

Introduction

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Christensen, Jesper Lindgaard; Gregersen, Birgitte; Holm, Jacob Rubæk; Lorenz, Edward

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Introduction¹

Globalisation, new and emerging technologies and sustainable development – the Danish innovation system in transition

*Jesper Lindgaard Christensen, Birgitte Gregersen,
Jacob Rubæk Holm and Edward Lorenz
Aalborg University Business School*

Introduction

This book explores the capacity of the Danish innovation system to respond to key societal challenges, including those linked to processes of globalisation and increasing competition from lower-cost emerging market economies, the impact of emerging and possibly disruptive technologies on productivity, skills and employment, and pressures for environmental sustainability and the transition to green energy systems. In this way, the book seeks to provide a broad, but at the same time, focussed understanding of the Danish national innovation system in transition. This is of interest beyond the Danish case as most countries face similar challenges (Fagerberg et al. (eds.) 2015).

What makes the Danish case interesting?

In many respects, the Danish case stands out as successful and a good point of departure for tackling these challenges. For several years, the Danish economy has been able to maintain low rates of unemployment and inflation, a balance of trade surplus, healthy public finances and a large foreign exchange reserve. Living standards are amongst the highest in the world, and Denmark also shows high performance in aspects not captured by GDP measurements, illustrated by its ranking fifth in the world in the Inclusive Development Index in 2018 and its Gini coefficient of 0.26, indicating a relatively egalitarian economic structure (OECD 2020). The public sector is relatively large, reflecting a welfare state model where education, social

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care for children and the elderly (including pensions), healthcare and infrastructure are mainly provided by the public sector and financed via the tax system. Many of the Danish production and innovation strongholds have their point of departure in public sector demand and regulation. For several years, the World Bank Doing Business Index has ranked Denmark consistently in the global top five. In other benchmarking exercises such as the EU Innovation Scoreboard, the Danish innovation system consistently belongs among the so-called ‘innovation leaders’ together with other small countries (Sweden, Finland, the Netherlands and Luxemburg). Moreover, the research system is demonstrating high performance.

A key question in this book is to what extent the Danish innovation system in its current stage is able to respond to key challenges on the horizon and maintain its high living standard. To discuss this, the book takes a closer look at key features of the Danish innovation system and considers how it is being put under pressure from globalisation, disruptive technologies and the transition to more sustainable production and consumption. While the empirical point of departure is Denmark, the challenges are not isolated to the Danish case or to small, open economies of which Denmark is an example. For this reason, the book is of general interest for the analysis of national innovation systems and policies to support their development.

Why is the national innovation system a relevant analytical focus?

Thinking about economic development in terms of innovation systems has evolved from a marginal position in the 1980s to a widespread approach adopted by researchers and policymakers alike today. This development was spurred partly by academics. The first studies of national innovation systems are from the late 1980s and early 1990s (see Freeman 1987; Lundvall (ed.) 1992 (reprinted 2010); Nelson (ed.) 1993; Edquist (ed.) 1997). Sharif (2006) and more recently Chaminade et al. (2018) provide an update on the national innovation system perspective and how it has evolved since the 1980s. Another driver of the upsurge of an innovation systems approach was policy needs at the time (cf. Chapter 1 in this volume). In particular, academics working in the Organisation for Economic Co-operation and Development (OECD), and the general efforts of the OECD to promote national innovation systems (NIS) thinking as a basis for policy formulation (and their collaboration with Eurostat to provide solid innovation statistics) were instrumental in the wide- spread adoption of the NIS concept (Chaminade et al. 2018; Lundvall (ed.) 2010; Rakas and Hain 2019).

In innovation systems research, the notion of ‘system’ has generally referred to an understanding of innovation as a process, which takes place in an interaction between agents in a specific institutional and historical context. This is important for how analyses of innovation systems are pursued. A mechanistic presentation of the elements of a system often misses important aspects of how the system functions. Whereas the functioning of a watch or a computer can be understood through breaking up their components into pieces, innovation systems are governed by informal institutions and historical contexts and trajectories that make the system not only more than its individual parts, but often different from the sum of its parts (Anderson 1972).

This may be seen as one of the common cornerstones of innovation systems thinking both in the analysis of nations and in the extension of the approach to cover different types of systems such as regional innovation systems (Cooke 1996; Asheim and Isaksen 1997; Cooke et al. (eds.) 2004), sectoral innovation systems (Breschi and Malerba 1997; Malerba (ed.) 2004), technological innovation systems (Carlsson and Stankiewicz 1991; Bergek et al. 2008), and ecosystems, a term which recently has been put on the agenda to describe both innovation and entrepreneurship systems (e.g., Stam 2015).

A related literature focuses on systems transformation, introducing a multi-level perspective (e.g., Geels 2004) and incorporating analyses of the dynamics of specific technological evolutions. Over the years, innovation systems analysis has been taken up in developing countries as well (Arozena and Sutz 2000; Lundvall et al. 2009; Niosi (ed.) 2018) where the role of system-building and the impact of the informal economy become particularly visible. Trust, reciprocity, social capital, norms for collaboration and other behaviour are generally important aspects of getting innovation systems to function, particularly in developing countries. In developed countries challenges for the economy continue to point to the relevance of the innovation systems approach (Fagerberg et al. (eds.) 2015).

The different system levels are not mutually exclusive but often interact and may complement each other, pointing to the multilevel nature of the analysis. The book adopts an approach showing how innovation dynamics at the enterprise, regional and national levels are embedded in a set of interrelated supporting institutions including the research and development (R&D) system, the education and training system, the structure of labour markets and distinctive

networking arrangement shaping patterns of interactive learning among firms and organisations.

Despite increasing globalisation and international institutional coordination, nation states still constitute relevant environments for interactive learning and innovation. One reason for this is diversity, meaning that there are still significant differences between countries in relation to their production structure and specialisation patterns, institutions, policies and knowledge infrastructures. Production structures and specialisation patterns are only slowly changing in cases where key production factors, including knowledge and learning, have a high degree of local, sectoral and technological foundation. A second reason is national policies that affect the regulation of institutions related to the process of innovation and structural change (including labour markets), the provision of infrastructure (both ‘traditional’ and knowledge infrastructure) and finally the nation as an expression of a ‘common culture’ supported by political power and the state (see for instance Lundvall (ed.) 2010; Weber and Truffer 2017; Chaminade et al. 2018 for further elaboration). Although a tragic background, when COVID-19 developed into a global pandemic crisis at the beginning of 2020, the role of the nation state in providing critical infrastructure, social security and compensation to private businesses hit by lockdowns, and in regulating mobility within and between countries, became very clear.

The impact of the COVID-19 crisis

The chapters in this book were in most cases completed prior to the outbreak of the global COVID-19 crisis at the start of 2020, and hence generally do not incorporate effects from this change. However, this does not make insights from the chapters any less relevant. On the contrary, in many cases, the dynamics described are reinforced by the crisis. For example, the competitive performance of firms and nations is likely to depend even more on the quality of their digital capabilities and infrastructure as the COVID-19 pandemic has led to increased use of distance working. In itself, the business churning caused by the crisis will lead to innovations, but it is likely that it will also have effects on what has been termed the digital divide, especially in geographical space. The COVID-19 pandemic will affect global value chains (GVCs) both due to the disruption of transport and logistics provision and to the way plant closures in specific segments and locations can affect production all along the supply chain. Related to this, many of the policy initiatives discussed in the chapters are even further accentuated during the pandemic as state aid for businesses has boomed. Of course, it is an open question whether the

effects of the COVID-19 pandemic are temporary or will have a long-lasting impact on patterns of outsourcing, production location, consumption patterns, CO₂ emissions and wider effects on the environment.

Content and structure of the book

Several previously edited volumes include single chapters on the Danish national innovation system (Freeman and Lundvall (eds.) 1988; Dosi et al. (eds.) 1988; Lundvall (ed.) 1992; Nelson (ed.) 1993; Edquist and Hommen (eds.) 2008). Lundvall (2002) provides a more comprehensive analysis of the Danish innovation system based on a large empirical study, which was organised around four themes and analytical levels: the firm level, inter-firm interaction, the institutional context and the innovation system as a whole.

In some respect this volume can be seen as an update on the key characteristics of the Danish innovation system. However, while this volume builds upon these earlier contributions, it is also novel in explicitly analysing the Danish system in the context of contemporary transformation pressures, particularly those pertinent to smaller open economies. Moreover, compared to earlier contributions, there is a greater emphasis on the impact of technological change, reflecting the widespread view that new and potentially disruptive technologies are having major impacts on economic and social life.

The book focuses on selected aspects of the innovation system which are grouped in four sections:

- the innovation systems approach and policy agenda
- value chains, innovation and inter-organisational relations
- technology, employee learning and the labour market
- green transition and sustainability.

These aspects are selected not only because they are important parts of any innovation system but also because they focus on areas that are currently undergoing substantial transition pressures and are of particular relevance to the Danish innovation system.

The innovation systems approach and policy agenda

Part I starts out by providing an overview of the history of innovation systems thinking and of the emergence of innovation policy in Denmark (Chapter 1 by Christensen and Fagerberg). When explaining the upsurge of innovation policy, the authors point to important inspirations from the theoretical and empirical understanding of innovations in the 1970s and 1980s and find that innovation system thinking was gradually incorporated into Danish innovation policies up to the turn of the century. At that time, innovation systems thinking became an established part of policies. The second chapter focuses on the performance of the Danish research and innovation system and on the emerging challenges it faces. As explained in Chapter 2 by Christensen and Knudsen, the Danish NIS has performed extremely well by any of the usual indicators and over the last decade has persistently ranked in the top three in the EU Innovation Scoreboard. Distinctive strengths of the Danish system include its high level of investment in human resources and public R&D, and the strengths of its research system as measured by several types of indicators, e.g., scientific publications. Despite the Danish system's overall exemplary performance, there are weaknesses that may hamper the future performance of the system. In particular, it is unclear if the system is able to leverage the well-performing research system to innovation in the small firm segment.

The chapters in Part I of this book also focus on several broader societal challenges that the Danish system currently faces, and on how policies play an important role in tackling these challenges. This includes designing entrepreneurship policies that balance creating opportunities for experimentation while avoiding unnecessary duplication and waste of resources (Chapter 3 by Nielsen, Christensen, Dahl and Timmermans). Similarly, using the case of a re-organisation of the Danish business promotion system, Chapter 4 by Drejer and Christensen analyses how Danish regional innovation policy has been shaped by different theoretically founded rationales since the turn of the millennium. The chapter discusses the proximity aspect of links between actors in the innovation system and whether links between actors are being adequately addressed in current policy changes, and whether a simplification of the system and a reduction in the number of actors risk leaving some firms lost. This problem area closely relates to a more general question on the appropriate level of policies and the number of actors involved in policies at different levels of aggregation.

Value chains, innovation and inter-organisational relations

Part II of the book explores the relation of interactive learning to innovation in both the private and public sectors. One area of considerable concern in developed countries linked to processes of globalisation and to technological catch-up in emerging market economies has been the impact of outsourcing on local suppliers. New technologies based on digitalisation and the Internet of Things (IoT) have dramatically increased the possibilities for global coordination of value chains and have improved conditions for doing business in a wide range of low-cost countries.

Chapter 5 by Andersen, Drejer and Østergaard in this part explores the diverse ways in which local Danish suppliers have responded to this challenge. It demonstrates that while a dominant focus has been developing the necessary capabilities for collaborating with customers in the development of new products and technologies, strategies that are more detached can be observed for sectors with a high degree of standardisation of products and services.

Chapter 6 by Kringelum, Gjerding and Taran focuses on the case of fourth-generation ports, an example of innovation in infrastructural projects, which despite often being neglected in economic analyses plays a central role in maintaining industrial competitiveness. Ports are considered hubs for transportation of physical goods, but also, and increasingly, as coordinators and disseminators of knowledge, hence creating a micro-system of high importance to the regional innovation system. This part of the book also focuses on public sector innovation and on the forms of collaboration between the public and private sector actors that support innovation (Chapter 7 by Stamhus and Nielsen). The evidence points to an important role for collaborative innovation and within this approach employee-driven innovation, where employees collaborate with external organisations and institutions in the generation of innovation, stands out as particularly important.

The impact of new and possibly disruptive technologies including smart robotics, 3D printing, artificial intelligence and smart sensors and the IoT have caught the attention of policy makers around the globe. Areas of impact include the global supply chain and infrastructural projects as discussed in Part II. More generally, these new technologies are seen as holding out promise for promoting more sustainable patterns of consumption and production in the economy as discussed in Part IV of the book.

At the same time, at the level of the labour market there is widespread concern that the adoption of these new technologies will result in large scale job losses as well as in growing inequality through the increasing ability of firms to automate routine mid-level jobs in both services and in manufacturing.

Technology, employee learning and the labour market

Part III of the book explores these challenges through an analysis of the evolution of work organisation, skills and labour market structure in Denmark.

Chapter 8 by Holm, Lorenz and Stamhus uses the results of a unique employee-level survey to develop what is a world-first survey-based investigation of the impact of the adoption of artificial intelligence on skills needs and mismatches and their relation to different forms of employee training. The chapter shows how robotics, artificial intelligence and machine learning have diffused in the Danish economy. While robots have been in use for decades, they have been largely confined to the manufacturing sector and this is only changing slowly despite novelties such as cobots and private service robots. Artificial intelligence and machine learning have rapidly diffused across all sectors of the economy so that large shares of the workforce across occupations and industries use such technologies regularly. Chapter 9 by Lorenz and Holm provides up-to-date insights into the relation between the skills and knowledge needed for successful innovation on the one hand, and the use of learning forms of work organisation that provide employees with opportunities for learning through their daily work activity on the other. The chapter shows that while the access of employees in Denmark to such learning opportunities is relatively high by European standards, there has been a downward trend since 2010 pointing to the need to develop policies, especially around vocational training that can support the adoption of learning organisations.

Chapter 10 by Nielsen, Holm and Lorenz in this part also contributes to the policy debate on the impact of new automation technologies on jobs and employment by arguing first for the prevalence of voluntarism in technology adoption. This voluntarism has implications for policy, which is summed up in the argument that labour market policy needs to be more than policy for the unemployed; it must be a work policy that also encompasses the employed. Such a policy is needed in order to meet the challenges posed to the national innovation system from technological change, and to ‘future-proof’ the labour market to assure labour market inclusiveness.

The final chapter in Part III, Chapter 11 by Eriksen and Holm, deals specifically with the education and training system in the Danish national innovation system. The chapter zooms in on continuous training programmes for life- long learning and demonstrates a shift over time from short spell vocational programmes, where participants acquire specific vocational skills, to a focus – in monetary resources if not in participant numbers – towards tertiary level programmes developing managerial competencies. The chapter demonstrates that having employees participate in such tertiary level continuous education is indeed associated with increased innovation at the firm.

Green transition and sustainability

Part IV of the book turns to the challenges of climate change and sustainability more broadly, which are increasingly recognised as amongst the most important challenges confronting developed and developing countries alike.

Achieving more environmentally sustainable patterns of production depends on leaving smaller environmental footprints. This in turn implies a need for new knowledge in the production process both in terms of the skills of the workforce and in the use of codified technical and scientific knowledge. Chapter 12 (Østergaard, Holm and Park) of the book provides evidence on firms that undertake green innovation and how the requirements for the workforce of such firms are changing, either because new skills are necessary for undertaking green innovation, or because they are in demand as a consequence of green innovation. The analysis shows that the education and training system in particular must be adapted if Danish firms are to lead and not just follow in this transition.

Appropriately, the concluding Chapter 13 by Gregersen and Johnson in this part of the book turns to the UN Sustainable Development Goals (SDGs) and assesses the performance of the Danish economy in meeting the challenge. The chapter turns to a more general assessment of the implications of the SDGs for how we measure innovation performance and the degree to which standard measures of innovation performance successfully inform policy makers towards a sustainability transition. There is a need for transformative capacity, i.e., an ability to mobilise major innovation and investment activities to restructure the society to meet the challenges in a wider, long-term perspective.

References

- Anderson, P. W. 1972. More is different. *Science*. 177(4047), 393–396.
- Arozena, R. and Sutz, J. 2000. Looking at national systems of innovation from the South. *Industry and Innovation*. 7, 55–75.
- Asheim, B. and Isaksen, A. 1997. Location, agglomeration and innovation: Towards regional innovation systems in Norway? *European Planning Studies*. 5, 299–330.
- Bergek, A., Jacobsson, S., Carlsson, B., Lindmark, S. and Rickne, A. 2008. Analyzing the functional dynamics of technological innovation systems: A scheme of analysis. *Research Policy*. 37(3), 407–429.
- Breschi, S. and Malerba, F. 1997. Sectorial innovation systems: Technological regimes, Schumpeterian dynamics and spatial boundaries. In Edquist, C. ed. *Systems of Innovation: Technologies, Institutions and Organizations*. London: Pinter Publishers, 130–156.
- Carlsson, B. and Stankiewicz, R. 1991. On the nature and composition of technological systems. *Journal of Evolutionary Economics*. 1, 93–119.
- Chaminade, C., Lundvall, B.-Å. and Haneef, S. 2018. *Advanced Introduction to National Innovation Systems*. Cheltenham: Edward Elgar.
- Cooke, P. 1996. The new wave of regional innovation networks: Analysis, characteristics and strategy. *Small Business Economics*. 8, 159–171.
- Cooke, P., Heidenreich, M. and Braczyk, J. eds. 2004. *Regional Innovation Systems. The Role of Governance in a Globalised World*. 2nd ed. London: Routledge.
- Dosi, G., Freeman, C., Nelson, R., Silverberg, G. and Soete, L. eds. 1988. *Technical Change and Economic Theory*. London: Pinter Publishers.
- Edquist, C. ed. 1997. *Systems of Innovation: Technologies, Institutions and Organizations*. London: Pinter Publishers.
- Edquist, C. and Hommen, L. eds. 2008. *Small Country Innovation Systems. Globalization, Change and Policy in Asia and Europe*. Cheltenham: Edward Elgar.
- Fagerberg, J., Laestadius, S. and Martin, B. R. eds. 2015. *The Triple Challenge for Europe – Economic Development, Climate Change and Governance*. Oxford: Oxford University Press.
- Freeman, C. 1987. *Technology Policy and Economic Performance: Lessons from Japan*. London: Pinter Publishers.

Freeman, C. and Lundvall, B.-Å. eds. 1988. *Small Countries Facing the Technological Revolution*. London: Pinter Publishers.

Geels, F. W. 2004. From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory. *Research Policy*. 33(6–7), 897–920.

Lundvall, B.-Å. ed. 1992. *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*. London: Pinter Publishers.

Lundvall, B.-Å. 2002. *Innovation, Growth and Social Cohesion, The Danish Model*. Cheltenham: Edward Elgar.

Lundvall, B.-Å. ed. 2010. *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*. London: Anthem Press.

Lundvall, B.-Å., Vang, J., Joseph, K. J. and Chaminade, C. 2009. Innovation system research and developing countries. In Lundvall, B.-Å., Joseph, K. J., Chaminade, C. and Vang, J. (eds) *Handbook of Innovation Systems and Developing Countries – Building Domestic Capabilities in a Global Setting*. Cheltenham: Edward Elgar. 1–30.

Malerba, F. ed. 2004. *Sectoral Systems of Innovation. Concepts, Issues and Analyses of Six Major Sectors in Europe*. Cambridge: Cambridge University Press.

Nelson, R. ed. 1993. *National Innovation Systems. A Comparative Analysis*. New York: Oxford University Press.

Niosi, J. (ed.) 2018. *Innovation Systems, Policies and Management*. Cambridge: Cambridge University Press.

OECD. 2020. *Income Inequality (Indicator)*. doi:10.1787/459aa7f1-en (Accessed on August 19, 2020).

Rakas, M. and Hain, D. S. 2019. The state of innovation system research: What happens beneath the surface? *Research Policy*. 48, 103787.

Sharif, N. 2006. Emergence and development of the national innovation systems concept. *Research Policy*. 35(5), 745–766.

Stam, E. 2015. Entrepreneurial eco-systems and regional policy – a sympathetic critique. *European Planning Studies*. 23(9), 1759–1769.

Weber, K. M. and Truffer, B. 2017. Moving innovation systems research to the next level: Towards an integrative agenda. *Oxford Review of Economic Policy*. 33(1), 101–121.