handle issues that are accordingly not yet regulated. In such cases, the application of the RRI concept may increase transparency of the innovation process and the accountability of the innovator which may create trust among stakeholder and eventually increase acceptance of an innovation.

Moreover, the assessment of RRI is a relative new approach and no generally accepted features to objectively measure RRI have been operationalized yet. In fact, the complexity of the notion of RRI and the different ideas that are projected into the concept prevents it from being directly measured. A review of recent approaches in the RRI literature shows that there are many different attempts of operationalizing RRI. Or, as van de Poel (2019) put it “one might wonder how what is supposedly one concept can lead to such diverse constructs.” In particular, there are various sets of indicators in the RRI context, which vary significantly in their characteristics regarding different targets, different dimensions, different types of evaluation. Moreover, we found that existing sets of indicators largely stand for themselves and have hardly any reference points to each other; existing preliminary work, which created a basis for indicator development, has not yet been taken up.

Furthermore, there is a concept immanent problem regarding reliability (van de Poel, 2019), a problem which is common in the RRI context as attributes are often not objectively measurable. To mitigate this problem, we follow a proposal by van de Poel (2019): the subjectivity of the assessment can be reduced by providing a "rubric" that offers guidance on how to score questions or items. In addition, there is a lack of contextual indicators (Monsonís-Payáet al., 2017). Existing indicator sets are rigid and lack contextual weighting. Finally, there is a lack of a systems approach. Here, the largely separate consideration of process and product indicators to date has resulted in previous approaches being more indicator sets than indicator systems.

In our approach, quality criteria developed in the RRI Tools project (Kupper et. al, 2015) form the basis for the development of process indicators. The quality criteria represent essential characteristics of research and innovation practices that should be taken into account in assessment, monitoring or (self-) evaluation tools in the RRI context. Quality criteria were reviewed and clustered (where possible) to create the indicator sets. The indicator expressions are taken from the literature or were formulated based on guiding questions formulated by Kupper et al. (2015).

This leads to four distinct dimensions of RRI regarding the innovation process: The first cornerstone draws upon the idea that science is not only conducted in or for society, but also with society via diversity and inclusion. Therefore, we combined three criteria with nine sub-criteria into a total of four indicators that broadly cover stakeholder engagement. Secondly, openness and transparency are among the requirements of the RRI process because they build the basis for building mutual understanding and trust among all stakeholders involved in R&I practices. Five criteria with 13 sub-criteria were combined to form a total of seven indicators related to sharing of results and information as well as accountability. Thirdly, looking to the future and reflecting on the diversity of potential impacts of R&D practices is one of the essential cores of RRI via anticipation and reflection. Five criteria with 16 sub-criteria were combined into a total of eight indicators. Fourth, solutions must evolve from collaboration and decisions must be made in response to changing circumstances and based on gradually evolving knowledge which requires dynamic attitudes by both individual researchers and institutions or project groups. Four criteria with 12 sub-criteria were merged into a total of four indicators.

The RRI product dimension captures products in relation to overarching and specific normative anchor points (von Schomberg, 2013). According to von Schomberg, these normative anchor points should be: ethical justifiability, sustainability and social desirability. The presentation of product indicators according to the respective rating enables identification of potentially critical aspects in the RRI context. Since "the product and process dimensions are naturally interrelated" (von Schomberg, 2013), we also derived a method for linking process indicators to product dimensions. Such a linkage allows a weighting of process indicators based on the rating of the product indicators. Process indicators associated with product anchor points rated as problematic are weighted higher. This enables a technology-specific ranking of the process indicators and thus a case-specific identification of the most important RRI aspects regarding the technology. Altogether, we develop an RRI assessment tool based on an indicator system which is unique since it (i) combines process and product indicators in a new way, (ii) is flexible but context specific enough to address the specificities of energy transition innovations and (iii) can be applied to potentially positively influence innovation acceptance.

Keywords: Renewable Energy Innovation, RRI, Innovation Process Dimensions

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Transition policy mixes and incumbents' business model adaptation: A case study of UK Zero-Carbon Homes.

Keywords: transition policy, policy mix, business models