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Advanced Introduction to

NATIONAL  
INNOVATION  
SYSTEMS

Cristina Chaminade  
Bengt-Åke Lundvall  
Shagufta Haneef



# Advanced Introduction to National Innovation Systems

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National Innovation Systems

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Advanced Introduction to

# National Innovation Systems

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## Preface

This book is part of the Advanced Introduction series at Edward Elgar and, as such, the intention is to provide newcomers with a simple, yet comprehensive picture of the past, present and future of research in National Innovation Systems. Chapters follow a similar structure. With a brief introduction, each short chapter summarizes the state of the art in the different sub-themes and presents the main messages as a way of concluding. For those who wish to go deeper into a particular topic, each chapter suggests a list of recommended readings. We have included numerous boxes with examples from all over the world. Our aim has been to ensure that there is a good representation of examples from developed and developing countries, from large and small countries and for different continents.

This book is the outcome of collaboration between three scholars belonging to different generations and coming from different parts of the world. We hope that this combination is reflected in a good mix of old and new ideas and of different perspectives on the issues raised. We learned a lot from working together and especially from the discussions that we maintained during our 'book retreats'.

The national system of innovation concept is not brand new anymore. It has become a standard reference in the literature on innovation and the concept is now used by policy makers all over the world. Some scholars have proposed that it is so not relevant anymore. Nonetheless, we believe that the issues raised in this book are highly topical. In 2016 and 2017, the world witnessed how heated national and international debates confronted narrow nationalist perspectives (key words are Trump and Brexit) with visions of the current form of globalization as the only possible way ahead (as illustrated by the new neoliberal wave in Latin America).

We hope that our book can serve as an antidote to both. One main message is that ‘free trade’ and unregulated international financial flows may not always be to the benefit of citizens living in countries with weak national innovation systems. Another main message is that there is a need to establish new forms of global governance to cope with issues such as global warming and growing inequality at the global level. While the national innovation systems concept evokes a perspective where nation states compete on the basis of a strong knowledge base we conclude that global challenges require new forms of international cooperation where lead countries share knowledge with countries with weak innovation systems.

While the responsibility for any errors and omissions is only ours, the book takes inspiration from many different scholars and communities. We are particularly grateful for the inspiration from working with colleagues in Globelics – the global network on economics of learning, innovation and competence building systems (<http://www.globelics.org>). We are also grateful for the support from the Department of Business and Management at Aalborg University and the Department of Economic History at Lund University. A special word of thanks goes to Björn Johnson from Aalborg University who provided a critical eye and gave useful comments to a late version of the manuscript.

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Aalborg and Lund, August 2017

Cristina, Bengt-Åke and Shagufta

# 1 Introduction

## 1.1 Introduction

The aim of this book is to introduce students as well as policy makers in developed and developing countries to the national innovation systems concept. Innovation studies is an evolving interdisciplinary field and we have taken this into account. We use a language that can be understood by students and scholars from different disciplines within social science and engineering and for each chapter we have proposed a brief list of suggested further readings.

Throughout this book, we will address the following questions. What is a national system of innovation? Where did the concept come from? How has it developed? What is the theoretical core of the concept? Who makes use of it? Why is it useful? How to measure it and how to use it in research? How can it be applied to countries at different income levels? What are its main limitations? Is it meaningful to study national innovation systems in a context of globalization? And what are the future challenges for developing it in research and policy?

This introductory chapter provides the reader with some first ideas about the topics and issues that will be addressed in more depth throughout the book.

## 1.2 Why is the national system of innovation important?

The concept of National Innovation Systems is built on the research-based insight that innovation is an interactive process where different kinds of knowledge are combined through communication within and across organizational borders. Research has demonstrated that firms absorb ideas from users, suppliers and knowledge institutions and that

**BOX 1.1 OUR DEFINITION OF NATIONAL INNOVATION SYSTEM**

... an open, evolving and complex system that encompasses relationships within and between organizations, 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. (Lundvall et al., 2009b, p. 7)

the innovation process involves interaction with many different kinds of actors (Kline and Rosenberg, 1986; Lundvall, 1985).

An innovation system encompasses all the organizations and institutions involved in this process and the *national* innovation system gives special attention to those institutions and organisations which are located in or rooted in a nation state. The system is open and one crucial characteristic of the national innovation system is its capacity to absorb and use knowledge developed abroad.

The national innovation system concept was introduced by evolutionary economists who found that neoclassical economics did not offer satisfactory explanations on what determines economic growth and international competitiveness. The most important weakness of neo-classical economics is actually that its basic assumptions on equilibrium and rational expectations block our understanding of innovation and learning processes.

In all countries governments refer to the international competitiveness of the economy as a major policy concern. Often this refers to the need to reduce the price of export goods through weakening trade unions with the aim to keep wages low. The focus on the national innovation systems offers a different understanding of competitiveness based on competence and interactive learning. It takes into account research and historical studies demonstrating that competitiveness reflects non-price factors and especially the strength of the national knowledge infrastructure.

Taking a long historical view, we can see how some national economies that started at the same income level have developed at very different speeds. Some remain poor and others become rich. The world

economy has witnessed shifts in economic leadership such as when Germany and the US took over leadership from the UK. The national innovation system concept is useful when it comes to understanding why growth rates differ. But, as we will discuss in Chapters 7 and 8, national innovation systems are not only important to understand income growth but also to achieve inclusive and environmental sustainable development.

### 1.3 When did the concept appear?

The national innovation system concept is quite recent. It was first used in an unpublished paper by Christopher Freeman (1982, 2004) where he linked the concept to a critical discussion of the free trade doctrine and referred to Friedrich List as a predecessor of the concept. It was next used in a booklet by Lundvall (1985) where it referred to the linkages between university and industry. Freeman used the concept in the title for his book on Japan (1987) and in 1988 Freeman, Lundvall and Nelson each presented a chapter on national innovation systems in Dosi et al. (1988). Lundvall (1992) brought together contributions analysing different dimensions of the innovation systems while Nelson (1993) compiled a number of national case studies using the concept (Sharif, 2006).

The previously mentioned authors had in common that they were critical to public policy inspired by standard economics and on the basis of their analysis they pointed to alternative policy prescriptions. When the Organisation for Economic Co-operation and Development (OECD) began to adopt the concept in the beginning of the 1990s it became widely used by international organizations and by national governments. Governments in Finland and Canada were among the first to use the concept as a basis for strategies for economic growth.

### 1.4 What new insights were gained with the national innovation system concept as compared to earlier work within innovation studies?

First and foremost it offered an explanation of why growth rates differ and why countries can build an absolute advantage in trade or structural competitiveness.

But it also gave inspiration for scholars studying innovation processes. It sent a strong signal that innovation theories should move from technology push and demand pull perspectives, respectively, towards a perspective of interaction and networking. It also signalled that innovation policies could not rely on linear models where investments in science were assumed to automatically result in innovation and economic growth.

The main novelty in relation to innovation studies and innovation policy was the message that innovation had more diverse origins besides science and that experience-based learning taking place within the production system was as important as the learning coming out of interaction between enterprises and research institutions. This was reflected in Freeman's first contribution from 1982 as well as in Lundvall (1985). In Freeman's book on Japan (1987) the focus is upon organizational and inter-organizational characteristics of the Japanese economy. This broader understanding of the innovation process was developed further in Lundvall (1988) and especially in Lundvall (1992).

Another lesson to be learned from the systemic perspective is that context matters and that the idea of international benchmarking looking for 'best-practice' policy in a specific field to be generally applied across national systems is inadequate, as we will discuss in Chapters 5 and 9. While comparing national systems may inspire institution building and policy strategies (learning by comparing), there is no reason to believe that what works well in one system will work equally well in a different system.

Finally, the new perspective stimulated attempts to develop more adequate indicators. The *Oslo Manual* took inspiration from the early work on national innovation systems, as will be discussed in Chapter 9.

## 1.5 How the national innovation systems concept inspired other innovation system scholars

The first contributions on national innovation systems (Dosi et al., 1988; Freeman, 1982, 2004; Lundvall, 1985, 1988, 1992) stimulated a wide set of academic work on innovation and led to a branching of the innovation system concept.

Economic geographers were among the first to adopt the idea of innovation as an interactive process located in geographical space, introducing the *regional innovation system* concept (Asheim and Isaksen, 1997; Cooke, 1996; Storper, 1995). This concept combined the work on regional industrial clusters and industrial districts with ideas presented in the work on national innovation systems. There is much conceptual overlap between the two literatures when it comes to understanding processes of innovation and interactive learning.

Carlsson and Stankiewicz (1991) introduced the concept of *technological innovation system*. Their focus was upon how the interaction between organizations evolves over time as *new technological systems* emerge, develop and become more settled. While they refer to the work on national systems, they point out that the geographical extension of a technological system may be variable as the technological system evolves.

Another example of branching was the work on the *sectoral system of innovation* (Breschi and Malerba, 1997). Here, the innovation system perspective was used to enrich industrial economics and industrial dynamics. The starting point was a Schumpeterian classification of sectors with emphasis on differences between them in terms of technological opportunities and appropriability conditions. The system perspective was used to analyse the evolution of how firms in a sector interacted with a wider set of organizations and institutions.

The intention behind the national innovation system concept was that it should inspire national policy strategies for economic growth and competitiveness. The three related system concepts do not have this ambition. Instead, they address specific subsystems within (and sometimes beyond) the national innovation system. The technological system gives insights useful for science, technology and innovation (STI) policy makers in charge of fostering a specific emerging new technology and has been recently used by scholars working with sustainability transition. The regional system perspective gives useful insights for policy makers in charge of regional development. The sectoral perspective offers important insights on the role of technological factors for those in charge of industrial policy.

In terms of theoretical perspectives, the regional system approach has the most overlap with the national innovation system approach – the difference is mainly one of level of analysis. The sectoral system

approach brings in an evolutionary microeconomic perspective but it puts less emphasis on organizational learning. The theoretical framework used for the technological innovation system is of special interest since its focus on emerging new technologies stands in contrast to the emphasis on cumulative and incremental interactive learning rooted in the existing production system in the national innovation systems literature.

In this book we will present theoretical and practical contributions that make direct references to the national level. But literature at all the three levels mentioned – technology, region and sector – have made important contributions when it comes to enriching the analysis at the national level. This is true in terms of conceptual ideas which have flowed between the different communities. It is also true for applied studies where comparisons of technological, regional and sectoral systems operating in different national contexts have been effective in helping to clarify the characteristics of national systems.

## 1.6 Different approaches within the national innovation system literature

From the very beginning different scholars who gave birth to the concept (Freeman, Lundvall, Nelson and Edquist) operated with different definitions. They shared the same view on the systemic interdependence and interaction of organizations which are rooted in or located in a specific country and which shape innovation. But their definitions differed regarding what organizations and institutions to include as components in the system.

There is thus an important distinction between narrow and broad definitions of national innovation systems and that reflects different theoretical and political perspectives (Table 1.2). Narrow definitions of national innovation systems such as the ones by Edquist (1997) and Nelson (1993) focus upon the interaction between firms and research institutions and they may be seen as extensions of an older concept, 'the national systems of science'. Broad definitions such as the one developed by Lundvall (1988, 1992) include user-producer interaction and interactive learning processes taking place inside firms, including learning by doing. They present the innovation system as rooted in 'the national production system' (Freeman, 1987). The distinction can be linked to different perspectives on knowledge and innovation.

### 1.6.1 The narrow definition is focused upon the role of national research institutions

The narrow definition gives attention to science-based learning and codified knowledge while the broad definition also includes experience-based learning and tacit knowledge. While the narrow definition puts emphasis on processes of search and exploration, the broad definition includes learning processes that are outcomes of routine activities. They also tend to differ in terms of the views on the innovation process. The narrow perspective gives special attention to radical innovations and emerging technologies while the broad definition regards the innovation process as including not only incremental innovation but also the diffusion and use of new technologies.

When we refer to the 'narrow' definition, it does not imply that what is included is not important or only relevant for some countries. The research system is very important for countries at all levels of development, big as well as small. Christopher Freeman points to the introduction of research and development (R&D) laboratories in private firms in Germany and the US as a fundamental reason for why these countries could take over the role as world leaders in technology and in terms of competitiveness and level of income. An important reason for the success was the linkages that were built between the public knowledge infrastructure and the enterprise sector. The private firms could benefit from public investments in health and military research. Public and private research plays an important role not only in lead countries engaged in developing front technologies with the aim to remain world leaders. For small and medium-sized, second rank, high-income countries developing a research system is a prerequisite for being able to absorb new technologies developed abroad and for adapting such technologies to the national context. Some of the most successful Asian economies have invested heavily in science and technology and they have developed new patterns of interaction between the public knowledge infrastructure and the enterprise sector.

### 1.6.2 The broad definition includes national institutions shaping human resources and learning

The broad definition of the national innovation system reflects a broader definition of the innovation process itself. It assumes that innovation is a process that includes the diffusion and use of new

technologies as well as the formation of new ideas and the introduction of new technologies. The speed and direction of the innovation process reflects interactive learning within and across organizational borders. Interactive learning is seen as a social process and the form and content of human interaction will reflect the experience and educational background of managers, scientists, engineers and workers.

Therefore, the broad definition of the innovation system includes national institutions and organizations that shape human resources and learning processes. Some of those institutions are formal organizations engaged in education and training and they aim directly at shaping competences. Others are informal and constitute frameworks for experience-based learning. The nation specificity of family patterns, civil society activities, the labour market dynamics and organizational learning at the workplace shape people's competences and their mutual relationships and thereby influence interactive learning as well as the innovation process.

To illustrate, recent research shows that international differences in forms of organizational learning reflect differences between national education, labour market and welfare systems (Holm et al., 2010). It has also shown that innovation performance at the national level reflects differences in how employees work and learn and that such differences are more dramatic than differences in the institutions and science system that are the focus for the narrowly defined innovation system approach (Arundel et al., 2007).

## 1.7 How do the different approaches relate to innovation policy?

The narrow definition of innovation systems inspires science and technology policies that aim at linking research institutions to users in the private and public sector. While strong and durable relationships between users and producers of research results may be beneficial for movement along a trajectory, they may also result in lock-in when there is a radical shift in technological trajectory. Here, the task of policy is more demanding and complex. In such periods, inspiration from the literature on technological innovation systems may be relevant since it has developed conceptual frameworks for innovation policies aiming at fostering new technologies.

**Table 1.1** Difference between narrow and broad definitions of national innovation systems

	Narrow	Broad
Building pillar	National Science System	Knowledge is the most important resource and learning the most important process in the economy
Main authors	Nelson (1993) and Edquist (1997)	Friedrich List (1841 [1959]), Freeman (1987) and Lundvall (1988, 1992)
Focus	Science-based learning, radical innovations and firm-level STI learning	STI and DUI learning and user-producer interaction and incremental innovations
Policy implications	Promotion of science-based learning and R&D expenditure	Framework conditions to improve learning across organizational borders, taking into account the institutions effecting learning, promote experience-based learning and tacit knowledge and diffusion of technologies

The broad definition of innovation systems inspires a wider set of policies including industrial policy and policies related to competence building such as education and labor market policy. Such policies have an impact upon the design of institutions and organizations related to learning by doing, using and interacting (DUI). Since the focus is on the link between innovation and national aggregate performance, it gives weight not only to radical innovations but also to incremental innovation, diffusion of innovation and effective use of innovations, as we will discuss in more detail in Chapter 9.

## 1.8 Alternative and related concepts to national innovation systems

In the literature, there are a number of concepts that have a certain degree of overlap with the national innovation systems concept either in its broad or narrow definition, notably the notion of National Learning Systems (Viotti, 2002), National Entrepreneurial Systems (Ács et al., 2014), the Triple and Quadruple Helix (Etzkowitz and Leydesdorff, 2000), the National Business System (Whitley, 1994) and the Innovation Ecosystem (Moore, 1993). In Box 1.2 we summarize the main commonalities and differences with the national innovation systems concept but before going through them, it is important to be aware that each of these – alternative and somehow competing – concepts emerge from different disciplines and attempt to explain different phenomena than innovation and competitiveness at a national level.

### BOX 1.2 NATIONAL INNOVATION SYSTEMS VIS-À-VIS OTHER CONCEPTS

*National Learning Systems:* The national learning system approach has been proposed by Viotti (2002). He argues that the national system of innovation approach is inadequate for late industrializing economies. He emphasizes that in the late industrializing economies, the process of technical change is not innovation but learning and absorption of technologies already existing in the industrialized economies. Therefore, this approach proposes that the late industrializing economies should be analysed as ‘national learning systems’ instead of national innovation systems. While his critique might be correct in the case of the narrow approach to national innovation systems, it is less so when it comes to the broad definition which puts knowledge and learning at the core of the national innovation systems and thus is applicable both for developed and developing countries, as will be further discussed in Chapter 6.

*National Systems of Entrepreneurship:* Defined by Ács et al. (2014, p. 11) as ‘a dynamic and institutionally embedded interaction between entrepreneurial attitudes, activities, and aspirations, by individuals, which drives the allocation of resources through the creation and operation of new ventures’. This approach to

entrepreneurship calls for employing the systemic perspective to entrepreneurial activities and emphasizes the contextual embeddedness of the entrepreneurship processes. It argues that entrepreneurship should be treated as a systemic phenomenon instead of as a black box. In this way, it attempts to explain the differences between the countries and regions in terms of economic performance on the basis of individual entrepreneurial activities. The national system of entrepreneurship differs from the national innovation systems perspective in focusing upon allocation rather than innovation.

*Triple Helix, Quadruple Helix and N-Tuple of Helices:* The triple helix approach proposed by Etzkowitz and Leydesdorff (2000) puts the university as a knowledge-producing agent at the core of innovation activity as opposed to the national innovation systems approach where firms are seen as leading the innovation process. The triple helix model also regards innovation as a systemic process and, inspired by molecular biology, it refers to university-industry-government relations as the three helices of the strand (Leydesdorff, 2012). The triple helix analysis operates on the basis of neo-evolutionary and neo-institutional perspectives linking the three sub-dynamics, namely, university, industry and government as a basis for analysis. It is applied at the sectoral, regional, national and transnational levels. The concept diverges from the national innovation systems concept in neglecting organizational and inter-organizational learning.

*National Business Systems:* Whitley (1994) proposed the concept of national business systems on the basis of variations in the economic organization experiences in East Asian economies. It is argued that there is a strong relation between social institutions and how firms and markets interact, all constituting the distinctive business systems. The interactions between firms and markets vary across various institutional settings. The key characteristics of the national business systems are summarized under three headings that form the components of the business systems, namely, (1) the nature of firms as economic actors; (2) the inter-firm relations in the markets; and (3) the nature of control systems within firms. On the other hand, in the national system of innovation the main components are organizations, institutions and the network interactions between them, while

knowledge and interactive learning processes are at the core of the system. Moreover, the national innovation system has different branches with respect to the level of analysis (regional, sectoral, sub-national), whereas national business systems have five major kinds based upon institutional setting and economic organization (centrifugal, partitioned, collaborative, coordinated, state dependent).

*Innovation Ecosystems:* The concept of ecosystems is mainly used in management research literature (Moore, 1993) to refer to a set of producers and users contributing to an organization's performance as an ecosystem around that organization. In the innovation ecosystems, the focal centre is the firm and its suppliers and customers who exist in an institutional and organizational environment from a value creation perspective.

## 1.9 Is it useful to focus upon the national level in a context of economic globalization?

Among scholars who share the view that innovation is important for economic development, the most controversial dimension of the concept refers to the national level. It is quite obvious that interactions related to innovation have always involved agents in different countries and that it is equally obvious that this kind of interaction has become increasingly widespread. Scientific institutions collaborate across borders, firms are multinational and suppliers of technology are located abroad. This is richly illustrated by scholars working on technological, regional and sectoral innovation systems. To disregard these kinds of interactions would be misleading.

There are different arguments for why it is important to keep a focus upon national innovation systems. The most fundamental is that as long as political governance remains predominantly localized at the level of the nation state, there is a need for an analytical framework that can produce insights on which national policies aiming at growth, development and competitiveness can be built.

Another argument is based upon empirical research showing that national economies, even big ones, differ in terms of specialization, institutions and mode of innovation. The fact that there is only little

and slow convergence in these dimensions makes it legitimate to take the national system as the analytical unit.

The third argument refers to the broad definition of the national innovation system and to the localization of different kinds of knowledge and different modes of learning. As specified above, the broad definition includes formal and informal institutions that shape human resources and those remain nation specific to a higher degree than those directly involved in linking science to innovation.

A more complex argument refers to the fact that historically nation states have served as frameworks for innovation-based growth. Globalization of the economy including the deregulation of financial transactions, transnational flows of knowledge, capital and people challenge the historical role of national institutions and organizations. It is crucial to understand the specific challenges this implies for national institutions and governance.

New modes of global governance may in the future surpass the current role of nation states as frameworks for political governance and should that happen the analytical focus upon national innovation systems may become obsolete. But current developments including the crisis for European integration do not signal that we are close to that point yet.

## 1.10 The structure of the book

After this introduction, Chapter 2 will look in more detail at the origins of the concept.

Chapter 3 presents discussions on the theoretical status of the concept. Chapters 4 and 5 are about how to study innovation systems. Chapter 4 is on the use of qualitative methods as represented in case studies, comparative studies and historical studies. In Chapter 5 the focus is upon the use of indicators and quantitative methods.

Chapters 6, 7 and 8 relate the national system of innovation to economic, inclusive and environmentally sustainable development, respectively.

Chapter 9 is about the use of the concept in the policy sphere while Chapter 10 takes a closer look at the literature that confronts the

national innovation system concept with the ongoing processes of globalization.

Chapter 11 summarizes and suggests proposals for future research.

## Recommended readings

- Lundvall, B.-Å. (2010). Post script: Innovation system research: where it came from and where it might go. In: Lundvall, B.-Å. (ed.), *National Systems of Innovation: Toward a Theory of Innovation and Interactive Learning*, London: Anthem Press, pp. 317–38.
- Sharif, N. (2006). Emergence and development of the National Innovation Systems concept. *Research Policy*, 35, 745–66.
- Soete, L., Verspagen, B., and Ter Weel, B. (2010). Systems of innovation. In: Hall, B.H. and Rosenberg, N. (eds), *The Economics of Innovation*, Vol. 2. Amsterdam: North Holland, pp. 1159–80.

# 11 Challenges for the research on national innovation systems

## 11.1 Introduction

The national innovation system is, as explained in Chapter 3, a historical as well as a theoretical concept and therefore it needs to be revisited and perhaps even reconstructed as historical circumstances change. New contexts challenge the assumptions underlying the concept and new problems call for a refocusing of the analysis. In this chapter we discuss how such changes may inspire future research agendas.<sup>1</sup>

## 11.2 The transformation of national production systems

The broad version of the national innovation system is based on the assumption that there is co-evolution between the national production system and the national innovation system. First, it is assumed that the specialization in national capabilities is reflected in the specialization of the national production system. Second, it is assumed that production activities will give rise to learning processes that bolster and further develop the specialization of national capabilities.

In a context of growing importance of global production and innovation networks, there is a need for innovation scholars to critically revisit these assumptions. While the basic principles behind the assumptions may still be valid, the meaning of specialization and the indicators to capture specialization need to be rethought, as more and more activities within the same production chain are located in different national production systems. Historically, we are used to thinking about specialization in terms of ‘industries’ each with a common technology and a common final product. How can we capture national specialization in production and knowledge in a context of increasing global fragmentation of production in value chains and networks? Is there an emerging hierarchy between national systems of innovation where

firms in high-income countries specialize in functions (R&D, Design, Finance, Branding and Distribution) rather than products while it may still be relevant to assume that the specialization of emerging countries' innovation and production systems co-evolve?

These questions can be illuminated by linking production and trade statistics to data on specialization in research, patenting and licensing. They can also be analysed through applying the concepts of technological systems and sectoral systems in case studies of specific technologies or sectors. Technological systems operate with 'functions' or 'activities' as units of analysis and therefore the concept is well adapted when it comes to understand changes in the global division of labour that lead towards a specialization in terms of functions rather than products.

Furthermore, the concept of production system gives associations mainly to the production of tangible goods and to manufacturing. In a world where international transactions increasingly involve trade in knowledge-intensive services there is a need to rethink basic concepts and to give more attention to innovation in sectoral systems of innovation for services like finance, communication, education, health and entertainment.

### 11.3 The transformation of knowledge production and learning systems

Another basic assumption underlying the broad definition of national innovation systems is that tacit knowledge is important for processes of innovation and that human interaction is crucial when it comes to combining different kinds of knowledge, as we outlined in Chapter 3. Christopher Freeman coined the concept 'the factory as laboratory' to indicate the importance of experience-based learning in processes of innovation (Freeman, 1987). There is a need for researchers to revisit this assumption in the light of new technologies and new modes of innovation.

The increasing use of modern technologies related to advanced ICT, artificial intelligence, robotics, 3D printing and big data will be reflected in changes in the production of knowledge and the innovation process. More and more experimentation takes place in closed laboratory spaces with little human intervention. Testing new combinations in the form of pharmaceutical products through the use of

computers goes far in this direction. Such testing can in principle take place anywhere and at any time.

New service innovations such as Airbnb, Uber, e-commerce and advanced tourist booking systems create new definitions and forms of interaction between service providers and users. One fundamental research question is how these changes influence the production and use of knowledge in the context of innovation. More specifically, there is a need to study to what degree they affect the involvement of users in processes of innovation. Are we moving towards new modes of innovation where localized user-producer interaction is substituted by the use of big data on user behaviour? More generally, is the DUI mode of innovation (experienced-based learning) becoming less relevant? We have reasons to believe that the answers to these questions will depend upon both the technology and stages in the innovation process.

New network technologies may open up new avenues of development for the least developed economies that are the weakest in terms of knowledge base and access to education and learning. Such technologies may bring positive change to the global landscape of knowledge exchange and learning. Through the availability of online MOOC-based platforms (Coursera, edX, Udemy, to name a few) geographical distances are becoming less significant and users have the opportunity to learn about almost any trade and subject from some very prestigious colleges and universities. Similarly, YouTube and blogs have drastically contributed to the knowledge body where professionals, lead users and bloggers post all kinds of information and experiences about products as well as knowledge of academic disciplines. This exchange of knowledge through virtual spaces and new platforms might be considered as an addition to the exchange of tacit knowledge through face to face interactions.

New actor constellations and new patterns of innovation interaction are on the rise. While innovation has traditionally been the realm of companies or researchers, civil society is becoming more active in the innovation system, often providing solutions to social problems. Similarly, while most technology and innovations are generated in the formal sector, a great deal of knowledge creation also takes place in the informal economy. These innovations might co-exist within existing infrastructures for knowledge production and learning or they may challenge existing systems. How is the knowledge generated in the fringe of the system absorbed and utilized? What are the enablers for an increasing fluidity of actors, constellations and systems?

## 11.4 The political economy of knowledge production – between subordination and autonomy

A possible negative consequence of the political focus upon innovation-based economic development is that policy makers introduce framework conditions for knowledge producers, including universities, that make them subordinate to powerful economic and political interests. The knowledge institutions have important social and cultural functions that go beyond the promotion of economic objectives.

Furthermore, subordination may undermine important dimensions of innovation. While the quality of knowledge production may benefit from interaction with advanced users of knowledge, a lack of autonomy undermines the capacity to produce radically new ideas and open up new paradigms.

Research shows that creativity thrives with intrinsic incentives and that it suffers when it becomes dominated by extrinsic pressure and incentives. Many major innovations have been the outcomes of serendipity and often the absence of close managerial or political control have been a necessary condition for such breakthroughs.

It is a challenge for research to analyse how national institutions balance between short-term exploitation and subordination of national knowledge production, on the one hand, and the promotion of autonomous creation of new ideas in the long term. A strong focus on military objectives will typically undermine autonomy while more diversification in funding mechanisms as well as in the knowledge infrastructure may give room for more autonomy.

## 11.5 National strategies and global progress

In standard economics it is assumed that free markets and competition between private actors aiming at profit contributes to the creation of wealth and economic growth. But it is also realized that unregulated competition will involve negative externalities for society and for the environment and that this gives governments a legitimate reason to intervene with regulations and public investments. The current world system dynamics may be seen as the outcome of competition between nation states and it is important to understand how combinations of national strategies affect global wellbeing.<sup>2</sup>

The research on national innovation systems has given insights for national innovation policy makers to promote 'competitiveness'. The increased focus of policy on knowledge as a factor of production may lead to a form of international competition where more resources are allocated to investment in knowledge. However, it may also lead to innovation mercantilism where the readiness to share knowledge between nations is undermined and more resources are allocated to protect knowledge. To explain how different forms of national conduct combine into global outcomes is a major challenge for research.

Conflicting approaches to innovation and knowledge production between nations slow down progress at the world level and lead to political frictions that may take on violent forms. The current deregulated rule of finance moves the focus away from real production and from innovation and it leads into new global crises. Accelerating innovation without giving it a new direction may further undermine environmental sustainability and contribute to global warming. Combinations of income inequality and growing social and cultural gaps threaten to stimulate nationalism and racism and it may result in political leadership that focus attention on discrimination of ethnic groups and on external enemies.

Today it has become increasingly obvious that a world economy where each nation state exclusively focuses on promoting their own economic objectives will lead to crises in international politics, finance, environment and society. Therefore, there is a need for research to study attempts to redirect the objectives set for national innovation systems.

## 11.6 Global changes and the importance of the nation state

We live in a world where public governance and state power remain located at the level of nation states and where the issue of national citizenship determines individuals' rights, duties and living conditions. This stands in contrast with the changing pattern of location of innovation processes where regionalization and concentration of innovation activities in major cities goes hand in hand with more innovation interactions taking place across national borders. It is a major challenge for innovation system research to study the contradictory co-evolution of the location of public governance and economic processes. One

fundamental dimension of openness relates to the flow of people across national borders. It relates not only to brain gain and brain drain. It may also be an important mechanism bringing institutional convergence between national systems.

As indicated above, the formation of global production chains and the development of new technologies are reflected in more open but less coherent and less cohesive national systems of innovation. A very important research issue is how these changes are reflected in world development. Is the current stagnation in the world economy a passing phenomenon or does it reflect chronic and structural problems? Can new technologies serve as platforms for a new long-term upswing and what role would there be for national initiatives and international cooperation, respectively, in this context?

To understand how new forms of international collaboration and governance can be made to interact with new initiatives at the level of the national innovation system is a major task for research. And it requires that economists join forces with scholars working on international relations, development, history, political science, sociology and sustainability, to name a few. More specifically, there is a need to focus research on the potential of building global institutions that promote knowledge sharing and innovation that is inclusive and sustainable.

## 11.7 System transformations and sustainable development

Another issue refers to the social and ecological sustainability of national systems of innovation. As we have seen, the original motivation to develop the national innovation system concept was to offer an evolutionary understanding of catching up and competitiveness. One of the main characteristics of the current form of globalization is growing income inequality not only between national systems but also *within* national systems.

At the same time, global warming has now finally been recognized as a real threat to the viability of the globe and the sustainability of the planet is under severe threat. Is it possible to design national innovation systems that address these new challenges without reducing the emphasis on economic growth as objective? Or do we need to subdue economic growth objectives to social and environmental sustainability

and strive for development rather than growth? How would national innovation systems need to look like under the new paradigm? Can we address the challenges of sustainable development without profound radical transformations of the national innovation systems?

Reorienting national innovation systems towards inclusive development and environmental sustainability will require the formation of new political forces and alliances at the national and international level, with new actor configurations and power structures and most importantly new or substantially changed production and knowledge production systems. There is growing consciousness about those threats in the elite but there are also strong interest groups that prefer the current unsustainable mode of growth. Analysing cases of successful transformation of national innovation systems is therefore a challenge for innovation system research. Is it possible to envisage a move towards open systems oriented towards social and environmental sustainability? How can national innovation systems mobilize different technological innovation systems to enact structural change? And which kind of institutional change is needed?

Furthermore, cities are increasingly becoming the place where transformations towards sustainability are taking place. Therefore, the relations between national systems of innovation and urban systems of innovation become more important. And so do the relations between national policies and regional or local policies. An important question to investigate is how can national policies enable rather than constrain local policies aiming at the transformation of the local system of innovation towards a sustainable system.

## 11.8 Embracing radical (and incremental) change

An important issue related to addressing the challenges of increased fragmentation of production, the changing nature of innovation and increased global conflicts anchored in unequal distribution of the costs and benefits of growth, social welfare and environmental impacts is to what degree national systems support, respectively, incremental and radical change. The original contributions did make distinctions between learning, searching and exploring, implying both path dependency and path breaking. But the emphasis was upon path dependency and upon how existing relationships would frame technical and organizational change.

To what extent is this perspective adequate in the new context? Can national innovation systems in high-income countries remain competitive on the basis of incremental innovation and absorption of new technologies from abroad or do they need to combine such a strategy with engaging in radical and disruptive innovations? Can national innovation systems in low-income countries catch up only through incremental innovations and gradual processes of competence building? Can any national innovation system at all address the challenges of environmental sustainable development without introducing radical institutional, social and technical changes?

In addition, which types of policies (and politicians) are needed in order to enact radical change? As we have discussed in this book, current innovation policies tend to reinforce incremental change. Supporting radical change requires a change of perspective on the role of government from being a reactive intervener to a more proactively involved agent. This perspective points to a need to move towards mission-oriented policies and an entrepreneurial state. Does the current political system allow for the long-term perspectives necessary to implement radical change and does the current generation of policy makers have the capabilities to support the formation of a new paradigm in innovation policies?

## 11.9 Addressing the 'dark' side of innovation

From the outset, national innovation system scholars were fundamentally concerned with economic development and societal challenges. However, over the last decades we see an increased detachment between innovation and development in research on innovation. An increasing amount of empirical work aims at understanding innovation per se, somehow implicitly assuming that innovation is always good and automatically leading to development (Soete, 2013). We believe it is time to reinforce the original research directions and intentions and reconnect innovation studies with global challenges like growing inequality, poverty, food scarcity and climate change.<sup>3</sup>

There is a need to critically discuss how innovation contributes positively by providing partial solutions to these global challenges but also negatively by aggravating them further. The community of scholars belonging to science-technology-society (STS) has long acknowledged

the 'dark' side of innovation. They have, for instance, showed how science and technology policy serve specific powerful groups in society while excluding others. They have raised critical questions to unduly optimistic interpretations of innovation as progress and shown that innovation has a negative side.

To make the analysis of national innovation systems more realistic, scholars should give due attention to power relationships between and within national systems. Innovation processes are often understood as exclusively involving the elite (capitalists, managers, scientists, engineers and policy makers). This elite perspective may be exposed to critical scholarship. How do vested interests result in innovations that do not respond to the needs of ordinary people? How can institutions and organizational forms inclusively offer citizens, consumers and workers an active role in shaping the direction of innovation?

### 11.10 Understanding the heterogeneity of national innovation systems

As we argued in Chapter 3, it is not meaningful to develop a general theory about nation states and countries. The United Nations recognizes 193 countries. This list of states is extremely heterogeneous in terms of size, income level and degree of cultural homogeneity.<sup>4</sup> The spatial and historical contexts in which their innovation systems have evolved are different. How can we theoretically develop the national innovation system approach without losing the richness of country specificity? One way to tackle the issue of heterogeneity is to develop taxonomies that group similar countries together. Taxonomies may reflect the strength of the knowledge base, the connectivity between elements within the system and the openness of the national system.

In the least developed countries, there is, for instance, very little organized R&D, in emerging economies the R&D activities in the business sector still remain weak while most OECD countries are characterized by a combination of substantial research activities within the public knowledge infrastructure and the business sector. There are rich international data sets on R&D, patenting, licensing and formal education levels that can be used to classify the strengths of national innovation systems in relation to STI learning. It is much more difficult to classify the systems in terms of DUI learning and in terms of connectivity

between the elements of the national system. To develop methods and data to do so is a major challenge for research.

In the Global South, the incentives to invest in research in general and in innovation systems in particular are with few exceptions almost non-existent. To explain why institutions are weak and why policy makers struggle to build the core elements of innovation system pose one of the greatest challenges for innovation systems research. The focus of research may be on the time horizon and management capacities among policy makers. Other challenges are to understand the role of the big informal sector activity in relation to the innovation process and to work on developing more relevant and reliable data for conducting research activities.

National innovation systems differ also in terms of how they link up with the world economy and in how they engage in transnational interactions that shape processes of innovation. Some countries depend on natural resource exports but remain weakly linked to the global economy, others have become dependent on the export of low wage manufacturing and on participation in global value chains, some get rich on oil and minerals and some combine a diverse production structure with outsourcing. Taxonomies should reflect how national systems of innovation are integrated in the world production and innovation system – maybe through different technological innovation systems or sectoral systems, as we discussed earlier.

By comparing national systems within taxonomic groups and through analysing how national systems are transformed (moving from one group to another) research may give new insights for the role of innovation in economic development as well as in the transformation of the World System. Such analysis should take into account the interdependence of national innovation system. Some national innovation systems are much more important than others when it comes to shaping global developments. The role of China in global growth processes has been of dramatic importance in the last three decades. The fact that China combined opening up the economy with building a strong national innovation system was crucial for its outstanding growth and for its impact on global poverty reduction. India may in the near future become a new catalyst of global economic development. To understand how some strategically important national innovation systems shape world dynamics is a crucial research task.

## 11.11 Reaching out!

The current challenges can only be addressed when and if there is a clear commitment to cooperation, knowledge creation and competence building in the true spirit that inspired the emergence of the national innovation system concept. There is a need to reach out to different communities in academia, to firms and policy makers to engage in a fruitful dialogue to address the current challenges of development in an increasingly globalized and ‘technified’ world.

The need for competence building and learning is crucial for all segments of socioeconomic and political systems. Policy makers must include learning and competence building in their development agenda, starting with their own competences. Firms have to invest in developing the competences of their workers and enabling different forms of learning. Individuals need to take responsibility for their own lifelong learning. In an ideal world, knowledge and learning opportunities should be available to all, independently of the place of birth. This ideal world is still far from reality and the privilege of the few. Networks like Globelics are among the many different ways to bring together researchers and practitioners from the Global South and Global North to discuss together how to address these global challenges for the benefit of all.

There is great potential in cross-fertilization between what often appears to be distinct and separate communities of scholars when it comes to answering the overarching questions for future research on national innovation systems. How do innovation processes in different sectors, locations and technologies contribute to economic, social and sustainable development in different types of more or less open national innovation systems? How to move beyond national systems in the direction of global knowledge sharing and global innovation systems? We hope that this book and the questions posed in this chapter will inspire current and future generations of researchers all over the world to develop new research agendas on national innovation systems for sustainable development in an interconnected world.

### NOTES

- 1 One famous example of how historical circumstances get reflected in the revision of theory is Schumpeter's theory of economic development. His original theory on economic development (Schumpeter Mark I) takes the individual entrepreneur as the central agent of change. In Schumpeter (1939) innovation is still the main driver of development but now the individual entrepreneur has been substituted by big oligopolistic corporations with dedicated R&D efforts.

- 2 But there are important differences when it comes to analyse the aggregate outcome of what, respectively, firms and governments do. The first difference is that governments operate with complex objectives that go beyond economic performance. The second difference is that governance at the global level is much weaker than at the national level.
- 3 Globelics, the international network of scholars (<http://www.globelics.org>), has developed a research agenda where inclusive and sustainable innovation for development is at the core.
- 4 This methodological problem of coping with heterogeneity is not unique for national innovation systems. It appears in other areas. Technologies, sectors and regions are equally diverse. Under the heading of 'the firm' we may find giant corporations such as IBM together with the self-employed owner of the hot dog stand. It is also worth noting that most macroeconomic models operate at the national level without much critical reflection about the problem of transferring the models from one national context to another.

## References

- Ács, Z.J., Autio, E., and Szerb, L., 2014. National systems of entrepreneurship: measurement issues and policy implications. *Research Policy* **43**, 476–94.
- Almeida, P. and Phene, A., 2004. Subsidiaries and knowledge creation: the influence of the MNC and host country on innovation. *Strategic Management Journal* **25**, 847–64.
- Altenburg, T., 2009. Building inclusive innovation systems in developing countries: challenges for IS research. 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, UK and Northampton, MA, USA: Edward Elgar, pp. 33–56.
- Altenburg, T. and Pegels, A., 2012. Sustainability-oriented innovation systems – managing the green transformation. *Innovation and Development* **2**(1), 5–22.
- Alvandi, K., Chaminade, C., and Lv, P., 2014. Commonalities and differences between production-related foreign direct investment and technology-related foreign direct investment in developed and emerging economies. *Innovation and Development* **4**, 293–311.
- Anderson, J. and Billou, N., 2007. Serving the world's poor: innovation at the base of the economic pyramid. *Journal of Business Strategy* **28**, 14–21.
- Anderson, J., Vedpuriswar, A.V., and Khan, A., 2005. Smart Communications Inc. Case A and Case B. European School of Management and Technology.
- Andersson, M. and Axelsson, T., 2016. Diversity of development paths and structural transformation in historical perspective – an introduction. In: Andersson, M. and Axelsson, T. (eds), *Diverse Development Paths and Structural Transformation in the Escape from Poverty*. Oxford: Oxford University Press, pp. 3–17.
- Arocena, R. and Sutz, J., 2000. Looking at national systems of innovation from the South. *Industry and Innovation* **7**, 55–75.
- Arora, A. and Gambardella, A., 2005. *From Underdogs to Tigers: The Rise and Growth of the Software Industry in Brazil, China, India, Ireland, and Israel*. New York: Oxford University Press.
- Artuc, E., Docquier, F., Özden, Ç., and Parsons, C., 2015. A global assessment of human capital mobility: the role of non-OECD destinations. *World Development* **65**, 6–26.
- Arundel, A., Lorenz, E., Lundvall, B.-Å., and Valeyre, A., 2007. How Europe's economies learn: a comparison of work organization and innovation mode for the EU-15. *Industrial and Corporate Change* **16**, 1175–210.

- Asheim, B. and Coenen, L., 2005. Knowledge bases and regional innovation systems: comparing Nordic clusters. *Research Policy* **34**, 1173–90.
- Asheim, B.T. and Isaksen, A., 1997. Location, agglomeration and innovation: towards regional innovation systems in Norway? *European Planning Studies* **5**, 299–330.
- Aslesen, H.W. and Harirchi, G., 2015. The effect of local and global linkages on the innovativeness in ICT SMEs: does location-specific context matter? *Entrepreneurship & Regional Development* **27**, 644–69.
- Athreye, S. and Kapur, S., 2015. Capital and technology flows: changing technology acquisition strategies in developing countries. In: Archibugi, D. and Filippetti, A. (eds), *The Handbook of Global Science, Technology, and Innovation*, Oxford: Wiley, pp. 191–211.
- Avelino, F., et al., 2015. Transitions towards ‘new economies’: a transformative social innovation perspective. TRANSIT Working Paper No. 3. Retrieved from <http://www.transitsocialinnovation.eu> (accessed January 2018).
- Ayres, R.U., 1996. Limits to the growth paradigm. *Ecological Economics* **19**, 117–34.
- Babbage, C., 1830. *Reflections on the Decline of Science in England and Some of its Causes*. London: Fellowes.
- Bakhshi, H., Mateos-Garcia, J., 2016. New data for innovation policy. Paper presented at the OECD Blue Sky Conference, Ghent, Belgium, 20 September.
- Balaguer, A., et al., 2008. The rise and growth of a policy-driven economy: Taiwan. In: C. Edquist and L. Hommen (eds), *Small Country Innovation Systems: Globalization, Change and Policy in Asia and Europe*. Cheltenham, UK and Northampton, USA: Edward Elgar, p. 31.
- Balzat, M., 2003. Benchmarking in the context of national innovation systems: purpose and pitfalls. Volkswirtschaftliche Diskussionsreihe, Institut für Volkswirtschaftslehre der Universität Augsburg.
- Balzat, M. and Hanusch, H., 2004. Recent trends in the research on national innovation systems. *Journal of Evolutionary Economics* **14**(2), 197–210.
- Barbieri, N., Ghisetti, C., Gilli, M., Marin, G., and Nicolli, F., 2016. A survey of the literature on environmental innovation based on main path analysis. *Journal of Economic Surveys* **30**, 596–623.
- Barnard, H. and Chaminade, C., 2017. Openness of innovation systems through global innovation networks: a comparative analysis of firms in developed and emerging economies. *International Journal of Technological Learning, Innovation and Development* **9**(3), 269–92.
- Barnard, H., Cowan, R., and Müller, M., 2012. Global excellence at the expense of local diffusion, or a bridge between two worlds? Research in science and technology in the developing world. *Research Policy* **41**, 756–69.
- Barnard, H., Cowan, R., Arranz Arroyabe, M., and Müller, M., 2015. The role of global connectedness in the development of indigenous science in middle-income countries. In: Archibugi, D. and Filippetti, A. (eds), *The Handbook of Global Science, Technology, and Innovation*. Oxford: Wiley, pp. 382–406.
- Bergek, A. and Jacobsson, S., 2003. The emergence of a growth industry: a comparative analysis of the German, Dutch and Swedish wind turbine industries. In: Metcalfe, J.S. and Canter, U. (eds), *Transformation and Development: Schumpeterian Perspectives*. Heidelberg: Physica/Springer, pp. 197–227.

- 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, 407–29.
- Bessant, J., Rush, H., and Trifilova, A., 2012. 'Jumping the tracks': crises-driven social innovation and the development of novel trajectories. *Swiss Journal of Business Research and Practice* 66(3), 217–25.
- Biegelbauer, P., 1995. Rich and highly informative. *Science and Public Policy* 22, 130–1.
- Binz, C., Truffer, B., Li, L., Shi, Y., and Lu, Y., 2012. Conceptualizing leapfrogging with spatially coupled innovation systems: the case of on site wastewater treatment in China. *Technological Forecasting and Social Change* 79(1), 155–71.
- Binz, C., Truffer, B., and Coenen, L., 2013. Systematic anchoring of global innovation processes and new industry formation – the emergence of on-site water recycling in China. Center for Innovation, Research and Competences in the Learning Economy (CIRCLE), Lund University, Lund.
- Binz, C., Truffer, B., and Coenen, L., 2014. Why space matters in technological innovation systems – mapping global knowledge dynamics of membrane bioreactor technology. *Research Policy* 43(1), 138–55.
- Binz, C., Truffer, B., and Coenen, L., 2016. Path creation as a process of resource alignment and anchoring – industry formation for on-site water recycling in Beijing. *Economic Geography* 92, 172–200.
- Borrás, S. and Edler, J., 2014. Introduction: on governance, systems and change. In: Borrás, S. and Edler, J. (eds), *The Governance of Socio-technical Systems: Explaining Change*. Cheltenham, UK and Northampton, MA, USA, pp. 1–22.
- Borrás, S., Chaminade, C., and Edquist, C., 2009. The challenges of globalisation: strategic choices for systems of innovation. In: Marklund, G., Vorontas, N., and Wessner, C. (eds), *The Innovation Imperative – Globalization and National Competitiveness*. Cheltenham, UK and Northampton, MA, USA: Edward Elgar, pp. 7–23.
- Bortz, G. and Thomas, H., 2017. Biotechnologies for inclusive development: scaling up, knowledge intensity and empowerment (the case of the probiotic yoghurt 'Yogurito' in Argentina). *Innovation and Development* 7, 37–61.
- Breschi, S. and Malerba, F., 1997. Sectoral innovation systems: technological regimes, Schumpeterian dynamics and spatial boundaries. In: Edquist, C. (ed.), *Systems of Innovation: Technologies, Institutions and Organizations*. London: Pinter Publishers, pp. 130–56.
- Brundtland, G.H. and Khalid, M., 1987. *Our Common Future*. New York: Oxford University Press.
- Bulman, D., Eden, M., and Nguyen, H., 2017. Transitioning from low-income growth to high-income growth: is there a middle-income trap? *Journal of the Asia Pacific Economy* 22, 5–28.
- Cantwell, J. and Zhang, F., 2011. Technological complexity and the evolving structure of MNC subsidiary knowledge accumulation. *Economia e Politica Industriale* 38(4), 5–33.
- Carlsson, B. and Stankiewicz, R., 1991. On the nature and composition of technological systems. *Journal of Evolutionary Economics* 1, 93–119.
- Carlsson, B. and Stankiewicz, R., 1995. On the nature, function and composition of technological systems. In: Carlsson, B. (ed.), *Technological Systems and Economic*

- Performance: The Case of Factory Automation*. Dordrecht: Kluwer Academic Publishers, pp. 21–56.
- Cassiolato, J.E., Matos, M., and Lastres, H., 2014. Innovation systems and development. In: Currie-Alder, B., Kanbur, R., Malone, D. and Mehdora, R. (eds), *International Development: Ideas, Experience, and Prospects*. Oxford: Oxford University Press, pp. 566–78.
- Castellacci, F. and Archibugi, D., 2008. The technology clubs: the distribution of knowledge across nations. *Research Policy* 37, 1659–73.
- Castellacci, F. and Natera, J.M., 2013. The dynamics of national innovation systems: a panel cointegration analysis of the coevolution between innovative capability and absorptive capacity. *Research Policy* 42, 579–94.
- Castellani, D. and Pieri, F., 2013. R&D offshoring and the productivity growth of European regions. *Research Policy* 42, 1581–94.
- Castelli, C. and Castellani, D., 2013. The internationalisation of R&D: sectoral and geographic patterns of cross-border investments. *Economia e Politica Industriale* 1, 127–43.
- Cervantes, M. and Guellec, D., 2002. The brain drain: old myths, new realities. *Organisation for Economic Cooperation and Development. The OECD Observer* 230, 40.
- Chaminade, C., 2010. C. Edquist L. Hommen Small Country Innovation Systems. Globalization, Change and Policy in Asia and Europe. A book review. *Research Policy* 39, 186–7.
- Chaminade, C., 2015. *Technology-driven FDI by Emerging Multinationals in Europe*. Lund: University.
- Chaminade, C. and Edquist, C., 2006. From theory to practice. The use of the systems of innovation approach in innovation policy. In: Hage, J. and de Meeus, M. (eds), *Innovation, Learning and Institutions*. Oxford: Oxford University Press, pp. 141–62.
- Chaminade, C. and Edquist, C., 2010. Rationales for public policy intervention in the innovation process: a systems of innovation approach. In: Kuhlman, S., Shapira, P., and Smits, R. (eds), *The Theory and Practice of Innovation Policy: An International Handbook*. Cheltenham, UK and Northampton, MA, USA: Edward Elgar, pp. 95–114.
- Chaminade, C. and Gomez, L., 2016. Technology-driven foreign direct investment within the Global South. In: WIPO (ed.), *The Global Innovation Index 2016*. Geneva: WIPO, pp. 81–90.
- Chaminade, C. and Padilla-Pérez, R., 2017. The challenge of alignment and barriers for the design and implementation of science, technology and innovation policies for innovation systems in developing countries. In: Kuhlmann, S. and Ordóñez, G. (eds), *Science, Technology and Innovation Policy in Developing Countries: Rationales and Relevance. An International Research Handbook*. Cheltenham, UK and Northampton, MA, USA: Edward Elgar, pp. 181–204.
- Chaminade, C. and Plechero, M., 2015. Do regions make a difference? Regional innovation systems in global innovation networks in the ICT industry. *European Planning Studies* 23(2), 215–37.
- Chaminade, C. and Vang, J., 2008. Upgrading in Asian clusters: rethinking the importance of interactive-learning. *Science, Technology and Society* 13(1), 61–94.
- Chaminade, C., Lundvall, B.-Å., Vang, J., and Joseph, K., 2009. Designing innovation policies for development: towards a systemic experimentation-based approach. 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, UK and Northampton, MA, USA: Edward Elgar, pp. 360–79.
- Chaminade, C., Intarakumnerd, P., and Sappasert, K., 2012. Measuring systemic problems in national innovation systems. An application to Thailand. *Research Policy* **41**(8), 1476–88.
- Chaminade, C., De Fuentes, C., Harirchi, G., and Plechero, M., 2017. The geography and structure of global innovation networks: global scope and regional embeddedness. In: Shearmur, R., Carrincazeaux, C., and Doloreux, D. (eds), *Handbook on the Geographies of Innovation*. Cheltenham, UK and Northampton, MA, USA: Edward Elgar, pp. 370–81.
- Chaudhary, A., Sagar, A.D., and Mathur, A., 2012. Innovating for energy efficiency: a perspective from India. *Innovation and Development* **2**, 45–66.
- Chen, X., Geng, Y., and Fujita, T., 2010. An overview of municipal solid waste management in China. *Waste Management* **30**, 716–24.
- Cimoli, M., 2013. *Developing Innovation Systems: Mexico in a Global Context*. London: Routledge.
- Cooke, P., 1996. The new wave of regional innovation networks: analysis, characteristics and strategy. *Small Business Economics* **8**, 159–71.
- Curnow, R. and Moring, G., 1968. 'Project SAPPHO': a study in industrial innovation. *Futures* **1**, 82–90.
- Dachs, B. and Pyka, A., 2010. What drives the internationalisation of innovation? Evidence from European patent data. *Economics of Innovation and New Technology* **19**, 71–86.
- Dachs, B., Kampik, F., Scherngell, T. et al., 2012. *Internationalisation of Business Investments in R&D and Analysis of their Economic Impact*. Luxembourg: European Commission.
- David, P. and Foray, D., 1995. Interactions in knowledge systems: foundations, policy implications and empirical methods. *STI Review* **16**, 14–68.
- De Liso, N., 2006. Charles Babbage, technological change and the national system of innovation. *Journal of Institutional and Theoretical Economics* **162**, 470–85.
- De Prato, G. and Nepelski, D., 2014. Global technological collaboration network: network analysis of international co-inventions. *Journal of Technology Transfer*, **39**(3), 358–75.
- Dewey, J., 1938. The pattern of inquiry. *The Essential Dewey* **2**, 169–79.
- Dicken, P., 2007. *Global Shifts: Mapping the Changing Contours of the World Economy*, 5th edn, New York: The Guilford Press.
- Dodgson, M., Hughes, A., Foster, J., and Metcalfe, S., 2011. Systems thinking, market failure, and the development of innovation policy: the case of Australia. *Research Policy* **40**, 1145–56.
- Dosi, G., Freeman, C., Nelson, R., Silverberg, G., and Soete, L., 1988. *Technical Change and Economic Theory*. London: Pinter Publishers.
- Dosi, G., Pavitt, K., and Soete, L., 1990. *The Economics of Technical Change and International Trade*. New York: Harvester Wheatsheaf.
- Edquist, C., 1997. *Systems of Innovation: Technologies, Institutions and Organizations*. London: Pinter Publishers.

- Edquist, C., 2004. Systems of innovation: perspectives and challenges. In: Fagerberg, J. (ed.), *The Oxford Handbook of Innovation*. Oxford: Oxford University Press, pp. 181–208.
- Edquist, C., 2005. Systems of innovation. In: Fagerberg, J., Mowery, D., and Nelson, R. (eds), *The Oxford Handbook of Innovation*. Cheltenham, UK and Northampton, MA, USA: Edward Elgar, pp. 181–208.
- Edquist, C. and Hommen, L., 1999. Systems of innovation: theory and policy for the demand side. *Technology in Society*, 21(1), 63–79. Edquist, C. and Hommen, L. (eds), 2008. *Small Country Innovation Systems: Globalization, Change and Policy in Asia and Europe*. Cheltenham, UK and Northampton, MA, USA: Edward Elgar.
- Edquist, C. and Lundvall, B.-Å., 1993. Comparing the Danish and Swedish systems of innovation. In: Nelson, R.R. (ed.), *National Innovation Systems. A Comparative Analysis*. New York: Oxford University Press, pp. 265–98.
- Ekins, P., 2010. Eco-innovation for environmental sustainability: concepts, progress and policies. *International Economics and Economic Policy* 7, 267–90.
- Ernst, D., Mytelka, L., and Ganiatsos, T., 1998. Technological capabilities in the context of export-led growth: a conceptual framework. In: Ernst, D., Mytelka, L., and Ganiatsos, T. (eds), *Technological Capabilities and Export Success in Asia*. London: Routledge, pp. 5–45.
- Etzkowitz, H. and Leydesdorff, L., 2000. The dynamics of innovation: from national systems and 'Mode 2' to a triple helix of university-industry-government relations. *Research Policy* 29, 109–23.
- Fagerberg, J., 1988. Why growth rates differ. In: Dosi, G.E.A. (ed.), *Technical Change and Economic Theory*. London: Pinter Publishers, pp. 432–57.
- Fagerberg, J. and Srholec, M., 2009. Innovation systems, technology and development: unpacking the relationship(s). 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, UK and Northampton, MA, USA: Edward Elgar, pp. 83–118.
- Fagerberg, J., Srholec, M., and Verspagen, B., 2010. Innovation and economic development. In: Hall, B.H. and Rosenberg, N. (eds), *Handbook of the Economics of Innovation*, Vol. 2. Amsterdam: Elsevier, pp. 833–72.
- Fagerberg, J., Fosaas, M., Bell, M., and Martin, B.R., 2011. Christopher Freeman: social science entrepreneur. *Research Policy* 40, 897–916.
- Fiaschi, D., Giuliani, E., and Nieri, F., 2017. Overcoming the liability of origin by doing no-harm: emerging country firms' social irresponsibility as they go global. *Journal of World Business* 52(4), June, 546–63.
- Filippetti, A. and Peyrache, A., 2011. The patterns of technological capabilities of countries: a dual approach using composite indicators and data envelopment analysis. *World Development* 39, 1108–21.
- Filippetti, A., Frenz, M., and Ietto-Gillies, G., 2016. The impact of internationalization on innovation at countries' level: the role of absorptive capacity. *Cambridge Journal of Economics* 41(2), 413–39.
- Folke, C., Jansson, Å., Rockström, J. et al., 2011. Reconnecting to the biosphere. *AMBIO: A Journal of the Human Environment* 40, 719–38.

- Foxon, T.J., 2015. Rationale for policy interventions in sustainability transitions. Paper for 6th International Sustainability Transition (IST) Conference, SPRU, University of Sussex, 25–28 August.
- Franceschini, S., Faria, L.G.D., and Jurowetzki, R., 2016. Unveiling scientific communities about sustainability and innovation. A bibliometric journey around sustainable terms. *Journal of Cleaner Production* **127**, 72–83.
- Freeman, C., 1982. Innovation as an engine of economic growth. In: Giersch, H. (ed.), *Emerging Technologies: Consequences for Economic Growth, Structural Change and Employment*. Tübingen: J.C.B. Mohr, pp. 1–27.
- Freeman, C., 1987. *Technology Policy and Economic Performance: Lessons from Japan*. London: Pinter Publishers.
- Freeman, C., 1988. Technology gaps, international trade and the problems of smaller and less developed economies. In: Freeman, C. and Lundvall, B.-Å. (eds), *Small Countries Facing the Technological Revolution*. London: Pinter Publishers, pp. 67–84.
- Freeman, C., 1992. *The Economics of Hope*. London: Pinter Publishers.
- Freeman, C., 1995. The national system of innovation in historical perspective. *Cambridge Journal of Economics* **19**, 5–24.
- Freeman, C., 2002. Continental, national and sub-national innovation systems – complementarity and economic growth. *Research Policy* **31**, 191–211.
- Freeman, C., 2004. Technological infrastructure and international competitiveness. *Industrial and Corporate Change* **13**, 541–69.
- Freeman, C. and Lundvall, B.-Å., 1988. *Small Countries Facing the Technological Revolution*. London: Pinter Publishers.
- Freeman, C. and Perez, C., 1986. The diffusion of technical innovations and changes of techno-economic paradigm. Paper presented at the Venice Conference on Innovation Diffusion, Venice, 18–22 March.
- Freeman, C. and Perez, C., 1988. Structural crises of adjustment: business cycles and investment behaviour. In: Dosi, G.E.A. (ed.), *Technical Change and Economic Theory*. London: Pinter Publishers, pp. 38–66.
- Freeman, C., Clark, J., and Soete, L., 1982. *Unemployment and Technical Innovation: A Study of Long Waves in Economic Development*. London: Pinter Publishers.
- Fu, X. and Gong, Y., 2011. Indigenous and foreign innovation efforts and drivers of technological upgrading: evidence from China. *World Development* **39**, 1213–25.
- Fu, X., Pietrobelli, C., and Soete, L., 2011. The role of foreign technology and indigenous innovation in the emerging economies: technological change and catching-up. *World Development* **39**, 1204–12.
- Furman, J., Porter, M., and Stern, S., 2002. The determinants of national innovative capacity. *Research Policy* **31**, 899–933.
- Gaffney, O. and Steffen, W., 2017. The Anthropocene equation. *The Anthropocene Review* **4**, 53–61.
- Galanakis, K., 2006. Innovation process. Make sense using systems thinking. *Technovation* **26**, 1222–32.
- Galli, R. and Teubal, M., 1997. Paradigmatic shifts in national innovation systems. In: Edquist, C. (ed.), *Systems of Innovation – Technologies, Institutions and Organization*. London, Pinter Publishers, pp. 342–70.

- Gammeltoft, P., 2008. Emerging multinationals: outward FDI from the BRICS countries. *International Journal of Technology and Globalisation* 4.
- Gee, S. and Kuo, W.-J., 1998. Export success and technological capability: textiles and electronics in Taiwan province of China. In: Ernst, D., Mytelka, L., and Ganiatsos, T (eds), *Technological Capabilities and Export Success in Asia*. London: Routledge, pp. 46–86.
- George, G., McGahan, A.M., and Prabhu, J., 2012. Innovation for inclusive growth: towards a theoretical framework and a research agenda. *Journal of Management Studies* 49(4), 661–83.
- Gereffi, G., Humphrey, J., and Sturgeon, T., 2005. The governance of global value chains. *Review of International Political Economy* 12, 78–104.
- Giuliani, E., Pietrobelli, C., and Rabellotti, R., 2005. Upgrading in global value chains: lessons from Latin American clusters. *World Development*, 33(4), 549–73.
- Godin, B., 2003. The most cherished indicator: Gross Domestic Expenditures on R&D (GERD). Project on the History of Sociology of S&T Statistics Working Paper, Canadian Science and Innovation Indicators Consortium (CSIIC), Quebec.
- Godin, B., 2009. National innovation system: the system approach in historical perspective. *Science, Technology & Human Values* 34(4), 476–501.
- Gregor, G., McGahan, A.M., and Prabhu, J., 2012. Innovation for inclusive growth: towards a theoretical framework and a research agenda. *Journal of Management Studies* 49, 661–83.
- Gruber, W., Mehta, D., and Vernon, R., 1967. The R&D factor in international trade and international investment of United States industries. *Journal of Political Economy* 75, 20–37.
- Gu, S. and Lundvall, B.-Å., 2006. Policy learning as a key process in the transformation of the Chinese innovation systems. In: Lundvall, B.-Å., Intarakurmond, P., and Vang, J. (eds), *Asian Innovation Systems in Transition*. Cheltenham, UK and Northampton, MA, USA: Edward Elgar, pp. 293–312.
- Guimón, J. and Guimón, P., 2012. How ready-to-use therapeutic food shapes a new technological regime to treat child malnutrition. *Technological Forecasting and Social Change* 79, 1319–27.
- Gupta, A.K., 2009. *Linking Vertical and Horizontal Markets for Innovations at Grassroots: Sustainability Imperative*. Indian Institute of Management.
- Hägerstrand, T., 1953. *Innovation Diffusion as a Spatial Process*. Chicago, IL: University of Chicago Press.
- Harirchi, G. and Chaminade, C., 2014. User-producer interaction and the degree of novelty of innovations: a global perspective. *World Development* 57, 19–31.
- Hee Lee, S. and Yoo, T., 2007. Government policy and trajectories of radical innovation in dirigiste states: a comparative analysis of national innovation systems in France and Korea. *Technology Analysis & Strategic Management* 19, 451–70.
- Heeks, R., Foster, C., and Nugroho, Y., 2014. New models of inclusive innovation for development. *Innovation and Development* 4, 175–85.
- Hekkert, M.P., Suurs, R.A., Negro, S.O., Kuhlmann, S., and Smits, R.E., 2007. Functions of innovation systems: a new approach for analysing technological change. *Technological Forecasting and Social Change* 74, 413–32.

- Herstad, S.J., Aslesen, H.W., and Ebersberger, B., 2014. On industrial knowledge bases, commercial opportunities and global innovation network linkages. *Research Policy* **43**, 495–504.
- Hirschman, A., 1958. *The Strategy of Economic Development*. New Haven, CT: Yale University Press.
- Hobday, M., 1995. East Asian latecomer firms: learning the technology of electronics. *World Development* **23**, 1171–93.
- Högselius, P., 2005. *The Dynamics of Innovation in Eastern Europe: Lessons from Estonia*. Cheltenham, UK and Northampton, MA, USA: Edward Elgar.
- Holm, J.R., Lorenz, E., Lundvall, B.-Å., and Valeyre, A., 2010. Organizational learning and systems of labor market regulation in Europe. *Industrial and Corporate Change* **19**, 1141–73.
- Hufbauer, G.C., 1966. *Synthetic Materials and the Theory of International Trade*. Cambridge, MA: Harvard University Press.
- Humphrey, J. and Schmitz, H., 2002. How does insertion in global value chains affect upgrading in industrial clusters? *Regional Studies* **36**(9), 1017–27.
- IRC Trade Task Force, 2016. Understanding the weakness in global trade. What is the new normal? European Central Bank, Occasional Paper Series No. 178, September. Retrieved from <https://www.ecb.europa.eu/pub/pdf/scpops/ecbop178.en.pdf> (accessed 25 September 2017).
- Isaksen, A. and Trippel, M., 2014. Path development in different regional innovation systems: a conceptual analysis. Center for Innovation, Research and Competences in the Learning Economy (CIRCLE), Lund University, Lund.
- Jacobsson, S. and Bergek, A., 2011. Innovation system analyses and sustainability transitions: contributions and suggestions for research. *Environmental Innovation and Societal Transitions* **1**, 41–57.
- Jensen, M.B., Johnson, B., Lorenz, E., and Lundvall, B.-Å., 2007. Forms of knowledge and modes of innovation. *Research Policy* **36**, 680–93.
- Johnson, A., 2001. Functions in innovation system approaches. Paper presented at the Nelson-Winter Conference, Aalborg, Denmark, 12–15 June.
- Johnson, B. and Andersen, A.D., 2012. *Learning, Innovation and Inclusive Development: New Perspectives on Economic Development Strategy and Development Aid*. Aalborg: Aalborg Universitetsforlag.
- Johnson, B. and Lundvall, B.-Å., 1994. The learning economy. *Journal of industry studies* **1**(2), 23–42.
- Johnson, B., Lema, R., and Villumsen, G., 2017. Research on innovation and development in the Anthropocene. Globelics Working Paper Series 2017-01.
- Kafourous, M.I., Buckley, P.J., and Clegg, J., 2012. The effects of global knowledge reservoirs on the productivity of multinational enterprises: the role of international depth and breadth. *Research Policy* **41**, 848–61.
- Karlsson, R., 2016. Après Paris: breakthrough innovation as the primary moral obligation of rich countries. *Environmental Science & Policy* **63**, 170–6.
- Khadria, B., 2001. Shifting paradigms of globalization: the twenty-first century transition towards generics in skilled migration from India. *International Migration*, **39**(5), 45–71.

- Khadria, B., 2002. *Skilled Labour Migration from Developing Countries: Study on India*. Geneva: International Labour Office.
- Kline, S. and Rosenberg, N., 1986. Innovation: an overview. In: *The Positive Sum Strategy: Harnessing Technology for Economic Growth*. Washington, DC: National Academy of Sciences, pp. 275–307.
- Koser, K. and Salt, J., 1997. The geography of highly skilled international migration. *Population, Space and Place* 3(4), 285–303.
- Kraemer-Mbula, E. and Wamae, W., 2010. *Innovation and the Development Agenda*. Paris: OECD.
- Leach, M., Rockström, J., Raskin, P. et al., 2012. Transforming innovation for sustainability. *Ecology and Society* 17, 11–16.
- Lee, K., 2013. *Schumpeterian Analysis of Economic Catch-up: Knowledge, Path-creation, and the Middle-income Trap*. Cambridge: Cambridge University Press.
- Lee, K. and Kim, B.-Y., 2009. Both institutions and policies matter but differently for different income groups of countries: determinants of long-run economic growth revisited. *World Development* 37, 533–49.
- Lee, K. and Malerba, F., 2017. Catch-up cycles and changes in industrial leadership: windows of opportunity and responses of firms and countries in the evolution of sectoral systems. *Research Policy* 46, 338–51.
- Lee, S.H. and Yoo, T., 2007. Government policy and trajectories of radical innovation in dirigiste states: a comparative analysis of national innovation systems in France and Korea. *Technology Analysis & Strategic Management* 19(4), 451–70.
- Lema, R. and Lema, A., 2012. Technology transfer? The rise of China and India in green technology sectors. *Innovation and Development* 2(1), 23–44.
- Lema, R., Johnson, B., Andersen, A.D., Lundvall, B.-Å., and Chaudhary, A., 2014. *Low-carbon Innovation and Development*. Aalborg: Aalborg Universitetsforlag.
- Leontief, W.W., 1986. *Input-output economics*. Oxford University Press on Demand.
- Leydesdorff, L., 2012. The triple helix, quadruple helix. . . , and an N-tuple of helices: explanatory models for analyzing the knowledge-based economy? *Journal of the Knowledge Economy* 3(1), 25–35.
- Lim, C., 2008. Towards knowledge generation with bipolarized NSI: Korea. In: Edquist, C. and Hommen, L (eds), *Small Country Innovation Systems*. Cheltenham, UK and Northampton, MA, USA: Edward Elgar, pp. 113–55.
- List, F., 1841. *The National System of Political Economy*, English edn 1904. Reprinted in 1958, London: Longman.
- Liu, X. and White, S., 2001. Comparing innovation systems: a framework and application to China's transitional context. *Research Policy* 30, 1091–114.
- López-Bassols, V., 2011. Innovation surveys and indicators: some experiences from the OECD. Paper presented at CeSTII workshop on the Review of Innovation Measurement in South Africa, Pretoria.
- Lorenz, E. and Lundvall, B.-Å., 2010. Accounting for creativity in the European Union: a multi-level analysis of individual competence, labour market structure, and systems of education and training. *Cambridge Journal of Economics* 35(2), 269–94.

- Lund-Thomsen, P. and Nadvi, K., 2010. Global value chains, local collective action and corporate social responsibility: a review of empirical evidence. *Business Strategy and the Environment* 19(1), 1–13.
- Lund-Thomsen, P., Nadvi, K., Chan, A., Khara, N., and Xue, H., 2012. Labour in global value chains: work conditions in football manufacturing in China, India and Pakistan. *Development and Change* 43(6), 1211–37.
- Lundvall, B.-Å., 1985. Product innovation and user-producer interaction. *Industrial Development Research Series* 31.
- Lundvall, B.-Å., 1988. Innovation as an interactive process: from user-producer interaction to the national system of innovation. In: Dosi, G.E.A. (ed.), *Technical Change and Economic Theory*. London: Pinter Publishers, pp. 349–69.
- Lundvall, B.-Å., 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, UK and Northampton, MA, USA: Edward Elgar.
- Lundvall, B.-Å., 2013. Adapting to the globalized learning economy paradigm. In: *Politics of Growth, Stability and Reform, Policy Network & Global Progress*, pp. 41–5.
- Lundvall, B.-Å., 2016. National innovation systems and globalization. In: *The Learning Economy and the Economics of Hope*. London: Anthem Press, pp. 351–73.
- Lundvall, B.-Å. and Borrás, S., 1997. *The Globalising Learning Economy: Implications for Innovation Policy*. Luxembourg: Office for Official Publications of the European Communities.
- Lundvall, B.-Å. and Borrás, S., 2005. Science, technology and innovation policy. In: Fagerberg, J., Mowery, D.C., and Nelson, R.R. (eds), *The Oxford Handbook of Innovation*. Oxford: Oxford University Press, pp. 599–631.
- Lundvall, B.-Å. and Tomlinson, M., 2001. Policy learning by benchmarking national systems of competence building and innovation. In Sweeney, G.P. (ed.), *Innovation, Economic Progress and Quality of Life*. Cheltenham, UK and Northampton, MA, USA: Edward Elgar.
- Lundvall, B.-Å. and Tomlinson, M., 2002. International benchmarking as a policy learning tool. In: Rodriguez, M.J. (ed.), *The New Knowledge Economy in Europe: A Strategy for International Competitiveness and Social Cohesion*. Cheltenham, UK and Northampton, MA, USA: Edward Elgar, pp. 203–31.
- Lundvall, B.-Å., Intarakumnerd, P., and Vang, J., 2006. *Asian Innovation Systems in Transition*. Cheltenham, UK and Northampton, MA, USA: Edward Elgar.
- Lundvall, B.-Å., Joseph, K.J., Chaminade, C., and Vang, J., 2009a. *Handbook of Innovation Systems and Developing Countries: Building Domestic Capabilities in a Global Setting*. Cheltenham, UK and Northampton, MA, USA: Edward Elgar.
- Lundvall, B.-Å., Vang, J., Joseph, K., and Chaminade, C., 2009b. 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, UK and Northampton, MA, USA: Edward Elgar, pp. 1–31.

- Malmberg, A. and Power, D., 2005. (How) do (firms in) clusters create knowledge? *Industry and Innovation* **12**(4), 409–31.
- Marshall, A., 1920. *Industry and Trade*. London: Macmillan.
- Martin, R. and Moodysson, J., 2013. Comparing knowledge bases: on the geography and organization of knowledge sourcing in the regional innovation system of Scania, Sweden. *European Urban and Regional Studies* **20**, 170–87.
- Mazzucato, M., 2011. The entrepreneurial state. *Soundings* **49**, 131–42.
- Mazzucato, M., 2015. The green entrepreneurial state. SPRU Working Paper Series 28.
- Mazzucato, M., 2016. From market fixing to market-creating: a new framework for innovation policy. *Industry and Innovation* **23**, 140–56.
- Mead, G.H., 1962. *The Self as Social Structure. Inside Social Life*. Los Angeles, CA: Roxbury Publishing.
- Mejias Esquivel, R. and Segura Bonilla, O., 2002. El pago de servicios ambientales en Centroamerica. In: Sostenible, C.I.D.P.E.P.E.D. (ed.), *Centro Internacional de Politica Economics para el desarrollo sostenible*. Costa Rica: Heredia.
- Metcalfe, J.S., 2006. Innovation, competition and enterprise: foundations for economic evolution in learning economies. In: Hage, J. and de Meeus, M. (eds), *Innovation, Science and Institutional Change*. Oxford: Oxford University Press, pp. 105–21.
- Metcalfe, S. and Ramlogan, R., 2008. Innovation systems and the competitive process in developing economies. *Quarterly Review of Economics and Finance* **48**, 433–46.
- Moore, J.F., 1993. Predators and prey: a new ecology of competition. *Harvard Business Review* **71**, 75–83.
- Moore, M.-L., Westley, F.R., Tjornbo, O., and Holroyd, C., 2012. The loop, the lens, and the lesson: using resilience theory to examine public policy and social innovation. In: Nicholls, A. and Murdock, A. (eds), *Social Innovation. Blurring Boundaries to Reconfigure Markets*. Basingstoke: Palgrave Macmillan, pp. 89–113.
- Moore, M.-L., Tjornbo, O., Enfors, E. et al., 2014. Studying the complexity of change: toward an analytical framework for understanding deliberate social-ecological transformations. *Ecology and Society* **19**, 54–63.
- Mowery, D. and Oxley, J., 1995. Inward technology transfer and competitiveness: the role of national innovation systems. *Cambridge Journal of Economics* **19**(1), 67–93.
- Muchie, M., Gammeltoft, P., and Lundvall, B.-Å., 2003. *Putting Africa First: The Making of African Innovation Systems*. Aalborg: Aalborg University Press.
- Myrdal, G., 1968. *Asian Drama, an Inquiry into the Poverty of Nations*. New York: Pantheon Books.
- Nadvi, K., 2004. The effect of global standards on local producers: a Pakistani case study. In: Schmitz, H. (ed.), *Local Enterprises in the Global Economy: Issues of Governance and Upgrading*. Cheltenham, UK and Northampton, MA, USA: Edward Elgar, pp. 297–325.
- Nadvi, K., 2008. Global standards, global governance and the organization of global value chains. *Journal of Economic Geography*, **8**(3), 323–43.
- Narula, R. and Martínez-Noya, A., 2015. International R&D alliances by firms: origins and development. In: Archibugi, D. and Filippetti, A. (eds), *The Handbook of Global Science, Technology and Innovation*. Oxford: Wiley, pp. 144–70.

- Ndichu, J., Blohmke, J., Kemp, R., Adeoti, J., and Obayelu, A.E., 2015. The adoption of energy efficiency measures by firms in Africa: case studies of cassava processing in Nigeria and maize milling in Kenya. *Innovation and Development* 5, 189–206.
- Nelson, R. (ed.), 1993. *National Innovation Systems. A Comparative Analysis*. New York: Oxford University Press.
- Nelson, R., 2007. The changing institutional requirements for technological and economic catch-up. *International Journal of Technological Learning, Innovation and Development* 1(1), 4–12.
- Nelson, R. and Winter, S., 1982. *An Evolutionary Theory of Economic Change*. Cambridge, MA: Harvard University Press.
- Nicholas, K., 1978. *Further Essays on Economic Theory*. London: Duckworth & Co.
- Nicholls, A. and Murdock, A., 2012a. The nature of social innovation. In: Nicholls, A. and Murdock, A. (eds), *Social Innovation: Blurring Boundaries to Reconfigure Markets*. Basingstoke: Palgrave Macmillan, pp. 1–30.
- Nicholls, A. and Murdock, A., 2012b. *Social Innovation: Blurring Boundaries to Reconfigure Markets*. Basingstoke: Palgrave Macmillan.
- Niosi, J., 2002. National systems of innovation are ‘x-efficient’ (and x-effective). Why some are slow learners. *Research Policy* 31, 291–302.
- Niosi, J., Saviotti, P., Bellon, B., and Crow, M., 1993. National systems of innovation: in search of a workable concept. *Technology in Society* 15, 207–27.
- OECD, 1993. *Proposed Standard Practice for Surveys of Research and Experimental Development*. FRASCATI Manual, 5th edn. Paris: OECD.
- OECD, 2002. *The Oslo Manual. The Measurement of Scientific and Technological Activities. Proposed Guidelines for Collecting and Interpreting Technological Innovation Data*. Paris: OECD.
- Olsson, P. and Galaz, V., 2012. Social-ecological innovation and transformation. In: Nicholls, A. and Murdock, A. (eds), *Social Innovation. Blurring Boundaries to Reconfigure Markets*. Basingstoke: Palgrave Macmillan, pp. 223–47.
- Padilla-Pérez, R. and Gaudin, Y., 2014. Science, technology and innovation policies in small and developing economies: the case of Central America. *Research Policy* 43, 749–59.
- Padilla-Pérez, R., Gaudin, Y., and Rodríguez, P., 2012. *Sistemas nacionales de innovación en centroamerica, CEPAL Estudios y Perspectivas*. CEPAL: Mexico.
- Pagiola, S., 2008. Payments for environmental services in Costa Rica. *Ecological Economics* 65, 712–24.
- Park, E., Hain, D.S., and Jurowetzi, R., 2016. Entrepreneurial upgrading? Exploring the interplay between global finance, knowledge flows, and technology-driven venture creation in Kenya. Paper presented at the OBEL symposium, Aalborg.
- Patel, P. and Pavitt, K., 1994. National innovation systems: why they are important, and how they might be measured and compared. *Economics of Innovation and New Technology* 3, 77–95.
- Perez, C., 2015. 11. Capitalism, technology and a green global golden age: the role of history in helping to shape the future. *The Political Quarterly* 86, 191–217.
- Perez, C. and Soete, L., 1988. Catching up in technology: entry barriers and windows of opportunity. In: Dosi, G., Freeman, C., Nelson, R.R., Silverberg, G., and Soete, L. (eds), *Technology and Economic Theory*. London: Pinter Publishers, pp. 458–79.

- Phills, J.A., Deiglmeier, K., and Miller, D.T., 2008. Rediscovering social innovation. *Stanford Social Innovation Review* 6(4), 34–43.
- Pietrobelli, C. and Rabellotti, R., 2009. Innovation systems and global value chains. *WP Series* 3(9), 1–18.
- Posner, M.V., 1961. International trade and technical change. *Oxford Economic Papers* 13, 323–41.
- Powell, W., 1990. Neither market nor hierarchy. *Research in Organizational Behaviour* 12, 295–36.
- Powell, W.W. and Grodal, S., 2004. Networks of innovators. In: Fagerberg, J., Mowery, D., and Nelson, R. (eds), *The Oxford Handbook of Innovation*. Oxford: Oxford University Press, pp. 1–29.
- Prahalad, C., 2012. Bottom of the pyramid as a source of breakthrough innovations. *Journal of Product Innovation Management* 29, 6–12.
- Radošević, S., 1999. Transformation of science and technology systems into systems of innovation in Central and Eastern Europe: the emerging patterns and determinants. *Structural Change and Economic Dynamics* 10, 277–320.
- Raworth, K., 2017. *Doughnut Economics: Seven Ways to Think Like a 21st-century Economist*. Chelsea Green Publishing.
- Rennings, K., 2000. Redefining innovation – eco-innovation research and the contribution to ecological economics. *Ecological Economics* 32, 319–32.
- RICYT, 2001. *Normalización de indicadores de innovación tecnológica en América Latina y el Caribe. Manual de Bogotá*. Bogotá: Red Iberoamericana de Indicadores de Ciencia y Tecnología (RICYT)/Organización de Estados Americanos (OEA).
- Robinson, J.A. and Acemoglu, D., 2011. Why nations fail: the origins of power, prosperity and poverty. Morishima Lecture, London School of Economics, 8 June.
- Rockström, J. and Klum, M., 2015. *Big World, Small Planet: Abundance Within Planetary Boundaries*. New Haven, CT: Yale University Press.
- Rockström, J., Steffen, W., Noone, K. et al., 2009. Planetary boundaries: exploring the safe operating space for humanity. *Ecology and Society* 14(2), 32.
- Rosen, F. and Olsson, P., 2013. Institutional entrepreneurs, global networks, and the emergence of international institutions for ecosystem-based management: the Coral Triangle Initiative. *Marine Policy* 38, 195–204.
- Rosenkopf, L. and Almeida, P., 2003. Overcoming local search through alliances and mobility. *Management Science* 49, 751–66.
- Rossi, A., 2011. Economic and social upgrading in global production networks: the case of the garment industry in Morocco. PhD thesis, University of Sussex, Brighton, UK.
- Rothwell, R., Freeman, C., Horley, A., Jervis, V., Robertson, A., and Townsend, J., 1974. SAPPHO updated – project SAPPHO phase II. *Research Policy* 3, 258–91.
- Samara, E., Georgiadis, P., and Bakouros, I., 2012. The impact of innovation policies on the performance of national innovation systems: a system dynamics analysis. *Technovation* 32, 624–38.
- Santiso, J., 2008. The emergence of Latin multinationals. OECD Emerging Markets Network Working Paper.
- Saxenian, A.L., 2006. *The New Argonauts: Regional Advantage in a Global Economy*. Cambridge, MA: Harvard University Press.

- Schiller, D. and Diez, J.R., 2010. Local embeddedness of knowledge spillover agents: empirical evidence from German star scientists. *Papers in Regional Science* **89**, 275–94.
- Schumpeter, J.A., 1939. *Business Cycles*, Vol. 1, New York: McGraw-Hill, pp. 161–74.
- Segura-Bonilla, O., 2000. *Sustainable Systems of Innovation: The Forest Sector in Central America*. Aalborg: Department of Business Studies. Aalborg Universitetsforlag.
- Segura-Bonilla, O., 2003. Competitiveness, systems of innovation and the learning economy: the forest sector in Costa Rica. *Forest Policy and Economics* **5**, 373–84.
- Sen, A.K., 1999. *Development as Freedom*. Oxford: Oxford University Press.
- Sharif, N., 2006. Emergence and development of the National Innovation Systems concept. *Research Policy* **35**, 745–66.
- Sharif, N. and Baark, E., 2008. From trade hub to innovation hub: Hong Kong. In: Edquist, C. and Hommen, L. (eds), *Small Country Innovation Systems: Globalization, Change and Policy in Asia and Europe*. Cheltenham, UK and Northampton, MA, USA: Edward Elgar, p. 194.
- Smith, K., 2000. Innovation as a systemic phenomenon: rethinking the role of policy. *Enterprise and Innovation Management Studies* **1**, 73–102.
- Soete, L., 2013. Is innovation always good? In: Fagerberg, J., Martin, B.R., and Andersen, E.S. (eds), *Innovation Studies: Evolution and Future Challenges*. Oxford: Oxford University Press, pp. 134–44.
- Soete, L., Verspagen, B., and Ter Weel, B., 2010. Systems of innovation. In: Bronwyn, H.H. and Nathan, R. (eds), *Handbook of the Economics of Innovation*. Amsterdam: North-Holland, pp. 1159–80.
- Soto, M.A.C., Bonilla, O.S., Gatjens, V.R., and Quirós, M.M., 2002. *Gestión local y participación en torno al pago por servicios ambientales: Estudios de caso en Costa Rica*. San Jose, Costa Rica: Centro Internacional de la Política Economía (CINPE).
- Stal, E. and Cuervo-Cazurra, A., 2011. The investment development path and FDI from developing countries: the role of pro-market reforms and institutional voids. *Latin American Business Review* **12**, 209–31.
- Steffen, W., Persson, Å., Deutsch, L. et al., 2011. The Anthropocene: from global change to planetary stewardship. *AMBIO: A Journal of the Human Environment* **40**, 739–61.
- Steffen, W., Richardson, K., Rockström, J. et al., 2015. Planetary boundaries: guiding human development on a changing planet. *Science* **347**(6223), 1259855.
- Stewart, T.A., 1998. *Intellectual Capital: The New Wealth of Organisations*. London: Doubleday.
- Stiglitz, J.E. and Greenwald, B.C., 2014. *Creating a Learning Society: A New Approach to Growth, Development, and Social Progress*. New York: Columbia University Press.
- Stöllinger, R., 2012. International spillovers in a world of technology clubs. WIIW Working Paper No. 99, Vienna.
- Storper, M., 1995. The resurgence of regional economies, ten years later the region as a nexus of untraded interdependencies. *European Urban and Regional Studies* **2**, 191–221.
- Strambach, S. and Klement, B., 2012. Cumulative and combinatorial micro-dynamics of knowledge: the role of space and place in knowledge integration. *European Planning Studies* **20**, 1843–66.

- Tallman, S. and Phene, A., 2007. Leveraging knowledge across geographic boundaries. *Organization Science* **18**, 252–60.
- The Swedish Big Data Analytics Network, 2016. *Big Data Analytics. A Research and Innovation Agenda for Sweden*. Stockholm: Vinnova.
- Trippel, M., Tödtling, F., and Lengauer, L., 2009. Knowledge sourcing beyond buzz and pipelines: evidence from the Vienna software sector. *Economic Geography* **85**, 443–62.
- UNCTAD, 2010. *Science, Technology and Innovation Policy Review – Mauritania*. New York and Geneva: United Nations.
- UNCTAD, 2011a. *Science, Technology and Innovation Policy Review – El Salvador*. New York and Geneva: United Nations.
- UNCTAD, 2011b. *Science, Technology and Innovation Policy Review – Ghana*. New York and Geneva: United Nations.
- UNCTAD, 2012. *Science, Technology and Innovation Policy Review – Dominican Republic*. New York and Geneva: United Nations.
- UNEP, 2015. *The Three Dimensions of Sustainable Development*. United Nations Environment Programme. Retrieved from <http://web.unep.org/ourplanet/march-2015/unep-work/three-dimensions-sustainable-development> (accessed January 2018).
- Ustyuzhantseva, O., 2017. Studies of inclusive innovation in sociotechnical systems: case studies in Russia and India. *Innovation and Development* **7**(1), 83–100.
- Valdés, B., 1999. *Economic Growth: Theory, Empirics and Policy*. Cheltenham, UK and Northampton, MA, USA: Edward Elgar.
- Viotti, E.B., 2002. National learning systems – a new approach on technological change in late industrializing economies and evidences from the cases of Brazil and South Korea. *Technological Forecasting and Social Change* **69**, 653–80.
- Wasserman, S. and Faust, K., 1994. *Social Network Analysis. Methods and Applications*. Cambridge: Cambridge University Press.
- Weber, K.M. and Rohracher, H., 2012. Legitimizing research, technology and innovation policies for transformative change: combining insights from innovation systems and multi-level perspective in a comprehensive ‘failures’ framework. *Research Policy* **41**, 1037–47.
- Westley, F. and Antadze, N., 2010. Making a difference: strategies for scaling social innovation for greater impact. *The Innovation Journal* **15**(2), 2–18.
- Westley, F.R., Tjornbo, O., Schultz, L. et al., 2013. A theory of transformative agency in linked social-ecological systems. *Ecology and Society* **18**(3), 27–42.
- Westley, F., McGowan, K., Antadze, N., Blacklock, J., and Tjornbo, O., 2016. How game changers catalyzed, disrupted, and incentivized social innovation: three historical cases of nature conservation, assimilation, and women’s rights. *Ecology and Society* **21**(4), 13–25.
- Whitley, R., 1994. Dominant forms of economic organization in market economies. *Organization Studies* **15**(2), 153–82.
- Williamson, O.E., 1975. *Markets and Hierarchies*. New York: The Free Press.
- Wong, P. K. and Singh, A., 2008. From technology adopter to innovator: Singapore. In: Edquist, C. and Hommen, L. (eds), *Small Country Innovation Systems: Globalization, Change and Policy in Asia and Europe*. Cheltenham, UK and Northampton, MA, USA: Edward Elgar, pp. 71–112.

- Woolthuis, R.K., Lankhuizen, M., and Gilsing, V., 2005. A system failure framework for innovation policy design. *Technovation* **25**, 609–19.
- World Bank, 2005. *Waste Management in China: Issues and Recommendations. East Asia Infrastructure Development*. Washington, DC: World Bank. Retrieved from <http://go.worldbank.org/2HoVMO7ZGo> (accessed January 2018).
- World Bank, 2010. *Innovation Policy. A Guide for Developing Countries*, Vol 1. Washington, DC: World Bank.
- Yuan, J., Xu, Y., Zhang, X., Hu, Z., and Xu, M., 2014. China's 2020 clean energy target: consistency, pathways and policy implications. *Energy Policy* **65**, 692–700.
- Zhang, S. and He, Y., 2013. Analysis on the development and policy of solar PV power in China. *Renewable and Sustainable Energy Reviews* **21**, May, 393–401.

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