

# Handbook of Innovation Systems and Developing Countries

Building Domestic Capabilities in a Global Setting

*Edited by*

**Bengt-Åke Lundvall**

*Professor of Economics, Department of Business Studies,  
Aalborg University, Denmark and Professor, Sciences-Po,  
Paris, France*

**K.J. Joseph**

*Professor, Centre for Development Studies, India*

**Cristina Chaminade**

*Associate Professor, Centre for Innovation, Research and  
Competence in the Learning Economy (CIRCLE), Lund  
University, Sweden*

**Jan Vang**

*Associate Professor, Copenhagen Institute of Technology,  
Aalborg University, Denmark*

**Edward Elgar**

Cheltenham, UK • Northampton, MA, USA

© Bengt-Åke Lundvall, K.J. Joseph, Cristina Chaminade and Jan Vang 2009

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical or photocopying, recording, or otherwise without the prior permission of the publisher.

Published by  
Edward Elgar Publishing Limited  
The Lypiatts  
15 Lansdown Road  
Cheltenham  
Glos GL50 2JA  
UK

Edward Elgar Publishing, Inc.  
William Pratt House  
9 Dewey Court  
Northampton  
Massachusetts 01060  
USA

A catalogue record for this book  
is available from the British Library

Library of Congress Control Number: 2009936742



**Mixed Sources**

Product group from well-managed  
forests and other controlled sources  
[www.fsc.org](http://www.fsc.org) Cert no. SA-COC-1565  
© 1996 Forest Stewardship Council

ISBN 978 1 84720 609 1 (cased)

Printed and bound by MPG Books Group, UK

---

# Contents

---

<i>List of contributors</i>	vii
<i>Acknowledgements</i>	xiv
1 Innovation system research and developing countries <i>Bengt-Åke Lundvall, Jan Vang, K.J. Joseph, Cristina Chaminade</i>	1
PART I INNOVATION AND DEVELOPMENT	
2 Building inclusive innovation systems in developing countries: challenges for IS research <i>Tilman Altenburg</i>	33
3 Innovation, poverty and inequality: cause, coincidence, or co-evolution? <i>Susan E. Cozzens and Raphael Kaplinsky</i>	57
4 Innovation systems, technology and development: unpacking the relationships <i>Jan Fagerberg and Martin Srholec</i>	83
PART II SCALES IN INNOVATION SYSTEMS: THEORETICAL PROGRESS AND EMPIRICAL OVERVIEW	
5 National innovation systems in developing countries: the Chinese national innovation system in transition <i>Xielin Liu</i>	119
6 Regional innovation systems in developing countries: integrating micro and meso-level capabilities <i>Ramón Padilla-Pérez, Jan Vang and Cristina Chaminade</i>	140
7 Sectoral innovation systems in developing countries: the case of ICT in India <i>K.J. Joseph</i>	183
8 The global dimension of innovation systems: linking innovation systems and global value chains <i>Carlo Pietrobelli and Roberta Rabellotti</i>	214

**PART III BUILDING BLOCKS IN INNOVATION  
SYSTEMS IN DEVELOPING COUNTRIES:  
CHALLENGES UNDER GLOBALIZATION**

- 9 The role of indigenous firms in innovation systems in developing countries: the developmental implications of national champion firms' response to underdeveloped national innovation systems 241  
*Helena Barnard, Tracy Bromfield and John Cantwell*
- 10 The role of multinational corporations in national innovation systems in developing countries: from technology diffusion to international involvement 280  
*Anabel Marin and Valeria Arza*
- 11 The role of universities in innovation systems in developing countries: developmental university systems – empirical, analytical and normative perspectives 311  
*Claes Brundenius, Bengt-Åke Lundvall and Judith Sutz*
- PART IV IS-BASED POLICIES IN THE NEW GLOBAL  
SETTING**
- 12 Institutions and policies in developing economies 337  
*Mario Cimoli, Giovanni Dosi, Richard R. Nelson and Joseph E. Stiglitz*
- 13 Designing innovation policies for development: towards a systemic experimentation-based approach 360  
*Cristina Chaminade, Bengt-Åke Lundvall, Jan Vang and K.J. Joseph*
- Epilogue: which way now? 380  
*Bengt-Åke Lundvall, K.J. Joseph, Cristina Chaminade and Jan Vang*
- Index* 387

---

## Contributors

---

**Tilman Altenburg** is an economic geographer and head of the department of Competitiveness and Social Development at the German Development Institute (DIE), the German think tank for development policy issues. He holds a Ph.D. from the University of Hamburg. Since 1986 he has carried out empirical research on different aspects of private sector development, including work on innovation systems, clusters and value chains, business development services, entrepreneurship development, and public–private partnerships in developing countries.

**Valeria Arza** is researcher in economics of innovation at the Argentinian National Research Council (CONICET) and Lecturer in the University of Buenos Aires (UBA). She holds a Ph.D. from SPRU, University of Sussex, and an M.Sc. from the London School of Economics. She has carried out research on several topics related to the determinants on firms' innovative behaviour in developing countries. More in particular, she has published papers on the role of the environment on firms' investment decisions and the relevance of public–private and global partnerships for technology diffusion.

**Helena Barnard** completed her Ph.D. at Rutgers with a dissertation on how developing country firms use FDI to the developed world as a mechanism for upgrading. She has published, amongst others, in *Research Policy* and *International Journal of Technology Management*. She is currently based at the Gordon Institute of Business Science of the University of Pretoria where she continues her research on the effect of concentrated local capacity and foreign connections in the learning and upgrading of developing countries.

**Tracy Bromfield** holds a Ph.D. in Chemistry from the University of Witwatersrand, and is currently the Manager of Applied Research at Sasol Technology R&D. She completed her MBA at the Gordon Institute of Business Science of the University of Pretoria in 2008. Her MBA research project was supervised by Dr Helena Barnard, and focused on the joint processes of technology accumulation and learning to manage Intellectual Property in a developing country firm.

**Claes Brundenius** is Honorary Professor at the Research Policy Institute (RPI), Lund University, Sweden. He holds a Ph.D. in Economic History

from Lund University. He has been Guest Professor in the United States and Research Director at the Centre for Development Research in Copenhagen. He has frequently worked for international agencies in developing countries, especially in Latin America. His main interest lies in analyses on the role and impact of STI policies and strategies in developing and emerging economies. His current work focuses on policy analysis of technological change and knowledge-based development in Latin America and the Caribbean, East Asia, and Southern Africa (SADC).

**John Cantwell** is Professor of International Business at Rutgers University, Newark, NJ, USA. He received his Ph.D. from Reading University in the UK, an M.Sc. from the University of London, and BA from the University of Oxford. His research focuses on technological innovation and multinational corporations. He has been Program Chair of the Academy of International Business (AIB), President of the European International Business Academy (EIBA), and he is an elected AIB Fellow and EIBA Fellow. He has so far published eleven books, over 55 articles in refereed academic journals, and over 70 chapters in edited collections.

**Cristina Chaminade** is Associate Professor in Innovation Studies at the Centre for Innovation, Research and Competence in the Learning Economy (CIRCLE), Lund University (Sweden). She is affiliated to LEAP4D (Learning Economy Analysis for Development) at the Research Policy Institute, Sweden and visiting professor at HHL Leipzig School of Business (Germany). She holds a Ph.D. in Economics from Autonomous University of Madrid (UAM). Her research focuses mainly on understanding innovation and knowledge creation in the globalized learning economy. She is coordinating several projects on globalization of innovation in China, India, South Africa and Central America. She has been author of numerous articles, book chapters and books in the fields of innovation systems and innovation system policy, particularly in developing countries.

**Mario Cimoli** has been Professor of Economics at the University of Venice (Ca'Foscari) since 1992 and Senior Economist at ECLAC (Economic Commission for Latin America and the Caribbean) of the United Nations since 1999. He obtained a D.Phil. at the SPRU (University of Sussex) and he has held a number of visiting appointments in different universities and institutions (University of Pisa, Metropolitan Autonomous University of Mexico (UAM), University of Campinas, etc). He has published several papers and books, including: 'Trade openness and technological gaps in Latin America: A low growth trap' (with N. Correa) in J.A.

Ocampo (ed.), *Beyond Reforms, Structural Dynamics and Macroeconomic Vulnerability*, Stanford University Press, 2005; 'Structural reforms, technological gaps and economic development: a Latin American perspective' (with J. Katz), *Industrial and Corporate Change*, 1993; *Developing Innovation Systems: Mexico in a Global Context*, Pinter Publishers, 2001; 'Technology, growth and development' (with J. De la Mothe), Pinter Publishers, 2000; 'Technological paradigms, patterns of learning and development: an introductory roadmap' (with G. Dosi), *Journal of Evolutionary Economics*, 1995; 'A Generalized Technology Gap Trade Model' (with L. Soete), *Economie Appliquée*, 1992; 'Technological gaps and institutional asymmetries in a north-south model with a continuum of goods', *Metroeconomica*, 1988.

**Susan E. Cozzens** is Professor of Public Policy at the Georgia Institute of Technology in Atlanta, Georgia, USA. She holds M.A. and Ph.D. degrees from Columbia University. Her research is on the connections between innovation policies and inequalities, in both developing and developed countries. Her current projects focus on global systems of innovation in nanotechnologies, biofuels, and water supply and sanitation.

**Giovanni Dosi** is Professor of Economics at the Sant'Anna School of Advanced Studies in Pisa – where he also coordinates the Laboratory of Economics and Management (LEM) and the International Doctoral Programme in Economics – and visiting Professor at the University of Manchester (UK). He is Co-director of the task forces 'Industrial Policy', and 'Intellectual Property Rights' within IPD, and editor for Continental Europe of *Industrial and Corporate Change*. He is author and editor of several works in the areas of Economics of Innovation, Industrial Economics, Evolutionary Theory, and Organizational Studies. A selection of his works has been published in *Innovation, Organization and Economic Dynamics. Selected Essays*, Edward Elgar, 2000.

**Jan Fagerberg** is Professor at the University of Oslo, where he is affiliated with the Centre for Technology, Innovation and Culture (TIK). He has studied history, political science and economics and holds a D.Phil. from the University of Sussex (1989). In his research Fagerberg has particularly focused on the relationship between technology (innovation and diffusion) on the one hand and competitiveness, growth and development on the other and has published extensively on these topics in books and journals. Fagerberg is one of the editors of *The Oxford Handbook of Innovation*, Oxford University Press, 2004. His most recent book is *Innovation Path Dependency and Policy: The Norwegian Case*,

Oxford University Press, 2009, co-edited with David Mowery and Bart Verspagen.

**K.J. Joseph** is Professor at the Centre for Development Studies at Trivandrum in India. Prior to this, he has been the Ford Foundation Fellow at Yale University, Visiting Senior Fellow at Research and Information System for Developing Countries (RIS), New Delhi, Visiting Professor at Jawaharlal Nehru University and a consultant to UNESCAP. In addition to a number of research papers, he has authored the following books: *Industry under Economic Liberalization: The Case of Indian Electronics*, Sage Publications, 1997 and *Information Technology, Innovation System and Trade Regime in Developing Countries: India and the ASEAN*, Palgrave Macmillan, 2006 and has co-edited *International Competitiveness & Knowledge-based Industries in India*, published by Oxford University Press, 2007.

**Raphael Kaplinsky** is Professor of International Development at the Open University in the UK. His current research interests include the distributional impacts of globalization, the impact of the Asian driver economies (China and India) on developing countries, the economic and social consequences of the commodities boom, and the emergence of disruptive innovation in China and India. He has an extensive publication record in the fields of globalization, global value chains and appropriate technology, and more recently on the impact of China on the developing world and on terms of trade reversal.

**Xielin Liu** is Professor and Director of the Research Center of Management of Information and Innovation, Graduate University of Chinese Academy of Science. He holds a Ph.D. from Tsinghua University. His research areas mainly cover innovation policy, management of technology and innovation. He has published many papers in *Research Policy*, *Technovation*, *Journal of Management Studies* and *International Journal of Technology Management*.

**Bengt-Åke Lundvall** is Professor of Economics at Aalborg University and Professor at Sciences-Po, Paris. He coordinates the worldwide research network Globelics. He and Christopher Freeman developed the concept 'national system of innovation' in the 1980s. Among his books are: *How Europe's Economies Learn*, 2006 (co-edited with E. Lorenz); *Innovation Policy in the Globalising Learning Economy*, 2002 (co-edited with S.D. Archibugi); and *National Systems of Innovation*, 1992.

**Anabel Marin** is a research fellow at SPRU, UK. She holds a Ph.D. from SPRU, University of Sussex, and an M.Sc. in Industrial Development. Her main research interests are about technological learning and growth, especially in industrializing countries, and the role of firms and institutions in those processes. She has published work on the role of multinational companies in technology creation and diffusion in industrializing countries. She has studied this topic in Argentina and India, and is now extending this analysis to Brazil and China. She is also currently involved in two projects on Latin America about innovation and diversification in industries based in natural resources in Latin American countries.

**Richard R. Nelson** is George Blumenthal Professor of International and Public Affairs Emeritus at Columbia University, Director of the Program of Science, Technology, and Global Development, at the Columbia Earth Institute, and Visiting Professor at the University of Manchester. Much of his research has been directed towards understanding technological change, how economic institutions and public policies influence the evolution of technology, and how technological change in turn induces institutional and economic change more broadly. Along with Sidney Winter, he has pioneered the development of a formal evolutionary theory of economic change. Their joint book, *An Evolutionary Theory of Economic Change*, is widely recognized as a landmark in this field.

**Ramón Padilla-Pérez** is currently an Economic Affairs Officer at the United Nations Economic Commission for Latin America and the Caribbean (ECLAC). He holds a Ph.D. in Science and Technology Policy from SPRU, University of Sussex and an M.Sc. in Economics from the London School of Economics (LSE). He has conducted extensive research on international trade, industrial policy, and science and technology policy in Latin America. He is involved in international research and technical assistance projects in the field of science, technology and innovation.

**Carlo Pietrobelli** is Professor of International Economics at the University of Roma Tre, Italy, where he directs the Centre for Research on the Economics of Institutions (CREI). He holds a Ph.D. in Economics from the University of Oxford (UK) and a Ph.D. in Economics from the University of Rome 'La Sapienza'. His fields of expertise include industry, technology and trade in developing countries, science and technology policies, clusters, networks and value chains. His recent books include: *Upgrading to Compete. Clusters and Value Chains in Latin America* (with R. Rabellotti), Harvard University Press, 2007; and *Failing to Compete:*

*Technology Development and Technology Systems in Africa* (with Sanjaya Lall), Edward Elgar, 2002.

**Roberta Rabellotti** is Associate Professor at the Economics Department, University of Piemonte Orientale, Italy. She holds a D.Phil. from the Institute of Development Studies, University of Sussex and an M.Sc. from the University of Oxford. Her areas of research interest are: industrial policies, small business promotion, international trade policies, industrial districts and clusters, sectoral industrial studies and global value chains. Professor Rabellotti has working experience with several international organizations such as the Inter-American Development Bank, the European Union, UNIDO, ILO, ECLAC-UN and UNCTAD. She has written numerous articles in international refereed journals as well as books.

**Martin Srholec** is a post-doctoral research fellow at the Centre for Technology, Innovation and Culture (TIK), University of Oslo, Norway. He holds Ph.D. degrees from the University of Oslo and University of Economics in Prague. He has published in the areas of innovation studies, international economics and economic growth. His current research interests include patterns of innovation in firms, multi-level modelling of innovation and the link between innovation and productivity.

**Joseph E. Stiglitz** holds a joint professorship at Columbia University's Economics Department, School of International and Public Affairs, and the Business School. He founded the Initiative for Policy Dialogue (IPD) in July 2000 to help developing countries explore policy alternatives, and enable wider civic participation in economic policymaking. Dr Stiglitz was awarded the Nobel Prize in Economics in 2001.

**Judith Sutz** is Academic Coordinator of the University Research Council and Professor of Science, Technology and Society at the Faculty of Social Sciences, Universidad de la República, Uruguay. She holds a Ph.D. on Socioeconomics of Development from Paris-Sorbonne University. Her research focuses on the specific conditions for innovation and knowledge production in developing countries, with special attention to public policies and the relations between research agendas, innovation and inequality. She has published widely, mainly with Rodrigo Arocena, on innovation and underdevelopment.

**Jan Vang** is currently Associate Professor in Internationalization of Technology and Innovations at the Copenhagen Institute of Technology,

Aalborg University. He holds a Ph.D. from Lund University and an M.Sc. and B.Sc. from the University of Copenhagen. His research focuses on the evolution of the global division of labour in R&D/innovation. Special attention is paid to Asian countries and IP-based industries. He is involved in several international research projects and conferences concerned with Asia as an innovation hub. He has written and (co-)edited numerous books, special issues and papers on globalization and innovation. He serves as review editor of *Science, Technology and Society*.

---

## Acknowledgements

---

The editors are very grateful to the following scholars for participating in the blind review of all chapters in this *Handbook*: Martin Bell, Mats Benner, Martina Fromhold-Eisebith, Elisa Giuliani, Raphie Kaplinsky, Dana Minbaeva, David Mowery, Michael Storper, Yifei Sun, Florian Taeube, Ted Tschang and Peter Wad.

We also extend our particular thanks to Monica Plechero (at CIRCLE, Lund University) for her valuable comments and her assistance in the revision and editing of the *Handbook*.

---

# 1 Innovation system research and developing countries

*Bengt-Åke Lundvall, Jan Vang, K.J. Joseph and Cristina Chaminade*

---

## 1.1 Introduction

This *Handbook* gives an overview of the current state of the art for research that links innovation system analysis to economic development. Normally you would expect a handbook to offer primarily academic readers an overview of a mature field of research. This *Handbook* is different from this standard in two respects.

It presents a rather young interdisciplinary research field – the origins of research on innovation systems go back to the early 1980s (Freeman, 1982; Lundvall, 1985; Freeman, 1987) although it links to a somewhat older sub-discipline in economics: development economics. As we shall see, since it took off in the 1940s (Rosenstein-Rodan, 1943), development economics has been through several dramatic changes and yet cannot be characterized as a ‘mature’ field. Therefore this book does not constitute a coherent body of well-established concepts on the basis of which one can easily move ahead. Rather it gives the reader an understanding of the diversity of an emerging research field while at the same time pointing to alternative research agendas that may be pursued by future generations of scholars.

Second, the *Handbook* is not a purely academic exercise. It is difficult to study economic development without reflecting upon policy. All scholars contributing to this book have an extra motivation that they see their research as being input for policy action aiming at promoting development in those parts of the world where a large proportion of the population live in poverty. Therefore almost all chapters in the book give room for a discussion of implications for public policy. It implies that the *Handbook* might be of use also for policy makers interested in understanding how to engage in catching-up in the world economy.

Is the innovation system a useful concept for understanding and explaining what goes on in a developing country? Can it be used as a tool and a framework for agents and agencies in charge of designing public policy and business innovation strategies? The assumption behind this *Handbook* is that we can answer a conditional ‘yes’ to both of these questions, and in

## 2 *Handbook of innovation systems and developing countries*

the first part of this introductory chapter we try to specify the conditions, doing so in a dialogue with critiques developed within the community of evolutionary scholars.

Another important question is how the approach fits into the historical and current trends in development economics. In the second part of this chapter we give a brief assessment of how development economics has evolved and we draw some lessons for a research strategy. We will argue that the crisis of the first generation of development economics that was represented by scholars such as Nurkse, Myrdal, Hirschman, Singer and Sen has left a void in development economics that cannot be filled either by mainstream neoclassical economics or by 'new growth theory'. We see the innovation system approach as a serious candidate to fill this void.

In the third section of this chapter we present the structure of the book and we show how the different chapters contribute to the understanding of innovation systems in the developing world.

### **1.2 Innovation systems research**

#### *1.2.1 The narrow and broad definition of innovation systems*

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

Almost from the beginning, innovation system research has taken two different perspectives, a narrow one, equalling innovation to science and technology, and a broader one encompassing learning, innovation and competence-building at different levels of aggregation (Lundvall, 2007). While acknowledging the different scales in which the innovation system concept can be applied, the following discussion will be mainly focused on the national level – national innovation systems (NIS).<sup>1</sup>

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

regulation, financial systems, education and communication infrastructures and market conditions as far as these have impact on the learning and competence-building process (Gu and Lundvall, 2006a). It provides a systemic perspective by linking the micro behaviour to the system level in a two-way direction. The changes at the system level are seen as an outcome of the interactions at the micro level, whereas the system shapes the learning, innovation and competence-building at the micro level.

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

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

But this leaves us with the task of specifying what we mean by the ‘broad’ definition. Broadness and holism are not attractive terms in themselves since they might signal lack of clarity and precision. And there has been a criticism of the broad definition that it is difficult to see which institutions, organizations and structures should be included and which could be excluded. An important aim of this introduction is to move this discussion forward.

In Box 1.1 a number of definitions of innovation systems have been listed. It is obvious that they have in common first a reference to ‘institutions’ and second a focus on ‘knowledge’ and/or ‘technology’.

Several of the definitions refer to system components and relationships.

### BOX 1.1 DEFINITIONS OF NATIONAL INNOVATION SYSTEMS

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

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

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

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

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

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

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

*Source:* Niosi (2002, p. 292).

But a system can also be defined in terms of what it does (its functions). This alternative approach is the one proposed by Edquist (2004) and others (Galli and Teubal, 1997; Johnson and Jacobsson, 2003; Liu and White, 2001; Rickne, 2000).

The authors in the *functional approach* consider the major function of the system as being to bring forward innovations and define different sub-functions or activities that contribute to the overall function. Edquist (2004) argues that the lack of agreement on where to draw the lines around the innovation system makes the concept 'diffuse' and that this lack of clarity constitutes a barrier for further progress toward a more 'rigorous' and 'theoretical' concept. Rather than defining the system as constituted by organizations, it should be defined by specifying different functions. He lists ten such activities/functions/factors influencing innovation: research and development, competence-building, formation of new product markets, articulation of user needs, creation and change of organizations, networking around knowledge, creating and changing institutions, incubating activities, financing innovation, and consultancy services (Edquist, 2004).

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

But to conclude that agreeing on such a list is the most useful way to 'create rigour' and scientific progress might not be correct. Several other activities/functions/factors influencing innovation could be listed (five candidates that might enter the top ten as 'factors influencing innovation' are: competition, openness to international trade and capital flows, labour market dynamics, social welfare systems and 'social capital'). Saying that further research will help us converge on the right ones is not a useful response to this selection problem.<sup>2</sup>

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

It should be pointed out that we are interested in linking innovation and macroeconomic performance together. We do not see it as the function of national innovation to maximize the amount of innovation. We are interested in understanding both how innovation takes place and how

it is transformed into macroeconomic performance. This corresponds to the perspective characterizing the original work on innovation systems (Freeman, 1982; Freeman, 1987; Freeman and Lundvall, 1988).

On this basis we would propose the following definition:

The national innovation system is an open, evolving and complex system that encompasses relationships within and between 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.

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

It is true that the sets of ‘organizations and its relationships, institutions and socio-economic structures’ that are evoked by this definition are very broad indeed. We need to take into account aspects of education and training, social policies that underpin social capital and interactive learning as well as the functioning of labour markets and the organization of firms. At this point we need to consider Edquist’s critical remark that ‘Within a geographical area the whole socio-economic system cannot, of course, be considered to be included in the SI.’ (Edquist, 2005, p. 200). This common sense remark might not be correct, however. The point is that we look at these elements from a specific perspective – how they contribute to innovation and competence-building. Alternatively we might therefore define the innovation system as a *focusing device* to be applied to the national economy and contrast it with the focusing device offered by neoclassical economics:

The (national/regional/sectoral) innovation system is a focusing device aiming at analysing and understanding processes of innovation (rather than allocation)

where agents interact and learn (rather than engage in rational choice). The aim of using this device is to find out which alternative institutional set-ups support strong dynamic performance of a (national/regional) economy or a sector.

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

### *1.2.2 National, regional or sectoral innovation systems? Different levels of aggregation*

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

To the extent that a major concern of many developing countries today is to bring about economic transformation and catch up with the developed world, the innovation system perspective as proposed by List should be directly applicable to the reality of developing countries. But there has been some scepticism among scholars who have worked in the tradition of development economics (Cooper, 1992; Lall, 1992; Viotti, 2002; Matthews, 1999 and others). It has been argued that building technical capabilities and promoting learning are legitimate concerns, while

'innovation' sets the goal too high for less-developed countries. And it has also been argued that there is no full-blown 'system' of innovation in a less-developed country that can be studied. Rather the task is to develop strategies to create such a system (Arocena and Sutz, 2000).

Nonetheless, more and more, national governments in developing countries refer to national (and regional) innovation systems as a framework for designing national (and regional) development strategies. The most important recent example is China, where the new long-term plan for science and technology explicitly points out that the plan has been designed on the basis of a national innovation system perspective (see also Chapter 5, by Xielin Liu in this volume).

Another criticism is related to processes of globalization and regionalization. It has been argued that the 'national' character of innovations is misleading in a world where knowledge evolves and is shared in global value chains and where the regional and sectoral differences within a national economy may be more dramatic than the differences between national systems. Some of the research on sectoral and regional innovation systems as well as the research on global value chains has been motivated by the concern that the national perspective is too narrow (see also Chapter 8, by Pietrobelli and Rabellotti in this volume).

Regional innovation systems (RIS) literature (Asheim and Gertler, 2004; Asheim et al., 2007; Chaminade and Vang, 2006) puts the emphasis on the localized nature of most interactions. According to scholars in the RIS tradition, proximity facilitates interaction and the emergence of systems of innovation at regional level. Four related system-elements can be identified (Doloreux, 2002): firms within a cluster (constituting the knowledge exploitation subsystem), knowledge infrastructure (constituting the knowledge exploration subsystem) in which universities are included, institutions (the 'rules' regulating the behaviour of the actors in the RIS and their interaction) and policy (intended to improve the overall innovative performance of the RIS). While there is a tension between micro and macro analysis in mainstream development economics (Rodrik, 2008) we see a complementary role for analyses at different levels of aggregation and it is important to note that the analysis of sectoral and regional innovation systems brings in a meso level that can mediate between the micro and macro dynamics.

### *1.2.3 National innovation systems or national learning systems?*

Several authors including Viotti (2002) and Matthews (1999) have argued against the use of the concept 'innovation system' and in favour of the concept 'learning system'. Viotti argues that innovation systems should be reserved for developed countries where the leading firms introduce

innovations that are new to the world. In less-developed countries incremental innovation, diffusion and learning may take place, but not innovation (*sensu stricto*). He then goes on to make a distinction between active and passive learning systems, using Korea and Brazil as illustrations.

While Viotti's comparative analysis is extremely interesting and useful we do not agree with the starting point. Much of the early work on innovation systems was developed in connection with small countries such as Sweden, Norway, Denmark and Finland (Freeman and Lundvall, 1988; Lundvall, 1988). These countries prosper not because their firms develop unique new innovations for the world market but because of a highly developed capacity to absorb and use new technology developed elsewhere (see also Fagerberg et al., 2008). Taking Viotti seriously would imply that these countries have learning systems but not innovation systems – perhaps we would end up with innovation systems only in the US, Japan, the UK, France and Germany? But even in the case of the US, which excels in 'innovation *sensu stricto*' we would argue that a broader perspective on innovation and innovation policy would benefit the performance of the economy.

One reason why Viotti wishes to reserve the innovation system for those countries that develop radically new technology is that he finds the use of innovation processes as covering both original development, diffusion and use of new technology too vague. But to find out where new ideas originate from is not always easy, and from the point of view of economic performance it is less important than understanding how they are diffused and used. As Chris Freeman puts it: despite similarly large investments in R&D by various industrialized and semi-industrialized countries starting in the 1950s and 1960s 'evidence accumulated that the rate of technical change and of economic growth depended more on efficient diffusion than on being first in the world with radical innovations and as much on social innovations as on technical innovations' (Freeman, 1995a, p. 10).

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

Finally, we would like to stress that in all innovation systems technical change and economic growth at the national level are the outcome of the innovative activities that take place in the *whole* population of firms. Having a long tail of slow adopters and a few world-leading firms may

be less attractive than having many firms that are quick adopters without any world leaders. The performance of the national innovation system will reflect technical and organizational change in the industrial system as a whole and therefore there is no reason why we should promote world leadership rather than quick follower strategies. Big countries such as Brazil, India and China may for different reasons have aspirations to become world leaders in specific technologies, for instance in order to avoid technological dependence when it comes to what the US may define as 'strategic technologies', but for most countries this is not the best way to promote competitiveness and growth.<sup>3</sup>

#### *1.2.4 The informal and formal dimension of innovation systems*

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

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

This is problematic since the elements and relationships of the innovation system that have the most important impact upon the learning capacity of the whole system may be informal and difficult to measure. Based on Schoser (1999) we distinguish not only between what might be included in the narrow and broad definition of innovation systems but also between formal and informal elements and relationships. In Table 1.1 we have included some examples of elements considered in each field.

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

On the other hand, elements such as the willingness of firms to cooperate with scientific institutions or the closeness of relationships between companies and technology policy might be considered as part of the informal and narrow system of innovation. While the quality of the relationships between customers and suppliers, the degree of trust in society or the

*Table 1.1 Interaction between formal and informal elements of the innovation system*

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

*Note:* \* Includes the organizations and networks included in the narrow concept of IS as well.

*Source:* Adapted from Schoser (1999).

values of the educational system are informal items to be considered under the broad definition of innovation systems.

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

1. The efficiency of efforts taking place in the formal narrow system (1) will reflect the informal narrow system (3). For example, interactive learning across organizations as well as learning within organizations will depend upon ‘informal cognitive and behavioural patterns in the innovation process’.
2. The informal narrow system (3) will be rooted in the informal broad system (4). For example, the business culture will reflect the broader pattern of ‘cultural and historical factors’.
3. Cultural and historical factors (4) will in the long term be influenced by changes in the formal broad system (2). Here we would add agrarian reform, democratic education systems, more or less egalitarian income distribution, transparency, rule of law, social policies compensating victims of change and policies restricting corruption and ethnic conflict.

The Nordic countries – especially Norway and Denmark – ought to be handicapped by their small size and by a rather weak knowledge base. Their record in terms of radical innovation is also weak. The fact that they

perform well has more to do with the causalities referred to above. They are outstanding in absorbing ideas from abroad and to some degree this has to do with the educational level. But the high level of generalized trust is also important. The high level of trust in the Nordic economies has to do with agrarian reform, democratic education systems, egalitarian income distribution, social policy, transparency, rule of law and policies restricting corruption. And empirical evidence shows that the high level of trust is reflected in more frequent inter-firm interaction in innovation processes as well as in a much broader participation in processes of change within firms. This specific mode of innovation is especially supportive for learning and absorption of new technology.

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

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

### **1.3 Development economics**

Several authors point to the paper by Rosenstein Rodan (1943) in the *Economic Journal* as marking the beginning of development economics as a sub-discipline in economics. Major contributions came in the 1950s (Dobb, 1951; Singer, 1952; Nurkse, 1953; Lewis, 1954; Hirschman, 1958). The analysis was far from unified. There were heated debates regarding balanced versus imbalanced growth as well as between Marxists such as Dobb and Baran (1957) and more liberal economists such as Lewis. Nonetheless there was some common ground for most of the economists taking part in the debate.

Using inspiration from Keynesian growth models and from Marxian theory of capitalist accumulation it was argued that an increase in the

rate of investment was necessary in order to raise the rate of growth. The analysis of Lewis demonstrating the dramatic differences in productivity between traditional informal sectors and agriculture on the one hand, and manufacturing on the other, saw the transfer of labour from the low productivity sectors to the high productivity ones as an important prerequisite for sustained growth.

Most of the development economists were in favour of import substitution and saw the role of the state as protector of infant industries as legitimate and necessary. This was based upon a certain pessimism regarding the potential for manufacturing exports – a pessimism that had real background in the period 1950–70 when most of the growth in international trade took place within the OECD area (Waterbury, 1999).

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

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

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

Amartya Sen's article is especially interesting because while it may be seen as closing one era of research, he also opens up new avenues for research by presenting his ideas about capabilities and freedoms as indicators of development. He argues that what matters for people is not so much what they own or earn as it is what they experience and are able to

### BOX 1.2 ECONOMIC GROWTH AND WELFARE IN CHINA

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

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

do. Owning a bicycle without roads or belonging to a culture or a gender where biking is not permitted is of limited value, as Box 1.2 illustrates with the example of China.

After the demise of the 'classical development economics' followed a period where economic development was analysed with the use of tools of standard economics.<sup>4</sup> Market failure was analysed with the most advanced tools from information economics. Advanced game theory was applied to manifold situations. But in both cases the analytical work gave few useful insights. The almost unlimited room for model specifications resulted in contradictory conclusions regarding policy. To quote

Dilip Mookherjee: the result was ‘an embarrassment of riches when it comes to the choice of a theoretical model for almost any phenomenon’ (Mookherjee, 2005).

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

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

The general impression from this debate is first that the open-mindedness and the capacity to engage in self-critical assessment shown by Mookherjee and the other participants in the seminar, is admirable. Second it is that mainstream economics tends to use developing countries’ problems as offering interesting opportunities to make use of advanced theoretical models and econometric tools, while the interest in understanding the structures that lie behind underdevelopment and the mechanisms that might trigger development tend to end up as being of secondary importance.<sup>5</sup>

## **1.4 Linking innovation system research to development economics**

### *1.4.1 The contribution of innovation system research to development economics*

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

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

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

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

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

We would argue that the innovation system approach has a potential to throw new light on these issues. One of those that insist that it is fundamental for developing countries to get their trade specialization right is

Erik Reinert (2006). There is great potential in comparing sectoral innovation systems and analysing the potential for learning and competence-building in different sectors, including not only activities from agriculture and manufacturing but also from service sectors. Such studies should also take into account knowledge-related linkages established between sectors. A major problem here might be to find the right level of aggregation since sectors, as they are defined in production and trade statistics, are quite heterogeneous and it is a challenge to group activities that have commonalities in terms of their learning dynamics.

When it comes to the openness of the economy all the contributions in this *Handbook* that analyse this issue tend to support the view of Lewis. While there is great potential for learning from abroad in global value chains or through inward foreign direct investments, the actual positive impact will depend on 'absorptive capacity'. This may be regionally specific as in the case of the Padilla-Pérez, Vang and Chaminade chapter or specific for the global value chain as in the chapter by Pietrobelli and Rabellotti. The Fagerberg and Srholec econometric analysis points in the same direction since they get no significant effect on income creation from the indicator of 'openness'.

The role of the state is at the very centre of political disagreements. Both when it comes to the country analysis of China (Liu) and the sector analysis of the software industry in India (Joseph) it is obvious that government initiatives were crucial for shaping the growth dynamics. But both analyses tend to see a need for governments to withdraw and give more space for private initiative. The debate is put in general and rather sharp terms by Tilman Altenburg (Chapter 2) and by Cimoli et al. (Chapter 12). While Altenburg emphasizes government failure, Cimoli et al. criticize the assumption that 'markets' are the most natural institutions in the economy and they see active industrial policy as necessary for the promotion of economic development.

#### *1.4.2 The contribution of development economics to innovation system research*

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

*Table 1.2 Resources fundamental for economic growth – combining the tangible and reproducible dimensions*

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

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

Circulars are networks that have this as their major aim. Similar initiatives are under way in India and within Africa.

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

Table 1.2 illustrates that economic growth is faced with a double challenge in terms of sustainability and that there is an imminent risk of undermining the basis of material production. In China pollution of water and air threatens the reproduction of tangible capital. We will argue that the production and efficient use of intellectual capital fundamentally depends upon social capital. In a successful learning economy rooted in social cohesion and trust it is easier to engage in interactive and apprenticeship learning resulting in the passing on of elements of tacit knowledge from individual to individual and from generation to generation. This is more difficult in a context without trust and where there is a long distance among professions and in hierarchies. Thus, undermining trust and social capital undermines the reproduction and use of intellectual capital. A development strategy that focuses only on production capital and intellectual capital is not sustainable.

Finally we see great potential in linking Sen's analysis of individual 'capabilities' to the analysis of innovation systems. In our view the most important of all capabilities is the capability to learn. This capability is

fundamental for all the other capabilities and it is the one that will shape the dynamics of welfare. To put it crudely economic development is about enhancing capability and opportunity to learn at all levels. Technological learning is fundamentally important but so is the social and political learning that is necessary to build institutions and policy strategies that support competence-building.

According to Krugman (1995), the classical development economics disappeared because the protagonists could not speak the language of the mainstream economists – they could not transform their ideas into mathematical models.<sup>6</sup> What can we learn from this for innovation system research? There are rich possibilities to build economic models and pursue econometrics with reference to innovation system research. But we need to think differently in several important respects. First, at the micro level, we need indicators that reflect the quality of relationships such as trust and we need to understand how this quality comes out of ‘problem solving in interaction with others in which our ends and means co-evolve’ and we also need indicators for what is learnt in such interactions between individuals and organizations.

At the aggregate level we need to take into account that national, regional and sectoral systems are much more diverse than individual beings. Therefore we might not aim at general theories about what is best practice for developing countries and try to apply that globally. But neither is it satisfactory to pursue individual case studies and to assume that results can be generalized to other systems – this is actually one of the major complaints against the micro-analysis based upon controlled randomization.

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

### **1.5 Purpose and organization of this *Handbook***

Linking innovation system research and development economics poses some challenges, as we have discussed before. This *Handbook* attempts to address some of these challenges. It includes academics from a variety of backgrounds and experiences, coming from different continents. Methodologically there is a variety of approaches. The book draws on research combining single and multiple case studies with traditional hypothesis testing.<sup>7</sup>

The *Handbook* follows a thematic structure starting with a general discussion of the relationship between innovation and development (Part I),

followed by a critical review of the different scales of innovation systems and its application to the analysis of developing countries (national, sectoral, regional and global innovation systems) (Part II). Part III is devoted to the analysis of different elements of the system of innovation that play a crucial role in developing countries: subsidiaries of multinational firms, indigenous (champion) firms and universities. The *Handbook* closes with a final section (Part IV) on public policy.

*Part I: Innovation and development*

Development research within the dominant organizations – The World Bank, IMF – has been dominated by a soft version of (textbook) neoclassical economics with emphasis on the market as the most efficient resource allocation mechanism, as we have discussed earlier. Innovation systems research differs from this view taking a pragmatic view and emphasizing that neither pure markets nor pure command economies can perform well in terms of innovation and competence-building. What appear as rigidities in the neoclassical universe may be elements that promote change and open up opportunities and help to overcome systemic failures (see Chapter 13). The innovation system literature recognizes that in order to create conditions for capability-building there is a need for government action. It can make important contributions by specifying why, when and how government intervention is required.

But development research also brings valuable lessons for innovation system (IS) research. Despite the fact that IS scholars have long highlighted the importance of the socio-economic and political context in which the system is embedded, few attempts have been made to link innovation with the specific needs of developing countries, such as poverty reduction as discussed by Tilman Altenburg in Chapter 2. The author also emphasizes that the innovation system literature tends to overestimate the role of governments as agents of resource allocation and to underestimate the importance of improving basic institutions that support the working of the market economy (competition, contract enforcement, entry and exit conditions, and financial intermediation).

Chapters 3 and 4 by Cozzens and Kaplinsky and Fagerberg and Srholec respectively respond to these challenges. Cozzens and Kaplinsky try to respond to the critical question of how innovation might contribute to ameliorate or exacerbate poverty and inequality in an increasingly globalized economy. In doing so, they look at how capability-building and different forms of innovation (product, process, functional) contribute to different forms of inequality (horizontal, environmental, firm size, geographical, and so on). Their analysis opens a rich research and policy agenda on the relations between innovation, poverty and inequality.

In Chapter 4 Fagerberg and Srholec explicitly explore the interrelations between various technological, economic and social factors in development in a large selection of countries all over the world. Among these factors are indicators related to the business climate as called for by Altenburg. They conclude that there are strong interdependencies between technological capabilities, innovation-friendly governance and deeper social and cultural factors. With regard to the latter, one of their main findings is the role of social inclusion for growth. Countries in Africa and Asia that score very low on social capital, mainly due to general attitudes towards exclusion of women, homosexuals and immigrants, also show very poor performance in terms of development.

*Part II: Scales in innovation systems: theoretical progress and empirical overview*

In development studies, there has been increasing focus on capabilities rather than resource accumulation as the main motor of development (Johnsson et al., 2003). The work by Amartya Sen (1999), Lall (1992) or Bell and Pavitt (1995) has largely contributed to raising awareness on the importance of accumulating a broad range of capabilities as the basis for development. This includes not only technological capabilities, but also general educational and experience-based skills. Innovation system research is also built around the concept of capabilities, more specifically, learning capabilities. Innovation is understood as the result of interactive learning, where different agents (user-producers for example) interact to share and produce new knowledge (Lundvall, 1992). However, most innovation system studies tend to assume the importance of interactive learning and learning capabilities rather than demonstrating it (Chaminade and Vang, 2008). Understanding how capabilities are accumulated over time in a system of innovation is a challenge for innovation system research in developing countries.

Chapters 5, 6 and 7 look explicitly at the processes of capability accumulation in national, regional and sectoral innovation systems, while raising the question as to what extent the concept of the innovation system needs to be re-conceptualized to respond to the specificities of developing countries. All three chapters pay special attention to the role of the government and multinational firms in shaping the emergence and development of the different innovation systems. Chapter 5, by Xielin Liu, explicitly addresses the question of the role of the government in facilitating the transition of the Chinese national innovation system.

The state-centric view of development followed by Liu and represented by Amsden and Chu (2003) or Evans (1995), among others, has provided detailed and convincing analyses of the role of the state in fostering the

development in East Asia (and has undertaken comparative studies with Latin America). However, the approaches have their strength in explaining the early phases of the East Asian development where the role of the state was more central than in the latter. Liu's analysis indicates that exposing China's firms more to competition may stimulate innovation in the system as a whole.

While the notion of systemic effects runs through the entire book, Padilla-Pérez, Vang and Chaminade (see Chapter 6) actually provide some of the first attempts at quantifying and testing the systemic effects in a developing country context. This chapter explores the role of regional innovation systems supporting capability-building among indigenous SMEs in two different regional innovation systems (RIS) in Mexico. It presents an attempt to test the validity of the underlying assumptions in RIS literature in the context of developing countries, such as the importance of interactive learning with foreign subsidiaries, universities and research centres or among firms in the system of innovation. The analysis highlights the importance of local conditions for catching-up and development. The same industry in the same country might perform very differently depending on the characteristics of local systems.

Chapter 7, by K.J. Joseph, highlights certain unique characteristics of the sectoral systems in developing countries in terms of their building blocks and dynamism as well as new challenges. It discusses to what extent sectoral systems of innovation can be built in developing countries by looking at the emergence and evolution of the ICT sector in India and its role in the global division of labour. It is argued that the nature and extent of dynamism that India achieved in the ICT sector has been crucially shaped by the sectoral innovation system evolved over the years.

While development economics has played great attention to the international and spatial division of labour within the production process (Humphrey and Schmitz, 2002; Gereffi, 1999), this dimension has been almost neglected hitherto in innovation system research. Yet this literature has suffered from an excessive emphasis on the importance of lead firms' power vis-à-vis competence-building in developing countries. Chapters 6 and 7 try to tackle this omission by putting emphasis on the importance of innovation and competence-building, identifying the mechanisms behind upgrading and the specificities of the types of institutions that support these processes.

Chapter 8, by Pietrobelli and Rabellotti, focuses on the global dimension of innovation systems, linking local and national capabilities with the global distribution of economic activities using the global value chain perspective. The main argument is that the endogenous concept of innovation systems is not adequate for developing countries. Rather, international

flows seem to be as relevant as the local–national interactions. Innovation systems in developing countries should be seen as open systems, inserted in global flows of knowledge. Some of the questions that this chapter discusses include the interplay between local and global interactions, bearing of global interactions on competence-building and the acquisition of indigenous capabilities in the developing countries. One of the most important contributions of the chapter to the innovation system literature is to critically discuss how different governance mechanisms in global value chains shape learning in systems of innovation.

*Part III: Building blocks in innovation systems in developing countries: challenges under globalization*

As highlighted by Marin and Arza (Chapter 10), one of the main characteristics of innovation systems in developing countries is their difficulty in producing and exploiting knowledge (Intarakumnerd et al., 2002; Alcorta and Peres, 1998; Arocena and Sutz, 2000; Radošević, 1999; Viotti, 2002; cf. Marin and Arza in this *Handbook*). Due to this, both development and innovation studies have acknowledged the importance for developing countries to remain open and receptive to knowledge and technologies created abroad (see for instance Lundvall, 1992; Narula, 2000) as well as to potential advanced sources of knowledge within the domestic or regional system of innovation (like universities or champion firms). This section explores the mechanisms under which such transfer of knowledge is possible.

Chapter 9, by Barnard, Bromfield and Cantwell, explores how indigenous firms get access to developed markets and how they manage the expansion in the new context. Based on the analysis of a champion South-African firm, Sasol, the chapter deals with the issues of competence-building and upgrading in global markets over time. One of their main conclusions is that national champions may play a limited role in developing local innovation systems. Although it is in principle possible for firms to co-evolve with their home country, it is by no means a straightforward relationship. If the technological distance between the champion firm and other indigenous firms is too large, the champion firm is more likely to engage in interactive learning with other global players. Thus, investments and public support targeted to the champion firm may have little or no impact on the local or national system of innovation.

Subsidiaries of multinational firms have been considered by innovation system research as an important source of knowledge in IS in developing countries. Despite the growing amount of literature (Marin and Bell, 2006; Narula, 2000; Cantwell and Piscitello, 2005, 2007) there are still many open questions in the literature on spillovers from TNCs and particularly on the role of the subsidiaries as potential bridging institutions between

the TNC and the local firms. Chapter 10 by Marin and Arza extends the frontier concerning the links between TNCs and innovation systems by focusing on the role that subsidiaries might play in competence-building and innovation in the host country.

The IS literature has long acknowledged the importance of TNCs but also of universities as fundamental sources of knowledge and engines for upgrading in developing countries. However, the literature has been rather vague when it comes to when and how universities are relevant for development in developing countries. Chapter 11, by Brundenius, Lundvall and Sutz, addresses these questions and discusses the necessity for conceptualizing universities in innovation systems in developing countries as development universities. Underlying the whole discussion is an emphasis on how the current phase of globalization challenges established ideas on the role that universities should or could play as agents of development in developing countries.

*Part IV: IS-based policies in the new global setting*

The last section of the *Handbook* is devoted to innovation policy in developing countries.

Chapter 12, by Cimoli, Dosi, Nelson and Stiglitz focuses on the analysis of the institutions and policies shaping industrial development. According to the authors of this chapter, there are two ways of conducting the analysis. First, no example can be found in history of a process of development nested in an environment even vaguely resembling the institution-free tale of economic interactions that one finds in contemporary economic theory. Moreover, much more narrowly, discretionary public policies have been major ingredients of national development strategies, especially in catching-up countries, throughout the history of modern capitalism. Conversely, from a symmetric perspective, there are extremely sound theoretical reasons supporting the notion that institutions and policies matter in all processes of technological learning and economic coordination and change. In the chapter the authors focus on the latter issue and outline some theoretical foundations for institution-engineering and policies.

The last chapter, by Chaminade, Lundvall, Vang and Joseph, sheds light on how to conceptualize innovation policies in the context of developing countries, based on the findings of the different chapters of the *Handbook*. To attain this goal the chapter refers to the notion of systemic failures and contextualizes it for the diverse specificities characterizing developing countries. The overall aim is to provide guidance for policy makers on where intervention is most needed and to encourage their engagement in policy experimentation.

With this *Handbook*, it has been our aim to illustrate the diversity of

views and approaches in innovation system research and to discuss the applicability of the concept in developing countries. We have attempted to address some of the challenges of innovation system research in developing countries. By doing so, we have opened several lines of research for the future. The *Handbook* closes with an epilogue, in which these new lines of research are suggested to inspire the young researchers in the field.

## Notes

1. It is useful to keep in mind that the innovation system concept originated from an analysis of 'national' innovation systems (Freeman, 1982, 2004) and that the regional and sectoral systems have been both inspired by and reacted to this original formulation. Arguably, the national level is the one that illustrates more clearly the differences between the narrow and the broad notion of innovation system that will be discussed in this chapter.
2. The listing echoes Denison's 'growth accounting' exercises where attempts were made to reduce the relative size of the 'residual'. It has in common with such efforts a certain agnostic approach where all factors are treated as equally important and without systematically linking them to each other. In this sense it is a move toward less theory rather than more theory. This is reflected in the disturbing lack of consistency in the list, that is the heterogeneous character of its elements. This way of defining innovation systems actually exaggerates what we do not know and defers from drawing upon what we do know regarding innovation.
3. If Viotti had come up with the proposed terminology 25 years ago it might have been worth considering. It might have helped avoid the current bias toward science-based learning. It is obvious that many policy makers and analysts attach to innovation the same narrow meaning as Viotti. The result has been that references to national innovation systems have been used to promote science in general or to impose market governance on universities. Now it is too late to change the vocabulary: the innovation system has become part of policy language world-wide – what is needed now is to re-conquer the concept and bring it back to what was intended with it 25 years ago.
4. The following is based upon material from a seminar held in October 2005 where development scholars (Mookherjee, 2005; Basu, 2005; Banerjee, 2005) made a critical assessment of their field of research.
5. One of the most interesting contributions to the debate comes from Basu who points out that the idea that the only form for truly reliable knowledge comes from 'randomized controlled experiments' is absurd since it implies that all that we have learnt through other forms of 'experience' is irrelevant.
6. Krugman's analysis might be too kind to the standard economics community, however. In order to remain within the neoclassical community you might also need to confess to a certain credo that includes methodological individualism, rational choice, general equilibrium as reference, and markets as the most natural elements in the economy.
7. Fagerberg and Srholec are at the forefront of using econometric testing to analyse innovation systems without sacrificing the inherent complexity of a system of innovation (see Chapter 4).

## References

- Abramovich, M. (1946), 'Resources and output trends in the USA since 1870', *American Economic Association Papers and Proceedings*, **46**, 5–23.
- Alcorta, L. and W. Peres (1998), 'Innovation systems and technological specialization in Latin America and the Caribbean', *Research Policy*, **25**, 857–81.
- Amsden, A.H. (1989), *Asia's Next Giant: South Korea and Late Industrialization*, New York: Oxford University Press.

- Amsden, A.H. and W. Chu (2003), *Beyond Late Development*, Cambridge, Mass: MIT Press.
- Antonelli, C. (2007), 'Technological knowledge as an essential facility', *Journal of Evolutionary Economics*, **17**(4), 451–71.
- Arocena, R. and J. Sutz (2000), 'Looking at National Systems of Innovation from the South', *Industry and Innovation*, **7**, 55–75.
- Arundel, A. (2006), 'Innovation survey indicators: any progress since 1996', paper prepared for the G20 at the Leader's level Workshop (L20 Workshop), Maastricht, The Netherlands.
- Arundel, A., E. Lorenz, B.-Å. Lundvall and A. Valeyre (2007), 'How Europe's economies learn: a comparison of work organization and innovation mode for the EU-15', *Industrial and Corporate Change*, **16**(6).
- Asheim, B. and L. Coenen (2005), 'Knowledge bases and regional innovation systems: comparing Nordic clusters', *Research Policy*, **34**(8), 1173.
- Asheim, B. and M. Gertler (2004), 'The geography of innovation: regional innovation systems', in J. Fagerberg, D. Mowery and R. Nelson (eds), *The Oxford Handbook of Innovation*, Oxford: Oxford University Press, pp. 291–317.
- Asheim, B. et al. (2007), 'Constructing knowledge-based regional advantage: implications for regional innovation policy', *International Journal of Entrepreneurship and Innovation Management*, **7**(2), 140–55.
- Balassa, B. (1971), 'Trade policies in developing countries', *American Economic Review*, **61**(2), 178–87.
- Banerjee, A.V. (2005), 'New development economics and the challenge to theory', in Ravi Kanbur (ed.), *New Directions in Development Economics: Theory or Empirics? A symposium in Economic and Political Weekly*, typescript, August 2005.
- Baran, P.A. (1957), *Political Economy of Growth*, New York: Monthly Review Press.
- Basu, K. (2005), 'The new empirical development economics: remarks on its philosophical foundations' in Ravi Kanbur (ed.), *New Directions in Development Economics: Theory or Empirics? A symposium in Economic and Political Weekly*, typescript, August 2005.
- Bell, M. and K. Pavitt (1995), 'The development of technological capabilities', in I. ul Haque (ed.), *Trade, Technology and International Competitiveness*, Washington: The World Bank, pp. 69–101.
- Bhagwati, J. (1978), *Foreign Trade Regimes and Economic Development: Anatomy and Consequences of Exchange Control Regimes*, New York: National Bureau of Economic Research.
- Borrás, S. (2004), 'System of innovation: theory and the European Union', *Science and Public Policy*, **31**(6), 425–33.
- Callon, M. (1992), 'The dynamics of techno-economic networks', in R. Loombs, P. Saviotti and V. Walsh (eds), *Technical Change and Company Strategies*, London: Academy Press, pp. 72–102.
- Cantwell, J. and L. Piscitello (2005), 'Recent location of foreign-owned research and development activities by large multinational corporations in the European regions: the role of spillovers and externalities', *Regional Studies*, **39**(1), 1–16.
- Cantwell, J. and L. Piscitello (2007), 'Attraction and deterrence in the location of foreign-owned R&D activities: the role of positive and negative spillovers', *International Journal of Technological Learning, Innovation and Development*, **1**(1), 83–111.
- Carlsson, B. and R. Stankiewicz (eds) (1995), *Technological Systems and Economic Performance: the Case of Factory Automation*, Dordrecht: Kluwer Academic Publishers.
- Chaminade, C. and Vang, J. (2006), 'Innovation policy for Asian SMEs: an innovation systems perspective', in M. Yeung, *Handbook of Research on Asian Business*, Cheltenham, UK and Northampton, MA, USA: Edward Elgar.
- Chaminade, C. and J. Vang (2008), 'Upgrading in Asian clusters: rethinking the importance of interactive-learning', *Science, Technology and Society*, **13**(1), 61–94.
- Cooke, P., M. Gomez-Uranga et al. (1997), 'Regional systems of innovation: institutional and organizational dimensions', *Research Policy*, **26**, 475–91.

- Cooper, C. (1992), 'Are innovation studies on industrialized economies relevant to technology policy in developing countries?', UNU/INTECH Working Paper No. 3, June, Maastricht, Netherlands: The United Nations University, Institute for New Technology, mimeo.
- Dasgupta, P. (1987), 'The economic theory of technology policy: an introduction', in P. Stoneman and P. Dasgupta (eds), *Economic Policy and Technological Performance*, Cambridge: Cambridge University Press, pp. 7–23.
- David, P. and D. Foray (1995), 'Accessing and expanding the science and technology knowledge base: a conceptual framework for comparing national profiles in systems of learning and innovation', *STI Review*, **16**, 13–68.
- David, P. and D. Foray (1995), 'Interactions in knowledge systems: foundations, policy implications and empirical methods', *STI Review*, **16**, 69–102.
- Denison, E. (1962), 'Sources of economic growth in the United States', New York: Committee for Economic Development.
- Dobb, M.H. (1951), 'some aspect of economic development', Delhi: Delhi School of Economics.
- Doloreux, D. (2002), 'What we should know about regional systems of innovation', *Technology in Society*, **24**(3), 243–63.
- Edquist, C. (2004), 'Systems of innovation: perspectives and challenges', in J. Fagerberg, R. Nelson and D. Mowery (eds), *The Oxford Handbook of Innovation*, Oxford: Oxford University Press, pp. 181–208.
- Edquist, C. and Lundvall, B.-Å. (1993), 'Comparing the Danish and Swedish systems of innovation', in Nelson (ed.).
- Evans, P. (1995), *Embedded Autonomy: States & Industrial Transformation*, Princeton, NJ: Princeton University Press.
- Fagerberg, J., D. Mowery and B. Verspagen (2008), 'Innovation-systems, path-dependency and policy: the co-evolution of science, technology and innovation policy and industrial structure in a small, resource-based economy', paper presented at the Prime-Latin America Conference at Mexico City, 24–26 September.
- Freeman, C. (ed.) (1981), *Technological Innovation and National Economic Performance* Aalborg: Aalborg University Press.
- Freeman, C. (1982), 'Technological infrastructure and international competitiveness', draft paper submitted to the OECD ad hoc group on Science, technology and competitiveness, August 1982, mimeo.
- Freeman, C. (1987), *Technology Policy and Economic Performance: Lessons from Japan*, London: Pinter Publishers.
- Freeman, C. (1988), 'Japan: a new national innovation system?', in G. Dosi, C. Freeman, R.R. Nelson, G. Silverberg and L. Soete (eds), *Technology and Economic Theory*, London: Pinter Publishers.
- Freeman, C. (1995a), 'The national innovation systems in historical perspective', *Cambridge Journal of Economics*, **19**(1), 5–24.
- Freeman, C. (1995b), 'History, co-evolution and economic growth', in IIASA Working Paper 95-76, Laxenburg, IIASA.
- Freeman, C. (2002), 'Innovation systems: city-state, national, continental and sub-national', *Research Policy*, **31**(2), 191–211.
- Freeman, C. (2004), 'Technological infrastructure and international competitiveness', *Industrial and Corporate Change*, **13**(3), 540–52.
- Freeman, C. and B.-Å. Lundvall (eds) (1988), *Small Countries Facing the Technological Revolution*, London: Pinter Publishers.
- Freeman, C. and L. Soete (eds) (1987), *Technical Change and Full Employment*, Oxford: Basil Blackwell.
- Furman, J., M. Porter and S. Stern (2002), 'The determinants of national innovative capacity', *Research Policy*, **31**, 899–933.
- Galli, R. and M. Teubal (1997), 'Paradigmatic shifts in national innovation systems', in C. Edquist (ed.), *Systems of Innovation: Technologies, Institutions and Organization*, London: Pinter.

- Gereffi, G. (1999), 'A commodity chains framework for analysing global industries', Institute of Development Studies, available at [www.ids.ac.uk](http://www.ids.ac.uk).
- Granstrand, O. (2000), 'Corporate innovation systems: a comparative study of multi-technology corporations in Japan, Sweden and the USA', Gothenburg: Chalmers University.
- Gu, S. and B.-Å. Lundvall (2006a), 'Policy learning as a key process in the transformation of the Chinese Innovation Systems', in B.-Å. Lundvall, P. Intarakurumend and J. Vang (eds), *Asian Innovation Systems in Transition*, Cheltenham: UK and Northampton, MA, USA: Edward Elgar.
- Gu, S. and B.-Å. Lundvall (2006b), 'China's innovation system and the move toward harmonious growth and endogenous innovation', *Innovation, Management, Policy and Practice*, **8**(1/2), 1–26.
- Gu, S., J. Liu, B.-Å. Lundvall and S. Schwaag-Serger (2008), 'China's system and vision of innovation: analysis of the national medium- and long-term science and technology development plan (2006–2020)', paper presented to the 6th Globelics conference in Mexico City, 26–28 September.
- Hausmann, R., D. Rodrik and C.F. Sabel (2008), 'Reconfiguring industrial policy: a framework with an application to South Africa', CID Working Paper No. 168, Center for International Development at Harvard University.
- Hirschman, A.O. (1958), *The Strategy of Economic Development*, Clinton, MA: Yale University Press.
- Hirschman, A.O. (1981), 'The rise and decline of development economics', in A.O. Hirschman (ed.), *Essays in Trespassing: Economics to Politics and Beyond*, Cambridge: Cambridge University Press.
- Hobday, M. (1995), *Innovation in East Asia: The Challenge to Japan*, Aldershot, UK and Brookfield, VT, USA: Edward Elgar.
- Hofstede, G. (1991), *Culture and Organisations: Software of the Mind*, Toronto: McGraw-Hill.
- Hughes, T.P. (1983), *Networks of Power. Electrification in Western Society 1880–1930*, Baltimore: Johns Hopkins.
- Humphrey, J. and H. Schmitz (2002), 'How does insertion in global value chains affect upgrading in industrial clusters?', *Regional Studies*, **36**(9), 1017–27.
- Intarakurmerd, P. et al. (2002), 'National innovation system in less successful developing countries: the case of Thailand', *Research Policy*, **31**(8–9), 1445–57.
- Jensen, M.B., B. Johnson, E. Lorenz and B.-Å. Lundvall (2007), 'Forms of knowledge and modes of innovation', *Research Policy*, **36**(5), June.
- Johnson, A. and S. Jacobsson (2003), 'The emergence of a growth industry: a comparative analysis of the German, Dutch and Swedish wind turbine industries', in J.S. Metcalfe and U. Canter (eds), *Transformation and Development: Schumpeterian Perspectives*, Heidelberg: Physica/Springer.
- Johnson, B. et al. (2003), 'Economic development and the national system of innovation approach', paper presented at 1st Globelics Conference, Rio de Janeiro, Brazil, 3–6 November.
- Joseph, K.J. (1997), *Industry under Economic Liberalisation: Case of Indian Electronics*, New Delhi: Sage Publications.
- Joseph, K.J. (2006), *Information Technology, Innovation System and Trade Regime in Developing Countries: India and the ASEAN*, London and New York: Palgrave Macmillan.
- Kanbur, Ravi (ed.) (2005), 'New directions in development economics: theory or empirics?', a symposium in Economic and Political Weekly, August 2005.
- Krueger, A.O. (1974), 'The political economy of the rent-seeking society', *American Economic Review*, **64**(3), 291–303.
- Krugman, Paul (1995), *Development, Geography, and Economic Theory*, Cambridge, MA: MIT Press.
- Lall, S. (1992), 'Technological capabilities and industrialization', *World Development*, **20**(2), 165–86.

- Lewis, W.A. (1954), 'Economic development with unlimited supply of labour', *Manchester School*, **22**, 139–91.
- Lewis, W.A. (1978), *The Evolution of the International Economic Order*, Princeton, NJ: Princeton University Press.
- List, F. (1841), *Das Nationale System der Politischen Ökonomie*, Basel: Kyklos (translated and published under the title: *The National System of Political Economy* by Longmans, Green and Co., London, 1841).
- Little, I.M.D., T. Scitovsky and M. Scott (1972), 'Industry and trade in some developing countries', *Journal of International Economics*, **2**(3), 303–5.
- Liu, X. and S. White (2001), 'Comparing innovation systems: a framework and application to China's transitional context', *Research Policy*, **30**(7), 1091–114.
- Lorenz, E. and A. Valeyre (2005), 'Organisational innovation, HRM and labour market structure: a comparison of the EU-15', *Journal of Industrial Relations*, **47**(4), 424–42.
- Lucas, R. (1988), 'On the mechanisms of economic development', *Journal of Monetary Economics*, **22**(1), 3–42.
- Lundvall, B.-Å. (1985), *Product Innovation and User-Producer Interaction*, Aalborg: Aalborg University Press.
- Lundvall, B.-Å. (1988), 'Innovation as inter-active process: from user–producer interaction to the national system of innovation', in G. Dosi, C. Freeman, R. Nelson, G. Silverberg and L. Soete (eds), *Technical Change and Economic Theory*, London: Pinter, pp. 349–69.
- Lundvall, B.-Å. (ed.) (1992), *National Systems of Innovation. Towards a Theory of Innovation and Interactive Learning*, London: Pinter.
- Lundvall, B.-Å. (ed.) (2007), 'Innovation system research: where it came from and where it might go', Globelics Working Paper, No. 2007-01, available at [www.globelics.org](http://www.globelics.org).
- Malerba, F. (2002), 'Sectoral systems of innovation and production', *Research Policy*, **31**(2), 247–64.
- Malerba, F. (2004), 'Sectoral systems: how and why innovation differs across sectors', in J. Fagerberg, D. Mowery and R. Nelson (eds), *The Oxford Handbook of Innovation*, Oxford: Oxford University Press, pp. 380–406.
- Marin, A. and M. Bell (2006), 'Technology spillovers from Foreign Direct Investment (FDI): the active role of MNC subsidiaries in Argentina in the 1990s', *Journal of Development Studies*, **42**(4), 678–97.
- Matthews, J.A. (1999), 'From national innovation systems to national systems of economic learning: the case of technology diffusion management in East Asia', paper submitted to DRUID Summer conference 'National Innovation Systems, Industrial Dynamics and Innovation Policy', Rebild, Denmark, 9–12 June.
- Metcalfe, J.S. (1995), 'The economic foundations of technology policy: equilibrium and evolutionary perspective', in P. Stoneman (ed.), *Handbook of Industrial Innovation*, London: Blackwell.
- Mookherjee, D. (2005), 'Is there too little theory in development economics today?', in Ravi Kanbur (ed.), *New Directions in Development Economics: Theory or Empirics? A symposium in Economic and Political Weekly*, typescript, August 2005.
- Mowery, D. and J. Oxley (1995), 'Inward technology transfer and competitiveness: the role of national innovation systems', *Cambridge Journal of Economics*, **19**(1), 67–93.
- Narula, R. (2000), 'Industrial development, globalization and multinational enterprises: new realities for developing countries', *Oxford Development Studies*, **28**(2), 141–67.
- Nelson, R. (1959), 'The simple economics of basic scientific research', in N. Rosenberg (ed.), *The Economics of Technological Change*, Harmondsworth: Penguin Books.
- Nelson, R. (ed.) (1993), *National Innovation Systems. A Comparative Analysis*, New York: Oxford University Press.
- Nelson, R. and N. Rosenberg (1993), 'Technical innovation and innovation systems', in Nelson (ed.).
- Niosi, J. (2002), 'National systems of innovations are "x-inefficient" (and x-effective) – why some are slow learners', *Research Policy*, **31**, 291–302.

- Niosi, J., P. Saviotti, B. Bellon and M. Crow (1993), 'National systems of innovations: in search of a workable concept', *Technology in Society*, **15**, 207–27.
- Nurkse, R. (1953), *Problems of Capital Formation in Underdeveloped Areas*, New York: Oxford University Press.
- Oyelaran-Oyeyinka, B. (2006), 'Systems of innovation and underdevelopment: an institutional perspective', *Science, Technology and Society*, **11**(2), 239–69.
- Parthasarathy, B. and Y. Aoyama (2006), 'From software services to R&D services: local entrepreneurship in the software industry in Bangalore, India', *Environment and Planning A*, **38**, 1269–85.
- Patel, P. and K. Pavitt (1994), 'The nature and economic importance of national innovation systems', STI Review, No. 14, Paris: OECD.
- Radošević, S. (1999), *International Technology Transfer and Catch-up in Economic Development*, Cheltenham, UK and Northampton, MA, USA: Edward Elgar.
- Reinert, E. (2006), 'Evolutionary economics, classical development, economics, and the history of economic policy: a plea for theorizing by inclusion', working papers in technology governance and economic dynamics, No. 1, Tallinn University of Technology.
- Rickne, A. (2000), 'New-technology based firms and industrial dynamics: evidence from the technological systems of biomaterials in Sweden, Ohio and Massachusetts', Department of Industrial Dynamics, Chalmers University of Technology.
- Rodrik, D. (2008), 'The new development economics: we shall experiment, but how shall we learn?', web-document, John F. Kennedy School of Government, Harvard University.
- Romer, P. (1986), 'Increasing returns and long run growth', *Journal of Political Economy*, **94**(5), 1001–37.
- Rosenstein-Rodan, P.N. (1943), 'Problems of industrialization of Eastern and South-Eastern Europe', *Economic Journal*, **53**, 202–11.
- Schmookler, J. (1966), *Invention and Economic Growth*, Cambridge, MA: Harvard University Press.
- Schoser, C. (1999), 'The institutions defining national systems of innovation: a new taxonomy to analyze the impact of globalisation', paper presented at the Annual Conference of the European Association of Evolutionary Political Economy, Prague, November.
- Schumpeter, J.A. (1934), *The Theory of Economic Development*, Cambridge, MA: Harvard University Press.
- Schumpeter, J.A. (1939), *Business Cycles: a Theoretical, Historical and Statistical Analysis of the Capital Process* (2 vols), New York: McGraw-Hill.
- Schumpeter, J.A. (1942), *Capitalism, Socialism and Democracy*, London: Unwin.
- Sen, A. (1983), 'Development: which way now?', *Economic Journal*, **93**(372), 745–62.
- Sen, A.K. (1999), *Development as Freedom*, Oxford: Oxford University Press.
- Singer, H.W. (1952), 'The mechanics of economic development', *Indian Economic Journal*, **1**(2), 1–18.
- Solow, R. (1957), 'Technical change and the aggregate production function', *Review of Economics Statistics*, **39**(3), 312–20.
- Stoneman, P. and P. Dasgupta (1987), *Economic Policy and Technological Performance*, Cambridge: Cambridge University Press.
- UNCTAD (2007), *The Least Developed Countries Report. Knowledge, Technological Learning and Innovation for Development*, Geneva: UNCTAD.
- Viotti, E. (2002), 'National learning systems: a new approach on technological change in late industrialising economies and evidence from the cases of Brazil and South Korea', *Technological Forecasting & Social Change*, **69**(7), 653–80.
- Wade, R.H. (2004), 'Is globalization reducing poverty and inequality?', *World Development*, **32**(4), 572–96.
- Wade, R.H. (2005), 'Failing states and cumulative causation in the world system', *International Political Science Review*, **26**(1), 17–36.
- Waterbury, John (1999), 'The long gestation and brief triumph of import-substituting industrialization', *World Development*, **27**(2), 323–41.