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Introduction

Charles Edquist and Maureen McKelvey

We are pleased to present this two-volume reference collection on *Systems of Innovation: Growth, Competitiveness and Employment*. This collection brings together academic work, which addresses topics about systems of innovation from a variety of angles and from contrasting but related theoretical perspectives. It deals with systems of innovation of different kinds, such as national, regional and sectoral systems and it approaches these from different attitudes, such as institutional and evolutionary economics and innovation studies. It also addresses questions about the importance of innovations for economic growth, competitiveness and employment, as well as issues related to government policies and firm strategies in the field of innovations.

All the contributions to these volumes have been published elsewhere as part of the vast and growing body of literature on systems of innovation. From this literature, we have chosen the articles and book chapters found in this collection because they all address crucial questions related to systems of innovation or the relationships between innovations and systems of innovation on one hand and economic growth, competitiveness and employment on the other.

'Systems of innovation' (SI) is an approach that has emerged during the last decade or so for the study of innovations as an endogenous part of the economy, and in fact, as an important determinant behind economic change. Innovations are seen as part of a larger process of development of knowledge of economic relevance. The SI approach is closely allied to neo-Schumpeterian theories about the dynamics of capitalism. The work on SIs highlights the fact that innovation processes involve evolutionary economic change over time and that these processes are also interactive and uncertain. For these reasons the SI approach does not make use of the notion of optimality.

This work stresses that firms do not innovate in isolation but in interaction with other organizational actors such as other firms, universities, standard setting agencies and so on. This interaction between firms and between firms and other organizations is in turn shaped by (and shapes) market competitions as well as the framework of existing institutional rules like laws, norms, technical standards and so on.¹ A broad definition of SI is all the important factors that influence the development, diffusion and use of innovations, including the relations between these factors.

The SI approach has diffused surprisingly fast in the academic world as well as in the realms of public innovation policy making and firm innovation strategy formulation. The Organization for Economic Co-operation and Development (OECD) has been particularly influential in using and further developing empirical analyses and research using this approach. 'Systems of innovation' is at the centre of modern thinking about innovation and the relations of innovation to economic growth, competitiveness and employment. One reason for this may be a measure of our ignorance. While it is almost universally accepted that technological change and other kinds of innovations have tremendously important effects on economic variables such as productivity growth, firm competitiveness and employment, the exact relationships between

innovations and these other variables are the subject of continuing scrutiny and debate. Understanding them is seen to be increasingly important as one way to understand the dynamics of the current economic system.

The contributions to this two volume collection have been carefully chosen in order to give readers an introduction into some key issues and debates about SIs as well as to serve as a reference collection of articles that one may return to, again and again. We have chosen many articles which we feel should be made accessible not only to innovation specialists but to a wider audience as well. Thus, we hope that the two volumes will be useful both for undergraduate and graduate students, for senior researchers, as well as for persons outside academia, such as public policy makers or firm managers interested in innovation. Read these two volumes and you will have a good understanding of the basic ideas and key debates within this lively field!

The structure of the two volumes is as follows:

Volume I

1. An Introduction to Systems of Innovation
2. National Systems of Innovation
3. Regional Systems of Innovation
4. Sectoral and Technological Systems
5. Case Studies of Systems of Innovation

Volume II

1. Interactive Learning and Networks of Innovation
2. Evolutionary Theories of Innovation
3. Institutional Theories
4. Innovations, Growth and Employment
5. Dynamics of Government Policy and Firm Strategy

Bibliography

We decided on this structure of the two volumes in order to focus on the three purposes of this reference collection. First, the collection should introduce some of the key issues and authors of current SI thinking. Second, it should acknowledge sources of intellectual stimulation, whether classical pieces written by economists or more contemporary research dealing with our central issues. Finally, the collection should contain areas of research which are currently, and will increasingly be, important for understanding interactions among innovation and economic change – even if those areas are not currently well developed.

Selection Criteria

By bringing together this specific selection of articles and book chapters and by presenting them as a whole, this reference collection is a novel combination. It goes beyond simply repeating previous work in that these two volumes structure the reader's thinking and enable his/her reflection over different sides of the debate, as we discuss further below. Readers of this collection will also find a solid grounding in how the SI approach has emerged as well as how it has been

used and further developed. The reference collection thus gives a foundation for reflection over future articles and debates. Having read some classical predecessors, founding articles, main contributions and some of the most important debates within the SI approach, the reader will be prepared – and perhaps challenged – to address future issues.

Our task in selecting among the numerous pieces that are relevant to SI and of a high quality has, however, been quite difficult. Moreover, we are trying to hit a moving target, as any database search will reveal that new reports, journal articles and books continue to be written. Therefore, we would like to say a few words about the criteria used to select chapters and articles so that this transparency helps the reader to understand better what the collection is, as well as what it is not.

A reference collection needs balance. Most pieces selected here directly address SIs, including both early and more recent contributions, as further discussed in subsequent sections of this introduction. These sections elucidate our rationale for choosing these combinations of articles. In trying to select among many truly interesting articles, we decided that there should be both overviews and state-of-the-art pieces on the subject as a whole, as well as certain pieces which focus on key issues of interest to readers. This implies that some articles were not selected simply because we had to choose between several dealing with similar issues. Some articles selected are not well known but develop an issue in an interesting way, or add a new twist on existing controversies.

Trying to achieve balance among the pieces we have chosen has also meant selecting some articles that are explicitly theoretical, others that are explicitly empirical and still others that are some combination of the two. A final meaning of balance that we have tried to achieve is between articles of more interest to academics in related fields and between articles of more interest to policy makers in firms, governments and international organizations. While we by no means claim to have addressed everyone's interest to their satisfaction, we are satisfied that many different kinds of readers will be able to use these two volumes.

In making our selections, the majority of the articles should – of course – deal explicitly with systems of innovation. However, we have also included articles that do not. As these are of three kinds, we would like to explain our selection criteria for each set. One group represents work dealing with related concepts like networks, clusters, filières, development blocks and so on. These approaches are similar or have been developed in parallel to the systems of innovation approach in contemporary social science thinking about innovation. We have therefore selected a few key articles which do not explicitly use the SI language but do explicitly deal with innovation in relation to our main topics. This implies, for example, that 'systems oriented' work which concentrates on production structures or on national organizational structures, but which does not discuss innovations, does not meet our criteria.

There is a second group of theoretical articles that do not mention SI, including classical pieces and some of more direct inspiration to the development of the SI approach. Some highly relevant pages from the work of Alfred Marshall, Friedrich List and Joseph Schumpeter are included, as well as an article about the necessity of co-ordination as well as division of contributions on interactive learning theories of innovation, evolutionary economics, and institutional theories. The third group of articles, which do not always use the language of SI, addresses more directly the consequences of innovation on the economy. These may be consequences for economic growth and employment or for government policies and firm strategies.

Finally, a Bibliography is included at the end of Volume II, with a list of other relevant literature selected according to the above criteria. We have made every effort to make the Bibliography as complete as possible, but we are aware that imperfections must still exist in its coverage. In this dynamically developing research and policy area, we do apologize for already published articles and book chapters which we have undoubtedly missed in the Bibliography. Moreover, new articles and studies are being, and will continue to be, written, and these are obviously not represented here, either in the collection or in the Bibliography. None the less, we believe that the Bibliography will be useful for readers wishing to go into one or another aspect of the debate in more detail.

Ideas and Debates

The first volume of this reference collection specifically addresses the issues of definition and levels of aggregation, through articles contributing to theoretical or empirical understandings of SIs. The debates and key issues will be briefly touched upon below, through a brief review of the key books in the field. Although these and other books are seen to have set much of the debate over SIs, our selection of pieces also includes many journal articles. Through new combinations and through new directions of thought, each contribution chosen in Volume I contributes to some of the central themes about regions, sectors, nations and globalization.

The second volume of this reference collection has two parts. Parts I, II and III deal with the theoretical origins of SI while Parts IV and V deal with implications for economic growth and employment as well as for government policy and firm strategy in relation to innovations and systems of innovation.

Books on Nations, Regions and Sectors

Volume I of this reference collection addresses questions about which level of analysis – national, regional, sectoral, global – can be used to address which issues. At a deeper level, however, this debate is not only about what level of analysis can be used for what purposes. Instead, it is also about how a specific definition of an SI, based on a particular theoretical perspective, affects which issues, relationships and types of dynamics which we do or do not see with the help of the analysis. Some approaches emphasize trust and interactions among small firms whereas others explicitly take an evolutionary perspective. Is it trust built through local relationships that matters? Or is it national policy making which encourages certain types of firm behaviour? How much influence does the previous specialization of firms, regions and nations into certain industrial and service sectors have on their future potentials for growth?

By defining the object of study differently and by trying to address different research questions, even articles that seem very similar at one level may be different at another level. We mostly leave it up to the reader, however, to analyse and compare the different book chapters and journal articles which have been included.

As an introduction to the topics covered in Volume I of the reference collection, we would like to mention and briefly discuss seven edited volumes and one monograph which explicitly deal with SIs. The first two – and probably also best known – books address national systems of innovation. They are *National Systems of Innovation: Towards a Theory of Innovation and*

Interactive Learning, edited by Bengt-Åke Lundvall (1992), and *National Innovation Systems: A Comparative Analysis*, edited by Richard R. Nelson (1993). These two books have been very influential in setting the debate. They were, however, pre-dated by the book *Technology Policy and Economic Performance: Lessons from Japan*, by Christopher Freeman.² Freeman analyses Japan in terms of how national institutions influence economic change and innovation by concentrating on four elements: (1) the role of government policy through MITI; (2) the role of corporate R&D; (3) the role of education and training; and (4) the conglomerate structure of industry.

The two edited books about national systems of innovation by Lundvall and Nelson differ markedly in style. The Nelson book brings together case studies of innovation systems of 15 countries: Argentina, Australia, Brazil, Canada, Denmark, France, Germany, Israel, Italy, Japan, South Korea, Sweden, Taiwan, the UK and the USA. The contributing authors are well-known researchers from each respective country.

In the Nelson book, some authors describe the organization of the research and development infrastructure of their country, whereas a few go further in analysing how national institutions influence innovation and work-place practices. Taken together, these 15 case studies of specific, national innovation systems give us insight into the diversity of national ways to create and diffuse knowledge, especially such knowledge and technology which may be relevant for firms and hence for broader economic change. The diversity of national innovation systems is apparent through the Nelson book; the case studies indicate the variety in national forms of capitalism as well as national peculiarities in using and diffusing economically relevant knowledge.

The Lundvall book takes a more unified theoretical approach. The authors are mostly all associated with Aalborg University, Denmark. Although Lundvall's introductory chapter also expresses doubts about the extent to which SIs are at all national or about the extent to which SIs are exclusively national, the theoretical perspective underlying the contributions argues that nations matter for two reasons. The first is due to national institutions and the second is due to national specializations in production and knowledge. Thus, existing institutions as well as the sectors in which a national economy is specialized is postulated to influence learning relations for the future. As an example, the fact that Denmark specializes in agricultural machinery whereas Sweden has a higher concentration in mechanical engineering – as well as national institutional differences – will affect the ability of each economy to move into future technologies and product specializations.³

The chapters in the book edited by Lundvall address theoretical and empirical aspects of national systems of innovation, such as the role of institutions or evidence on the stability of national export specialization over time. One of their major arguments is that innovations and learning are normal and continuous processes in all parts of economies and not something that only happens in the R&D departments. Unlike most of the Nelson book contributions, which emphasize the importance of development (and sometimes diffusion) of technological and scientific knowledge, the Lundvall book contributions put more emphasis on the structure of production. Like von Hippel (1988), Lundvall argues that user-producer relations play a particularly important role, although Lundvall also emphasizes how the national context influences firms' ability and willingness to engage in such relations.

Together, these books have stimulated a lively debate concerning the appropriate level of analysis for SIs. The national systems of innovation literature has provoked many readers, especially some who interpreted their work to argue that only the national level influences the

pattern and development of innovations. Some of these authors protest against the national systems of innovation literature in order to make their own arguments that regions or sectors matter more or else that nations are passé in a world characterized by globalization. Other readers have instead been inspired to further develop the ideas, through, for example, a national analysis over a longer historical period or integrate the national perspective with a sectoral or regional analysis.

The book *Technology, Globalisation and Economic Performance* edited by Daniele Archibugi and Jonathan Michie addresses this question about whether nations matter in an increasingly globalized world as well as more explicitly addressing government policy. This collection was originally published in 1995 in the *Cambridge Journal of Economics* and reproduced as a book in 1997. This collection of articles comes down on the side of nations, by concluding that nations matter, perhaps even more than ever, in a globalized world.

The other side of this same debate about regions – nations – globalism is the question of how, and why, regions matter. This type of question is sometimes seen as in polemic with the argument about the predominate importance of national institutions for understanding the dynamics of innovation. As found in Volume I of this collection, some leading economic geographers are making strong arguments about the importance of regions and the influence of regional or local agglomeration to explain economic competitiveness and also innovativeness. At times the emphasis is on the structure and frequency of interactions among firms and other organizations in a region and at times on more diffuse concepts like trust, culture and social capital.

In fact, there is a growing interest in the regional level, for example in analyses of regional systems of innovation. One example is the book entitled *Regional Innovation Systems: The Role of Governances in a Globalized World*, edited by Hans-Joachim Braczyk, Philip Cooke and Martin Heidenreich (1998). This book is a collection of descriptions and analyses of 14 regional innovation systems all over the world written by experts from these regions. The design is similar to the Nelson book, but at a regional level. The regions addressed are Baden-Wurtemberg, Brabant (the Netherlands), California, Catalonia, Denmark, Midi-Pyrénées, North Rhine-Westphalia, Ontario, Pirkanmaa (Finland), Québec, Singapore, Tohoku (Japan), Tuscany and Wales. There is also an introductory chapter tracing the origins of the concept of Regional Innovation System and specifying it, as well as a summary chapter dealing with regional governance structures in a globalized world.

Rather than starting the analysis based on divisions of geography, some approaches within the broader SI field address the importance of industrial sectors and/or technology fields; that is, the approach is sectoral. The rationale for starting from that perspective is that sectors and/or technologies include differences in the types of knowledge developed, in the rate of development of innovative opportunities, in the structure of networks of relationships, and so forth.

Bo Carlsson has edited two books about technological systems in a national context, namely *Technological Systems and Economic Performance: The Case of Factory Automation* (1995) and *Technological Systems and Industrial Dynamics* (1997). Although Carlsson and his colleagues do not use the term 'system of innovation', their 'technological systems' approach is very similar to the SI approach.

The two books edited by Carlsson ask questions about the importance of technology fields. Thus, for example, Carlsson (1995) analyses different aspects of the technological system of

factory automation in Sweden, while Carlsson (1997) describes a number of different technological systems in Sweden: factory automation, electronics and computers, pharmaceuticals, and powder technology. Their ambition is to analyse innovations in different technological systems and they stress aspects like economic competence, networks, entrepreneurs and the institutional infrastructure (Carlsson and Stankiewicz 1991).

In a different but closely related approach, Stefano Breschi and Franco Malerba (and others) develop an analysis of sectoral systems of innovation (SSI). An SSI is a group of firms which develops and manufactures the products of a specific sector of production and which generates and utilizes the technologies of that sector (Breschi and Malerba 1997). In this perspective, firms are the most important actors, although other organizations and agents also play a role. Both market and non-market interactions are addressed and sector specific knowledge and institutions are stressed. Moreover, there is a recent book about sectoral systems of innovation, which is edited by Richard Nelson and David Mowery entitled *Sources of Industrial Leadership: Studies of Seven Industries* (1999). This book analyses how the following seven high-tech sectors evolved in the USA, Japan, and Western Europe: machine tools, organic chemical products, pharmaceuticals, medical devices, computers, semiconductors, and software. The purposes of this book are: (1) to understand the differing sectoral dynamics in terms of knowledge and economic variables over time; (2) to identify the key factors that determined in which country the leadership in the seven industries was located and (3) the reasons behind the shifts of leadership when they occurred.

Charles Edquist has also edited a book on SIs, namely *Systems of Innovation: Technologies, Institutions and Organizations*. This collection of chapters deals with some of the larger issues related to SI. This includes, clarifying basic concepts used in the SI approach, dealing with evolutionary perspectives, addressing transformations of systems of innovation, public policy recommendations and so forth. This book identifies important similarities between the national, sectoral and regional approaches, and on this basis suggests that these may be clustered together as variants of a single broadly encompassing 'systems of innovation approach'. Taken as a whole and individually, the various chapters demonstrate both the similarities and differences between different theoretical starting points and SI approaches. More importantly, perhaps, they also address a variety of specific issues relevant for further research, such as the relative importance of development versus diffusion of knowledge.

Theoretical Origins of the SI Approach

As mentioned earlier, Volume II of the reference collection has chapters on some theoretical contributions relevant to SI as well as on the mutual relationships between innovation and economic change. We have focused on three types of theoretical origins of the SI approach, namely theories of interactive learning, evolutionary theories and institutional theories.⁴

The interactive learning theories stress interactions between users and producers in the production system, and this notion of interaction paved the way for a systemic approach. The main point of departure for these theories was a critique of orthodox views that saw innovation as a process that takes place within firms situated in perfectly competitive markets, and where firms make decisions only on the basis of price signals.

The argument against this view is that, in the learning economy, firms and other agents are involved more or less permanently in processes of interactive learning. This might involve

exchange of knowledge between firms and even creating new knowledge in collaboration. Such interactive learning is seen as an important source of innovation. Various network approaches have a close affinity to these interactive learning theories in that they stress the importance of relationships for creating and transferring knowledge about technical and economic opportunities.

Several innovation theorists have convincingly argued that the model of the isolated, homogeneous, profit-maximizing firm is an inappropriate tool for interpreting certain important aspects of innovation processes. Innovation has to be understood in a broader context because of the central role of new knowledge, where different types of actors may contribute to its development and use. Many of the actors and organizations involved – for example, governmental or private non-profit organizations – are not primarily governed by profit seeking motivations. Non-profit organizations and profit-oriented ones, like firms, also interact with each other in complex ways when pursuing learning and innovation.⁵

As an alternative to understanding technical change to be a result of seeking to maximize profits, Nelson and Winter propose that it can be understood as an evolutionary process.⁶ An evolutionary theory of technical change often contains the following components:

- The point of departure is the existence and reproduction of entities like genotypes in biology or a certain set-up of technologies and organizational forms in innovation studies.
- There are mechanisms that introduce novelties in the system, that is, create diversity. These mechanisms include significant random elements, but may also produce predictable novelties (for example, purpose-oriented development work). In biology the novelties are mutations and in our context they are innovations.
- There are mechanisms that select among the entities present in the system. This increases the relative importance of some and diminishes that of others. The selection process reduces diversity and the mechanisms operating may be the ‘natural selection’ of biology or either ‘market selection’ or ‘political-institutional selection’ as regards technical change. Together the selection mechanisms constitute a filtering system that functions in several stages and leads to a new set-up of, for example, technologies and organizational forms. There might also be feedback from the selection to the generation of new innovations.

Nelson writes, ‘Technical change clearly is an evolutionary process; the innovation generator keeps on producing entities superior to those earlier in existence, and adjustment forces work slowly’.⁷ The technologies that are developed are only superior in a relative sense, not optimal in an absolute sense, and – contrary to standard economic theory – the economic system never reaches a state of equilibrium. Technological change is an open-ended and path dependent process where no optimal solution to a technical problem can be identified.

Although the resource bases of various national systems strongly influence their patterns of innovation, technical change will probably also involve considerable randomness. This does not mean randomness in the sense of actors randomly doing something and coming up with an innovation. Indeed, many firms have quite sophisticated routines for trying to intentionally develop innovations. Instead, it means randomness in outcome, in that the results of, for example, an R&D project or of a market launch, often cannot be predicted in advance. In addition, the processes through which new technologies are screened, selected, and implemented take considerable time. Randomness, combined with the time-consuming nature of innovation processes,

indicates that evolutionary models help us understand the longer-term dynamics of economic change through innovation better than the models provided by neoclassical economics.⁸

Both evolutionary and interactive learning theories of innovation contain certain institutionalist perspectives that are absent from standard economic theory. Innovation processes, like almost all learning processes, are considered to be influenced by the institutional set-up of the economy. The focus on interaction within national systems also highlights the importance of institutions and organizations ‘beyond’ the market or institutions that influence how a market functions. There is also an implicit institutionalist perspective in evolutionary theory’s rejection of the isolated profit-maximizing firm as a primary focus in studying innovation processes. Institutions matter to this school of thought because it bases explanations of evolutionary patterns of change on the decisions and actions of agents in relation to institutions and organizations.⁹ Hence, non-firm organizations are important for innovation processes. And institutions such as legal conditions, rules and norms also affect firms as well as other organizations. Hence, the institutional framework can help explain the inclination and ability of organizations – firms as well as others – to develop new knowledge and to innovate.¹⁰

Practically all the founding researchers of the SI approach are committed to the idea that technological change is an evolutionary process. Not only are SI approaches compatible with evolutionary theories but it could even be argued that there is a close affinity between them. This is also true of interactive learning theories. In addition, as we have seen both evolutionary and interactive learning theories are connected, either implicitly or explicitly, with institutionalist perspectives. These connections appear to be strongest with respect to their common emphasis on the importance of non-market actors and mechanisms in addition to firms. Hence, theories of interactive learning together with evolutionary economic and institutional economic theories constitute important origins of SI approaches.

Innovation and the Dynamics of the Economy

The final sections of Volume II more explicitly address how innovations are related to the dynamics of economic change. We have chosen ‘innovations, growth and employment’ and ‘dynamics of government policy and firm strategy’ because of their relevance to analysing economic change. They are broad topics which are currently in an early stage of development in the systems of innovation approach but which will be increasingly important for future research.

Innovations are related to both economic growth and changes in employment in complex ways. The most important source of long-term economic growth is increased labour productivity, that is the ratio between the value of production and the input of labour. There is general agreement among economists that the most important source of labour productivity growth is the so-called residual – sometimes called ‘technical change’. This residual is more or less equivalent to innovations in the wide sense of improvements to machines, technology, knowledge, and so forth. In other words, innovations are the most important source of increased labour productivity – which, in its turn, is the dominant source of increased economic growth and welfare in the long term. This is actually the main rationale for treating innovations as endogenous to economic processes, for example by means of the SI approach. Some of the articles in these last sections of the second volume explicitly address how knowledge and innovations are related to longer-term economic change.

While economic growth is generally seen as positive to increasing welfare, the relationships between economic growth and other variables like environment impact and employment are not always straightforward. For example, there has been a discussion arguing that some national economies have followed growth and development paths that tend to greatly increase employment while other economies tend to follow trajectories that decrease overall employment. Some kinds of growth destroy jobs while others create jobs. Chapter 15 in Volume II explicitly relates innovations to employment. It argues that if we distinguish between process innovations (*how* goods and services are produced) and product innovations (*which* goods and services are produced), then on the whole, process innovations destroy jobs while product innovations create jobs. The differing effects on economic growth, competitiveness and employment is one example why economists are increasingly arguing that it is crucial to know what kinds of innovations lie behind productivity growth.

Innovations are also increasingly recognized as a major source of competitiveness for firms, regions and countries. Although sharing a market orientation, it is increasingly recognized that national, regional or firm-level diversities in terms of capabilities, abilities, perception, relationships, and so forth will influence both innovation ability and longer run economic change. For example one firm may be locked in to one trajectory rather than another due to past choices in terms of industrial specialization, culture, types of relationships with other firms and education organizations, and so on. Similar arguments are being applied to the level of regions, in order to compare, for example, Silicon Valley and the Third Italy with less advantaged regions. Diversity matters when it influences the relative ability of firms, regions and nations to innovate and to capture the returns of innovations for growth and other economic variables.

This implies that government policies and firm strategies in relation to innovations and other forms of learning (education, R&D, and so on) are of great importance to productivity growth, competitiveness and employment. Therefore the final part of Volume II includes selections which address innovation policies and strategies from an evolutionary and institutional perspective. This includes issues such as the creation of innovation-based growth, competitiveness and employment as well as the problems and opportunities to create (or avoid) technological discontinuities. Hence innovation policies and strategies should be seen as integral parts of overall economic policy and firm strategy.

Both volumes in this *Systems of Innovation: Growth, Competitiveness and Employment* reference collection deal with important topics from a new perspective, leading to theoretical reflections, new insights, and different policy recommendations. We hope that, by structuring these contributions and bringing them together in a new combination, this reference collection will challenge the reader to think in new directions, thereby stimulating further analysis.

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Notes

1. Organizations here refers to formal structures with an explicit purpose, which have been consciously created. They are the players or actors. Institutions are not organizations. Rather, institutions are the rules of the game; they shape the behaviour of firms and other organizations by constituting constraints and/or incentives for innovation.
2. The term 'national system of innovation' was also used in *Technical Change and Economic Theory*, edited by Giovanni Dosi *et al.* 1988. However, those using the term there included Christopher Freeman, Bengt-Åke Lundvall and Richard Nelson.
3. Although based largely on these theoretical assumptions, this example is not found in the Lundvall book but in the Nelson book, where Bengt-Åke Lundvall and Charles Edquist have a chapter comparing the Danish and Swedish national systems of innovation (Edquist and Lundvall 1993).
4. These predecessors to the SI approach have been reviewed in more detail in Edquist and Hommen (1999), upon which this section is partly based.
5. Nelson and Winter 1977.
6. Nelson and Winter 1977; Nelson and Winter 1982; Nelson 1987; Nelson 1995.
7. Nelson 1987, p. 16.
8. Nelson 1981.
9. Hodgson 1991.
10. Furthermore, there is an intimate relation between learning theories and evolutionary theories of innovation in the sense that learning is one mechanism through which diversity is created. Learning might even be an element in processes of selection (Edquist and Hommen 1999).

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Part I

An Introduction to Systems of Innovation