EE

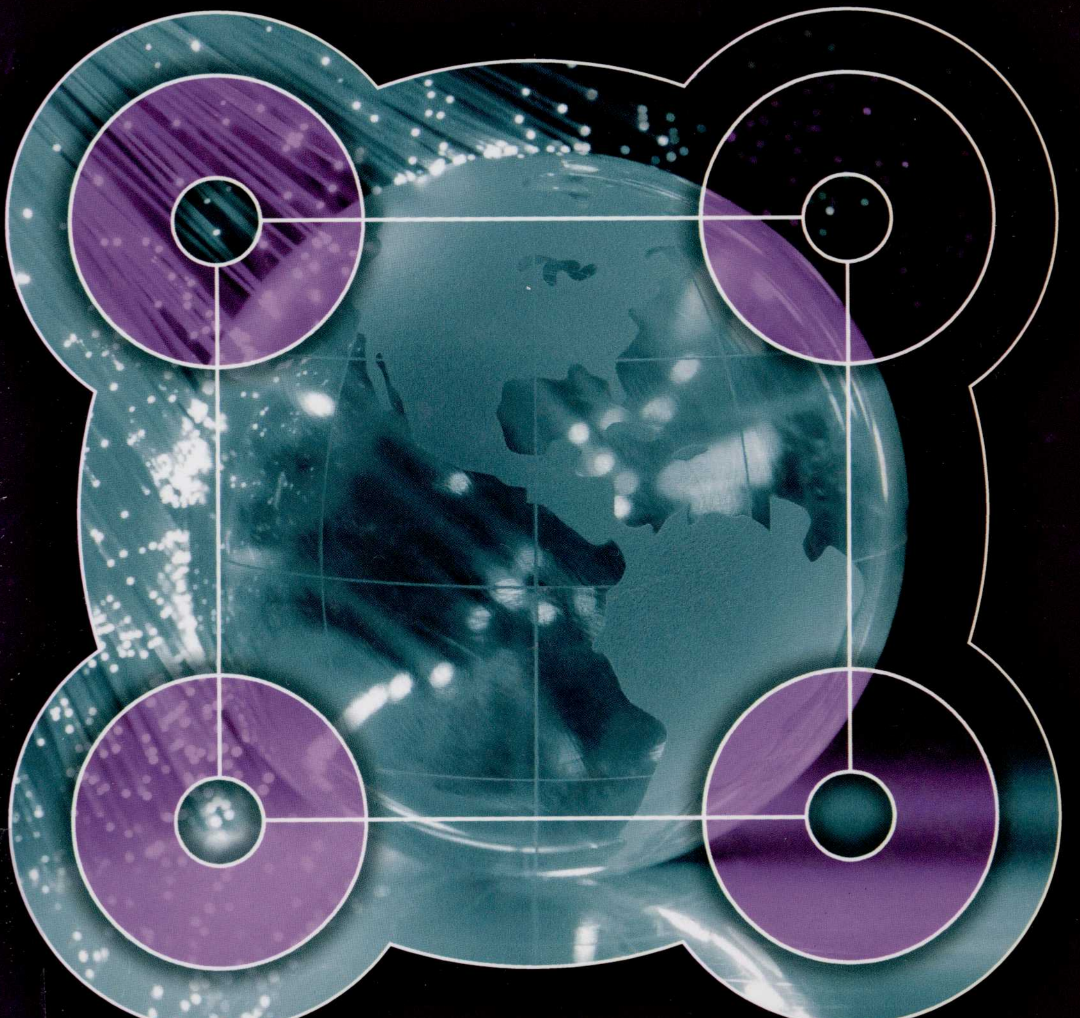
Knowledge Transfer and Technology Diffusion

EDITED BY

PAUL L. ROBERTSON

AND

DAVID JACOBSON



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: 2010934010

MIX
Paper from responsible sources
FSC® C018575

ISBN 978 1 84844 106 4

Typeset by Servis Filmsetting Ltd, Stockport, Cheshire
Printed and bound by MPG Books Group, UK

Contributors

Tine Aage, Region Zealand-Sorø, Denmark

José Albors, Universidad Politecnica de Valencia, Spain

Fiorenza Belussi, University of Padova, Italy

Diego Campagnolo, University of Padua, Italy

Arnaldo Camuffo, Bocconi University, Italy

Bahar Çelikkol Erbas, TOBB University of Economics and Technology, Turkey

Liang-Chih Chen, National Taiwan University, Taiwan

Lorenzo Ciapetti, Antares Research Unit, University of Bologna, Italy

Ali Fikirkoca, Ankara University, Turkey

Francesco Garibaldo, Independent research professional

Guo Yung-Hsing, Chinese Culture University, Taiwan

José L. Hervas-Oliver, Universidad Politecnica de Valencia, Spain

David Jacobson, Dublin City University, Ireland

Staffan Laestadius, Royal Institute of Technology, Stockholm, Sweden

Vicky Long, Royal Institute of Technology, Stockholm, Sweden

Andrea Morrison, URU, Utrecht University and Knowledge, Internationalization and Technology Studies, Università Bocconi

Daniele Porcellato, University of Padova, Italy

Saon Ray, Indian Council for Research on International Economic Relations, New Delhi, India

Thierry Rayna, London Metropolitan University, UK

Paul L. Robertson, University of Tasmania, Australia

Silvia R. Sedita, University of Padova, Italy

Ludmila Striukova, University College London, UK

Arcan Tuzcu, Ankara University, Turkey

Acknowledgements

The editors of this collection would like to thank the contributors for their commitment to the project. They all provided original work for which there were many alternative markets. Others assisted in the process of producing the final product. David Meehan tirelessly and enthusiastically provided bibliographical support from Dublin City University (DCU) library. Elaine Healy, the Research Administrator in DCU Business School, helped in the preparation of the final manuscript. We also wish to thank Keith Smith and Nick von Tunzelmann for advice during the early stages of preparation.

Contents

List of contributors vii
Acknowledgements viii

1. Knowledge transfer and technology diffusion: an introduction 1
Paul L. Robertson and David Jacobson
2. Resources and innovation in low-tech industries: an empirical study of clusters in Spain and Italy 35
José L. Hervas-Oliver and José Albors
3. Inward flows of information and knowledge in low-tech industrial districts: contrasting the 'few firms gatekeeper' and 'direct peer' models 64
Fiorenza Belussi, Silvia R. Sedita, Tine Aage and Daniele Porcellato
4. The role of company networks in low-tech industries 90
David Jacobson and Francesco Garibaldo
5. Technological change, knowledge integration and adaptive processes: the mechatronic evolution of the Reggio Emilia district 107
Lorenzo Ciapetti
6. Globalization and low-technology industries: the case of Italian eyewear 138
Diego Campagnolo and Arnaldo Camuffo
7. Innovation and external knowledge sources in industrial districts: evidence from an Italian furniture cluster 162
Andrea Morrison
8. Engineering versus craftsmanship: innovation in the electric guitar industry, 1945–1984 186
Thierry Rayna and Ludmila Striukova
9. How low- and medium-technology industries in developing countries compete with multinationals: lessons from China's home electronics sector 211
Guo Yung-Hsing
10. New patterns in knowledge transfer and catching up: Chinese R&D in ICT 238
Vicky Long and Staffan Laestadius

11. Technological learning and capability building in LMT industries in newly industrializing countries: selected examples from Taiwan 260
Liang-Chih Chen
12. Understanding regional innovation systems in LMT industries: the case of Turkey as an emerging market economy 280
Ali Fikirkoca, Bahar Çelikkol Erbas and Arcan Tuzcu
13. International technology diffusion and productivity in low- and medium-technology sectors in India 313
Saon Ray

Index 331

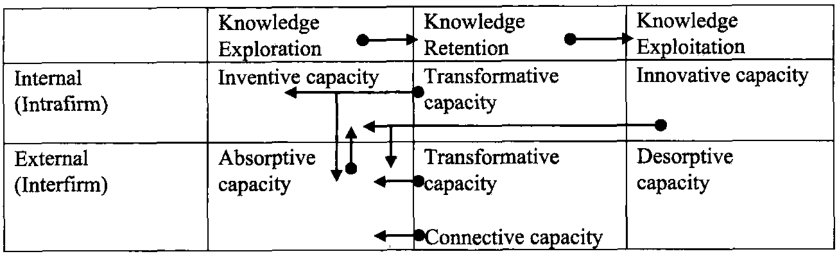
1. Knowledge transfer and technology diffusion: an introduction

Paul L. Robertson and David Jacobson

1. DIFFUSION AND DEVELOPMENT

For present purposes, diffusion can be defined as the spread of knowledge from an original source or sources to one or more recipients. From an economic standpoint, the efficient diffusion of knowledge on new technologies is an essential characteristic of growth and development. In itself, new knowledge has no economic value until it has been used productively – the more widely a particular bit of knowledge can be used, the greater its value becomes (Robertson and Patel, 2007). This is, of course, hardly a secret. Diffusion, along with innovation and implementation, is one of the three building blocks of the influential Linear Model of Innovation (Godin, 2006), but it remains a nebulous field in many respects despite a vast literature on various aspects. The problem is not conceptual so much as practical because, while diffusion is easy to define, it is often difficult to accomplish. As a result, knowledge that might be broadly useful tends to be restricted to narrow areas for unnecessarily long periods of time, retarding economic performance.[1]

Although the Linear Model of Innovation has been discredited in many respects (Kline and Rosenberg, 1986), its basic building blocks of innovation, diffusion and production or implementation remain central to technology studies. Nevertheless, much as was true in the early post-World War II period when the model was originally developed (Godin, 2006), the general thrust of conceptualization and empirical research remains heavily focused on the innovation stage, without much attention given to feedback or other complications. The Linear Model has also been the framework for the New Growth Theory models that have been popular for the past two decades (for example, Romer, 1986, 1990, 1994). The popularity of the Linear Model is easy to explain. In it, the activities surrounding innovation are the triggers for the entire sequence: if innovation is not undertaken wisely, the whole subsequent series of events will be impaired. In addition, innovation has long been characterized as a



Source: Adapted from Lichtenthaler and Lichtenthaler (2009), Figure 1, p. 1318.

Figure 1.1 Knowledge capacities

rational process that, at least up to a point, can be managed. Innovation is therefore regarded as a good target for government policy because, if the Linear Model is accepted, then a smoothly functioning innovation system is assumed to activate a chain of events including diffusion and the ultimate deployment of the new knowledge that has been generated by expenditures on research in pure science and industrial R&D.

The diffusion and use of new knowledge, on the other hand, cannot be schematicized as easily because they are grassroots activities, undertaken in diverse environments in order to meet particular needs which may seem trivial to outsiders but can affect the viability of individual organizations and entire industries. Thus they are messy and irregular processes that are hard to summarize in a few precepts that policy makers can use as levers for change. Furthermore, for analysts of a neo-classical bent, there can be no serious problems surrounding diffusion and implementation because they are assumed to occur automatically in a world of rational and perfectly informed actors.

As Lissoni and Metcalfe (1994) have argued, however, there are several distinct approaches to diffusion. In recent years, these have come together and, '[a] much richer pattern is emerging which distinguishes technology in terms of knowledge and skills as well as discrete artefacts' (p. 106). Newer trends in research are more complex and nuanced, and more attuned to the real world (Tunzelmann, 2002), in which diffusion and implementation are not frictionless, costless or instantaneous. In a recent article, for example, Lichtenthaler and Lichtenthaler (2009) outline a series of 'knowledge capacities' that firms need in order to move through the entire innovation process from planning to implementation (Figure 1.1).[2] These reflect the diverse and non-linear nature of the problems faced over the course of the process.

The categories of knowledge exploration, retention and exploitation do not correspond directly to the Linear Model. In order to engage successfully in receiving knowledge diffused from outside, organizations cannot rely on absorptive capacity alone (Cohen and Levinthal, 1989, 1990). As well as possessing an understanding of externally generated knowledge, it is valuable to establish and maintain external relationships that simplify the search for useful new knowledge (connective capacity) and to be able to put knowledge in a form that meets an organization's particular requirements (innovative capacity). Individually and collectively, these capacities call upon significant management activity to build, coordinate and mobilize the skills that form their foundations. Moreover, different societies – and firms with varying organizational cultures within a single society – are likely to have strengths in different combinations of knowledge capacities. A large part of the managerial mission, therefore, is to identify and develop those capacities that are weak and to ensure that their organizations have the requisite dynamic capabilities (Helfat *et al.*, 2007; Teece, 2009) to create and deploy the full range of knowledge capacities when and where they are needed.

Taken together, these activities encompass a degree of diversity that policy makers and scholars may find daunting. How can they design instruments to encourage diffusion when the mechanisms are so varied and may even be contradictory across different cases? And yet it is clear that diffusion is an essential driver of any system for generating and using technological knowledge. As we argue in Section 2 of this chapter, most organizations in any economy are not at the high technology end of the spectrum, no matter how this is defined. Because these low and medium technology (LMT) organizations account for well over 90 per cent of output and employment in even the most advanced economies, any productivity improvements that they make can, in aggregate, greatly affect overall levels of economic performance and welfare. Equally significant are the very substantial markets that LMT organizations offer for many high-tech products, generating the profits needed to cover past research costs and to encourage future investment in R&D (Robertson *et al.*, 2003). Widespread diffusion of knowledge in LMT sectors is therefore a central cause as well as a result of research leading to high-tech breakthroughs.

In this book, we address several (but by no means all) of the questions associated with diffusion of new knowledge to and within LMT industries, especially by small and medium size firms. Our objective is to expose some of the mechanisms that these firms use in gaining access to new knowledge developed externally and then transforming it for their own purposes. The next two sections briefly outline the importance of new technology to LMT organizations and the role of knowledge in the diffusion process.

These are followed by discussions of innovation in industrial districts (IDs) and of LMT sectors in developing economies. In the final section, we offer suggestions for further research on diffusion.

2. TECHNOLOGICAL INNOVATION IN LOW AND MEDIUM TECHNOLOGY SECTORS

All of the contributions in this book concentrate on technology diffusion in low and medium technology manufacturing sectors. Technology levels are measured by the OECD (Hatzichronoglou, 1997) based on the share of firm revenue that is reinvested in research and development. In high-tech industries, the share is greater than 5 per cent; in medium-high-tech industries, between 3 and 5 per cent; in medium-low-tech industries, between 1 and 3 per cent; and in low-tech industries, less than 1 per cent (Smith, 2005). The assumption is that investment in R&D is directly correlated with the degree of innovation in an industry and with its rate of growth. As innovation and growth are posited to be good for the economy and for society, high technology industries have been granted preferential treatment by governments while the roles of other sectors have been dismissed as being relatively unimportant for welfare (Hirsch-Kreinsen *et al.*, 2006; Robertson *et al.*, 2009).

LMT industries are defined as those that are not high-tech, that is as sectors that devote less than 5 per cent of their revenue to R&D. They include not only most manufacturing production, but almost all branches of the service, agricultural and mining sectors.[3] LMT industries in general are 'mature' in the sense that they are well advanced along their life cycles. Their outputs are usually well-established in the minds of their customers and their rates of growth are no longer high,[4] especially by the standards of high-tech industries. Levels of both product and process innovation tend to be low by conventional measures (Heidenreich, 2009) and, when innovation does occur, it is incremental rather than radical. Taken as a whole, however, LMT sectors are far from technologically stagnant and their role in economic dynamics is very large.

The extent of the attention accorded to high-tech industries and the relative neglect of LMT industries derive from several misunderstandings or logical distortions. Firstly, in an empirical sense, the importance of high-tech sectors to the economy is generally overemphasized. Even in very large economies such as those of the USA, the EU and Japan, high-tech industries rarely account for as much as 10 per cent of manufacturing activity, and their share in services, agriculture and other sectors is substantially lower. Thus only about 1 to 2 per cent of economic output can be attributed to high-tech industries even in advanced economies (Robertson and Patel, 2007). As LMT sectors comprise such overwhelming shares not only of output, but of employment and investment, it is clearly vital to ensure that they perform well. For example, as Sandven *et al.* (2005) have shown, the combined contribution of medium-low and low-tech sectors to growth in OECD member countries in the last two decades of the twentieth century (34.8 per cent) was greater than that of high-tech sectors (32.7 per cent). Furthermore, LMT industries are notable contributors to the well-being of high-tech sectors because they are often their major customers. In the absence of sales to LMT firms, the return on investment in R&D by high-tech firms would be considerably reduced, leading to reductions in R&D expenditures and growth (Robertson and Patel, 2007). Finally, innovations originating in LMT industries are substantial contributors to improved productivity in high-tech sectors, as well as the other way around (Hauknes and Knell, 2009).

These facts point to a major shortcoming in the implicit theorizing favoured by analysts and policy makers who advocate special support for high-tech sectors and effectively disregard the performance of the rest of the economy. Modern market economies do not grow linearly on a sector-by-sector basis, nor is growth simply the result of increased inputs such as larger investments in R&D. Instead, economies operate on the principle of a 'circular flow' (Schumpeter, 1934) in which organizations are both consumers and producers that convert inputs (produced by themselves or bought in the market) into outputs that are then sold to others. Although some developing nations may have 'dual economies' in which modern and traditional sectors are only loosely linked (Robertson *et al.*, 2003), in developed countries the viability of any sector depends ultimately on effective demand, that is on the willingness and ability of consumers to pay for its outputs. Even when external demand from other countries, which may be substantial in some cases, is considered, the point remains that the functioning of a sector is in general heavily dependent on the performance of the economy, broadly or narrowly defined, in which it is embedded. This, in turn, depends on the overall level of efficiency within the economy and not just on the efficiency of any sector regarded in isolation. Improved productivity must be widespread – rather than restricted to a few, generally small, high-tech fields – in order to avoid the creation of bottlenecks that will eventually retard the economy as a whole. The implications of this for most high-tech sectors in advanced economies are even stronger, because the major consumers of their products are, ultimately, in LMT sectors. In short, while high-tech industries are indeed vital to a well functioning economy, their value derives in large part from their interactions with the much larger LMT sectors. Therefore, any set of policies that allegedly favours high-tech over LMT sectors is seriously deficient because a wide range of sectors with varying characteristics must interact efficiently for an entire economy to perform well.

It is also necessary to choose the proper time horizon when formulating policy. Economic sectors expand and contract as technology and other conditions change. To take an obvious example, steam power generation and the production of steam engines have been replaced by electricity and equipment for generating electrical power. Furthermore, it is clear that the growth of most industries slows as markets become saturated, and also that this maturity is often accompanied by a reduction in the rate of innovation (Utterback, 1994). It is rare, however, for new industries of economic significance to replace older ones quickly since high rates of growth are applied to low initial bases. In the meanwhile, older industries continue to be substantial employers and producers of goods that markets demand, even as they reach maturity and their growth levels off. More importantly, some large industries are unlikely to ever be eliminated because they provide products for which there are no satisfactory substitutes. Motor vehicles may have replaced trains for many uses over the course of a century, but the food industry remains at the centre of human life as it has been for thousands of years. The evolution of food processing illustrates our point that technological change in mature LMT industries is a crucial source of economic welfare. Because of the sector's heavy weighting, even modest improvements in productivity can be major contributors to overall economic performance. Thus even as the economy goes through periods of Schumpeterian transformation, in which the main drivers of economic change move from sector to sector, a process which Schumpeter (1939) himself measured in terms of cycles of approximately half a century, it is necessary to keep the core of existing economic activity as healthy as possible by encouraging innovation in the short and medium terms wherever it will yield a positive return.

3. KNOWLEDGE AND DIFFUSION IN LMT SECTORS

Because of their low levels of investment in formal R&D, LMT organizations have always engaged in 'open innovation' (Chesbrough, 2003) – in buying many of their new technologies or otherwise acquiring them from external sources instead of developing them internally. This can raise important issues in product development because a great deal of effort may be needed to successfully blend new and old knowledge, acquired from both internal and external sources (Morone and Taylor, 2010; Oerlemans *et al.*, 2000). For example, as Thierry Rayna and Ludmila Striukova show in Chapter 8 in this volume, the development of the modern electric guitar involved a great deal of experimentation over decades in order to determine which aspects of traditional guitar design and manufacturing were appropriate for the new instruments.

However, in part because of the tendency of low-tech firms in particular to operate in relatively highly saturated markets in which price competition is important, they have tended to emphasize process innovation[5] and to rely heavily on embodied technology as innovations are acquired through the purchase of equipment that includes developments that often originated in other parts of the economy (Pavitt, 1984). But it is naive to believe that innovations can usually be acquired on a 'plug and play' or 'turnkey' basis in which they are useable without any further inputs such as tacit knowledge. In mature industries with well developed asset bases, this is especially unlikely because new equipment frequently needs to be fitted into a larger production process dominated by existing equipment. To ensure compatibility across the entire asset base, adjustments must be made to the new purchases, to the remaining existing assets, or to both. Important modifications in organizational routines (Nelson and Winter, 1982) may also be needed. All of these changes are likely to be organizationally specific because of subtle or large differences in equipment and routines among organizations. As a result, managers may need to develop local solutions even when the problems they face are very general. Of the knowledge capacities referred to in Figure 1.1, this requires at least a combination of absorptive and transformative capacities.

Practices used to promote high-tech innovations in high-tech environments may not be appropriate for LMT organizations (Liagouras, 2010). Tödling *et al.* (2009) suggest that while extensive internal R&D is needed in the introduction of advanced innovations, less internal R&D (largely to maintain absorptive capacity (Cohen and Levinthal, 1990)) is needed for the introduction of products that are only new to the firm (as is common for LMT organizations) and that this is generally accompanied by external knowledge acquired through cooperation with service firms such as suppliers. Limited internal R&D may be supplied by 'peripheral inside innovators' who 'are not responsible for innovative activity by their job description, but nonetheless [are] interested in and [have] the potential to produce innovative ideas and contribute to the innovation process by suggesting, supporting, or refining innovative concepts' (Neyer *et al.*, 2009, 411).

These peripheral inside innovators can be production engineers or mechanics responsible for making the adjustments needed to validate incremental innovations in existing systems. Even when service firms are called upon, the innovating organizations need to contribute to, and to supervise, the introduction of innovations because they are more aware of aspects of technical and strategic requirements than outsiders can be (Brusoni, 2005).

Nevertheless, the main problem in knowledge use by LMT firms may be to find the knowledge in the first place. Even when valuable knowledge is available, this does not mean that organizations that could benefit from its use (problem holders) know where to find it or that recognized paths for locating knowledge are available. Equally importantly, firms that have valuable knowledge that they would like to commercialize (solution holders) do not always have good ways of making contact with possible customers (Robertson, 1998). In the diverse and segmented situations that prevail in modern economies, possible innovations may emanate from a huge number of sources, and while some locations may seem a priori to be more likely to yield valuable results than others, the most important innovations may, in fact, originate in areas that are not often considered (Granovetter, 1973). This is especially important for small organizations that lack the resources needed to meet extensive search (or, in the case of suppliers, advertising) costs, a category that includes most LMT firms both in advanced economies and especially in developing economies.

If LMT organizations are to maintain, or better yet improve their competitiveness, they need to find ways of coping with the knowledge problems that are at the core of innovation. While in some cases, these smaller firms in mature industries are more sceptical of the benefits of change than high-tech firms, their status as 'later adopters' (Rogers, 2003) is the result of their inability to find and implement knowledge that they need to solve problems. The mechanisms used by LMT firms to overcome the obstacles posed by a lack of knowledge (ignorance) in the face of competitive threats by better informed rivals are the main topic of this volume, and are discussed further in Sections 4 and 5 of this chapter.

Networks, especially industrial districts (IDs) and clusters, are a widespread approach to finding a shortcut to locating important knowledge (Beccatini *et al.*, 2009; Porter, 1998). These arrangements allow firms to economize on search costs by creating 'strong ties' (Granovetter, 1973) among firms that formally and informally trade information relatively freely. In practice, however, reduced search costs for smaller firms are available only for information generated within a district, while superior information from outside must be accessed through larger, or 'leading' firms that function as 'gatekeepers' (see the special 'clusters' issue of *Regional Studies*, 2008). As long as the important information is generated within a particular ID or cluster, this is not a problem, but clusters can be vehicles for stagnation when important innovations are beyond the normal channels cultivated by the gatekeepers (Menzel and Fornahl,

2010) or when the gatekeepers do not share their new knowledge equally among district firms but favour some over others. Membership in multiple networks may reduce this problem to some extent (Robertson and Smith, 2008), but cannot guarantee that sources of innovation are tapped efficiently.

The schema of Lichtenthaler and Lichtenthaler (2009) helps to tie these threads together by acknowledging the relationships between internal and external capabilities for finding and processing knowledge in innovative situations (Figure 1.1). All of the knowledge capacities that they discuss reside within an organization even if some of the knowledge has originated externally. As they demonstrate, if organizations are to innovate successfully – as they must in general do in competitive situations – they cannot expect outsiders to do all of the work for them, even if they pay for the services: organizations need to develop their own knowledge skills in order to make sense of other people's knowledge. Furthermore, this is a dynamic process in that areas of ignorance may not become evident until firms need to cope with newly acquired knowledge.

Thus 'transformative capacity' (Figure 1.1) refers to an organization's ability to retain and recycle knowledge after it has been internalized, to make sure that nothing useful is lost from a growing database of knowledge. This growing fund of knowledge[6] then feeds back into absorptive capacity in order to increase an organization's ability to acquire external knowledge in the future. Organizations use 'connective capacity' to maintain relationships with external knowledge sources and to improve their chances of gaining future access to knowledge held by partners if they need to, perhaps transferring some of their own knowledge to ease the process. This again should strengthen absorptive capacity in the future. Finally, 'innovative capacity' is the ability to use new knowledge to create new solutions, while a firm's 'desorptive capacity' refers to its skill in marketing knowledge that it has generated internally. This may be restricted to new product development, as Lichtenthaler and Lichtenthaler suggest, but it can also extend to process improvements and to making adjustments to improve the assimilation of knowledge and artefacts (embodied technology) brought in from external sources. Taken together, these capacities frame the general guidelines for knowledge acquisition and deployment by LMT organizations while emphasizing that each stage also involves learning in order to make adequate use of knowledge gained in the past.

The following two sections discuss how LMT firms in industrial districts and in developing countries are responding to competitive pressures to modify their current roster of capacities to engage in innovation. As most of the contributions to the volume are case studies, they provide a rudimentary foundation for a set of techniques that LMT firms can use to improve knowledge diffusion and their own innovative capabilities in the future.

4. DIFFUSION IN SPATIAL AGGLOMERATIONS

There is a huge and growing literature on clusters and industrial districts, and on the impact of spatial proximity on the success of these spatial agglomerations.[7] There are two broad types of concentrations of firms, one in which the firms are from a variety of different industries or sectors, and the other in which they are from the same or closely related industries or sectors. The processes leading to the first – different sectors and sub-sectors of manufacturing and services – are associated with the development of cities. The second, more industrially homogeneous concentrations of firms, are known as industrial agglomerations (Jacobson *et al.*, 2002). In this book, we are concerned mainly with the latter.

As a dynamic process, industrial agglomeration is what happens when firms set up close to other firms to derive certain benefits. Marshall (1920) addressed these benefits as the three advantages of localization. In the context of diffusion, the most important is where people involved in the same industry live and work in close proximity to one another, so that new products, 'and improvements in machinery, in processes and the general organization of the business' become quickly known and copied (Marshall, 1920, iv.x.7). This is what Krugman (1993, 52) refers to as technological spillovers, 'the more or less pure externality that results from knowledge spillovers between firms'.

Marshall's (1920) other two advantages of agglomeration are: the 'growth of subsidiary trades', where both firms in an industry and those producing intermediate products are close to one another; and the development of a local labour market of relevant skills, or labour market pooling. These may also enhance diffusion of innovations; an innovation by a spatially proximate supplier of inputs – especially of such key inputs as machinery – will quickly diffuse to all the local users through face-to-face communication. And new skills will similarly diffuse rapidly among similarly qualified and/or experienced workers living and working in close proximity.[8]

These ideas are in essence about how social aspects of a community impinge on economics. Without prioritizing either social or economic factors, it can be suggested that economic interactions are in some sense embedded in the structures of social relations (Granovetter, 1985). Marshall's ideas suggest, further, that the degree of embeddedness may be related to innovation and the rate of diffusion. We address this issue later in this section.

Marshall's (1920) 'growth of subsidiary trades' is similar to what Porter calls 'related and supporting industries' (Porter, 1998). These are producers of inputs, or providers of services that are used by the industry. They may also include industries that use the same or similar inputs, machinery or skills. Aircraft production and automotive production are, for example, both customer industries of the machine tool industry.

Marshall's ideas have been used extensively to explain 'industrial districts'; indeed he was the first to provide both the conceptual and empirical explanations for IDs. Industrial districts were noticed in the post-World War II period as locations, typically villages, especially in Emilia-Romagna in Italy, where 'a myriad of firms specialized in various stages of the production of a homogeneous product, often using flexible production technology and connected by extensive local inter-firm linkages' (Andreosso and Jacobson, 2005, 192[9]). As small, owner-managed firms, often with other members of the family also working in the firm, their internal communication lines are short. In addition, flexible production requires most people working in the firm to be able to do most of the jobs. Organizationally, this implies an absence of long top-down chains of authority: firms in industrial districts have relatively flat organizational structures. Between firms, while there is competition at some levels, at others the activities of these independent firms are strongly coordinated; they contribute to the production of the same good within the same geographical area (for example, toys in Canneto sull'Oglio in Lombardy). These geographically defined districts are said to form a 'social and economic whole' and were at least in part responsible for the rejuvenation of the dormant economy of the Third Italy (Best, 1990, Ch. 7).

A key factor in the success of IDs has been the large number of independent, owner-run firms, with constant experimentation and rapidly circulating information, all of which produced 'an environment favouring imitation of the right strategies and innovative change' (Bigarelli and Crestanello, 1994). At least at certain phases in the evolution of IDs, they have been extremely successful; that success is based mainly on the extent to which their structures facilitated rapid diffusion of innovations of all kinds. Although their industries are mainly LMT, and although there is very little R&D in IDs, there is a great deal of evidence of this innovation and its diffusion. The chapters on IDs in this volume add substantially to this evidence.

Porter (1990) is generally credited with having introduced the 'cluster' concept. Where a relatively large number of independent firms are located close to one another, and are involved in the same or associated industries,