



Sectoral Systems of Innovation

Concepts, Issues and Analyses of Six
Major Sectors in Europe

Edited by Franco Malerba

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Sectoral Systems of Innovation

Innovation and technological change have different characteristics and follow different paths depending on the sector in which they take place. The knowledge, actors and institutions of a sector all exert a major influence on innovation. With contributions from nineteen experts in their field, this book proposes a “sectoral system of innovation” (SSI) homework to analyze the innovation process, the factors affecting innovation, the relationship between innovation and industry dynamics, the changing boundaries and the transformation of sectors, and the determinants of the innovation performance of firms and countries in different sectors. Innovation in a sector is considered to be affected by three groups of variables: knowledge and technologies; actors and networks; and institutions. In addition to providing a general framework, this book examines innovation in six major sectors in Europe: pharmaceuticals and biotechnology, telecommunications equipment and services, chemicals, software, machine tools and services.

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Contents

<i>List of figures</i>	<i>page</i> ix
<i>List of tables</i>	x
<i>List of contributors</i>	xii
<i>Acknowledgements</i>	xv

Introduction	1
FRANCO MALERBA	

Part I Sectoral systems: concepts and issues

1 Sectoral systems of innovation: basic concepts	9
FRANCO MALERBA	
1 Introduction	9
2 Antecedents and theoretical bases	11
3 Sectoral systems of innovation and production: a proposed definition and a framework	16
4 The building blocks of a sectoral system of innovation	17
5 The dynamics and transformation of sectoral systems	29
6 The regional and national dimensions	33
7 The next chapters	35
2 Sectoral dynamics and structural change: stylized facts and “system of innovation” approaches	42
FABIO MONTOBBIO	
1 Introduction	42
2 Innovation, performance and structural change in European Union countries, the United States and Japan	44
3 The aggregate analysis of four sectors: pharmaceuticals (and biotechnology), telecommunications, chemicals and machinery	54
4 Structural changes and national trajectories in an “innovation system perspective”	63
5 Conclusions	65
Appendix	67

Part II Six sectoral systems

3	Pharmaceuticals analyzed through the lens of a sectoral innovation system	73
	MAUREEN McKELVEY, LUIGI ORSENIGO AND FABIO PAMMOLLI	
1	Introduction	73
2	Innovation and the evolution of the sectoral system of innovation in the pharmaceutical industry: an overview	76
3	The advent of molecular biology and the age of cost containment	89
4	Conclusions: linking the empirical evidence to theory	110
4	The chemical sectoral system: firms, markets, institutions and the processes of knowledge creation and diffusion	121
	FABRIZIO CESARONI, ALFONSO GAMBARDELLA, WALTER GARCIA-FONTES AND MYRIAM MARIANI	
1	Introduction	121
2	The boundaries of the sector	122
3	The geography of the chemical sectoral system and international performance	129
4	Evolutionary and coevolutionary processes	131
5	The knowledge base and learning processes: knowledge generation	135
6	The knowledge base and learning processes: patterns of technology diffusion	142
7	Conclusions	150
	Appendix – The networks of inventors: data description	151
5	The fixed Internet and mobile telecommunications sectoral system of innovation: equipment production, access provision and content provision	155
	CHARLES EDQUIST	
1	Introduction	155
2	The fixed Internet and mobile telecommunications sectoral system of innovation	157
3	Policies and strategies	184
6	The European software sectoral system of innovation	193
	W. EDWARD STEINMUELLER	
1	Introduction	193
2	Creating software: for profit, out of necessity and for fun	207
3	Innovative capabilities and organizations: configuring the software industry	219
4	Making it pay: models for software commercialization	230
5	Conclusions: public and private strategies for the future of the European software industry	238

7	Machine tools: the remaking of a traditional sectoral innovation system	243
	JÜRGEN WENGEL AND PHILIP SHAPIRA	
1	Introduction	243
2	Economic and structural trends in the sector	245
3	Germany: digesting reunification and regaining strength	253
4	Italy: a dynamic sector in flux	267
5	Japan: the sectoral innovation system from a firm's perspective	271
6	The United States: continuing sectoral change	275
7	Conclusions	279
8	Services and systems of innovation	287
	BRUCE S. TETHER AND J. STAN METCALFE	
1	Introduction	287
2	Services: what are they?	289
3	Services and sectoral systems of innovation	297
4	Elements of systems of innovation	311
5	Innovation systems as problem- or opportunity-centered and contingent	316
Part III Sectoral systems and national systems; international performance and public policy		
9	National institutional frameworks, institutional complementarities and sectoral systems of innovation	325
	BENJAMIN CORIAT AND OLIVIER WEINSTEIN	
1	Introduction	325
2	How can we define institutions? How do they operate?	326
3	For innovation, what are the relevant "national" institutions?	331
4	Sectoral relevance and specificities	339
5	Conclusions	344
10	Sectoral systems of innovation and varieties of capitalism: explaining the development of high-technology entrepreneurship in Europe	348
	STEVEN CASPER AND DAVID SOSKICE	
1	Introduction	348
2	Varieties of capitalism and patterns of innovation	349
3	Case studies: patterns of subsector specialization in European high technology	358
4	Conclusions and implications for policy	381
11	The international performance of European sectoral systems	388
	BENJAMIN CORIAT, FRANCO MALERBA AND FABIO MONTOBBIO	
1	Introduction	388

2	Sectoral systems and industrial leadership	389
3	The international performance of six European sectors	391
4	The diverse determinants of industrial leadership	416
5	Enlarging the discussion on European sectoral performance: the roles of product differentiation, industry life cycles and science	418
6	Conclusions, with a controversial point	421
12	Sectoral systems: implications for European innovation policy	427
	CHARLES EDQUIST, FRANCO MALERBA, J. STAN METCALFE, FABIO MONTOBBIO AND W. EDWARD STEINMUELLER	
1	Introduction	427
2	Reasons for public policy intervention in an innovation system perspective	429
3	From systems of innovation to sectoral systems: general public policy considerations	439
4	Some specific policy conclusions	445
5	Conclusions	458
Part IV Conclusions		
13	Summing-up and conclusions	465
	FRANCO MALERBA	
1	Introduction	465
2	A characterization of the various sectoral systems	466
3	Sectoral systems in Europe: a summing-up	467
4	The coexistence of the local, national and global dimensions	479
5	Coevolutionary processes in sectoral systems	481
6	A note on sectoral systems in services	485
7	International performance seen through the lens of sectoral systems	488
8	Policy implications	500
9	The challenges ahead	503
	 <i>Index</i>	 508

Figures

6.1 Inward and outward migration of software design	<i>page</i> 205
7.1 The spectrum of innovations in the machine tool industry	245
7.2 Employment developments in the machine tool industry	249
7.3 Developments in the production of machine tools	250
7.4 The dynamics of machine tool output, consumption and trade	250
7.5 The dynamics of company structure in the machine tool industry	251
7.6 Innovation behavior in the machine tool industry in Germany compared to mechanical engineering and radio and telecommunication equipment	258
7.7 Changes in the qualification (knowledge) base in mechanical engineering in Germany between 1995 and 1999	262
7.8 The effects of mobile fuel cell diffusion on suppliers	264
7.9 Comparative publication output – ultra-precision machining	278
8.1 The composition of value added in the European Union, the United States and Japan	289
8.2 Employment by enterprise size in European Union services, 1995	293
8.3 The system of innovation as contingent and problem-/opportunity-centered	319
9.1 Institutional complementarities and relative institutional advantage	341

Tables

2.1 Structural changes and variations in countries' share	<i>page</i> 48
2.2 Structural decomposition	52
2.3 Annual rate of growth of 1995 constant price value added for a selected number of countries and sectors	55
2.4 Annual rate of growth of employment for a selected number of countries and sectors	56
2.5 Annual rate of growth of labor productivity for a selected number of countries and sectors	57
2.6 Annual rate of growth of world export shares in selected countries and sectors: 1990–2000	58
4.1 Characteristics of DL and CL patents	138
4.2 Firms' characteristics versus patent characteristics	138
4.3 Cluster versus non-cluster regions and patent characteristics	140
4.4 Technological clusters, firms' and patent characteristics	141
4.5 Licensing agreements: 1980–97 (shares of total licenses by type of licensor and region)	144
4.6 Licensing agreements: 1980–97 (shares of total licenses by type of licensor and licensee)	145
4.7 Market share of SEFs – licenses: 1980–90 (shares of total number of plants by region)	146
4.8 Licenses – value and number by sector: 1990–97	146
4.9 Technology strategies by large chemical corporations	149
6.1 Indicators of software trade: 1999 (millions of dollars)	199
6.2 Employees in software-related professions	201
6.3 European market for software products and services: 2000 (millions of euros)	202
7.1 Machine tool output, consumption and trade trends: 2001	246
7.2 Basic characteristics of the machine tool sector in Germany	253

7.3	Comparison of sector distribution in Germany in the target group and the sample of the Fraunhofer-ISI <i>Manufacturing Innovation Survey</i>	257
7.4	Knowledge base and learning processes in the machine tool industry in Germany in a sector comparison	260
7.5	In-house development and production activities of machine tool companies in Italy	269
7.6	Size of Japanese machine tool manufacturers: 1997	272
7.7	Comparison of strategies to improve competitiveness in German and Georgia (United States) mechanical engineering firms	279
7.8	Traditional and emerging characteristics of sectoral innovation systems in machine tools	280
10.1	Technology regimes for radical and incremental innovation in sectoral systems	352
10.2	Institutional framework architectures in Germany and the United Kingdom	353
10.3	Patterns of sub-market specialization of German <i>Neuer Markt</i> Internet software firms	366

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Introduction

Franco Malerba

Innovation and technological change are highly affected by the sector in which they take place. The agents, the relationships among actors and the institutions of a sector all exert a major and profound influence on the differences in innovation across sectors. How to consider these effects on innovation? And how to take into account differences across sectors?

This book examines innovation in six major sectors in Europe and in other advanced countries: pharmaceuticals and biotechnology, telecommunications equipment and services, chemicals, software, machine tools and services (airports, medical and retailing). These sectors have been chosen because, in them, technological change is quite rapid, and innovation plays a major role in fostering growth and in affecting the competitiveness of firms and countries.

This volume proposes a novel approach to looking at innovation in sectors. It provides a *sectoral systems of innovation* framework, which uses a multidimensional, integrated and dynamic view of sectors in order to analyze innovation. Although this book focuses on innovation, the concept of sectoral systems can also be applied to *production*. The notion of SSIs departs from the traditional concept of sector used in industrial economics because it examines other agents in addition to firms, places great emphasis on knowledge, learning and sectoral boundaries, focuses on non-market as well as on market interactions, and pays much attention to institutions. In an SSI perspective, firms are active actors that shape their technological and market environments. Innovation is considered a process that involves continuous and systematic interactions among a wide variety of actors.

In this book innovation in a sector is considered to be affected by three main factors:

- a. *Knowledge and technologies;*
- b. *Actors and networks;*
- c. *Institutions.*

a. Knowledge and technologies. Any sector can be characterized by a specific knowledge base, technologies and inputs. In a dynamic way, the focus on knowledge and technology places the issue of sectoral boundaries at the centre of analysis. In sectors in which innovation is quite rapid, sectoral boundaries are not fixed but change over time. Knowledge and basic technologies constitute major constraints on the full range of diversity of the behaviors and organizations of firms. Links and complementarities among artifacts and activities also play a major role in defining the real boundaries of a sectoral system. These links and complementarities can be static (as input-output links are) or dynamic. Dynamic complementarities take into account interdependencies and feedback, both at the demand and at the production levels. They are major sources of the transformation and growth of sectoral systems, and may set in motion virtuous cycles of innovation and change.

b. Actors and networks. A sector consists of heterogeneous agents that are organizations or individuals (e.g. consumers, entrepreneurs, scientists). Organizations may be firms (e.g. users, producers and input suppliers) or non-firm organizations (e.g. universities, financial organizations, government agencies, trade unions or technical associations), including subunits of larger organizations (e.g. research and development – R&D – or production departments) or groups of organizations (e.g. industry associations). Agents are characterized by specific learning processes, competencies, beliefs, objectives, organizational structures and behaviors. They interact through processes of communication, exchange, cooperation, competition and command. Within sectoral systems, heterogeneous agents are connected in various ways through market and non-market relationships. The types and structures of relationships and networks differ from sectoral system to sectoral system, as a consequence of the features of the knowledge base, the relevant learning processes, the basic technologies, the characteristics of demand, key links and dynamic complementarities.

Thus, in a sectoral system perspective, innovation and production are considered to be processes that involve systematic interactions among a wide variety of actors for the generation and exchange of knowledge relevant to innovation and its commercialization. Interactions include market and non-market relations that are broader than the market for technological licensing and knowledge, inter-firm alliances, and formal networks of firms. Often their outcome is not adequately captured by our existing ways of measuring economic output.

c. Institutions. Agents' cognition, actions and interactions are shaped by institutions, which include norms, routines, common habits, established