

*Innovation Policy in a Global Economy* concludes the successful sequence of books on globalisation and technology edited by Daniele Archibugi and Jonathan Michie following *Technology, Globalisation and Economic Performance* (Cambridge, 1997) and *Trade, Growth and Technical Change* (Cambridge, 1998). This final volume argues that the opportunities offered by globalisation will only be fully realised by organisations which have developed institutions that allow for the transfer, absorption and use of knowledge.

*Innovation Policy in a Global Economy* is relevant for graduate and undergraduate courses in management and business, economics, geography, international political economy and innovation and technology studies. Presenting original theoretical and empirical research by leading international experts in an accessible style, *Innovation Policy* will be vital reading for researchers and students and of use for public policy professionals.

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# Innovation Policy in a Global Economy



# **Innovation Policy in a Global Economy**

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edited by Daniele Archibugi, Jeremy Howells  
and Jonathan Michie



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# Contents

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<i>List of figures</i>	<i>page</i> ix
<i>List of tables</i>	x
<i>List of contributors</i>	xii
<i>Foreword by Chris Freeman</i>	xiii
<i>Preface and acknowledgements</i>	xv
1 Innovation systems and policy in a global economy	1
DANIELE ARCHIBUGI, JEREMY HOWELLS AND JONATHAN MICHIE	
<b>PART I National systems of innovation</b>	
2 Technology policy in the learning economy	19
BENGT-ÅKE LUNDVALL	
3 Some notes on national systems of innovation and production, and their implications for economic analysis	35
GIOVANNI DOSI	
4 Technology, growth and employment: do national systems matter?	49
MARIO PIANTA	
<b>PART II Regional, national and global forces</b>	
5 Regional systems of innovation?	67
JEREMY HOWELLS	

viii      **Contents**

6	Global corporations and national systems of innovation: who dominates whom?	94
	KEITH PAVITT AND PARIMAL PATEL	
7	Globalisation and financial diversity: The making of venture capital markets in France, Germany and UK	120
	MICHAEL F. KLUTH AND JØRN B. ANDERSEN	
8	Patterns of national specialisation in the global competitive environment	139
	PAOLO GUERRIERI	
 <b>PART III Globalisation and economic performance</b>		
9	The political economy of globalisation	163
	MICHAEL KITSON AND JONATHAN MICHIE	
10	The geographical sourcing of technology-based assets by multinational enterprises	185
	JOHN H. DUNNING AND CLIFFORD WYMBS	
11	Innovation as the principal source of growth in the global economy	225
	JOHN CANTWELL	
12	The policy implications of the globalisation of innovation	242
	DANIELE ARCHIBUGI AND SIMONA IAMMARINO	
	<i>Index</i>	272



## Figures

---

4.1	Globalisation, national system of innovation and their economic impact	<i>page</i> 52
4.2	Total R&D and investment per employee	55
4.3	Product innovation sectors and employment change, 1989–94	58
4.4	Process innovation sectors and employment change, 1989–94	59

## Tables

---

6.1	Nationalities of the top 20 firms in US patenting in eleven broad technological fields, 1985–90	<i>page</i> 95
6.2	The source of large firms' patenting in the USA, according to their principal product group, 1985–90	96
6.3	The source of large firms' patenting in the USA, according to their country of origin, 1985–90	97
6.4	Large firms in national technological activities, 1985–90	100
6.5	National performance in basic research (mean citations per paper) and in technology (business-funded R&D as percentage of GDP)	102
6.6	Qualifications of the workforce in five European countries	103
6.7	Trends in business-funded R&D as percentage of GDP	105
6.8	Own R&D expenditures by world's 200 largest R&D spenders (1994)	106
6.9	Sectoral patterns of revealed technological advantage; 1963–8 to 1985–90	109
8.1	Weights of the sectoral groups in total exports	141
8.2	Shares of intra-regional trade of the three regional groupings (percentage)	143
8.3	Patterns of trade specialisation: United States, Japan and the EU	148
8.4	Patterns of trade specialisation: Germany, France and the United Kingdom	151
8.5	Patterns of trade specialisation: Sweden, Italy and Spain	153
9.1	Growth of world output and world trade, 1870–1990 (annual % growth rates, calculated peak to peak)	165
9.2	The growth and volatility of world output and world trade, 1870–1990	166

**List of tables**

xi

9.3	GDP shares of world capitalist countries (% benchmark years)	170
9.4	Export shares of world capitalist countries (% benchmark years)	171
9.5	Exports: shares of world exports of manufactures (%)	172
9.6	Shares of OECD trade in manufactures (%)	173
10.1	Distribution of 150 leading industrial MNEs by sector, 1994–5	188
10.2	Distribution of 150 leading industrial MNEs by region or country of origin, 1994–5	189
10.3	Percentage of R&D undertaken outside home country by technology grouping	191
10.4	The sourcing of technological advantage of sample firms by industrial sector	194
10.5	The sourcing of technological advantage of sample firms by industrial sector and degree of multinationality of sales and assets	196
10.6	The sourcing of technological advantage of sample firms by industrial sector and degree of multinationality of R&D	198
10.7	The sourcing of technological assets of sample firms by country and degree of multinationality (a) sales and assets	200
10.8	The sourcing of technological assets of sample firms by country and degree of multinationality (b) R&D	201
10.9	Importance of FDI as a means of accessing foreign technological advantage, 1994–5	202
10.10	Importance of alliances as a means of accessing foreign technological advantage, 1994–5	203
10.11	Importance of trade as a means of accessing foreign technological advantage, 1994–5	204
10.12	Assets by mode of sourcing	213
12.1	A taxonomy of the globalisation of innovation	244
12.2	The regimes of the globalisation of innovation – interactions	247
12.3	The regimes of the globalisation of innovation – implications for the national economies	249
12.4	Public policies' targets and instruments for the globalisation of innovation	256

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## Foreword

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This is a brilliant set of papers. Unlike many such collections by diverse authors, the standard is uniformly high and even more surprisingly, there is a clear common theme which links them together despite the lack of common authorship. That theme is the elucidation of just what is meant by 'globalisation'. As Archibugi and Iammarino observe, this is a catch-all concept which is used indiscriminately to describe many diverse phenomena.

In particular, the book concentrates on the ways in which globalisation affects and is affected by technical change and systems of innovation. Over the last decade or so many authors have used the expression 'national system of innovation' to describe and analyse those networks of institutions and activities, which in any country, initiate, modify, import and diffuse new technologies. Some of the authors have attributed the origin of this concept to me. This is not accurate. To the best of my knowledge the expression was coined by Lundvall, who contributes the first chapter in this book in which he argues cogently that what matters most is *learning*, rather than knowledge itself. In any case, as I am sure he would agree, and as several of the chapters point out (e.g. Dosi and Kluth and Andersen) there is a long tradition in economic thought of this combined approach to technical innovation and institutional change, going back at least to Count Serra in Naples.

As this discussion has unfolded, it has become apparent that both the international ('global') and the sub-national ('regional') dimensions of innovative activities merit investigation and debate as well as the national dimension. This book explores all three of these and contributed substantial new theoretical insights and empirical evidence at each level. It would be invidious to single out individual chapters in a book where the overall standard is so high but for reasons of space it is not possible to discuss them all in a brief preface. I therefore just comment on a few points which are of exceptional interest.

The chapter by Jeremy Howells provides an outstandingly good review and analysis of regional systems of innovation. He points out, with a wealth of illustrations, the necessity of an historical as well as a geographical approach to this topic. The example of Scotland illustrates very well his point that what were once 'nations' may become 'regions' and *vice-versa*. This leads to the conclusion that an historical 'multi-layered' approach is essential.

This conclusion is just as relevant for the global/national level which is the main focus of most of the chapters. Patel and Pavitt sustain their well-known position that the domestic national home base of multi-national corporations continues to be the main platform for most of their innovative activities. However, Dunning and Wymbs provide interesting new evidence of the increasing efforts of many MNCs to extend their sources of information and new ideas through the activities of their subsidiaries abroad. It is especially welcome to see the contributions to this volume from John Dunning and John Cantwell from Reading University. John Dunning pioneered the programme of research at this university which made it a leading centre in Europe for the study of MNCs, and it is good to see that he is still an active source of inspiration for this work about 40 years later.

Perhaps it is not too far-fetched to suggest that this is a small example of that type of sustained and cumulative learning by research (in this case in the academic world), which underlies institutional trajectories and in the industrial sphere leads to the 'strickness' of the patterns of specialisation, which many of the chapter authors observe. It is to be hoped that the editors continue their own collaboration in promoting this research trajectory which has produced such fruitful results. The cohesion of the book should be attributed to their sustained efforts, as well as to the fascination of the topic and the work of the authors. All of them merit warm congratulations and a wide circulation for this excellent publication.

Chris Freeman  
University of Sussex

## Preface and acknowledgements

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All the chapters in this book were commissioned specifically for this volume and draft versions were discussed at a working conference in April 1996 in Rome. This conference marked the second in a series of Euroconferences entitled 'The Globalization of Technology: Lessons for the Public and Business Sectors' co-funded by DGXII of the European Commission as part of the Human Capital Mobility (HCM) Programme (Grant no. ERBCHCCT940230), organised by the three of us.

The overall Euroconference initiative has a number of objectives, but a key aim is to help inform, involve and support young scientists and researchers in the field of industrial innovation and technology policy. The Rome conference therefore sought to bring together an informal group of some young and some not so young researchers working in this field. The result was a lively and interesting debate surrounding the issues of national innovation systems and of the globalisation of technology which is of such crucial strategic importance to both private and public sectors alike.

Obviously a vital role was played by all the conference presenters, many of whom have subsequently become contributors to this book. We would therefore like to thank Jørn Andersen, Giovanni Dosi, Paolo Guerrieri, Simona Iammarino, Michael Kitson, Michael Kluth, Bengt-Åke Lundvall, Keith Pavitt and Mario Pianta for presenting papers and participating in the discussions. We would also like to thank John Cantwell, John Dunning, Pari Patel and Clifford Wymbs for their contributions.

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xvi      **Preface and acknowledgements**

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Daniele Archibugi  
Jeremy Howells  
Jonathan Michie



# 1 Innovation systems and policy in a global economy

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DANIELE ARCHIBUGI, JEREMY HOWELLS  
AND JONATHAN MICHIE

New technologies are a fundamental part of modern economic life. Economists and engineers, no less than politicians and public opinion, are devoting increasing attention to understanding why, how and where technological innovations are generated. This book is devoted to discussing two separate, but closely connected bodies of literature on the sources and nature of new technologies. The first set is focused on the similarities and differences in the organisation of innovative activities at the national level, whilst the second group is centred on the role of globalisation in shaping technological change.

The first body of literature stresses that a proper understanding of technological developments, and their dissemination throughout the economy and society, requires us to also understand the social fabric that shapes these developments. Over the last decade, the notion of systems of innovation, either local, regional, sectoral or national, has been widely used to map and explain the interactions between agents that generate and use technology.

The second body of literature has studied how innovation interacts with economic and social globalisation. The debate on globalisation has flourished over the last decade and a large number of themes connected to it have been investigated. Trade, production, finance, culture, media and many other fields have been scrutinised from the viewpoint of globalisation. The issue of technological change has been at the core of these debates on globalisation, and rightly so. On the one hand, technology is a vehicle for the diffusion of information and knowledge across borders; on the other hand, technological developments have themselves been stimulated by the globalisation of markets.

This book is devoted to studying the interplay between these national and global forces shaping technological change; it builds on three previous books that have analysed related issues (Archibugi and Michie eds., 1997;

Howells and Michie eds., 1997; Archibugi and Michie eds., 1998). This introductory chapter sets out the key concepts addressed in more detail in the subsequent chapters. The first part is devoted to outlining the origin of, and latest developments in, the systems of innovation approach; we then turn to consider more specifically the implications of globalisation for systems of innovation.

### **The origin of the 'system of innovation' approach**

The 'systems of innovation' approach has developed and evolved since its initial appearance in the form of the 'national systems of innovation' (NSI) studies presented by Freeman (1987, 1988, 1995), Lundvall (1988), Lundvall ed., (1992) and Nelson ed. (1993). Chris Freeman (1987) was among the first to use the concept to help describe and interpret the performance of Japan over the post-war period. He identified a number of vital and distinctive elements in its national system of innovation to which could be attributed its success in terms of innovation and economic growth (Freeman, 1988, p. 338). It has subsequently been applied in a number of different contexts, many of which have been outside the original focus of a national setting. Thus, although the national focus remains strong, and rightly so, it has been accompanied by studies seeking to analyse the notion of systems of innovation at an international (or pan-national) level and at a sub-national scale.

Studies have also examined the systems of innovation approach within the context of a sectoral or technology perspective. Thus Bo Carlsson has developed what has become termed the 'technological systems' approach, indicating that systems can be specific to particular technology fields or sectors (Carlsson ed., 1995). Sectors and technologies do matter and have their own dynamic. But as argued by Nelson, it is also the case that 'nationhood matters and has a pervasive influence' (Nelson, 1993, p. 518). Sectors and technological systems within a nation have a powerful shaping influence on the structure and dynamic of a national innovation system, whilst national contexts have important influences on sectoral conditioning and performance. Thus, prior institutional endowments of a national system may help or hinder innovative activity and performance within particular sectors of a national economy (Howells and Neary, 1995, p. 245). The concepts of national (or spatially bounded) systems of innovation and technology systems (or sectoral innovation systems) should not be seen as mutually exclusive. Indeed, establishing the interrelationships between the two can yield valuable insights into the wider systems of innovation approach (Archibugi and Michie, 1997, p. 13).

### Some definitions and concepts

Much of the literature on systems of innovation, and more especially on national systems of innovation, has been covered in an excellent review by Edquist (1997), which draws on earlier valuable discussion and reviews by Lundvall (1992a), Nelson and Rosenberg (1993) and Freeman (1995). However, certain preliminaries in terms of definitions and concepts are useful here for two reasons. Firstly, they form the basis of the subsequent discussion within this chapter and in the rest of the book, and, secondly, such a discussion highlights areas that may prove particularly profitable in terms of future work within the 'systems of innovation' research area.

Chris Freeman (1987, p. 1) defined the concept as 'the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies'. Lundvall (1992a, p. 12) makes a distinction between a narrow and broad definition of a system of innovation. His narrow definition would include 'organisations and institutions involved in searching and exploring – such as R&D departments, technological institutes and universities'. His broader definition would include 'all parts and aspects of the economic structure and the institutional set-up affecting learning as well as searching and exploring – the production system, the marketing system and the system of finance present themselves as sub-systems in which learning takes place'.

In respect of the 'national' element, Lundvall (1992a, pp. 2–3) stresses that this is not as clear-cut as is often assumed. The concept of 'national systems of innovation' has two dimensions: the national-cultural and the *Étatist*-political. The ideal, abstract nation state where these two dimensions coincide controlled by one central state authority is difficult, if not impossible, to find in the real world. Moreover, this nationally bounded view, at least in geographical terms, has been loosened over time. The approach has now been widened and developed to include systems of innovation that are sectoral in dimension and those that are at a different geographical scale, both above in terms of what Freeman (1995) coined 'upper' regions ('triad' and continental regions), and below in relation to regional<sup>1</sup> and local systems.

Regarding the term 'innovation', Edquist (1997, p. 10) has stressed the ambiguity and wide variation in its use. Thus, Nelson and Rosenberg (1993) and Carlsson and Stankiewicz (1995) have tended to adopt narrower definitions, mainly (though not wholly) centred on technological innovations, whilst Lundvall (1992a) seeks to include non-technological innovations, in particular institutional innovations (this point is further developed in his chapter in this volume). In his analysis of the Japanese

innovation system, Freeman (1988, pp. 339–41) also emphasised the role of social and educational innovations, whilst Carlsson and Stankiewicz (1995, p. 28), in adopting Dosi's (1988) definition of innovation would also seem to include the emergence and development of new organisational set-ups.

Lastly, discussion of the term 'system' has been strangely limited. Lundvall (1992a, p. 2) is the most specific here although still brief. Thus he makes a short reference to Boulding's (1985) definition of a system as 'anything not in chaos' as well as noting that a system 'is constituted by a number of elements and by the relationships between these elements' (p. 2). Little reference is made to earlier work on systems theory, or to how this literature originally defined, or perceived, a system (see, for example, Hall and Fagen, 1956).

### **The evolution and development of the concept**

Edquist (1997) reviewed the different elements and perspectives of the systems of innovation literature, in particular concentrating on the commonalities of the different approaches. More specifically, he outlines nine common characteristics of the systems of innovation approach and their advantages and problems. These core characteristics of systems of innovation approaches are: innovation and learning; their holistic and interdisciplinary nature; the natural inclusion of a historical perspective; differences between systems and non-optimality; their emphasis on interdependence and non-linearity; the incorporation of product technologies and organisational innovations; the central role of institutions in the systems of innovation approach; their conceptually diffuse nature; and the focus of the systems of innovation literature on conceptual constructs rather than on a more deeply rooted theoretical framework (Edquist, 1997, pp. 16–29).

Edquist's contribution is important because it seeks to determine common foundations of a 'systems of innovation' approach and seeks to build common frames of reference. It also highlights the high degree of diversity of approaches. While at one level this diversity is problematic, it might also explain why the approach has provoked such interest and produced such a rich vein of inter-disciplinary work. Seeking to harmonise and more closely delimit definitions and concepts may now be necessary if the research programme is to develop further; on the other hand, it is important to avoid the danger of foreclosing on ideas too early on. The following sections focus on a number of these ideas and key issues in current systems of innovation thinking.

*The role of learning in an innovation system*

Although Lundvall noted the role that learning played in binding together production and innovation in a national system of innovation (Lundvall, 1988, p. 362) and sought to further emphasise the importance of learning in his 1992 discourse on the notion of national systems of innovation (Lundvall, 1992a, pp. 9–11), it has been only recently that he has sought to develop the role of learning and to put it at the core of the national systems of innovation construct (Lundvall, 1995; Lundvall and Johnson, 1995; see also his chapter in this volume). In these latter works he has stressed the role of learning in new and competitive national systems of innovation and especially the process of interactive learning (Lundvall, 1995, p. 39).

Learning is important in Lundvall's conception of systems of innovation because it is a key element in both the *dynamic* of the system and as a key agent in *binding* the whole system together. Thus, 'many different sectors and segments of the economy contribute to the overall process of interactive learning and the specificity of the elements, as well as the linkages and modes of interaction between them, are crucial for the rate and direction of technical change' Lundvall (1995, p. 40).

Learning thus plays a major role in the development of the system, whilst forming the key element in its connectivity. In this framework learning takes place at all levels from the individual, through to the firm and organisation, on to inter-firm and inter-organisational learning, institutional learning (Johnson, 1992), cross institutional learning, and on through to the whole system – the 'learning economy'. Obviously the learning process involves a clear interactive and collective dimension. There are also inter-firm and more general institutional routines that can be set up through this interactive learning process (Hodgson, 1988). However, it is much harder to ascribe collections of firms, organisations and institutions as having a single, clear cognitive process, involving both a decision-making and memory function. The notion that what is learnt will be exactly the same for each individual, firm, organisation and institution is difficult to accept (see Antonelli, 1994).

*The evolutionary nature of systems of innovation*

There have been important attempts recently to develop the latent evolutionary aspects of the national systems of innovation concept. This has been done by outlining the value of evolutionary concepts in providing a stronger theoretical underpinning to the national systems of innovation model (Saviotti, 1997) and also by highlighting the utility of evolutionary

concepts in helping to define what is meant by a national system of innovation (McKelvey, 1997).

Although such evolutionary approaches have, a posteriori, helped to explain the dynamic aspects of systems of innovation they have provided very little, if any, predictive insights into how national systems of innovation might develop in the future. While Galli and Teubal (1997, pp. 345–64) have outlined what they see as paradigmatic changes and structural adjustments of national systems of innovation since the late 1970s, this approach does not directly draw upon an evolutionary perspective, nor does it suggest what new transition stages will appear or when. The lack of any predictive element within systems of innovation thinking is a reflection of the fact that it represents a partial model rather than claiming to be a complete formal theory (Edquist, 1997, pp. 28–9). As yet, although the systems of innovation approach stresses historical processes, it has yielded few insights into the dynamics of the innovation process.

#### *Systems as flows, links and networks*

Although there is a general stress on ‘interaction’ and more specifically ‘interactive learning’ by Lundvall (1992a; see also Lundvall and Johnson, 1995) and on knowledge flows by, for example, David and Foray (1995; 1996) there are very few references to, let alone analysis of, the specific nature of these interactions in terms of flows and linkages connecting the actors in a network. This neglect of linkages and flows is strange, given that networks form one of the cornerstones in defining a system (Saviotti, 1997, pp. 193–5).

There are, of course, notable exceptions. An important analysis of the flows within and across systems of innovation is supplied by the literature on inter-industry technology flows (see Scherer, 1982; Pavitt, 1984; Archibugi, 1988; DeBresson ed., 1996). This literature has managed to map to what extent certain industries benefit from the innovations generated by ‘upstream’ suppliers which in turn has indicated the degree of sectoral integration amongst industries. This body of literature has also had the notable advantage of being able to quantitatively map these flows. However, this approach has so far not been specifically integrated into the framework of innovation systems.

As discussed above, the concept of innovation systems is much wider than inter-industry technology flows. Firstly, because it includes also flows which are not necessarily inter-sectoral, such as knowledge and information flows that occur within firms belonging to the same industry. Secondly, because it takes into account also the transfer of tacit and non-codified knowledge (Howells, 1996), which is not captured by the indicators that

have so far been used to map inter-industry technology flows. Thirdly, because the innovation systems approach also considers flows which occur between different types of organisations and institutions, including firms, agencies and government establishments.

One attempt to take into account an extended framework is provided by Galli and Teubal (1997, pp. 347–8), who briefly mention linkages in their commentary on the main components of systems of innovation. Another is the analysis by Andersen (1992, 1996; Andersen and Lundvall, 1997) of innovation systems using firstly, 'primitive graph techniques' (see, for example, Andersen and Lundvall, 1997, p. 243, and for an earlier attempt, Santarelli, 1995) and, secondly, simulation modelling to describe vertical relationships in innovations, although as yet these techniques outlined by Andersen have not been empirically applied or tested (Andersen and Lundvall, 1997, p. 253).

This relative under analysis of linkages and flows within the systems of innovation literature represents an important barrier to the further conceptual development of the approach for three key reasons:

- 1 Firstly, the way that networks and, in turn, systems are usually defined is by the volume and characteristics of the linkages that bind them together. In short, systems are made up of the interactions between the actors or nodes in a system. Without any interaction between actors and nodes it is difficult to accept that a system exists.
- 2 Following on from this, flows and linkages in a system are also critical in defining an innovation system, and the way in which it functions and operates.
- 3 Lastly, a key element in gaining an adequate dynamic and evolutionary perspective on a system is by analysing the changing flow and linkage patterns between the actors and institutions that compose a system. Although the nature of the actors and institutions can change and forms an essential dynamic in itself, this change is also reflected and altered by the changing relationships between such actors and institutions.

Thus, growth in a system can be characterised in a number of different ways. In relation to an innovation system, growth could be confined within the individual elements or actors (the firms or other organisations), or it could result from increased flows between the elements of the system. Similarly, all the growth in a system could reside within the system if it was fully 'closed' but could flow out of it, to varying degrees, if it was an 'open' system. Even changing these two simple dimensions, in relation to growth and linkages within an innovation system, can alter its growth characteristics and dynamics radically. The fact that these aspects are as yet relatively under researched may reflect the 'youthfulness' of the systems of

innovation research programme, and also the relative difficulty of trying to measure such innovation flows and linkages in a dynamic context. Nevertheless, a more detailed analysis of innovation flows and linkages is certainly required if an adequate model (or set of models) of innovation systems is to be provided.

*Systems as innovation 'task environments' for firms*

Another rich seam for future research within the systems of innovation literature is a bottom-up perspective of how national/sectoral systems of innovation may condition and influence the innovation decision making and behaviour of firms. The systems of innovation approach tends, by its very nature, to take a 'top-down' view of firms' innovative activity (see Howells, this volume). There is still much to be learned regarding how firms respond to, and interact with, the innovation system (national, sectoral or otherwise) at any point in time.

Much of the discussion that does indirectly refer to firm-level action, *de facto* considers *individual* firms as simply reacting to changes that are occurring within the wider system – or within the more specific network or at the institutional level. There has been little discussion about firm behaviour and technology strategy in terms of their relationship with systems of innovation approaches, even though firms represent important actors within the innovation system. Exceptions include Carlsson and Stankiewicz (1995, pp. 25–6) who consider the issue of individual firm behaviour in their outline of a technology system.<sup>2</sup> Ehrnberg and Jacobsson (1997, pp. 320–6) also discuss firm-level strategy, although mainly within the context of a firm's response to technological discontinuities.

The key issue here is how much the presence (or indeed absence) of a national or sectoral system of innovation may affect the innovation behaviour, actions and outcomes of firms. Yet the systems of innovation research programme has, as yet, had little impact on the technology strategy and management literature. Certainly an empirical analysis of the innovative performance of firms in weak and strong national and/or sectoral systems of innovation might provide an interesting new avenue of research.

*The empirical analysis of systems of innovation*

Archibugi and Pianta (1992) and Patel and Pavitt (1994) set out a list of indicators that might be used to 'measure' a national system of innovation, and these have been taken up to varying degrees by a number of subsequent studies (see, for example, Gassler *et al.*, 1996). In this volume, a valuable set of empirically based studies, using aggregate data sets on a national and



international basis, outline national patterns of innovative activity and performance (see the chapters by Guerrieri, and by Pavitt and Patel).

However, on a more micro, firm or organisational level, most acknowledge that there remains a gap between theoretical developments and empirical analysis (Saviotti, 1997) and researchers are still at the stage of discussing and defining which analytical tools and methods might most profitably be used in empirical studies to bridge this gap. The work by Andersen, noted above, using graph techniques and simulation modelling appears to be a promising avenue of empirical work along these lines (Andersen and Lundvall, 1997). However, more certainly needs to be done to review, systematise and apply existing empirical studies covering these issues to systems of innovation work.

Perhaps the biggest task that remains in the development of the systems of innovation approach remains in providing a better linkage between the more aggregate, macro level studies and the micro level analysis of firm relationships and behaviour. In terms of the conceptual framework of the approach it is at this 'meta' level where the role of institutions and wider organisational networks is crucial, and where further empirical work beckons.

### **What is globalisation?**

It is certainly telling that the debate on national innovation systems has developed in an age when the forces of globalisation are transforming economic life. It seems that the pressures of globalisation have generated a new concern regarding the role played by nation-specific factors. The term 'globalisation', however, has been used and abused. The recent literature has used the concept in, at least, two different ways.<sup>3</sup>

The first is related to the mapping of global factors in economic and social life. Global factors have always influenced the performance of local and/or national communities, but the reason why we talk about globalisation in this age is based on the assumption (right or wrong) that the importance of world-wide relations has increased both quantitatively and qualitatively. To map the resulting global transformations requires the ability to identify the dynamic context which is leading, according to some authors, to a dramatic increase of cross-border flows of information, knowledge, commodities and capital.

The second meaning of globalisation is linked to policy analysis. For example, the term 'globalisation' is often used implicitly, if not explicitly, as equivalent to the term 'liberalisation'. This is however inappropriate since globalisation is mainly a descriptive concept while liberalisation has a prescriptive meaning. In a related context, the debate on globalisation has

often collided with the assessment of the effectiveness of government policies (see Michie and Grieve Smith eds., 1995). It has been argued that globalisation is reducing the impact of certain policy instruments, for example interest rate changes, since all national public policies act under international constraints. Certainly, globalisation is putting new pressures on nation states which often lead to unwelcome outcomes. However, to influence these outcomes, a different mix of policies may be needed. While certain traditional macroeconomic policies, such as those based on exchange rates and interest rates, may have lost a significant part of their effectiveness, other kinds of policies, such as industrial policies, may be becoming increasingly important if governments are to pursue their own objectives.

Policies directed towards competence (such as those favouring training, education, the acquisition of managerial skills and encouraging technological change) become crucial instruments to allow national communities to face the processes of globalisation. Thus several of the subsequent chapters argue that policies aimed at the creation of technological competence are needed to strengthen national competitiveness and to preserve local well-being (see, for example, the chapters by Lundvall, by Pavitt and Patel, and Archibugi and Iammarino).

### **The boundaries of innovation systems in a global economy**

Technological change provides a privileged viewpoint from which to understand the dynamics of globalisation. New technologies have always been international in scope; the transmission of knowledge has never respected states' borders. There is a complex interplay between technological change and globalisation. On the one hand, new technologies act as a powerful vehicle for the diffusion of information across distant communities. For example, it would be difficult to imagine the current globalisation of financial markets without the existence of the new information and communication technologies, since they have made it possible to obtain instant transactions across the world. On the other hand, the process of generating and diffusing new technologies has been moulded and strengthened by the flows of individuals, commodities and capital. This has created a circular process whereby technology has facilitated globalisation and vice versa.

The focus of several chapters in this book is on the following questions: (i) If the globalisation of technological innovation is occurring, will it lead to the eventual dissolution of national systems of innovation?<sup>4</sup> (ii) Will national systems of innovation converge towards more similar structures

because of the forces of globalisation? (iii) Is globalisation eroding the importance of innovation policies carried out at the national level?

It is often argued that globalisation is making spatially bounded systems less relevant. This implies that technology-based innovation systems (such as semiconductors) will be dominated by common technological regimes, regardless of the spatial location in which the connected production will take place. It is therefore possible to compare two approaches: the first stresses the importance of spatially bounded (local, regional or national) innovation systems, but which pays less attention to the differences between neighbouring firms operating in different industries. The second approach stresses instead the role of global factors in the making of innovation systems, but has the consequent danger of overlooking location-specific aspects of this process.

As already stressed, we need to go beyond an either/or debate and try to identify the relative role of regional, national, sectoral and global factors in shaping innovation systems (see Howells, this volume, within the context of regional innovation systems). The innovation systems concept is itself flexible enough to allow us to take into account the relative importance of each of these factors; some criteria can be identified in order to assess when and how local or global factors will prevail and how they will interact.

First, globalisation makes easier the transmission of best-practice techniques across countries. Semiconductors, antibiotics and new materials are based upon similar and shared knowledge across the globe. This, however, does not imply an automatic process of acquisition of knowledge since learning is neither instant nor automatic (see Lundvall's chapter, this volume).

Second, globalisation does not act only as the vehicle of best-practice techniques; it is also a vehicle for the international flow of goods and services. In order to survive in a competitive environment, firms are forced to find their own market niches where they can exploit their own competitive advantages. Often these niches rely heavily on endogenous capabilities. The problem that firms and nations have to face is not simply in being able to access the basic knowledge for semiconductors, new molecules or materials, but also to be able to use this knowledge to generate competitive products.

Third, there are location-specific advantages which have not lost their importance. Foreign direct investment by multinational corporations is increasingly sensitive to exploiting the locality-specific advantages associated with certain areas or regions. These growing capital flows are directed at picking out the best-practice conditions in specific countries (this is an issue discussed in this volume by Dunning and Wymbs). Cantwell (this

volume) stresses that globalisation has made even more important the role of nation-specific assets for multinational corporations.

Fourth, there is increasing evidence that the international distribution of production and of technological capabilities is becoming more sectorally differentiated (see Archibugi and Michie eds., 1998; and Guerrieri, this volume). The process of international integration is leading to an increased division of labour and this implies that each country is focusing on selected industries and relying on trade for others. Even if the manufacture of semi-conductors, for example, is becoming increasingly similar across countries, this does not imply that all countries are active in semiconductor production.

### **The role of multinational corporations in the global economy**

Multinational enterprises have a major influence on national systems of innovation. Several chapters in this book discuss the interplay between large firms and nation-specific factors (see in particular Pavitt and Patel, and Dunning and Wymbs). Do large multinational firms have more influence on a national system of innovation, or do more nationally oriented, medium-sized companies that are more strongly embedded in the national system? Valuable work on this issue has been undertaken by Chesnais (1992) and more recently by Barré (1995) in his analysis of the relationship of multinational firms' strategies and national innovation systems. However, as Barré (1995, p. 218) admits, his work has been restricted by the nature and availability of the data that could be deployed and the assumptions behind their use.

Pavitt and Patel (this volume) provide significant evidence on three aspects of the innovative behaviour of large firms: first, multinational corporations are rather reluctant to locate technological activities in host countries. Core competences, including R&D and innovation centres, are still heavily concentrated in the companies' home countries. Second, traditional industries are, in proportion, more internationalised than high-tech industries. This result is certainly significant since it indicates that knowledge-intensive productions are more dependent on territorially bounded competences. Third, when companies decide to move part of their R&D and innovation centres abroad, they generally select the fields of excellence of the host countries. In other words, companies are more likely to go abroad to exploit the national capabilities of the country they are invading rather than to expand their own core competences. This last point is confirmed by the survey results reported by Dunning and Wymbs (this volume), which documents how firms augment their technological advantages from foreign sources.

### Conclusions

We live in a turbulent world dominated by an increasing rate of technological change. Economic agents, including firms and governments, are forced to adapt to technological change in order to survive in a competitive environment. This book is an attempt to identify some of the emerging patterns in the resulting organisation of innovative activities. The notion of innovation systems proves to be a hugely useful tool in understanding how innovative activities are generated and disseminated, and what their impact is on economic and social life. This book thus makes an attempt to evaluate the notion of innovation systems in the context of current trends in the globalisation of economic, as well as technological, activities. We have suggested that globalisation does *not* make local, regional or national systems redundant; it is however relevant to identify how location-specific factors are transformed by global relations. We began our enquiry with the hypothesis that technological change is a factor in globalisation and, at the same time, one of its most important outcomes. The chapters in this volume seek, from a variety of viewpoints, to shed some light on this complex inter-connection.

### Notes

- 1 Freeman (1995, p. 21) defines these as 'nether' regions to avoid the confusion of some commentators who use the word 'region' to denote triad or continental regions.
- 2 However, this is only within the context of variety and diversity. Also they appear to rather downplay the point by citing Alchian's (1951) argument that attention should be paid to distributions of economic behaviour rather than to the behaviour of the individual (see also Metcalfe 1989, pp. 59–66).
- 3 Paul Streeten (1996) has, half in jest, provided a long list of different definitions of the term globalisation.
- 4 See, for example, the conclusions presented on this by Saviotti (1997, p. 196).

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