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Bridging Innovation System Research and Development Studies: challenges and research opportunities

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1. Introduction

This paper links innovation system analysis to economic development. Both fields are young and interdisciplinary. The origins of research on innovation systems goes back to the early 1980s (Freeman 1982, Lundvall 1985, Freeman 1987) although it links to several predecessors such as Babbage (1832, 3rd edition), List (1941) or Marshall (1965). Development economics, on the other hand, took off in the 1940s (Rosenstein-Rodan 1943) but, since then, it has been going through so many dramatic changes that yet cannot be characterised as a 'mature' field.

In the recent years, particularly in the framework of Globelics, there has been a renewed interest on applying the innovation system concept in developing countries. However, some critical questions remained unanswered: Is innovation system a useful concept for understanding and explaining what goes on in a developing country? Can it be used as a tool and a framework for agents and agencies in charge of designing public policy and

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business innovation strategies? The assumption behind this paper is that we can answer a *conditional* 'yes' to both of these questions and in the first part of this paper we try to specify the conditions and we do so in a dialogue with critiques developed within the community of evolutionary and development scholars.

Another important question is how the approach fits into the historical and current trends in development economics. In the second part of the paper we give a brief assessment of how development economics has evolved and we draw some lessons for a research strategy. We will argue that the crisis of the first generation of development economics that was represented by scholars such as Nurkse, Myrdal, Hirschman, Singer and Sen has left a void in development economics that cannot be filled neither by mainstream neoclassical economics nor by 'new growth theory'. We see the innovation system approach as a serious candidate to fill this void.

The paper is structured as follows. In the next section we review the concept of innovation system (in dialogue with other alternative concepts like national learning systems), the different forms of studying innovation systems and the critical dimensions to consider when studying innovation systems, particularly in developing countries. Section 3 reviews the recent evolution of Development Economics, pointing out to the main weakness of this discipline, particularly when it comes to the analysis of the factors underlying under-development. Section 4 proposes and discusses how innovation system research can contribute to development economics and vice-versa. The paper concludes highlighting the main research gaps in innovation systems and development and proposes a future research agenda in this topic.

2. Innovation systems research

2.1. The narrow and broad definition of innovation systems

The initial work on innovation systems by Freeman (1987), Lundvall (1992) and Nelson (1993) operated at the national level. It inspired the work on regional (Asheim and Gertler, 2004), sectoral (Malerba, 2002, 2004) technological (Carlsson and Stankiewicz 1995) and corporate levels (Granstrand 2000). Common for these contributions was that they deviated from the linear approach to technological progress and regarded innovations at micro, meso and macro level as a driving force behind growth. It went beyond the narrow confines of product and process innovation, focusing on interactive learning and emphasized inter-dependence and non-linearity wherein institutions play the central role (Joseph 2006).

Almost from the beginning, innovation system research has encompassed two different perspectives, a narrow one linking innovation to science and a broader one encompassing learning, innovation and competence building (Lundvall 2007). While acknowledging the different scales in which the innovation system concept can be applied, the following discussion will be mainly focused on the national level – national innovation systems (NIS)².

NIS in a narrow perspective, in tune with the earlier analyses of national science systems and national technology policies (Mowery and Oxley 1995), aimed at mapping indicators of national specialization and performance with respect to innovation, research and development efforts and science and technology organizations. In contrast, the broader approach to NSI takes into account social institutions, macro economic regulation,

² It is useful to keep in mind, that the innovation system concept originated from an analysis of ‘national’ innovation systems (Freeman 1982, Freeman 2004) and that the regional and sectoral systems have been both inspired by and reacted to this original formulation. Arguably, the national level is the one that illustrates more clearly the differences between the narrow and the broad notion of innovation system that will be discussed in this paper.

financial systems, education and communication infrastructures and market conditions as far as these have impact on learning and competence building process (Gu and Lundvall 2006). It links the micro behaviour to the system level in a two-way direction. Changes at the system level are seen as outcomes of interactions at the micro level whereas the system shapes the learning, innovation and competence building at the micro level.

The bearing of the broad and narrow definitions of innovation system in a developing country context may be explained by considering the distinction between a STI (Science-Technology-Innovation) mode and a DUI (Doing Using and Interacting) mode of innovation as articulated by Jensen et al (2007) and Lundvall (2007). The STI mode of innovation, in tune with the narrow definition of innovation system, focuses on innovations based upon R&D-efforts. This suggests an innovation model which is based on experimentation (typically in labs) formalisation, and codification of the identified knowledge. However, the STI mode constitutes only one of the pillars of the learning and innovation process. Much learning, especially of tacit and localised knowledge, is through the DUI mode that refers to learning at the job as employees face on-going changes that confront them with new problems and as well learning taking place in an interaction with external customers. The DUI mode, given its focus on interactive learning through structures and relationships, is in tune with the broader definition of innovation system.

We will argue that narrow definitions of the national innovation system are of limited relevance when it comes to understand the problems of less developed economies. Actually they are misleading when it comes to inform innovation policy strategy everywhere. This may be illustrated by the debate on ‘innovation paradoxes’ for Europe as a whole and in many individual countries, where investment and progress in science does not match innovation outcomes and economic performance (Lundvall 2007).

But this leaves us with the task to specify what we mean with the ‘broad’ definition. Broadness and holism are not attractive terms in themselves since they might signal lack of clarity and precision etc. And there has been a criticism of the broad definitions

pointing out to the difficulties selecting which institutions, organisations and structures should be included and what could be excluded. An important aim with this paper is to bring this discussion some steps ahead.

In the box below a number of definitions of (national) innovation systems have been listed. It is obvious that they have in common first a reference to ‘institutions’ and second a focus on ‘knowledge’ and/or ‘technology’.

Box 1.: Definitions of National Innovation Systems

“... The network of institutions in the public- and private-sectors whose activities and interactions initiate, import, modify and diffuse new technologies” (Freeman, 1987)

“... The elements and relationships which interact in the production, diffusion and use of new, and economically useful knowledge... and are either located within or rooted inside the borders of a nation state”(Lundvall, 1992)

“... The set of institutions whose interactions determine the innovative performance of national firms” (Nelson and Rosenberg, 1993)

“... The national system of innovation is constituted by the institutions and economic structures affecting the rate and direction of technological change in the society” (Edquist and Lundvall, 1993)

“... A national system of innovation is the system of interacting private and public firms (either large or small), universities, and government agencies aiming at the production of science and technology within national borders. Interaction among these units may be technical, commercial, legal, social, and financial, in as much as the goal of the interaction is the development, protection, financing or regulation of new science and technology” (Niosi et al., 1993)

“... The national institutions, their incentive structures and their competencies, that determine the rate and direction of technological learning (or the volume and composition of change generating activities) in a country” (Patel and Pavitt, 1994)

“... That set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artifacts which define new technologies” (Metcalf, 1995)

Source: Niosi, 2002, p. 292

Several of the definitions refer to *system components and relationships*. But a system can also be defined in terms of what it does (its functions). This alternative approach is the one proposed by Edquist (2005) and others (Galli & Teubal, 1997; Johnson & Jacobsson, 2003; Liu & White 2001; Rickne, 2000).

These authors, applying the *functional approach*, argue that the innovation system major function is to bring forward innovations or to create new knowledge. Scholars in this line of research define different sub-functions or activities that contribute to this overall function. Edquist (2005) argues that the lack of agreement on where to draw the lines around the innovation system makes the concept ‘diffuse’ and that this lack of clarity constitutes a barrier for further progress toward a more ‘rigorous’ and ‘theoretical’ concept. Rather than defining the system as constituted by organizations it should be defined by specifying different functions. He lists ten such activities/functions/factors influencing innovation: Research and development, competence building, formation of new product markets, articulation of user needs, creation and change of organizations, networking around knowledge, creating and changing institutions, incubating activities, financing innovation, and consultancy services (Edquist, 2005).

It is true that all the listed factors may be seen as contributing to or being media for innovation. And the point made that the same activity may be organized differently in different national systems is certainly relevant at least for some of the activities. We would also agree that such lists may be used as check-lists for governments to make sure that the innovation policy pursued does not become too narrowly defined.

But to conclude that agreeing on such a list is the most useful way to ‘create rigour’ and scientific progress might not be correct. Several other activities/functions/factors influencing innovation could be listed (five candidates that might enter the top ten as ‘factors influencing innovation’ are: competition, openness to international trade and capital flows, labor market dynamics, social welfare systems and ‘social capital’). Saying that further research will help us converge on the right ones is not a useful response to this selection problem³.

While it might be unsatisfactory to define the innovation system in terms of its organizational components and their interactions we find it equally unsatisfactory to do it by listing activities or functions. The *third way* being proposed here is to focus upon the innovation process and to draw upon innovation theory based upon stylized facts and rooted in an evolutionary perspective.

It should be pointed out that we are interested in linking innovation and macroeconomic performance. We do not see it as the function of the national innovation system to maximize the amount of innovation. We are interested in understanding both how innovation takes place and how it is transformed into macroeconomic performance. This corresponds to the perspective characterizing the original work on innovation systems (Freeman 1982, Freeman 1987 and Freeman and Lundvall 1988).

³ The listing echoes Denison’s ‘growth accounting’ exercises where attempts were made to reduce the relative size of the ‘residual’. It has in common with such efforts a certain agnostic approach where all factors are treated as equally important and without systematically linking them to each other. In this sense it is a move toward less theory rather than more theory. This is reflected in the disturbing lack of consistency in the list, i.e. the heterogeneous character of its elements. This way of defining innovation systems actually exaggerates what we do not know and defers from drawing upon what we do know regarding innovation.

On this basis we would propose the following definition:

“The national innovation system is an open, evolving and complex system that encompasses relationships within and between organisations, institutions and socio-economic structures which determine the rate and direction of innovation and competence building emanating from processes of science based and experience based learning.”

The definition highlights three important issues:

1. That innovation and learning will reflect the combination of prevailing institutions and the *socio-economic structure*. This was a basic idea in Lundvall (1992) where it was emphasized that what you do (as reflected in the economic structure – the presence of industrial sectors) will reflect what you know which, in turn, will be reflected in what you learn. This starting point is of fundamental importance for developing countries since it opens up the possibility to manipulate the pattern of specialisation so that the rate of learning and competence-building is high.
2. The definition also specifies that *competence building* is the other side of the process of innovation. Sometimes ‘learning’ is used to refer mainly to passive adaptation to changing circumstances. We see the creation of capabilities in firms and the formation of competences among people as important outcomes of processes of “active” learning.
3. Finally, and this is very important, the definition specifies that innovation is rooted not only in science-based learning but also in *experience based learning* (broad definition of innovation systems)

It is true that the sets of ‘organisations and its relationships, institutions and socio-economic structures’ that are evoked by this definition are very broad indeed. We need to take into account aspects of education and training, social policies that underpin social

capital and interactive learning as well as the functioning of labour markets and the organisation of firms. At this point we need to consider Edquist's critical remark that 'Within a geographical area the whole socio-economic system cannot, of course, be considered to be included in the SI.' (op. cit. p.200). This common sense remark might not be correct, however. The point is that we look at each of these elements from a specific perspective – how they contribute to innovation and competence building. Alternatively we might therefore define the innovation system as *a focusing device* to be applied to the national economy and contrast it with the focusing device offered by neoclassical economics:

'the (national/regional/sectoral) innovation system is a focusing device aiming at analyzing and understanding processes of innovation (rather than allocation) where agents interact and learn (rather than engage in rational choice). The aim of using this device is to find out which alternative institutional and organizational set-ups support stronger dynamic performance of a (national/regional) economy or a sector.'

The basic underlying proposition is that the form and content of organizations, institutions and socio-economic structures that appear as most attractive when we focus upon economic change and agents that learn will not be the same as when the focus is upon allocation of existing resources on the basis of rational agents. It is also taken into account that while different institutional set-ups may be more or less efficient there is no single 'optimal' way to organize a national or regional economy. As we shall argue below, this proposition is true everywhere. But it is not least true in the context of a developing country. It follows from this that while the interest in the impact of technology on growth is in common the theoretical core of national innovation studies is incompatible with New Growth Theory based on revised neoclassical assumptions.

2.2. National, regional or sectoral innovation systems? – Different levels of aggregation

The focus of Freeman's unpublished OECD-paper from 1982 where the concept 'national innovation system' appeared for the first time was on how countries could build knowledge and knowledge infrastructure at the national level with the aim to promote economic development and international competitiveness. A key reference in the paper was to Friedrich List (1842) and his concept 'the national system of production'. Freeman pointed out that List was concerned that applying Adam Smith's invisible hand and his 'cosmopolitan' strategy would leave countries that were less developed than Great Britain permanently and increasingly behind. List pointed to the need for national governments to be active and build infrastructure and invest in knowledge. In this context he argued that the most important form of capital was neither physical nor financial – it was 'mental' – today we would call it 'intellectual'. He also pointed to the need to protect 'infant industries' until they could become strong enough to compete on equal terms with firms from England.

To the extent that a major concern of many developing countries today is to bring about economic transformation and catch up with the developed world the innovation system perspective as proposed by List should be directly applicable to the reality of developing countries. But there has been some scepticism among scholars who have worked in the tradition of development economics (Lall 1992, Viotti 2001, Matthews 1999 and others) who argue that building technical capabilities and to promote learning are legitimate concerns while 'innovation' sets the goal too high for less developed countries. And it has also been argued that there is no full-blown 'system' of innovation in a less developed country that can be studied. Rather the task is to develop strategies to create such a system (Arocena and Sutz, 2000).

Nonetheless, more and more, national governments in developing countries refer to national (and regional) innovation systems as a framework for designing national (and regional) development strategies. The most important recent example is China where the

new long term plan for science and technology explicitly points out that the plan has been designed on the basis of a national innovation system perspective.

2.3. National innovation systems or national learning systems?

Several authors including Viotti (2002) and Matthews (1999) have argued against the use of the concept *innovation* system and in favour of the concept '*learning* system'. Viotti argues that innovation system should be reserved for developed countries where the leading firms introduce innovations that are new for the world. In less developed countries incremental innovation, diffusion and learning may take place but not innovation (*stricto sensu*). He then goes on to make a distinction between Active and Passive learning systems using Korea and Brazil as illustrations.

While Viotti's comparative analysis is extremely interesting and useful we do not agree with the starting point. Much of the early work on innovation systems was developed in connection with small countries such as Sweden, Norway, Denmark and Finland (Freeman and Lundvall 1987, Lundvall 1988). These countries prosper not because their firms develop unique new innovations for the world market but because their firms have developed a capacity to absorb and use new technology developed elsewhere (see also Fagerberg, Mowery and Verspagen 2008). Taking Viotti seriously would imply that these countries have learning systems but not innovation systems – perhaps we would end up with innovation systems only in the US, Japan, the UK, France and Germany

One reason why Viotti wishes to reserve the innovation system for those countries that develop radically new technology is that he finds the use of 'innovation process' as covering both original development, diffusion and use of new technology too vague. But to find out where new ideas originate from is not always easy and from the point of view of economic performance it is less important than understanding how they are diffused and used. As Chris Freeman puts it: despite similarly large investments in R&D by various industrialized and semi-industrialized countries starting in the 1950's and 60's "evidence accumulated that the rate of technical change and of economic growth

depended more on efficient diffusion than on being first in the world with radical innovations and as much on social innovations as on technical innovations” (Freeman, 1995, p. 10).

Therefore it is important to assess to what degree the original set of ideas developed around the concept of national system of innovation are valid in relation to less developed countries operating in a globalising context. As we shall see the scepticism is well-founded when we operate with narrow definitions of innovation and innovation systems but not when we operate with the broad understanding as it was presented in the founding work by Christopher Freeman and the Aalborg-school (Freeman 1987, Lundvall 1992).

Finally, we would like to stress that in all innovation systems technical change and economic growth at the national level are the outcome of what innovative activities that take place in the *whole* population of firms. Having a long tail of slow adopters and a few world leading firms may be less attractive than having many firms that are quick adopters without any world leaders. The performance of the national innovation system will reflect technical and organisational change in the industrial system as a whole and therefore there is no reason why we should promote world leadership rather than quick follower strategies. Big countries such as Brasil, India and China may for different reasons have aspirations to become world leaders in specific technologies - for instance in order to avoid technological dependence when it comes to what the US may define as ‘strategic technologies’ but for most countries this is not the best way to promote competitiveness and growth.⁴

⁴ If Viotti had come up with the proposed terminology 25 years ago it might have been worth considering. It might have helped avoid the current bias toward science-based learning. It is obvious that many policy makers and analysts attach to innovation the same narrow meaning as Viotti. The result has been that references to national innovation systems have been used to promote science in general or to impose market governance on universities. Now it is too late to change the vocabulary: The innovation system has become part of policy language world-wide – what is needed now is to re-conquer the concept and bring it back to what was intended with it 25 years ago.

2.4. The informal and formal dimension of innovation systems

There is a strong bias in theory as in policy to focus upon what can be easily measured and to neglect what appears to be impossible or difficult to measure. The core of any standard study of (national) innovation systems will thus contain data on R&D-efforts and patents. If data based upon innovation surveys are accessible these might be added but most policy makers seem to remain reluctant to go outside the traditional data sets relating to R&D (Arundel 2006).

Institutions and policies studied are mainly those directly or indirectly related to R&D activities sometimes inspired by triple helix concept and since it is more easy to measure the performance of single firms and knowledge infrastructure organisations the ‘quality of relationships’ between them is normally not captured by the analysis.

This is problematic since the elements of the innovation system that have the most important impact upon the learning capacity of the whole system may be informal and difficult to measure. Based on Schoser (1999) we distinguish not only between what might be included in narrow and broad definitions of innovation systems but also between formal and informal elements and relationships. In Table 1 we have included some examples of elements considered in each field.

Table 1. Interaction between formal and informal elements of the innovation system

	Narrow	Broad ⁵
Formal	(1) Science& Technology organizations, institutions and formal networks	(2) Organizations supporting innovation in general, institutions & formal networks
Informal	(3) S&T informal institutions	(4) Informal institutions influencing

⁵ Includes the organizations and networks included in the narrow concept of IS as well

	and informal networks	innovation and informal networks (like cultural and historical values)
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Source: Adapted from Schoser (1991)

The functioning of universities and research institutions, patents and publications or technology policy and programs are examples of components of the formal and narrow innovation systems. The educational and financial system, the environmental competition and policy or the labor market are other organizations and institutions to be included in the broad and formal definition of the innovation system.

On the other hand, elements such as the willingness of firms to cooperate with scientific institutions or the closeness of relationships between companies and technology policy might be considered as part of the informal and narrow system of innovation; while the quality of the relationships between customers and suppliers, the degree of trust in the society or the values of the educational system are informal items to be considered under the broad definition of innovation systems.

So far the focus of innovation system research and innovation policy has been on formal elements and narrow definitions. But the mode of innovation as well as the performance of the system will reflect that the narrow and broad systems as well as the formal and informal systems are extremely interdependent For example:

1. The efficiency of efforts taking place in the formal narrow system (1) will reflect the informal narrow system (3). For example, interactive learning across organisations as well as learning within organisations will depend upon ‘informal cognitive and behavioural patterns in the innovation processes.
2. The informal narrow system (3) will be rooted in the informal broad system (4). For example, the business culture will reflect the broader pattern of ‘cultural and historical factors’.

3. Cultural and historical factors (4) will in the long term be influenced by changes in the formal broad system (2). Here we would add agrarian reform, democratic education systems, more or less egalitarian income distribution, transparency, rule of law, social policies compensating victims of change and policies restricting corruption and ethnical conflict.

The Nordic countries – especially Norway and Denmark – ought to be handicapped by small size and by a rather weak knowledge base. Their record in terms of radical innovation is also weak. The fact that their economies have performed well in terms of economic growth has more to do with the causalities referred to above. They are outstanding in absorbing ideas from abroad and to some degree this has to do with the educational level. But the high level of generalised trust is also important. The high level of trust in the Nordic economies has to do with agrarian reform, democratic education systems, egalitarian income distribution, social policy, transparency, rule of law and policies restricting corruption and ethnical conflict. And empirics show that the high level of trust is reflected in more frequent inter-firm interaction in innovation processes as well as in a much broader participation in processes of change within firms. This specific mode of innovation is especially supportive for learning and absorption of new technology.

The reality of most developing countries is far away from the Nordic model. But, nonetheless, it might be the case that strong efforts to upgrade the formal narrow system will prove to be without major effect without upgrading aspects of the informal part. The fact that Korea succeeded both with agrarian reform and with building an all encompassing education system may have been crucial for creating the informal basis that supported its narrow innovation system. Democratising working life and building a welfare state may be important next steps for Korea. In less developed countries offering general access to modest forms of education, health service and food for all children without regard of social and ethnical origin might be a kind of reform that would contribute to generalised trust that can spill over to the innovation system.

This implies that innovation research needs to develop new tools and indicators to analyse and capture difficult slippery concepts such as ‘social capital’ and ‘generalised trust’. It also implies that ‘innovation policy’ needs to be anchored not in one single ministry but rather at the very top of the government and in strategic bodies aiming at building sustained learning at all levels of the economy.

3. Development economics

Several authors point to the paper by Rosenstein-Rodan (1943) in *Economic Journal* as marking the beginning of development economics as a sub-discipline in economics. It was followed by major contributions came in the fifties (Dobb 1951, Singer 1952, Nurkse 1953, Lewis 1954, Hirschman 1958) but the analysis was far from unified. There were heated debates regarding balanced versus imbalanced growth as well as between Marxists such as Dobb and Baran (1957) and more liberal economists such as Lewis.

Nonetheless there was some common ground for most of the economists taking part in the debate. Using inspiration from Keynesian growth models and from Marxian theory of capitalist accumulation it was argued that an increase in the rate of investment was necessary in order to raise the rate of growth. The analysis of Lewis demonstrating the dramatic differences in productivity between traditional informal sectors and agriculture on the one hand and manufacturing on the other hand saw the transfer of labour from the low productive sectors to the high productive ones as an important prerequisite for sustained growth.

Most of the development economists were in favour of import substitution and saw the role of the state as protector of infant industries as legitimate and necessary. This was based upon a certain pessimism regarding the potential for manufacturing exports – a

pessimism that had real background in the period 1950-70 when most of the growth in international trade took place within the OECD-area (Waterbury 1999).

Less than forty years after Rosenstein-Rodan's seminal article first Hirschman (1981) and then Amartya Sen (1983) recognised that the era of development economics based upon this common ground had come to a close. Hirschman pointed out that the development economists had overestimated the power of their ideas to overcome underdevelopment and also that there had been lack of respect for the emotions and culture of those who were expected to realise their ideas.

Amartya Sen recognised that the position of development economics had been weakened. But he argued that their basic ideas had not been refuted by what had actually happened. Those countries that have had success in catching-up actually followed most of the advice given by the classical development economists. Specifically, while growth in some of these countries became export-led it did so after periods of import substitution that created the basis for the new export industries.

But the pro-market neo-liberal criticism of Keynesianism and of state-intervention had a major impact on all sub-disciplines in economics and it was especially devastating for development economics. There are different interpretations of what went wrong for development economics. One interesting proposal comes from Noble Prize Winner in economics Paul Krugman (1995) who argues that the main reason was not political but the fact that the protagonists could not present their argument in a language that the mainstream in economics could understand. (Not surprisingly Krugman indicates that with the arrival of new trade and new growth theory the situation now has changed).

Amartya Sen's article is especially interesting because while it may be seen as closing one era of research he also opens up new avenues for research by presenting his ideas about capabilities and freedoms as indicators of development. He argues that what matters for people is not so much what they own or earn as it is what they experience and are able to do. Owning a bicycle without roads or belonging to a culture or a gender

where biking is not permitted is of limited value, as Box 2 illustrates with the example of China.

Box 2. Economic growth and welfare in China

The development in China after Amartya Sen's article was published has illustrated both the relevance of traditional developmental economics and the need to make a distinction between growth and welfare. First it is obvious that the most important driver of economic growth in China is the very high rate of capital accumulation. And there is little doubt that government policies have been instrumental in establishing this process. China did not follow the classical doctrine of import substitution since there was a bold opening of the economy for imports of both commodities and foreign capital. This is where China now indicates that there might be a need to protect the building of domestic competencies that make it possible to develop 'independent innovation' (Gu et al 2008).

Second, the divergence between indicators of economic growth and indicators of capabilities and well-being – including access to education and health services as well as to clean air and water – have been quite dramatic in China. Again the government is aware of the problem and it is now referring to 'harmonious growth' as what should be aimed at in the future (Gu and Lundvall 2006b). This implies concern about regional imbalances and about social and ecological sustainability. The case of China is especially important since the outstanding economic growth of China is the single development that makes it possible to argue that globalisation has contributed to increased global equality (Wade 2005). It is not obvious that a calculation of global inequality on the basis of 'capabilities' would end up with the same result.

After the demise of the ‘classical developments economics’ followed a period where economic development was analysed with the use of tools of standard economics⁶. Market failure was analysed with the most advanced tools from information economics. Advanced game theory was applied to manifold situations. But in both cases the analytical work gave few useful insights. The almost unlimited room for model specifications resulted in contradictory conclusions regarding policy. To quote Dilip Mookherjee: the result was “an embarrassment of riches when it comes to the choice of a theoretical model for almost any phenomenon” (Op.cit. 2005).

This was the background for the strong move toward econometrics and evidence-based public policy that is still reigning the discipline. Today almost all research in mainstream development economics is empirical and it is driven by the use of increasingly advanced econometric models. ‘The key problems confronted by a typical empirical paper today concerns the various possible econometric biases’ (Op cit 2005). Specific new techniques such as the use of ‘instruments’ for potentially endogenous regressors and ‘randomised controlled experiments’ that can be used to inspire public policy (much in the spirit of research in medicine) are regarded as constituting the frontline of research.

But Dilip Mookherjee who was the author of the central paper to which the other scholars added their reflections at the 2005-occasion referred to in foot-note 5 - and most of the others contributing to the debate - was not completely happy with the current content and style of research. Mookherjee’s paper had the following title ‘Is there too little theory in development economics today?’ and his answer to this question is yes. While he and others recognise that there has been important progress in the econometrics they worry that ‘Research papers tend to get evaluated almost exclusively in terms of their success in combating econometric problems often to the exclusion of the importance of the context or issues addressed by the analysis, the imaginativeness of the underlying hypotheses formulated or tested, or the importance of the findings from a wider standpoint’ (op cit).

⁶ The following is based upon material from a seminar held at in October 2005 where development scholars (Mookherjee 2005, Basu 2005, Banerjee 2005) made a critical assessment of their field of research.

The general impression from this debate is first that the admirable open-mindedness and capacity to engage in self-critical assessment shown by Mookherje and the other participants in the seminar. Second it is that currently mainstream economics tends to use developing countries' problems as offering interesting opportunities to make use of advanced theoretical models and econometric tools while the interest in understanding the structures that lie behind underdevelopment and the mechanisms that might trigger development tend to end up as being of secondary importance.⁷

4. Linking innovation system research to development economics

4.1. The contribution of innovation system research to development economics

Mookherjee and the other participants in the debate pleaded for more emphasis on theoretical work and specifically they pointed to several important issues where there is a need to develop theory:

1. Interaction of economic processes with political institutions and norms.
2. Replacing traditional assumptions regarding rationality with behavioural models.
3. Endogenous evolution of preferences in public policy.
4. Theories of institutions that relate them to specific community characteristics.
5. Firm heterogeneity.
6. Problem solving in interaction with others in which our ends and means co-evolve, with ends discovered and transformed in the process.
7. Need to go beyond methodological individualism and rational choice.

⁷ One of the most interesting contributions to the debate comes from Basu who points out that the idea that the only form for truly reliable knowledge comes from 'randomised controlled experiments' is absurd since it implies that all that we have learnt through other forms of 'experience' is irrelevant.

Most of the issues proposed are actually at the core of evolutionary economics, including heterogeneity of agents and agents that learn in an interaction with each other resulting in a transformation of their preferences. Nonetheless it is striking that the role of knowledge, competence building and innovation in the development process are for the most part not explicitly addressed in these calls for new research. The issues addressed by the micro-studies referred to as examples are quite specific. They relate for instance to the optimal use of markets when it comes to distribute of malaria nets or of the impact on learning of the use of flipcharts in education. There are considerations of factor markets but little on how those support innovation and competence building.

The innovation system approach implies that the very focus of the analysis should be on the creation, diffusion and use of knowledge seen both as information and competence. Getting markets to allocate existing resources efficiently is important but it is not what drives economic development. Both markets and other institutions need to be assessed according to how they affect the competence of people and the capacity of organisations. Therefore the focus of the analysis should be on economic structures and institutions that support competence building among people and capacity building in organisations. Public policies should be designed in such a way that they get structures and institutions right.

There are at least three classical and highly politicized issues that go through the debates in development economics. The first is on the role of governments versus markets. The second is about free trade and the openness of the market. The third is about industrialization as a necessary step toward modernization.

We would argue that the innovation system approach has a potential to throw new light on these issues. One of those that insists that it is fundamental for developing countries to get their trade specialization right is Erik Reinert (2006). There is a great potential in developing the analysis of sectoral innovation systems with focus upon the potential for learning and competence building in different sectors, including not only activities from agriculture and manufacturing but also service sectors. Such studies should also take into

account knowledge related linkages established between sectors. A major problem here might be to find the right level of aggregation since sectors, as they are defined in production and trade statistics, are quite heterogeneous and it is a challenge to group activities that have commonalities in terms of their learning dynamics.

With regards to the openness of the economy, many innovation system scholars tend to support the view of Lewis: while there is a great potential for learning from abroad in global value chains or through inward foreign direct investments the actual positive impact will depend on the indigenous 'absorptive capacity'.

The role of the state is at the very centre of political disagreements. While it is obvious that government initiatives were crucial for shaping the growth dynamics in countries like China (Gu and Lundvall, 2006a and Gu et al, 2008) or India, it is also obvious that most studies stress the need for governments to withdraw and give more space for private initiative. The debate is put in general and rather sharp terms by Tilman Altenburg (2008) and by Cimoli et al (2008). While Altenburg emphasizes government failure Cimoli et al criticize the assumption that 'markets' are the most natural institutions in the economy and they see active industrial policy as necessary for the promotion of economic development.

4.2. The contribution of development economics to innovation system research

Innovation system research may draw lessons from the fate of classical development economics and not the least from the reflections made by Hirschman and Sen at the end of the era. Hirschman pointed out that there was an element of arrogance in the work assuming that the development economists as outsiders could dictate rational behaviour on central actors, without considering the culture and passions of those directly concerned. One way to overcome this problem is to strengthen the competence and research capacity in the field of innovation systems and development economics within the developing countries. Globelics, Asialics and Cicalics are networks that have this as their major aim. Similar initiatives are under way in India and within Africa.

The major message from Amartya Sen’s work over the past decades (Sen, 1983, 1999) is that growth in the material assets is not equivalent with growth in welfare and well-being. This may be seen as recognition that ‘classical development economics’ had a tendency to see growth as identical to development. Research on innovation and competence building should learn from this mistake. Not least it is clear that the current development in China illustrates the need to have a broader understanding of development that takes into account social and ecological consequences of growth strategies. One intuitive way to indicate such a broader perspective is to link development to different kinds of ‘capital’.

Table 2: Resources fundamental for economic growth – combining the tangible and reproducible dimensions

	Easier to produce, reproduce or use	Not easy to produce or reproduce
Tangible resources	1. Production capital	2. Natural capital
Intangible resources	3. Knowledge capital ⁸	4. Social capital

The table illustrates that economic growth is faced with a double challenge in terms of sustainability and that there is an imminent risk of undermining the basis of material production. In China pollution of water and air threatens the reproduction of tangible capital. We will argue that the production and efficient use of intellectual capital is fundamentally depending upon social capital. In a successful learning economy rooted in

⁸ It is important to highlight that our point here is not that knowledge is easy to reproduce but that if we do not combine it with other dimensions (like social capital – much more difficult to reproduce) the production and dissemination of knowledge (particularly of a tacit nature) will be severely hampered.

social cohesion and trust it is easier to engage in interactive and apprenticeship learning resulting in the passing on of elements of tacit knowledge from individual to individual and from generation to generation. This is more difficult in a context without trust and with long distance among professions and in hierarchies. Thus, undermining trust and social capital undermines the reproduction and use of intellectual capital. A development strategy that focuses only on production capital and intellectual capital is not sustainable.

Finally we see a great potential in linking Sen's analysis of individual 'capabilities' to the analysis of innovation systems. In our view the most important of all capabilities is the capability to learn. This capability is fundamental for all the other capabilities and it is the one that will shape the dynamics of welfare. To put it crudely economic development is about enhancing capability and opportunity to learn at all levels. Technological learning is fundamentally important but so is the social and political learning that is necessary to build institutions and policy strategies that support competence building.

According to Krugman (1995), the classical development economics disappeared because the protagonists could not speak the language of the mainstream economists – they could not transform their ideas into mathematical models⁹. What can we learn from this for innovation system research? There are rich possibilities to build economic models and pursue econometrics with reference to innovation system research. But we need to think differently in several important respects. First, at the micro level, we need indicators that reflect the quality of relationships such as trust and we need to understand how this quality comes out of 'problem solving in interaction with others in which our ends and means co-evolve' and we also need indicators for what is learnt in such interactions between individuals and organisations.

At the aggregate level we need to take into account that national, regional and sectoral systems are much more diverse than individual beings. Therefore we might not aim at

⁹ Krugman's analysis might be too kind to the standard economics community however. In order to remain within the neoclassical community you might also need to confess to a certain credo that includes methodological individualism, rational choice, general equilibrium as reference and markets as the most natural elements in the economy.

general theories about what is the best practise for developing countries and try to apply that globally. But neither is it satisfactory to pursue individual case studies and to assume that results can be generalised to other systems – this is actually one of the major complaints against the micro-analysis based upon controlled randomisation.

An intermediary approach would be to use methods that make it possible to group systems in ‘families’ on the basis of certain commonalities and then to look for the underlying structures within each family. It might be more meaningful to pursue comparative econometric analysis within Latin America and Asia rather than to include countries from both continents.

5. So, which way now?

There are many different paths to follow for future research on innovation systems and economic development. The fact that there is a lot of overlap and interaction between analysis of innovation systems at different levels of aggregation and that the field, while anchored in socio-economics, has been open for interdisciplinary collaboration is a major strength. It makes it more relevant than mainstream development economics where there is little feed-back between and micro and macro approaches and where disciplines outside economics are regarded with disdain. Several of the issues raised below will require interdisciplinary efforts.

5.1. What is development?

A first priority might be to give a more clear meaning to ‘development’ and to understand better how it relates to economic growth. Sen’s capability approach constitutes a kind of micro-foundation for a theory about development. We believe that it might be possible to develop a macro theory of development by combining Adam Smith economic perspective and the extension of the division of labour with George Herbert Meads’ interactionist perspective. According to Mead ‘civilisation’ grows out of extending who is defined as a ‘significant other’ and he refers to the spread of markets and religion as forces that

extends communities from village, to region, to nation etc. This may correspond to a transformation of social capital establishing more 'generalized trust'.

Another important dimension of development that is not fully reflected in Sen's capabilities refers to learning and autonomy at the workplace. Economic development has been linked to industrialisation. And this is a process where farmers engaged in simple work are brought into factories with taylorist working conditions. After an immediate period of drastic cultural adaptation the room for learning is limited. This may be contrasted with the patterns in the most developed economies. Here only a small proportion of the workforce has taylorist (less than 10% in the Scandinavian countries) or simple (less than 20%) jobs. The rest are engaged in problem solving where they learn new things (Lorenz and Valeyre 2005). What people do and what they learn in their daily work is fundamental for the structuring of society and we would propose that researchers should pay more attention to this dimension of innovation systems. Combining different forms of learning correlates with innovation performance (Arundel et al 2007) and at the same time it may be used as an important indicator for economic development.

Deepening our understanding of the factors affecting development is another fundamental venue for research, particularly understanding the role of institutions in development. The interaction between social inclusion, governance, adequate business environment and development, capability building and innovation needs to be fully understood. This is an important research venue in which researchers in innovation systems might shed some light.

5.2. Innovation, Inequality and development

In the last Globelics conference (Mexico, 2008) one of the key themes of the conference was the relationship between innovation and inequality. Of special interest in the context of innovation system perspective would be the inequality in accessing learning (Lundvall 1996). Innovation may be seen as part of a process of creative destruction and while some specific sectors and locations may benefit from it others may get worse off. Some of the

most successful economies in the world have developed welfare states that tax the winners and compensate the losers by offering them some basic security in processes of change. Research might highlight the potential for building embryonic welfare states that fulfil such functions.

In general it is important to get a better understanding of how income distribution, social cohesion and generalised trust relate to each other as well as to economic processes including interactive learning, networking and innovation. Such research might end up showing that there are different development paths and different modes of innovation where some operate with high degrees of inequality while others build upon social cohesion. Such studies may be helpful in showing that there are alternative policy strategies for developmental states.

5.3. Understanding knowledge and learning

One important challenge for innovation system analysis both in the more and the less developed parts of the world is to deepen the understanding of how different kinds of knowledge are created and used in the process of innovation. Some elements of knowledge are local and tacit, embodied in people and embedded in organizations. Other elements are global, explicit and can easily be transferred from one part of the world to another.

While information in principle can move freely from one part of the world to another through the use of telecommunication technologies, competence is embodied in people or embedded in organisations or even in institutions. But even in the case of information the capacity to understand and use it may be very demanding. The geographical distribution of people with the background necessary to make use of scientific information is extremely unevenly distributed and actually today the forces attracting the scientific elite to a limited number of places (such as the universities in Berlin, Paris, Oxford, Cambridge, Harvard, MIT, Stanford etc.) are strong.

To understand how learning takes place within organizations as well as in the interaction between organizations is key to comprehend how systems of innovation work. While it is important to study national characteristics in terms of organisations that pursue R&D, it is equally important to understand national characteristics in terms of how firms interact with customers and to what degree different firms give employees access to competence-building in connection with on-going economic activities.

One major challenge for research is to develop concepts that can be transformed into measurable indicators. Human capital measurements may represent formal investment in education but what people learn at the workplace or as consumers is not easy to capture through standard measurements. The absence of indicators makes the area less visible for policy makers and this contributes to a bias in innovation policy toward promoting STI-rather than DUI-activities.

5.4. Innovation systems, institutions and entrepreneurship

To understand how learning takes place it is fundamental to understand the role of institutions. So far most innovation system research has paid attention only to formal institutions or organizations while informal institutions such as culture, customs, time-horizon etc. are often ignored. Some exceptions are Lundvall (Lundvall 1992, Lundvall et al. 2006), Johnsson (Johnsson et al. 2003) or Oyelaran-Oyeyinka (2006). This is much in line with Business systems research, varieties of capitalism research and the early intercultural communication research represented by authors like Hofstede (1991). Understanding institutions and the role they play in innovation and development is an issue that deserves more attention by researchers.

Equally central is the conceptualization of the role of entrepreneurs. Despite the centrality of the entrepreneur in the initial work by Schumpeter on innovation (1934, 1939, 1942), innovation system researchers are yet to provide adequate attention towards evolving an institutionally grounded theory of entrepreneurship. It is worth exploring the linkages between national innovation styles and the essentially non-institutional entrepreneurship

literature drawing on Burt's structural holes and maybe even Kirzner's analysis of the entrepreneur as an 'equilibrium' creator. It is important to sort out different conceptualisations of entrepreneurship. Some developing countries are leading the world in terms of the frequency of start up firms but suffer from too little entrepreneurship initiative within existing firms. Bringing in the perspective of 'collective entrepreneurship' might open up more fruitful directions for research.

5.5. National, international, sectoral and regional dimensions

Since the national level appears as central in the innovation system approach it is important to analyse the role of the nation state both as a political cultural phenomenon and as a territorial concept. There is little doubt that nation states have played a key role in mobilising resources and not least as frameworks for building competence through education. For good reasons 'nationalism' has got itself a bad reputation in the history of mankind but it might be difficult to establish the necessary developmental effort without some common purpose and here the nation has been an important option. But nation states are very different constructs in terms of the degree of size, heterogeneity and inequality. One priority is to specify the conditions for nation states to become developmental and at the opposite end to explain why some nation states appear to be failed states (Wade 2005).

Another priority is to understand how the different forms of opening of national and regional economies contribute to or hinder economic development. While the emergence of global value chains as well as the formation of global champions opens up the national and regional systems of innovation it is not obvious that the process makes them less important as a framework for economic development. To understand what capabilities

and institutions that need to be established in order to benefit from different forms of international openness is fundamental.

Innovation systems in developing countries are heterogeneous. Often modern sectors making use of advanced technology co-exist with informal sectors characterised by underemployment, low productivity and stagnation. In the classical development economics development was seen as moving labour from the primitive to the modern sector. This is still an important issue. But more research is needed to find out if there is room also for building modern activities more directly within informal sectors and for creating stronger links between the two types of sectors. Here the sectoral system approach may play a key role in pointing to cases where such strategies have been successful and to specify the mechanisms at work.

Innovation systems in developing countries are heterogeneous also in terms of the geography of competence and knowledge. The modern activities are often concentrated in regional industrial clusters and they draw upon local knowledge infrastructure as well as on international sources of knowledge. To pursue research that compares and contrasts different regional systems of innovation within major emerging economies such as India and China may be the best way to understand the specificities of innovation systems. Developing analysis of how the degree of integration of such regional systems in the overall local economy, including activities in the informal sector may inspire industrial and regional policy.

5.6. Dynamics of innovation systems

Notwithstanding the clear links between innovation system research and evolutionary economics, understanding the dynamics of different innovation systems and different evolution paths still remains a major research challenge in innovation system research, particularly when dealing with developing countries.

From an evolutionary perspective, innovation systems in developing countries can generally be characterized as emergent innovation systems as opposed to the well functioned matured innovation systems of developed countries (Chaminade and Vang, 2008). Understanding what determines the emergence of a system of innovation and how a system evolves over time is a major research challenge, both for academics and for policy makers. The lack of indicators that capture innovation and learning processes over time is a very important limitation for researchers interested in this line of research, that can only be overcome working in parallel with the development of longitudinal data sets and new indicators to capture the more informal aspects of innovation systems mentioned earlier.

Another great challenge is to understand the dynamics between institutions, the socio-economic context and the ability of firms and other organizations to engage in interactive learning and capability accumulation and its changes over time.

6. Corollary – Possible research strategies

How to organise research in the future? What are the specific circumstances for doing research on innovation systems particularly in developing countries? What kind of information can be gathered in research and what kind of research is most worthwhile to pursue?

One way of organizing research might be rather big national projects with a 2-5 year time horizon dominated by local scholars but integrating international experts, including experts from other developing countries. Such a big project may combine data from the micro-level of the single firm, with data on inter-firm cooperation and interaction with knowledge structure with analysis of institutions shaping finance, labour markets and education systems. Within such a framework comparisons between regions taking into

account their openness to other regions as well as the international openness would be very relevant.

Another way would be systemic comparative analysis of systems of innovation across countries, regions and industries. Most research on systems of innovation is based on the analysis of one national innovation system, sectoral or regional. While individual analysis are useful to understand the evolution of an innovation system over time, the systematic comparative analysis of different systems across similar dimensions might help to identify similarities as well as differences in innovation systems. We cannot fully grasp what are the differences between the agro processing system of innovation and the ICT if we do not compare the same sectoral innovation systems across countries or regions. Only then we will be able to identify what are the sectoral specific elements that hold across countries or regions.

Often statistics will be lacking and major systematic surveys may be difficult to pursue in a developing country. A good starting point is to contact some experienced people from business, public sector, trade unions and research and interview them about the problems to be analysed. This might lead scholars to other experts and at the end of such an opening round hypotheses about barriers for change as well as unexploited opportunities may be formulated. A wider set of agents may be called upon to qualify the hypotheses and on this basis it might be possible to design questionnaires and rather specific quests for data. This strategy takes as its starting point that there is valid knowledge based upon experience and that this knowledge should be used. It also has the advantage of building up a set of advanced users of the results of the project.

One problem with such strategies is that the incentive structure in current academic life does not promote this kind of research. As mentioned before in the connection with the new wave of statistics in developmental economics what matters most when it comes to get published is the elegant use of advanced tools. Since scholars in developing countries are rewarded mainly on the basis of publications in international journals they need to adjust to this reality. On the other hand the big project mentioned here constitutes an ideal

training ground for Ph.D.-students. But without major backing from outside the academic community the chance to establish and pursue such projects is small.

The road ahead is long but very stimulating and challenging. We are faced with many research challenges and unanswered research questions. But there is a growing community of researchers in innovation systems and development. Networks such as Globelics, Asialics or Cicalics provide a good platform for researchers around the world to exchange ideas, build large projects and contribute to our understanding of innovation systems in developing countries.

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