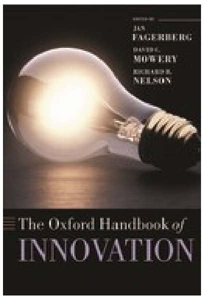

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CHAPTER

11 The Geography of Innovation: Regional Innovation Systems

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Abstract

The process of knowledge production exhibits a very distinctive geography. This article argues that this geography is fundamental, not incidental, to the innovation process itself: that one simply cannot understand innovation properly if one does not appreciate the central role of spatial proximity and concentration in this process. The goal of this article is to demonstrate why this is true, and to examine how innovation systems at the subnational scale play a key part in producing and reproducing this uneven geography over time. This article addresses four key issues. First, it looks at the reason why location matters when it comes to innovative activity. Second, it turns to examine regional innovation systems, and the role played by them in generating and circulating new knowledge leading to innovation. Third, the article considers the relationship between regional systems of innovation and institutional frameworks at the national level. Finally, the relationship between local and global knowledge flows is examined.

Keywords: geography, innovation process, spatial proximity, innovative activity, regional innovation systems

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11.1 Introduction

THERE are two paradoxical characteristics of the contemporary global economy. First, innovative activity is not uniformly or randomly distributed across the geographical landscape. Indeed, the more knowledge-intensive the economic activity, the more geographically clustered it tends to be. The best examples include industries such as biotechnology or financial services, which have become ever more tightly clustered in a small number of major centers, despite the attempts of many other places to attract or generate their own activities in these sectors. Second, this tendency toward spatial concentration has become more marked over time, not less (Leyshon and Thrift 1997; Feldman 2001; Cortright and Mayer 2002). This reality contradicts longstanding predictions that the increasing use of information and communication technologies would lead to the dispersal of innovative activity over ↳ time. Given these rather striking
p. 292 stylized facts, it would appear that the process of knowledge production exhibits a very distinctive geography.

We argue in this chapter that this geography is fundamental, not incidental, to the innovation process itself: that one simply cannot understand innovation properly if one does not appreciate the central role of spatial proximity and concentration in this process. Our goal is to demonstrate why this is true, and to examine how innovation systems at the subnational scale play a key part in producing and reproducing this uneven geography over time.

This chapter addresses four key issues. First, why does location "matter" when it comes to innovative activity? If one considers the production and circulation of new knowledge to be the core of innovation, then it is important to have a sound understanding of the nature of the different types of knowledge involved and their geographical tendencies. Second, what are regional innovation systems, and what role do they play in generating and circulating new knowledge leading to innovation? Third, what is the relationship between regional systems of innovation and institutional frameworks at the national level? Finally, what is the relationship between local and global knowledge flows, and is there any evidence that the global nature of today's economy has weakened or altered the influence of proximity on the geography of innovation?

11.2 Types of Knowledge and their Geographies

A growing body of thought argues that in a competitive era in which success depends increasingly upon the ability to produce new or improved products and processes, tacit knowledge constitutes the most important basis for innovation-based value creation (Pavitt 2002). As Maskell and Malmberg (1999: 172) have put it, when everyone has relatively easy access to explicit/codified knowledge, the creation of unique capabilities and products depends on the production and use of tacit knowledge:

> Though often overlooked, a logical and interesting consequence of the present development towards a global economy is that the more easily codifiable (tradable) knowledge can be accessed, the more crucial does tacit knowledge become for sustaining or enhancing the competitive position of the firm.... In other words, one effect of the ongoing globalisation is that many previously localised capabilities and production factors become ubiquities. What is not ubiquified, however, is the non-tradable/non-codified result of knowledge creation—the embedded tacit
> p. 293 knowledge that at a given time can only be produced in practice. The ↳ fundamental exchange inability of this type of knowledge increases its importance as the internationalisation of markets proceeds.

Implicit in the above quote is a fundamentally spatial argument: tacit knowledge is a key determinant of the *geography* of innovative activity. There are two closely related elements to this argument. First, because it defies easy articulation or codification (Polanyi 1958, 1966), tacit knowledge is difficult to exchange over long distances. It is heavily imbued with meaning arising from the social and institutional context in which it is produced, and this context-specific nature makes it spatially sticky (Gertler 2003). The second relates to the changing nature of the innovation process itself and, in particular, the growing importance of socially organized learning processes. The argument here is that innovation has come to be based increasingly on the interactions and knowledge flows between economic entities such as firms (customers, suppliers, competitors), research organizations (universities, other public and private research institutions), and public agencies (technology transfer centers, development agencies). This is fundamental to Lundvall and Johnson's (1994) learning economy thesis, and is especially well reflected in their concept of "learning through interacting." When one combines these two features of the innovation process—the centrality of "sticky," context-laden tacit knowledge and the growing importance of social interaction—it becomes apparent why geography now "matters" so much.

The recent literature on learning regions further explores the character and geographical consequences of tacit knowledge (see Lundvall and Johnson 1994; Florida 1995; Asheim 1996, 2001; Morgan 1997; Cooke and Morgan 1998; Lundvall and Maskell 2000). It argues that tacit knowledge does not "travel" easily because its transmission is best shared through face-to-face interaction between partners who already share some basic commonalities: the same language; common "codes" of communication and shared conventions and norms that have been fostered by a shared institutional environment; and personal knowledge of each other based on a past history of successful collaboration or informal interaction. These commonalities are said to serve the vital purpose of building trust between partners, which in turn facilitates the local flow of tacit (and codified) knowledge between partners.

This approach adopts the learning-by-interacting model as the cornerstone of its conceptual framework, and argues that the production of tacit knowledge occurs simultaneously with the act of transmission—primarily through the mechanism of user–producer interaction (Lundvall 1988; Gertler 1995). According to this perspective, knowledge does not flow unidirectionally from technology producers to users. Instead, users provide tacit and proprietary, codifiable knowledge to producers in order to enable the latter to devise innovative solutions to users' practical problems. But at the same time, by supplying users with innovative technologies, producers are also sharing their tacit and other proprietary knowledge with their customers. p. 294 The end product arising from this close interaction benefits both users and producers, ↳ and embodies within it new knowledge that could not have been produced by either party working in isolation. This, in effect, describes a social process of joint innovation and knowledge production.

Lam (1998, 2000) points out that the skills required for effective knowledge transfer within collective learning processes are highly time- and space-specific. Interactive, collective learning is based on compatible intra- or interorganizational routines, tacit norms and conventions regulating collective action as well as tacit mechanisms for the absorption of codified knowledge. This requires that the actors in question have a shared understanding of "local codes," on which collective tacit as well as disembodied codified knowledge is based (Asheim 1999; Lundvall 1996). Thus, the ability to interpret local codes in consistent ways will be critical for the integration of the operations of a firm within a local interfirm learning network.

Since spatial proximity is key to the effective production and transmission/sharing of tacit knowledge, this reinforces the importance of innovative clusters, districts, and regions. Moreover, as Maskell and Malmberg (1999) point out, these regions also benefit from the presence of localized capabilities and intangible assets that further strengthen their centripetal pull (Dosi 1988; Storper 1997). Many of these are social assets—i.e. they exist between rather than within firms. Although they are therefore not fully appropriable by individual firms, only local firms can enjoy their benefits. These assets include the region's unique institutional endowment, which can act to support and reinforce local advantage. Because such assets evolve slowly over time, exhibiting strong tendencies of path-dependent development (David 1994; Zysman 1994), they may prove to be very difficult to emulate by would-be imitators in other regions, thereby preserving the initial advantage of "first mover" regions. Maskell and Malmberg argue (1999: 181):

> It is the region's distinct institutional endowment that embeds knowledge and allows for knowledge creation which—through interaction with available physical and human resources—constitutes its capabilities and enhances or abates the competitiveness of the firms in the region. The path-dependent nature of such localised capabilities makes them difficult to imitate and they thereby establish the basis of sustainable competitive advantage.

We discuss the precise nature of this "distinct institutional endowment" in the following section of this chapter. Before doing so, however, it is important to explore further the different types of knowledge base in the economy, since the precise roles of tacit and codified (or codifiable) knowledge tend to differ accordingly.

11.2.1 Industrial Knowledge Bases

When one considers the actual knowledge base of various industries and sectors of the economy, it is clear that knowledge and innovation have become increasingly complex in recent years. There is a larger variety of knowledge sources and inputs to p. 295 ↳ be used by organizations and firms, and there is more interdependence and a finer division of labour among actors: individuals, companies, and other organizations (Cowan et al. 2000). Nonaka and Takeuchi (1995) and Lundvall and Borrás (1999) have pointed out that the process of knowledge generation and exploitation requires a dynamic interplay between, and transformation of, tacit and codified forms of knowledge as well as a strong interaction of people within organizations and between them. Thus, these knowledge processes have become increasingly inserted into various forms of networks and innovation systems—at regional, national and international levels (see Ch. 3 by Powell and Grodal in this volume for a discussion of the role of networks in innovation).

Despite the general trend towards increased diversity and interdependence in the knowledge process, Pavitt (1984) and others have argued that the innovation process of firms is also strongly shaped by their *specific* knowledge base, which tends to vary systematically by industrial sector (see also Ch. 1 by Fagerberg and Ch. 15 by von Tunzelmann and Acha, in this volume). For the purposes of this chapter, we distinguish between two types of knowledge base: "analytical" and "synthetic" (Laestadius 1998). These types entail different mixes of tacit and codified knowledge, as well as different codification possibilities and limits. They also imply different qualifications and skills, reliance on different organizations and institutions, as well as contrasting innovation challenges and pressures.[1]

A synthetic knowledge base prevails in industrial settings where innovation takes place mainly through the application or novel combination of existing knowledge. Often this occurs in response to the need to solve specific problems arising in the interaction with clients and suppliers. Industry examples include specialized industrial machinery, plant engineering, and shipbuilding. R&D is in general less important than in other sectors of the economy. When it occurs, it tends to take the form of applied research, but more often it involves incremental product or process development related to the solution of specific problems presented by customers (von Hippel 1988). University–industry links are relevant, but they are clearly more significant in the realm of applied research and development than in basic research. Knowledge is created less in a deductive process or through abstraction than through an inductive process of testing, experimentation, computer-based simulation, or practical work. Knowledge embodied in the respective technical solution or engineering work is at least partially codified. However, tacit knowledge seems to be more important than in other types of activity, due to the fact that knowledge often results from experience gained at the workplace, and through learning by doing, using, and interacting. Compared to the second knowledge type ("analytical") described below, more concrete know-how, craft and practical skill is required in the knowledge production and circulation process. These forms of knowledge are often provided by professional and polytechnical schools, or by on-the-job training.

The innovation process for industries with a synthetic knowledge base tends to be oriented towards the
p. 296 efficiency and reliability of new solutions, or the practical ↳ utility and user-friendliness of products from the perspective of the customers. Innovation-related activities are dominated by the modification of existing products and processes. Since these types of innovation are less disruptive to existing routines and organizations, most of them take place in existing firms, making spin-offs and new firm formation for the development and exploitation of new synthetic knowledge relatively infrequent.

In contrast, an analytical knowledge base dominates economic activities where scientific knowledge is highly important, and where knowledge creation is often based on formal models, codified science and rational processes. Prime examples are biotechnology and information technology. Both basic and applied research, as well as the systematic development of products and processes, are central activities in this form of knowledge production. Companies typically have their own in-house R&D departments but they also rely on the research output of universities and other research organizations in their innovation process. University–industry links and networks are thus important, and this type of interaction is more frequent than in the synthetic type of knowledge base. Knowledge inputs and outputs in this type of knowledge base are more often codified (or readily codifiable) than in the case of synthetic knowledge. This does not imply that tacit knowledge is irrelevant, since both kinds of knowledge are always involved in the process of knowledge creation and innovation (Nonaka et al. 2000, Johnson, Lorenz, and Lundvall 2002).

The importance of codification in analytic knowledge reflects several factors: knowledge inputs are often based on reviews of existing (codified) studies, knowledge generation is based on the application of widely shared and understood scientific principles and methods, knowledge processes are more formally organized (e.g. in R&D departments), and outcomes tend to be documented in reports, electronic files, or patent descriptions. Knowledge application takes the form of new products or processes, which are more likely to constitute radical innovations than in those industries for which synthetic knowledge constitutes the principal knowledge base. New firms and spin-off companies (i.e. new market entrants rather than existing firms) are an important conduit for the application of knowledge embodied in these radically new inventions or products.[2]

How is the importance of tacit, as opposed to codified, knowledge, as well as the geography of innovation, affected by this differential importance of synthetic and analytical knowledge bases across industries and technologies? Clearly, the "learning through interacting" scenario at the core of the learning economy and learning regions thesis seems to be based implicitly on activities for which synthetic forms of knowledge are central. For instance, many of Lundvall's (1988) original examples come from the realm of mechanical engineering and specialized industrial machinery, where non-linear, iterative interaction between users and producers represents the primary mode of innovation. For such economic activities, the spatial concentration of interacting firms sharing a common social and institutional context is an obvious
p. 297 prerequisite to socially organized, interactive learning ↳ processes (Gertler 2004). But what about those sectors for which analytical knowledge is pre-eminent? Given the greater prominence of codified and codifiable knowledge in the innovation process, might we not expect innovation processes within analytically based industries to be more widely distributed spatially?

Apparently not. For starters, economists have produced much striking evidence about the highly uneven geography of innovation in analytically based activities. One important approach proceeds by measuring knowledge spillovers through the use of indicators such as patent citations.[3] For example, in their classic study, Jaffe et al. (1993) find evidence that patent applicants in analytically based industries cite other patents originating in the same city more frequently than they cite patents originating non-locally.

Furthermore, they find that patent citations are more likely to be localized in the first year following the establishment of the patent, with the effect fading over time, as the knowledge diffuses more widely.

A related approach tracks knowledge spillovers in analytically based industries such as biotechnology and pharmaceuticals through the analysis of "star scientists." Zucker, Darby, and colleagues have tracked the location of these highly productive scientists and their impact on innovation in the local economy, demonstrating that the rates of start-up of new biotech firms are significantly higher in those regions in which these key scientists live and work (Zucker and Darby 1996; Zucker, Darby, and Armstrong 1998; Zucker, Darby, and Brewer 1998). Moreover, firms that have established working relationships with star scientists outperform firms that do not enjoy this kind of access, in terms of productivity growth, new product development, and employment growth.

Both of these sets of findings strongly suggest that in fact the innovation process in industries based on analytical forms of knowledge is no less spatially concentrated than those forms of innovative economic activity based on synthetic types of knowledge. Indeed, if anything, there is compelling evidence to suggest that the former may exhibit an even higher degree of geographical concentration than the latter (Cortright and Mayer 2002).[4]

How can one explain this counterintuitive finding? What are the processes underlying innovation in analytically based industries that explain their distinctive and highly uneven geography? There are three principal forces at work here. First, it is clear that, despite the importance of codifiable knowledge in analytically oriented sectors, the circulation of new knowledge remains highly localized, as the economic literature on knowledge spillovers (reviewed above) attests. This is because these spillovers occur first, fastest and most readily within established local social networks of scientists—often by word of mouth, well before formal results are published in widely accessible outlets. Some forms of valuable knowledge are almost never transmitted non-locally. For example, knowledge concerning failures in scientific experiments is rarely, if ever, published. Yet, the knowledge that a particular research strategy failed to yield expected results can save research teams considerable time and expense if it prevents them from pursuing unproductive lines of inquiry ↳ (Enright 2003). The existence of this type of localized knowledge circulation—underpinned by commonly shared frames of experience and understandings—has been highlighted in the recentwork of Storper and Venables (2003), who have coined the term "buzz" to capture this phenomenon.

Second, the central importance of highly educated (and potentially footloose) workers in the production of innovations in analytically based industries means that those places that offer the most attractive employment opportunities will be favored over others. Only a relatively small number of places offer a local labor market that is sufficiently rich and deep to promise not just one but a series of challenging employment opportunities in which these people canwork at the cutting edge for well-known firms or research institutes (Florida 2002*a*). In otherwords, theseworkers are attracted to those places that offer this kind of career-based "buzz," and where they can also find a critical mass of people working in the same or similar occupational categories. Once a particular place becomes recognized by such workers for its portfolio of attractive employment prospects, as well as by employers for its deep pool of highly skilled labor, increasing-returns dynamics will generate a powerful virtuous circle of long-term growth and dynamism for analytically based sectors.

Third, those locations that offer a high quality of life in addition to attractive career opportunities will have an even more marked advantage in the "battle for talent." These highly talentedworkers can live in many places, but they tend to choose to live in those cities that offer a high quality of place, defined by a particular social character. According to Florida (2002*b*), such places are imbued with a critical mass of creative activity and workers, strong social diversity (measured in terms of ethnic or national origin) and tolerance (best indicated by, for example, a large gay population). Florida argues that such places have low barriers to entry for talented newcomers from diverse social backgrounds, making it easy for them to gain entry to local social networks and labor markets. They are also likely to offer colorful, attractive neighborhoods and cultural amenities that further enhance the attractive power of such places. The more highly educated (and creative) the worker, the stronger this effect will be. Hence, in those industries with the most knowledge-intensive workforce, we ought to find the strongest degrees of geographical concentration.

11.3 Regional Innovation Systems and Localized Learning

Having presented the most important arguments to explain the consistent tendency towards the
p. 299 geographical concentration of innovative activities, we turn now to ↳ consider the role of innovation systems at the subnational level in fostering and promoting this process.

The concept of a regional innovation system (RIS) is a relatively new one, having first appeared in the early 1990s (Asheim 1995, Asheim and Isaksen 1997; Cooke 1992, 1998, 2001), following Freeman's use of the innovation system concept in his analysis of Japan's economy (Freeman 1987), and at approximately the same time that the idea of the national innovation system was examined in books by Lundvall (1992) and Nelson (1993). As this chronology suggests, the regional innovation system concept was inspired by the national innovation system concept, and it is based on a similar rationale that emphasizes territorially based innovation systems.[5]

One such rationale stems from the existence of technological trajectories that are based on "sticky" knowledge and localized learning within the region. These can become more innovative and competitive by promoting stronger systemic relationships between firms and the region's knowledge infrastructure. A second rationale stems from the presence of knowledge creation organizations whose output can be exploited for economically useful purposes by supporting newly emerging economic activity. The emergence of the concept of a regional innovation system coincides with the success of regional clusters and industrial districts in the post-Fordist era (Asheim 2000; Asheim and Cooke 1999; Piore and Sabel 1984; Porter 1990, 1998), and the elaboration of the concept represents an attempt by students of the geographical economy to understand better the central role of institutions and organizations in promoting innovation-based regional growth (Asheim et al. 2003; Gertler and Wolfe 2004).[6]

The regional innovation system can be thought of as the institutional infrastructure supporting innovation within the production structure of a region. Taking each element of the term in turn (Asheim and Cooke 1999), the concept of region highlights an important level of governance of economic processes between the national level and the level of the individual cluster or firm. Regions are important bases of economic coordination at the meso-level: "the region is increasingly the level at which innovation is produced through regional networks of innovators, local clusters and the cross-fertilizing effects of research institutions" (Lundvall and Borrás 1999: 39). In varying degrees, regional governance is expressed in both private representative organizations such as branches of industry associations and chambers of commerce, and public organizations such as regional agencies with powers devolved from the national (or, within the European Union, supranational) level to promote enterprise and innovation support (Asheim et al. 2003; Cooke et al. 2000).

The systemic dimension of the RIS derives in part from the team-like character associated with innovation in networks. Although an innovation system is a set of relationships between entities or nodal points involved in innovation (see Lundvall 1992 for more discussion), it is much more than this. Such relationships, to be systemic, must involve some degree of interdependence, though to varying degrees.
p. 300 Likewise, not all such systemic relations need be regionally contained, but many are.[7] ↳ As the interactive mode of innovation grows in importance, these relations are more likely to become regionally contained, especially in the case of specialized suppliers with a specific technology or knowledge base. Such suppliers

often depend on tacit knowledge, face-to-face interaction and trust-based relations and, thus, benefit from cooperation with customers in regional clusters, while capacity subcontractors are increasingly sourced globally.[8] Further reinforcing the systemic character of the RIS is the prevalence of a set of attitudes, values, norms, routines, and expectations—described by some as a distinctive "regional culture"—that influences the practices of firms in the region. As noted earlier, it is this common regional culture—itself the product of commonly experienced institutional forces—that shapes the way that firms interact with one another in the regional economy.

11.3.1 Varieties of Regional Innovation Systems

The "innovation system" concept can be understood in both a narrow as well as a broad sense (see Ch. 7 by Edquist, in this volume). A narrow definition of the innovation system primarily incorporates the R&D functions of universities, public and private research institutes and corporations, reflecting a top-down, linear model of innovation as exemplified by the triple helix approach (Etzkowitz and Leydesdorff; 2000). A broader conception of the innovation systems includes "all parts and aspects of the economic structure and the institutional set-up affecting learning as well as searching and exploring" (Lundvall 1992: 12). This broad definition incorporates the elements of a bottom-up, interactive innovation model of the sort described in our earlier discussion of the "learning regions" concept.

In order to reflect the conceptual variety and empirical richness of the relationships linking the production structure to the "institutional set-up" in a region, Asheim (1998) distinguishes among three types of RISs (see also Cooke 1998; Asheim and Isaksen 2002). The first type may be denoted as *territorially embedded regional innovation systems*, where firms (primarily those employing synthetic knowledge) base their innovation activity mainly on localized learning processes stimulated by geographical, social and cultural proximity, without much direct interaction with knowledge organizations. This type is similar to what Cooke (1998) calls "grassroots RIS," and implies the broader definition of innovation systems described by Lundvall (1992) above.

The best examples of *territorially embedded regional innovation systems* are networks of SMEs in industrial districts. Thus in Italy's Emilia-Romagna, for example, the innovation system can be described as territorially embedded in spatial structures of social relations within that particular region (Granovetter 1985). These territorially embedded systems provide bottom-up, network-based support through, for
p. 301 example, technology centers, innovation networks, or industry centers ↳ providing market research and intelligence services, to promote the "adaptive technological and organizational learning in territorial context" (Storper and Scott 1995: 513).

Another type of RIS is the *regionally networked innovation system*. The firms and organizations are still embedded in a specific region and characterized by localized, interactive learning. However, policy interventions lend these systems a more planned character through the intentional strengthening of the region's institutional infrastructure—for example, through a stronger, more developed role for regionally based R&D institutes, vocational training organizations, and other local organizations involved in firms' innovation processes. The networked system is commonly regarded as the ideal type of RIS: a regional cluster of firms surrounded by a regional "supporting" institutional infrastructure. Cooke (1998) also calls this type "network RIS." The network approach is most typical of Germany, Austria, and the Nordic countries.

Box 11.1 Baden-Württemberg's regionally networked innovation system

The German state of Baden-Württemberg is one of the country's most prosperous regions. It is home to some of Germany's most important mechanical engineering firms, including Daimler-Chrysler, Porsche, and Robert Bosch. These firms are well supported by a highly developed network of small and medium-sized enterprise specializing in the development, production, and supply of components, machinery, and systems, within a finely articulated social division of labor. Their most important local competence is their ability to solve the complex technological problems of their customers, resulting in custom-designed solutions or improvements to existing products and processes. While analytical knowledge is not irrelevant, synthetic knowledge predominates throughout this set of industries.

Given the importance of these supplier firms to the competitiveness of the region's large, flagship firms (and hence, to the overall performance of the regional economy), the regional innovation system has evolved to produce and diffuse these competencies in incremental mechanical engineering innovation. The most important elements of this regionally networked innovation system are:

- A strong vocational education, apprenticeship, and training system that produces a highly skilled and versatile work force.
- A well-developed infrastructure for technology transfer, incorporating both basic research facilities and market-oriented development, with special focus on the needs of SMEs. The Steinbeis Foundation operates a region-wide network of tech-transfer offices to help SMEs solve technical problems.
- A well-organized Chamber of Commerce (IHK), in which membership is mandatory. Among other responsibilities, the Chamber plays a leading role in co-ordinating the design of training programs tailored to local industry's needs.
- Highly developed and specialized, regionally organized producer associations. These organizations conduct research on market trends, economic forecasting and emerging, market-ready technologies on behalf of producer firms.

In addition to these regionally based elements, the entire regional innovation system is embedded within a national regulatory framework that reinforces innovative activity at the regional scale. The most important features of this system are:

- Labor market structures that foster stable employment relations, facilitating learning by doing and strengthening employers' incentives to train.
- An industrial relations system that formalizes worker participation in day-to-day and longer-term strategic decision making, enabling employers to harness workers' tacit knowledge acquired through learning by doing and using.
- Centralized collective bargaining systems that minimize interfirm variation in wage and benefit levels, inducing firms to compete on the basis of quality and innovativeness.
- Capital market structures that encourage longer-term time horizons in firm-level decision making, thus further reinforcing stability in the workplace.

Sources: Morgan (1999); Gertler (2004).

The regionally networked innovation system is a result of policy intervention to increase innovation capacity and collaboration. SMEs, for example, may have to supplement their informal knowledge (characterized by a high tacit component) with competence arising from more systematic research and development in order to carry out more radical innovations. In the long run, most firms cannot rely exclusively on informal localized learning, but must also gain access towider pools of both analytical and synthetic knowledge on a national and global basis. The creation of regionally networked innovation systems through increased cooperation with local universities and R&D institutes, or through the establishment of technology transfer agencies and service centers, may provide access to information and competence that supplements firms' locally derived competence. This not only increases their collective innovative capacity, but may also serve to counteract technological "lock-in" (the inability to deviate from an established but outmoded technological trajectory) within regional clusters of firms.

The third main type of RIS, the *regionalized national innovation system*, differs from the two preceding types in several ways. First, parts of industry and the institutional infrastructure are more functionally integrated into national or international innovation systems—i.e. innovation activity takes place primarily in cooperation with actors outside the region. Thus, this represents a development model in which exogenous actors and relationships play a larger role. Cooke (1998) describes this type as "dirigiste RIS," reflecting a narrower definition of an innovation system incorporating mainly the R&D functions of universities, research institutes, and corporations. Second, the collaboration between organizations within this type of RIS conforms more closely to the linear model, as the cooperation primarily involves specific projects to develop more radical innovations based on formal analytical–scientific knowledge. Within such systems, p. 303 cooperation is most ↳ likely to arise between people with the same occupational or educational background (e.g. among engineers). This functional similarity facilitates the circulation and sharing of knowledge through "communities of practice," whose membership may cross inter-regional and even international boundaries (Amin and Cohendet 2004).

One special example of a *regionalized national innovation system* is the clustering of R&D laboratories of large firms and/or governmental research institutes in planned "science parks." These may be located in close proximity to universities and technical colleges, but the evidence suggests that science park tenants typically have limited linkages to local industry (Asheim 1995). Science parks are, thus, a typical example of a planned innovative milieu comprised of firms with a high level of internal resources and competence, situated within weak local cooperative environments. These parks have generally failed to develop innovative networks based on interfirm cooperation and interactive learning within the science parks themselves (Asheim and Cooke 1998; Henry et al. 1995). Technopoles, as developed in countries such as France, Japan, and Taiwan, are also characterized by a limited degree of innovative interaction between firms within the pole, and by vertical subcontracting relationships with non-local external firms. In those rare cases where local innovative networks arise, they have normally been orchestrated by deliberate public sector intervention at the national level. These characteristics imply a lack of local and regional embeddedness, and lead us to question the capability of science parks and technopoles to promote innovativeness and competitiveness more widely within local industries (especially SMEs) as a prerequisite for endogenous regional development[9] (Asheim and Cooke 1998; and Longhi and Quére 1993).

11.4 The Relationship Between Regional and National Innovation Systems

Recent work applying the RIS concept has begun to explore the linkage between the larger institutional frameworks of the national innovation system and national business system, and the character of regional innovation systems. This question has recently been addressed by Cooke (2001) in studies of biotechnology in the UK, the USA, and Germany. Cooke has introduced a distinction between the traditional regional innovation system (which he refers to as the institutional regional innovation system—IRIS) and the new economy innovation system (NEIS), which he p. 304 ↳ refers to as an entrepreneurial regional innovation system (ERIS) (Cooke 2003). The traditional IRIS is more typical of German regions such as Baden-Württemberg or regions in the Nordic countries, whose leading industries draw primarily from synthetic knowledge bases. Its effectiveness flows from the positive effects of systemic relationships between the production structure and the knowledge infrastructure embedded networking governance structures and supporting regulatory and institutional frameworks. According to Cooke, the IRIS form "works well where technology and innovation tends to be path dependent rather than disruptive (the latter being more typical of the ERIS set-up), where institutions have grown incrementally to meet needs in an evolving but well-understood sectoral innovation system" (Cooke 2003: 57).

In contrast, the NEIS or ERIS (found in the US, the UK, and other Anglo-American economies) lacks the strong systemic elements of the IRIS form discussed above, and instead gets its dynamism from local venture capital, entrepreneurs, scientists, market demand, and incubators to support innovation that draws primarily from an analytical knowledge base. Thus, Cooke calls this a "venture capital driven" system. Such a system is more flexible and adjustable and, thus does not run the same risk of ending up in "lock-in" situations. On the other hand, new economy innovation systems do not have the same long-term stability and provide less systemic support for historical technological trajectories, raising important questions about their long-term economic sustainability.

Box 11.2 US biotechnology clusters: entrepreneurial regional innovation systems

A recent study (Cortright and Mayer 2002) of biotechnology in the United States concludes that innovation in this industry is dominated by just a handful of metropolitan centers. Boston and San Francisco are the two largest and best-established centers, followed by recent entrants San Diego, Seattle, and Raleigh-Durham. Philadelphia, New York, Washington-Baltimore, and Los Angeles also have significant concentrations of biotech activity. The authors of this study conclude that the two most important overarching factors supporting the emergence of strong biotech clusters are: (i) the presence of first-class pre-commercial medical research in a local university or government laboratory, and (ii) local systems to support and encourage entrepreneurial activity leading to successful translation of research into commercially viable outputs.

In emphasizing these two factors, this study emphasizes the key roles played by both public and private sectors actors in such innovation systems. Government support, through key granting councils such as the National Institutes of Health and state-level programs to invest in university systems and research, is at least a necessary condition for the emergence of a local biotechnology cluster. It also plays a role in the active-recruitment of "star scientists." But this process also requires the local presence of venture capital and managerial expertise in the development of technology-based companies. For the reasons outlined earlier in this chapter, a high local quality of life is also a crucial determinant of a region's ability to attract and retain highly educated scientific workers.

Despite these important local processes, non-local forces and relationships also play a key role. Three of the most important include: organizations such as the National Institutes of Health mentioned above; research alliances with large, global pharmaceutical firms with the financial resources to bankroll expensive research and clinical trials; and non-local venture capitalists with money and expertise to identify and support promising local firms and commercially viable research.

Once such local centers become established and attain critical mass, they begin to attract inward investment from multinational firms, who set-up their own research facilities in these locations in order to tap into distinctive local research competencies. This further reinforces the technological dynamism, entrepreneurial capabilities and commercialization potential of the region, setting in motion a virtuous circle of increasing returns.

Additional sources: Cooke (2001; 2003); Feldman (2001); Zucker et al. (1998).

 In making these arguments about a general correspondence between the macroinstitutional characteristics of the economy and the dominant form and character of its regional innovation systems, Cooke provides a link to another useful literature on "varieties of capitalism" and national business systems (Lam 1998, 2000; Whitley 1999; Hall and Soskice 2001). Soskice (1999) argues that different national institutional frameworks evolve to support particular forms of economic activity—i.e. that coordinated market economies such as Germany and the Nordic countries base their competitive advantage in "diversified quality production" (Streeck 1992), while liberal market economies such as the US and UK are most competitive in industries characterized by science-based innovative activities. Within the coordinated market economies, the driving force is the non-market coordination and cooperation that exists inside the business sphere and between private and public actors, as well as the degree to which labor is meaningfully "incorporated" within the production process and the financial system is able to supply long-term finance (Soskice 1999). In a comparison between coordinated market economies such as Sweden, Germany, and Switzerland on the one hand, and liberal market economies such as the US and UK on the other, he found that the coordinated economies performed best in the production of "relatively complex products, involving complex production processes and after-sales service in well-established industries" (e.g. synthetically based sectors such as the machine tool industry). By contrast, the US performed best in industries producing complex systemic products such as IT and defense technology, where the importance of analytical, scientific-based knowledge—often with the major support of the state—is significant (Soskice 1999: 113–14).

p. 306 Thus, Soskice argues that competitive strength in markets for diversified quality production is based on problem-solving knowledge developed through interactive learning and accumulated collectively in the workforce (Soskice 1999). This type of production system is incompatible with an employment relation in which work processes are controlled exclusively by management—a preference generated by certain finance and governance systems found in liberal market economies. Competitive strength in other markets—e.g. markets characterized by a high rate of change through radical innovations—is based on the institutional freedom as well as financial incentives to continuously restructure production systems in light of new market opportunities (Gilpin 1996). While coordinated market economies on the macro level support cooperative, long-term, and consensus-based relations between private as well as public actors, liberal market economies inhibit the development of these relations but instead offer the opportunity to quickly adjust formal structures to new requirements. Such institutional specificities both contribute to the formation of divergent national business systems, and constitute the context within which different organizational forms with different mechanisms for learning, knowledge accumulation and knowledge appropriation have evolved (Asheim and Herstad 2003).

Christopherson (2002) has argued that the kinds of organizational features and labor market characteristics of interest to Lam (1998, 2000) are shaped by the structure of capital markets and "investment regimes" determined at the national level. Moreover, these different investment regimes produce the societal conditions for divergent forms of competitive advantage in global markets. An American-style "market governance model" dominated by the drive to maximize short-term investment returns has promoted the emergence of US strengths in analytically based sectors such as biotechnology and ICT, as well as in a set of "project-oriented" industries such as electronic media and entertainment, advertising, management consulting, public relations, engineering and industrial design, and computer services.

The essence of Christopherson's argument is that, under divergent sets of national institutions governing capital and labor markets and corporate governance, the kinds of social relationships that are likely to develop between economic actors locally—and hence the social organization of local innovation and production systems—will vary dramatically. Clearly, there is considerably more emphasis in the US system (than in, say, the German system) on the role of individual workers as mobile agents of knowledge circulation and local social learning, since they are the principal actors responsible for the sharing of knowledge between firms. Grabher's (2001, 2002) recent work on the project-based nature of production organization in the London advertising industry documents many structural similarities with Christopherson's description of US-style, project-based economic activity, strongly suggesting the continuing viability of a distinctive "Anglo-American" model of regionally based production and innovation systems.

p. 307 Thus, liberal market economies as represented by the US and the UK seem to have advantages in industries characterized by an analytical knowledge base, as well as in those sectors that depend on a high degree of mobility in labor markets. Concerning the former, the elite universities and education institutions, often privately organized, provide strengths in R&D, the generation of formalized knowledge, inventions, and radical innovations. Other institutional features such as close university–industry links, academic spin-offs and an active scientific labor market all operate to promote the transfer and application of scientific knowledge.

Placed in this context the classic “traditional” institutional regional innovation system typified by a region such as Germany's Baden-Württemberg is most compatible with the institutional framework of a coordinated market economy, while the new economy innovation system (London advertising, Silicon Valley, or New York City's new media “Silicon Alley”) reflects the institutional framework of a liberal market economy.

This raises an important issue that has been the subject of some debate in the literature, concerning the extent to which markedly different regional innovation systems can emerge within the same national institutional space. Saxenian's (1994) landmark study comparing the electronics and computing industries in two dominant regions of the United States—California's Silicon Valley and Route 128 in Massachusetts—has reinforced the view that widely divergent regional innovation systems can and do emerge within a single national institutional framework. She argues that Silicon Valley outperformed Route 128 in terms of employment growth and new firm formation because of its more open, flexible, high-mobility system compared to Route 128's more closed, rigid, hierarchical, loyalty-based system. While both regions were home to world-renowned institutions of higher learning and research, the Silicon Valley system proved more effective in generating successful innovations in response to profound competitive challenges from abroad.

It is important to note, however, that this analysis was based on the evolution of these two regional systems during the 1980s and early 1990s. In fact, the Massachusetts innovation system experienced a profound transformation over the 1990s. Best (2001) documents this transition, describing the emergence of new industries in biotechnology, medical devices, nanotechnology, and related fields. He argues that this transformation was underpinned by a more fundamental shift in the social organization of the leading sectors of the regional economy towards open systems architecture—in other words, through its evolution towards a structure that much more closely resembles the new economy innovation system of Silicon Valley. Best's analysis suggests that Saxenian's earlier case studies captured two regional innovation systems at a time when one of them (Route 128) was exhausting the innovative capabilities of an older, already outmoded system, but before a coherent, fullyformed alternative had emerged (Kenney and von Burg 1999; Saxenian 1999). Now that the organizational contours of this new system are clear, they suggest that the
p. 308 character of different *regional* innovation systems within the same *national* ↳ institutional space may vary within a considerably narrower range than was previously thought. This variation is likely to depend primarily upon regionally specific technological trajectories and knowledge bases.

11.5 Alternative Organizational Forms and Emerging Relationships Between Local and Global Knowledge

Questions have lately been raised over whether the spatial embeddedness of learning and knowledge creation might be challenged by alternative organizational forms—in particular, temporary organizations—which some see as becoming more prevalent in the global economy (Asheim 2002; Grabher 2002). For example, Gann and Salter (2000) suggest that firms in the construction and engineering sector now rely on projects to organize the production of knowledge-intensive and complex products and systems. What impact might the adoption of temporary forms of organization have on the spatial embeddedness of learning and innovation? Grabher's (2002) work on projects in London advertising (discussed above) shows how co-location facilitates the continuous and rapid reconfiguration of project teams as well as the circulation of knowledge concerning the competencies and experience of potential project partners.

In contrast, Alderman (2004) argues that “there are … important a priori or theoretical reasons why a project-based model does not fit comfortably with ideas about clustering, localized learning and local innovation networks.” His argument relies on a recent literature that sees “communities of practice” as key entities driving the firm's knowledge-processing activities. This literature argues that routines and established practices shaped by organizations (or subset communities within organizations) promote the production and sharing of tacit and codifiable knowledge (Brown and Duguid 1996, 2000; Wenger 1998). Communities of practice are defined as groups of workers informally bound together by shared experience, expertise and commitment to a joint enterprise. These communities normally self-organize for the purpose of solving practical problems facing the larger organization, and in the process they produce innovations (both product and process). The commonalities shared by members of the community facilitate the identification, joint production and sharing of tacit knowledge through collaborative problem-solving assisted by story-telling and other narrative devices for circulating tacit knowledge.

According to this view, organizational or relational proximity and occupational similarity are more
p. 309 important than geographical proximity in supporting the ↳ production, identification, appropriation and flow of tacit knowledge (Allen 2000; Amin 2000; Amin and Cohendet 2004). The resulting geography of innovation differs from that envisioned by adherents to the learning region approach. In this view, the joint production and diffusion/transmission of tacit and codifiable knowledge across intra-organizational boundaries is possible, so long as it is mediated within these communities. Moreover, because communities of practice may extend outside the single firm to include customers or suppliers, knowledge can also flow across the boundaries of individual organizations.

Furthermore, the communities of practice literature asserts that tacit knowledge may also flow across regional and national boundaries if organizational or "virtual community" proximity is strong enough. In other words, learning (and the sharing of tacit knowledge) need not be spatially constrained if relational proximity is present. For large, multinational firms with "distributed" knowledge bases and multiple sites of innovation, the use of communities of practice, aided and supported by ever-cheaper and more powerful ICTs and air travel, is seen as an effective strategy for overcoming geographical separation.

These arguments are useful reminders of the importance of relationships and the strength of underlying similarities rather than geographical proximity *per se* in determining the effectiveness of knowledge-sharing between economic actors. However, they fail to answer a key question: what forces shape or defines this "relational proximity," enabling it to transcend physical, cultural, and institutional divides? How are shared understandings produced? Much of the communities of practice literature is largely silent on this question. A notable exception is the work of Brown and Duguid (2000: 143) who stake out a very different position on the spatial reach of communities of practice:

> They are usually face-to-face communities that continually negotiate with, communicate with, and coordinate with each other directly in the course of work. And this negotiation, communication, and coordination is highly implicit, part of work practice … In these groups, the demands of direct coordination inevitably limit reach. You can only work closely with so many people.

11.6 Conclusions and Issues for Future Research

In this chapter we have argued that the geographical configuration of economic actors—firms, workers, associations, organizations, and government agencies—is fundamentally important in shaping the
p. 310 innovative capabilities of firms and ↳ industries. We have distinguished between two types of knowledge base—synthetic and analytical—and have demonstrated that, while the nature of innovation processes may differ in each case, innovative activity tends to be spatially clustered in both cases, though for somewhat different reasons.

We then introduced the concept of regional innovation systems, describing the elements, relationships, and systemic character that comprise a key part of a region's distinct institutional endowment. We also explored the variety of different types of regional innovation systems that can be identified, noting how particular regional systems may be more strongly associated with particular regimes of business systems and institutional frameworks at the national level. Although there is significant variation in economic performance across different regions within the same national system, the characteristics of *successful* regional innovation systems under the same national regime will exhibit certain consistencies from case to case.

Despite the emergence of a strong consensus around the above issues, there remain a number of contentious or unresolved questions that are likely to provide the focus for future research. First, in the ongoing discourse on the nature and impact of globalization, some authors have argued that tacit knowledge has become increasingly codified and hence ubiquitous, ultimately eroding the competitive advantage of high-cost regions and nations (Maskell et al. 1998; Maskell 1999). Others maintain that much strategic knowledge remains "sticky," and that important parts of the learning process continue to be localized as a result of the enabling role of geographical proximity and local institutions in stimulating interactive learning (Asheim 1999; Markusen 1996).

Nevertheless, global knowledge networks and flows are important sources of innovative ideas for a growing number of economic activities (Mackinnon et al. 2002). If so, then how should we understand their impact on the geographical distribution of innovative activity, and on the future importance of regionally based innovation systems? In a recent conceptual paper, Bathelt et al. (2004) seek to reconcile these divergent views. They argue that firms clustered in particular locales require access to non-local sources of knowledge as an essential complement to the knowledge they generate and share locally. The metaphor they have adopted to capture the dual nature of emerging geographies of innovation is "local buzz and global pipelines." They view these global knowledge pipelines as extending between different nodal geographical concentrations of firms and other knowledge-producing organizations around the world. On the one hand, no firm—especially in analytical, science-based sectors such as biotechnology—can afford to cut themselves off from non-local knowledge sources. To do so would be to court potential disaster, as regional innovation systems would be prone to encouraging technological stagnation and "lock-in" tendencies. On the other hand, the abilities of firms to make the most effective use of this knowledge—that is, to convert it most effectively into economic value—still depends on their access to important place based assets, both p. 311 tangible and intangible, and the close interaction with other ↳ organizations around them that such locations foster (see also Asheim and Herstad 2003; Cooke et al. 2000; Freeman 2002).

This work is a welcome conceptual contribution, but the empirical basis for its framework remains underdeveloped. Clearly, there is a need for future research—both case studies and aggregate statistical analyses—to investigate the prevalence of this "dual geography" of innovation more systematically. At the same time, this approach raises a further question that remains unanswered: is this metaphor of local buzz and global pipelines appropriate only for those science-intensive industries whose innovation rests on an analytical knowledge base? To what extent are non-local knowledge flows and learning relationships extending between localized centers of innovation becoming important for those industries that rely more heavily on a synthetic knowledge base?

A problematic aspect of the learning economy and learning regions literature has been its focus on learning by doing and using based largely on local synthetic knowledge with a high tacit content and incremental innovations. We continue to agree with Freeman's useful insight concerning "the tremendous importance of incremental innovation, learning by doing, by using and by interacting in the process of technical change and diffusion of innovations" (Freeman 1993: 9–10). Yet in a highly competitive, globalizing economy, it may be increasingly difficult for the reproduction and growth of a learning economy to rely primarily on incremental improvements to products and processes, and not on new products (i.e. radical innovations).

Crevoisier (1994: 259) argues that the exclusive reliance on incremental innovations "would mean that these areas will very quickly exhaust the technical paradigm on which they are founded."

In future studies it will be important to follow these tendencies, which undoubtedly will be reinforced by globalization processes (see Ch. 12 by Narula and Zanfei in this volume). The basic rationale of regional innovation systems is that the systemic promotion of localized learning processes can improve the innovativeness and competitive advantage of regional economies. What remains to be seen is how the capacity of regional innovation systems to upgrade the knowledge bases of firms in regional clusters will develop over time.

Notes

1. Pavitt (1984: 353–65) offers a three-way taxonomy of industries based on the predominant nature and sources of technical change. Supplier-dominated industries include agriculture and traditional manufacturing sectors such as textiles. Production-intensive industries can be further subdivided into scale-intensive sectors such as steel, consumer durables, and automobiles, and specialized supplier sectors such as machinery and instruments. Science-based industries include electronics and chemicals (including pharmaceuticals). In the discussion that follows, our observations about industries p. 312 with ↳ synthetic knowledge bases correspond closely to those sectors encompassed by the first two of Pavitt's categories (supplier-dominated and production-intensive). Similarly, the analytical category corresponds directly to Pavitt's science-based industries.

2. We should acknowledge that many industries draw significantly upon both synthetic and analytical forms of knowledge. A clear example would be medical devices and technologies, whose development rests upon knowledge drawn from fields as diverse as bioscience, ICT, software, advanced materials, nanotechnology, and mechanical engineering. For this reason, it makes sense to conceive of individual industrial sectors being arrayed along a continuum between purely analytical and synthetic industries, with many—such as the automotive industry—occupying an intermediate position along this spectrum.

3. See Feldman (2000) for a useful overview of this literature.

4. Cortright and Mayer produce evidence to show that the degree of geographical concentration in the US life sciences industries is considerably higher than the population as a whole. They also demonstrate—using indicators such as venture capital, funded research conducted through inter-firm alliances, and new firm formation rates—that this concentration has increased dramatically during the past two decades.

5. This conceptualization of regional innovation systems corresponds with the one found in Cooke et al. (2000). In their words any functioning regional innovation system consists of two subsystems: (i) the knowledge application and exploitation subsystem, principally occupied by firms within vertical supply-chain networks; and (ii) the knowledge generation and diffusion subsystem, consisting mainly of public organizations.

6. There is a strong historical correspondence between these concepts and approaches and agglomeration theories within regional science and economic geography, such as Perroux's (1970) growth pole theory.

7. In a recent study Carlsson (2003) shows that the majority of theoretical as well as empirical analyses of innovation systems have a regional focus (see also Bathelt 2003 for a critical discussion of RIS).

8. A recent comparative study of European clusters shows that firms increasingly find relevant research activities and other supporting services inside the cluster boundaries (Isaksen 2004).

9. See Ch. 8 in this volume by Mowery and Sampat for a similarly critical assessment of science parks.

References

ALDERMAN, N. (2004), "Mobility versus Embeddedness: The Role of Proximity in Major Capital Projects," in A. Lagendijk and P. Oinas (eds.), *Proximity, Distance and Diversity: Issues on Economic Interaction and Local Development*, Aldershot: Ashgate.
Google Scholar Google Preview WorldCat COPAC

ALLEN, J. (2000), "Power/Economic Knowledge: Symbolic and Spatial formations," in J. R. Bryson, P. W. Daniels, N. Henry, and J. Pollard (eds.), *Knowledge, Space, Economy*, London: Routledge, 15–33.
Google Scholar Google Preview WorldCat COPAC

AMIN, A. (2000), "Organisational Learning through Communities of Practice," Paper presented at the workshop on *The Firm in Economic Geography*, University of Portsmouth, UK, 9–11 March.
Google Scholar Google Preview WorldCat COPAC

—— and COHENDET, P. (2004), *Architectures of Knowledge*, Oxford: Oxford University Press.
Google Scholar Google Preview WorldCat COPAC

p. 313 ASHEIM, B. T. (1995), "Regionale innovasjonssystem—en sosialt og territorielt forankret teknologipolitikk," *Nordisk Samhällsgeografisk Tidskrift* 20: 17–34.
WorldCat

—— (1996), "Industrial Districts as 'Learning Regions': A Condition for Prosperity?" *European Planning Studies* 4(4): 379–400.
WorldCat

—— (1998), "Territoriality and Economics: On the Substantial Contribution of Economic Geography," in O. Jonsson and L.-O. Olander, (eds.), *Economic Geography in Transition, The Swedish Geographical Yearbook*, vol. 74, Lund, 98–109.
Google Scholar Google Preview WorldCat COPAC

—— (1999), "Interactive Learning and Localised Knowledge in Globalising Learning Economies," *Geo Journal* 49(4): 345–52.
WorldCat

—— (2000), "Industrial Districts: The Contributions of Marshall and Beyond," in G. Clark, M. Feldman, and M. Gertler (eds.), *The Oxford Handbook of Economic Geography*, Oxford: Oxford University Press, 413–31.
Google Scholar Google Preview WorldCat COPAC

—— (2001), "Learning Regions as Development Coalitions: Partnership as Governance in European Workfare States?" *Concepts and Transformation. International Journal of Action Research and Organizational Renewal* 6(1): 73–101.
WorldCat

—— (2002), "Temporary Organisations and Spatial Embeddedness of Learning and Knowledge Creation," *Geografiska Annaler, Series B, Human Geography*, 84b(2): 111–24. 10.1111/j.0435-3684.2002.00117.x
WorldCat Crossref

—— and COOKE, P. (1998), "Localised Innovation Networks in a Global Economy: A Comparative Analysis of Endogenous and Exogenous Regional Development Approaches," *Comparative Social Research* 17, Stamford, Conn: JAI Press, 199–240.
Google Scholar Google Preview WorldCat COPAC

—— —— (1999), "Local Learning and Interactive Innovation Networks in a Global Economy," in E. Malecki and P. Oinas (eds.), *Making Connections: Technological Learning and Regional Economic Change*, Aldershot: Ashgate, 145–78.
Google Scholar Google Preview WorldCat COPAC

—— and HERSTAD, S. J. (2003), "Regional Innovation Systems, Varieties of Capitalism and Non-Local Relations: Challenges from the Globalising Economy," in B. T. Asheim and Å. Mariussen (eds.), *Innovations, Regions and Projects*, Stockholm: Nordregio, R 2003:3, 241–74.

Google Scholar Google Preview WorldCat COPAC

—— and ISAKSEN, A. (1997), “Location, Agglomeration and Innovation: Towards Regional Innovation Systems in Norway?” *European Planning Studies* 5(3): 299–330.
WorldCat

—— —— (2002), “Regional Innovation Systems: The Integration of Local ‘Sticky’ and Global ‘Ubiquitous’ Knowledge,” *Journal of Technology Transfer* 27: 77–86. 10.1023/A:1013100704794
WorldCat Crossref

—— et al. (eds.) (2003), *Regional Innovation Policy for Small-Medium Enterprises*, Cheltenham: Edward Elgar.
Google Scholar Google Preview WorldCat COPAC

BATHELT, H. (2003), “Geographies of Production: Growth Regimes in Spatial Perspective 1: Innovation, Institutions and Social Systems”, *Progress in Human Geography* 27(6): 789–804.
WorldCat

*—— MALMBERG, A., and MASKELL, P. (2004), “Clusters and Knowledge: Local Buzz, Global Pipelines and the Process of Knowledge Creation,” *Progress in Human Geography*, 28(1): 31–56. 10.1191/0309132504ph469oa
WorldCat Crossref

BEST, M. (2001), *The New Competitive Advantage*, Oxford: Oxford University Press. 10.1093/0198297459.001.0001
Google Scholar Google Preview WorldCat COPAC Crossref

BROWN, J. S., and DUGUID, P. (1996), “*Organisational Learning* and Communities-of- Practice: Towards a Unified Theory of Working, Learning and Innovation,” in M. Cohen and L. Sproul (eds.), *Organisational Learning*, New York: Sage, 58–82.
Google Scholar Google Preview WorldCat COPAC

*—— —— (2000), *The Social Life of Information*, Boston: Harvard Business School Press.
Google Scholar Google Preview WorldCat COPAC

p. 314 CARLSSON, B. (2003), “Innovation Systems: A Survey of the Literature from a Schumpeterian Perspective,” in A. Pyka (ed.), *The Companion to Neo-Schumpeterian Economics*, Cheltenham: Edward Elgar.
Google Scholar Google Preview WorldCat COPAC

CHRISTOPHERSON, S. (2002), “Why do National Labor Market Practices Continue to Diverge in the Global Economy? The “Missing Link” of Investment Rules,” *Economic Geography* 78(1): 1–20. 10.2307/4140821
WorldCat Crossref

COOKE, P. (1992), “Regional Innovation Systems: Competitive Regulation in the New Europe,” *Geoforum* 23: 365–82. 10.1016/0016-7185(92)90048-9
WorldCat Crossref

—— (1998), “Introduction: Origins of the Concept,” in H. Braczyk, P. Cooke, and M. Heidenreich (eds.), *Regional Innovation Systems*, London: UCL Press, 2–25.
Google Scholar Google Preview WorldCat COPAC

*—— (2001), “Regional Innovation Systems, Clusters, and the Knowledge Economy,” *Industrial and Corporate Change* 10(4): 945–74. 10.1093/icc/10.4.945
WorldCat Crossref

—— (2003), “Integrating Global Knowledge Flows for Generative Growth in Scotland: Life Sciences as a Knowledge Economy Exemplar,” in *Inward Investment, Entrepreneurship and Knowledge Flows in Scotland—International Comparisons*, Paris: OECD.
Google Scholar Google Preview WorldCat COPAC

—— and MORGAN, K. (1998), *The Associational Economy: Firms, Regions and Innovation*, Oxford: Oxford University Press.
Google Scholar Google Preview WorldCat COPAC

—— BOEKHOLT, P., and TÖDTLING, F. (2000), *The Governance of Innovation in Europe. Regional Perspectives on Global Competitiveness*, London: Pinter.
Google Scholar Google Preview WorldCat COPAC

CORTRIGHT, J., and MAYER, H. (2002), *Signs of Life: The Growth of Biotechnology Centers in the U.S.*, Washington, DC: Center on Urban and Metropolitan Policy, The Brookings Institution.
Google Scholar Google Preview WorldCat COPAC

COWAN, R., DAVID, P. A., and FORAY, D. (2000), "The Explicit Economics of Knowledge Codification and Tacitness," *Industrial and Corporate Change* 9: 211–53. 10.1093/icc/9.2.211
WorldCat Crossref

CREVOISIER, O. (1994), Book review of G. Benko and A. Lipietz (eds.), *Les Régions qui gagnent*, Paris, 1992, *European Planning Studies* 2: 258–60.
Google Scholar Google Preview WorldCat COPAC

DAVID, P. A. (1994), "Why are Institutions the 'Carriers of History'? Path Dependence and the Evolution of Conventions, Organizations and Institutions," *Structural Change and Economic Dynamics* 5: 205–20. 10.1016/0954-349X(94)90002-7
WorldCat Crossref

DOSI, G. (1988), "The Nature of the Innovative Process," in G. Dosi et al. (eds.), *Technical Change and Economic Theory*, London: Pinter, 221–38.
Google Scholar Google Preview WorldCat COPAC

ENRIGHT, M. (2003), "Competitiveness, Innovative Clusters and Positive Externalities", paper presented at the Sixth Annual Conference of the Competitiveness Institute, Gothenburg, Sweden, 17–19 September.

ETZKOWITZ, H., and LEYDESDORFF, L. (2000), "The Dynamics of Innovation: From National Systems and 'Mode 2' to a Triple Helix of University–Industry–Government Relations," *Research Policy* 29: 109–23. 10.1016/S0048-7333(99)00055-4
WorldCat Crossref

* FELDMAN, M. P. (2000), "Location and Innovation: The New Economic Geography of Innovation, Spillovers, and Agglomeration," in G. L. Clark, M. P. Feldman, and M. S. Gertler (eds.), *The Oxford Handbook of Economic Geography*, Oxford: Oxford University Press, 373–94.
Google Scholar Google Preview WorldCat COPAC

—— (2001), "Where Science Comes to Life: University Bioscience, Commercial Spin-offs, and Regional Economic Development," *Journal of Comparative Policy Analysis: Research and Practice* 2: 345–61. 10.1080/13876980008412651
WorldCat Crossref

FLORIDA, R. (1995), "Toward the Learning Region," *Futures* 27: 527–36. 10.1016/0016-3287(95)00021-N
WorldCat Crossref

*—— (2002*a*), "The Economic Geography of Talent," *Annals of the Association of American Geographers* 92: 743–55. 10.1111/1467-8306.00314
WorldCat Crossref

—— (2002*b*), *The Rise of the Creative Class*, New York: Basic Books.
Google Scholar Google Preview WorldCat COPAC

p. 315 FREEMAN, C. (1987), *Technology Policy and Economic Performance: Lessons from Japan*, London: Pinter.

Google Scholar Google Preview WorldCat COPAC

—— (1993), “The Political Economy of the Long Wave,” Paper presented at EAPE 1993 conference on “The economy of the future: Ecology, technology, institutions”. Barcelona, October 1993.

—— (1995), “The ‘National System of Innovation’ in Historical Perspective,” *Cambridge Journal of Economics* 19: 5–24.
WorldCat

*—— (2002), “Continental, National and Sub-National Innovation Systems—Complementarity and Economic Growth,” *Research Policy* 31: 191–211. 10.1016/S0048-7333(01)00136-6
WorldCat Crossref

GANN, D. M. and SALTER, A. J. (2000), “Innovation in Project-Based, Service Enhanced Firms: The Construction of Complex Products and Systems,” *Research Policy* 29: 955–72. 10.1016/S0048-7333(00)00114-1
WorldCat Crossref

GERTLER, M. S. (1995), “‘Being there’: Proximity, Organization, and Culture in the Development and Adoption of Advanced Manufacturing Technologies,” *Economic Geography* 71: 1–26. 10.2307/144433
WorldCat Crossref

—— (2003), “Tacit Knowledge and the Economic Geography of Context, or the Undefinable Tacitness of Being (there),” *Journal of Economic Geography* 3: 75–99. 10.1093/jeg/3.1.75
WorldCat Crossref

—— (2004), *Manufacturing Culture: The Institutional Geography of Industrial Practice*, Oxford: Oxford University Press.
Google Scholar Google Preview WorldCat COPAC

—— and WOLFE, D. A. (2004), “Ontario's Regional Innovation System: The Evolution of Knowledge-Based Institutional Assets,” in P. Cooke, and M. Heidenreich, H. Braczyk (eds.), *Regional Innovation Systems*, 2nd edn., London: Taylor and Francis.
Google Scholar Google Preview WorldCat COPAC

GILPIN, R. (1996), “Economic Evolution of National Systems,” *International Studies Quarterly* 40: 411–43. 10.2307/2600718
WorldCat Crossref

GRABHER, G. (2001), “Ecologies of Creativity. The Group, the Village and the Heterarchic Organisation of the British Advertising Industry,” *Environment and Planning A* 33: 351–74. 10.1068/a3314
WorldCat Crossref

—— (2002), “Cool Projects, Boring Institutions: Temporary Collaboration in Social Context,” *Regional Studies* 36: 205–14. 10.1080/00343400220122025
WorldCat Crossref

GRANOVETTER, M. (1985), “Economic Action and Social Structure: The Problem of Embeddedness,” *American Journal of Sociology* 91: 481–510. 10.1086/228311
WorldCat Crossref

HALL, P., and SOSKICE, D. (2001), “An Introduction to Varieties of Capitalism,” in Hall and Soskice (eds.), *Varieties of Capitalism: The Institutional Foundations of Comparative Advantage*, Oxford: Oxford University Press, 1–68.
Google Scholar Google Preview WorldCat COPAC

HENRY, N. et al. (1995), “Along the Road: R&D, Society and Space,” *Research Policy* 24: 707–26. 10.1016/0048-7333(94)00793-7
WorldCat Crossref

ISAKSEN, A. (2004), “Regional Clusters between Local and Non-Local Relations: A Comparative European Study,” in A. Lagendijk

and P. Oinas (eds.), *Proximity, Distance and Diversity: Issues on Economic Interaction and Local Development*, Aldershot: Ashgate.
Google Scholar Google Preview WorldCat COPAC

JAFFE, A., TRAJTENBERG, M., and HENDERSON, R. (1993), "Geographical Localization of Knowledge Spillovers as Evidenced by Patent Citations," *Quarterly Journal of Economics* 108: 577–98. 10.2307/2118401
WorldCat Crossref

JOHNSON, B., LORENZ, E., and LUNDVALL, B.-Å. (2002), "Why All this Fuss about Codified and Tacit Knowledge?" *Industrial and Corporate Change* 11: 245–62. 10.1093/icc/11.2.245
WorldCat Crossref

KENNEY, M., and VON BURG, U. (1999), "Technology, Entrepreneurship and Path Dependence: Industrial Clustering in Silicon Valley and Route 128," *Industrial and Corporate Change* 8(1): 67–103. 10.1093/icc/8.1.67
WorldCat Crossref

LAESTADIUS, S. (1998), "Technology Level, Knowledge Formation and Industrial Competence in Paper Manufacturing," in G. Eliasson et al. (eds.), *Microfoundations of Economic Growth. A Schumpeterian Perspective*, Ann Arbor: University of Michigan Press, 212–26.
Google Scholar Google Preview WorldCat COPAC

p. 316 LAM, A. (1998), "The Social Embeddedness of Knowledge: Problems of Knowledge Sharing and Organisational Learning in International High-Technology Ventures," *DRUID Working Paper* 98-7, Aalborg.
WorldCat

—— (2000), "Tacit Knowledge, Organizational Learning and Societal Institutions: An Integrated Framework," *Organization Studies* 21(3): 487–513. 10.1177/0170840600213001
WorldCat Crossref

LEYSHON, A., and THRIFT, N. J. (1997). *Money/Space: Geographies of Monetary Transformation*, London: Routledge.
Google Scholar Google Preview WorldCat COPAC

LONGHI, C., and Q UÉRE, M. (1993), "Innovative Networks and the Technopolis Phenomenon: The Case of Sophie-Antipolis," *Environment and Planning C: Government & Policy* 11: 317–30. 10.1068/c110317
WorldCat Crossref

LUNDVALL, B-Å. (1988), "Innovation as an Interactive Process: From User–Producer Interaction to the National System of Innovation," in G. Dosi, C. Freeman, G. Silverberg, and L. Soete (eds.), *Technical Change and Economic Theory*, London: Pinter.
Google Scholar Google Preview WorldCat COPAC

—— (ed.) (1992), *National Innovation Systems: Towards a Theory of Innovation and Interactive Learning*, London: Pinter.
Google Scholar Google Preview WorldCat COPAC

—— (1996), "The Social Dimension of the Learning Economy," *DRUID Working Papers* 96-1, Aalborg.
WorldCat

—— and JOHNSON, B. (1994), "The Learning Economy," *Journal of Industry Studies* 1: 23–42.
WorldCat

—— and BORRÁS, S. (1999), *The Globalising Learning Economy: Implications for Innovation Policy*, DGXII-TSER, The European Commission.
Google Scholar Google Preview WorldCat COPAC

—— and MASKELL, P. (2000), "Nation States and Economic Development—from National Systems of Production to National Systems of Knowledge Creation and Learning," in G. L. Clark, M. P. Feldman, and M. S. Gertler (eds.), *The Oxford Handbook of*

Economic Geography, Oxford: Oxford University Press, 353–72.
Google Scholar Google Preview WorldCat COPAC

MACKINNON, D., CUMBERS, A., and CHAPMAN, K. (2002), “Learning, Innovation and Regional Development: A Critical Appraisal of Recent Debates,” *Progress in Human Geography* 26(3): 293–311. 10.1191/0309132502ph371ra
WorldCat Crossref

MARKUSEN, A. (1996), “Sticky Places in Slippery Space: A Typology of Industrial Districts,” *Economic Geography* 72(3): 293–313. 10.2307/144402
WorldCat Crossref

MASKELL, P. (1999), “Globalisation and Industrial Competitiveness: The Process and Consequences of Ubiquitification,” in E. Malecki and P. Oinas (eds.), *Making Connections: Technological Learning and Regional Economic Change*, Aldershot: Ashgate, 35–59.
Google Scholar Google Preview WorldCat COPAC

—— et al. (1998), *Competitiveness, Localised Learning and Regional Development*, London: Routledge.
Google Scholar Google Preview WorldCat COPAC

*—— and MALMBERG, A. (1999), “Localised Learning and Industrial Competitiveness,” *Cambridge Journal of Economics* 23: 167–86. 10.1093/cje/23.2.167
WorldCat Crossref

* MORGAN, K. (1997), “The Learning Region: Institutions, Innovation and Regional Renewal,” *Regional Studies* 31: 491–504. 10.1080/00343409750132289
WorldCat Crossref

—— (1999), “Reversing Attrition? The Auto Cluster in Baden-Württemberg,” in T. J. Barnes and M. S. Gertler (eds.), *The New Industrial Geography: Regions, Regulation and Institutions*, London: Routledge, 74–97.
Google Scholar Google Preview WorldCat COPAC

NELSON, R. (ed.) (1993), *National Innovation Systems: A Comparative Analysis*, Oxford: Oxford University Press.
Google Scholar Google Preview WorldCat COPAC

NONAKA, I., and TAKEUCHI, H. (1995), *The Knowledge Creating Company*, Oxford and New York: Oxford University Press.
Google Scholar Google Preview WorldCat COPAC

—— et al. (2000), “SECI, Ba and Leadership: A Unified Model of Dynamic Knowledge Creation,” *Long Range Planning* 33: 5–34. 10.1016/S0024-6301(99)00115-6
WorldCat Crossref

p. 317 PAVITT, K. (1984), “Sectoral Patterns of Technical Change: Towards a Taxonomy and a Theory,” *Research Policy* 13: 343–73. 10.1016/0048-7333(84)90018-0
WorldCat Crossref

—— (2002), “*Knowledge about Knowledge since Nelson and Winter: A Mixed Record,*” Electronic Working Paper Series Paper No. 83, SPRU, University of Sussex, June.
Google Scholar Google Preview WorldCat COPAC

PERROUX, F. (1970), “Note on the Concept of Growth Poles,” in D. McKee et al. (eds.), *Regional Economics: Theory and Practice*, New York: The Free Press, 93–103.
Google Scholar Google Preview WorldCat COPAC

PIORE, M., and SABEL, C. (1984), *The Second Industrial Divide: Possibilities for Prosperity*, New York: Basic Books.

Google Scholar Google Preview WorldCat COPAC

POLANYI, M. (1958), *Personal Knowledge: Towards a Post-Critical Philosophy*, London: Routledge & Kegan Paul.
Google Scholar Google Preview WorldCat COPAC

—— (1966), *The Tacit Dimension*, New York: Doubleday.
Google Scholar Google Preview WorldCat COPAC

PORTER, M. (1990), *The Competitive Advantage of Nations*, New York: Basic Books.
Google Scholar Google Preview WorldCat COPAC

PORTER, M. E. (1998), "Clusters and the New Economics of Competition," *Harvard Business Review* (Nov.–Dec.): 77–90.
WorldCat

* SAXENIAN, A. (1994), *Regional Advantage: Culture and Competition in Silicon Valley and Route* 128, Cambridge, Mass.: Harvard University Press.
Google Scholar Google Preview WorldCat COPAC

—— (1999), "Comment on Kenny and von Burg, 'Technology, Entrepreneurship and Path Dependence: Industrial Clustering in Silicon Valley and Route 128'," *Industrial and Corporate Change* 8(1): 105–10. 10.1093/icc/8.1.105
WorldCat Crossref

SCHOENBERGER, E. (1997), *The Cultural Crisis of the Firm*, Oxford: Blackwell.
Google Scholar Google Preview WorldCat COPAC

SOSKICE, D. (1999), "Divergent Production Regimes: Coordinated and Uncoordinated Market Economies in the 1980s and 1990s," in H. Kitschelt et al. (eds.), *Continuity and Change in Contemporary Capitalism*, Cambridge: Cambridge University Press, 101–34.
Google Scholar Google Preview WorldCat COPAC

STORPER, M. (1997), *The Regional World: Territorial Development in a Global Economy*, New York: Guilford Press.
Google Scholar Google Preview WorldCat COPAC

—— and SCOTT, A. (1995), "The Wealth of Regions," *Futures*, 27(5): 505–26.
WorldCat

*—— and VENABLES, A. J. (2003), "Buzz: The Economic Force of the City," Paper presented at the DRUID Summer Conference 2003 on "Creating, sharing and transferring knowledge: the role of geography, institutions and organizations," Elsinore, Denmark.

STREECK, W. (1992), *Social Institutions and Economic Performance—Studies of Industrial Relations in Advanced Capitalist Economies*, New York: Sage.
Google Scholar Google Preview WorldCat COPAC

von Hippel, E. (1988), *The Sources of Innovation*, Oxford: Oxford University Press.
Google Scholar Google Preview WorldCat COPAC

WENGER, E. (1998), *Communities of Practice: Learning, Meaning and Identity*, Cambridge: Cambridge University Press.
Google Scholar Google Preview WorldCat COPAC

WHITLEY, R. (1999), *Divergent Capitalism: The Social Structuring and Change of Business Systems*, Oxford: Oxford University Press.
Google Scholar Google Preview WorldCat COPAC

ZUCKER, L. G., and DARBY, M. R. (1996), "Star Scientists and Institutional Transformation: Patterns of Invention and Innovation in the Formation of the Biotechnology Industry," *Proceedings of the National Academy of Science* 93: 12709–16. 10.1073/pnas.93.23.12709

WorldCat Crossref

—— —— and ARMSTRONG, J. (1998), “Geographically Localized Knowledge: Spillovers or Markets?” *Economic Inquiry* 36: 65–86. 10.1111/j.1465-7295.1998.tb01696.x
WorldCat Crossref

—— —— and BREWER, M. B. (1998), “Intellectual Human Capital and the Birth of U.S. Biotechnology Enterprises,” *American Economic Review* 88: 290–306.
WorldCat

ZYSMAN, J. (1994), “How Institutions Create Historically Rooted Trajectories of Growth,” *Industrial and Corporate Change* 3: 243–83. 10.1093/icc/3.1.243
WorldCat Crossref