8. Regional innovation networks

Leon Oerlemans, Marius Meeus and Patrick Kenis

INTRODUCTION

Over the last 20 years, several new theoretical approaches have been developed to understand the determinants of successful regional development and policy in an economic environment that has become increasingly competitive and global. As argued by Mouleart and Sekia (2003), this search for a 'new' model of regional development was partially a result of the ambiguous results of regional policies implemented in the period after the Second World War. The larger part of regional policies in this period encompassed relative price incentive structures aimed at attracting employment to traditional manufacturing regions, building new infrastructures and the encouragement of production investments in lagging regions. Although these measures stimulated job creation in local firms and attracted external direct investments to these regions, these policies often suffered from a lack of structural embeddedness within regions.

From the early 1980s onwards, several scholars (Lundvall and Borras, 1999; Asheim, 1999) observed a qualitative and structural change in the development of capitalist economies, that is, a transition from Fordism to post-Fordism leading to a so-called learning economy. Combined with an ongoing globalization, innovation and learning are regarded as core processes for maintaining and improving organizational competitiveness. Moreover, in this different context the nature of the innovation process has changed considerably. The linear model of innovation, in which innovation activities are sequentially conducted in the absence of feedback loops, is succeeded by the view that innovation is an interactive, cumulative and path-dependent process, following specific technological trajectories (Tödtling, 1999).

Starting in the early 1980s, the outlined regional policy and structural developments resulted in a growing attention to theoretical perspectives and policy strategies that stimulated the innovative capabilities of regions. A regional endogenous development approach emerged in which elements

such as human capital, regional institutions, infrastructure, educational and regulatory institutes, quality of production factors and systems, innovation and learning were the main ingredients (Moulaert and Sekia, 2003). These elements were cemented together by regional (innovation) networks in which regional actors were linked by informal and formal social, economic and political relationships.

In this chapter, the focus will be on these regional (innovation) networks. Two related questions will be answered. First, why would firms organize parts of their activities in (innovation) networks and, second, why should these innovation networks be regional? To answer the first question, insights derived mainly from organization science will be used. To answer the second question, a brief overview of the literature on territorial innovation models will be presented. The main aim of this overview is to analyse and evaluate the ways in which the proximity–network relationship is conceptualized in these models. These insights will be used to propose some alternative theoretical and empirical directions that will enable researchers to study the importance of proximity in a more fine-grained way.

At the end of this section, it is important to note that, in the literature, innovation can have at least two meanings. On the one hand, innovation is defined as an outcome, indicated by the number of patents an organization has filed or the number of new product announcements it has made. On the other hand, innovation is conceptualized as a process pointing to the generation and introduction into the market (economic or social) of new or improved processes, products and services. Where possible, we will indicate which definition of innovation is applicable to avoid confusion and misinterpretation of the literature discussed in this chapter.

WHY PARTICIPATE IN INNOVATION NETWORKS?

Fortunately, there exists a large body of earlier research on networks specifying what motivates organizations to cluster in networks (see, e.g., Oliver, 1990; Alter and Hage, 1993; Ebers and Jarillo, 1998). Research has found several important causes for networking between for-profit business organizations, such as technology development, increased (market) power, market development, uncertainty reduction and cost savings, among others. In her seminal paper, Oliver (1990) provided a general set of reasons for inter-organizational network and relationship formation:

- *Necessity*: linkages are established to meet necessary legal or regulatory requirements or to supplement internal resource deficits.

- *Asymmetry*: ties are formed in order to exercise power or control over other organizations or their resources.
- *Reciprocity*: tie formation is motivated by reciprocity; that is, the willingness to cooperate, collaborate and coordinate for the purpose of pursuing mutual beneficial goals or interests.
- *Efficiency*: organizations link with other organizations to improve their internal input–output ratios. For instance, by networking, organizations want to increase return on assets, and reduce unit or transaction costs.
- *Stability*: many organizations are confronted with environmental uncertainty. As an adaptive response to this uncertainty, organizations establish relationships to achieve stable and predictable resource flows and exchanges.
- *Legitimacy*: by linking to other, specific organizations, an organization can improve its reputation or image, or show congruence with dominant norms in its institutional environment.

When dealing with technological innovation processes and networks, two groups of motives can be distinguished (Pyka, 2002). A first group can be labelled incentive-based approaches to networking; it comprises motives such as cost sharing, putting in place pre-emption strategies or reducing time to market. This group of motives uses a marginalist perspective by comparing the marginal costs and benefits of different organizational modes and has found a powerful application in transaction cost economic theory.

A second group of motives reflects so-called knowledge-based approaches. Important motives in this group are the exploration of new markets and market niches, technology transfer, profiting from technological complementarities, and monitoring technological developments and opportunities. The view on the innovation process changes from an optimal cost–benefit analysis to a collective, experimental and problem-solving process. Knowledge in general, and new technological knowledge in particular, is no longer considered freely available, but as specific, tacit, and complex. To understand and utilize this knowledge, firms have to develop specific competences, absorptive capacity and receiver competence, the development of which takes time. Moreover, due to the increased complexity of modern innovation processes, firms have to master multiple knowledge fields, which is a difficult task. Therefore, the probability that firms are successful in these complex technological environments with strategies that focus on their own R&D effort only, has lowered considerably. Innovation networks are viewed as flexible organizational devices to overcome these difficulties (Teece, 1986: 416).

In sum, networks perform three important general functions for innovation (Osborn and Hagedoorn, 1997; Kraatz, 1998; Pyka, 2002). First, they are a coordinating device enabling and facilitating interfirm learning and the diffusion of new technological know-how. Second, they facilitate exploitation of and access to technological complementary assets. Third, they provide an organizational platform to combine different technological competences, which is an important feature since mastering technological complexity and multiple knowledge fields are important necessities in modern innovation processes.

The literature distinguishes two approaches in which networks perform these functions: a structural and a relational account (Borgatti and Foster, 2003). The structural account focuses on the impact of structural or topological (e.g. centrality, density or betweenness) aspects of (whole) network structures on knowledge flows and innovation outcomes. However, a debate has arisen about the form of network structure that is (most) beneficial for innovation outcomes. One view advocates that densely embedded networks with many interconnections between actors are advantageous (Coleman, 1988). In such 'closed networks', the extensive relations between partners foster the development of trust, shared norms of behaviour and inter-organizational, knowledge-sharing routines. Moreover, dense networks stimulate relation-specific investments that help to utilize the yields of collaboration and facilitate fine-grained transfer of information and joint problem solving. Further, dense networks are also helpful in minimizing opportunistic behaviour because information about an actor's opportunistic actions diffuses quickly to other actors in the network, resulting in a loss of reputation.

According to an alternative view within the structural account (Burt, 1992), advantages arise from brokerage opportunities created by so-called open networks. Open networks contain many structural holes. Structural holes are gaps in information flows between actors linked to the same actor (the broker), but not linked to each other. As a result, actors on either side of the structural hole have access to different flows of knowledge and information. Therefore, innovating actors can benefit from open networks since they produce low levels of redundant information and knowledge. This diversity and variety is beneficial for innovation outcomes because innovation is regarded as combining new knowledge and information or recombining existing knowledge and information in new ways. Since innovation depends on the level of newness of knowledge and information, open networks are usable devices.

Mainstream network research focuses heavily on the structural features of networks, paying less attention to *relational* characteristics. However, little is known about the ways in which different types of network

relationships condition information flows and learning in networks (Borgatti and Cross, 2003). Here, the relational account could be helpful. Several network researchers have investigated the role of strong and weak ties in the acquisition of new information. Granovetter (1973) argued that weak ties are more likely than strong ties to be bridges to different, low interconnected parts of a network and, therefore, new information. Subsequent research on the importance of weak ties has revealed that this type of relationship can be helpful to finding a job (Lin, 1988), individual advancement (Burt, 2000) and the diffusion of ideas (Rogers, 1995). More recently, however, the role of strong ties has been emphasized more often. Jack et al. (2004), for example, pointed to the importance of strong ties in entrepreneurial networks for the performance of the enterprise, whereas Hansen (1999) argued that strong ties promote the transfer of complex knowledge, while weak ties facilitate the transfer of simple knowledge and information. Recently, Nooteboom and Gilsing (2006) argued that in networks for exploration (i.e. for more radical innovation) higher levels of density and stronger ties are more beneficial to innovators, since both facilitate competence (for the transfer of tacit knowledge) and governance (for the management of risk and opportunism).

However, this literature does not answer the question as to which precise mechanisms are at work when actors search for external information in order to learn and innovate. Recently, Borgatti and Cross (2003) proposed an argument that takes relational aspects into account. In their view, the process of information seeking – who seeks whom for information and knowledge – is dependent on what they label as 'learned relational characteristics'. They argue that an intentional search for information and knowledge in an organizational setting can be viewed as a dynamic choice process. The decision to seek informational resources from other specific actors, in their view, depends on the characteristics of the relationship between the knowledge seeker and a set of other actors that serve as information sources. In turn, interactions between these actors update the seeker's perception of other actors with respect to these features. More specifically, they propose that knowledge and information seeking is a function of (1) the extent to which an actor knows and values the expertise of another actor, (2) the accessibility of this actor and (3) the potential costs incurred in seeking information from this actor (Borgatti and Cross, 2003: 434). As far as 'knowledge about the other' is concerned, they draw on work in transactive memory and distributed knowledge, in which a baseline condition for approaching a given actor for information is the awareness of that actor as a possible source in light of a current problem or opportunity. Moreover, it is also important that a knowledge seeker positively evaluates the knowledge and skills embodied in the other actor. Although an actor

positively evaluates the expertise of another actor, their knowledge is valuable only if they are accessible. Actors' accessibility can be viewed as a function of timeliness, engagement, information-processing capabilities, culture, and power distance. Therefore, the decision to seek information from a given actor depends on an actor's perception of the accessibility of other actors. Lastly, information seeking is not without cost. These costs concern interpersonal risks and obligations (e.g. norms of reciprocity), for example. On the basis of their empirical research, Borgatti and Cross found that knowledge, value and access predict information-seeking behaviour in networks, whereas cost does not. Therefore, this study shows that so-called learned relational characteristics facilitate information-seeking behaviour.

In this section, the question 'why do organizations participate in innovation networks?' was answered by (1) looking at the motives organizations can have to do so, (2) discussing the functions networks have for innovating and learning organizations and (3) studying the determinants of knowledge and information-seeking behaviour in networks. As far as the first point is concerned, it was found that two groups of motives for technological collaboration could be discerned. On the one hand, so-called incentive-based motives, such as cost sharing or reducing time to market and, on the other hand, knowledge-based motives such as technology transfer or monitoring external technological developments. The functions of networks (the second point) for innovation are threefold. Networks function as a coordinating device facilitating learning; they help to exploit and provide access to technological complementary assets; and networks serve as platforms for technological combination. The behaviour of actors seeking knowledge and information (the third point) turned out to be determined by the knowledge about other actors in the network, the accessibility of the actors, and search costs.

At this point in our discussion, it is important to note that a vast majority of studies dealing with networks, inter-organizational relationships and innovation in the field of organization studies take a structural approach to the issue. However, since innovation is highly dependent on flows of knowledge and information between actors, one could argue that the structural approach is missing the point. In other words, by mainly focusing at the topological features of networks and relating these to innovation outcomes, interactions and flows between actors are only assumed (in a later section, we will see that the knowledge spillover literature in economics has the same problem), but not measured. This does not mean that we would like to downplay the merits of the structural account of networks, but we argue for an approach balancing the two accounts.

Up to now the spatial dimension of innovation in networks has not been discussed. This issue will be addressed in the next section.

WHY DO ORGANIZATIONS PARTICIPATE IN REGIONAL INNOVATION NETWORKS?

The question raised in the title of this section is basically a specification of the first research question. To answer this question, two bodies of literature have to be discussed. On the one hand, there is the 'geography of innovation' literature (e.g. Feldman, Audretsch) that tries to answer the question to what extent and why unintended knowledge flows (knowledge spillovers) are geographically bounded. This literature is strongly rooted in the economics of technology and innovation, and mainly takes an empirical approach to the issue. On the other hand, there is a group of approaches that we label 'spatial interaction' literature. Examples of this group are the innovative milieu approach (Maillat), the new industrial spaces approach (Storper), or the industrial district approach (Becattini). In contrast to knowledge spillover literature, which *assumes* interaction between actors in geographical space, these approaches study *actual interaction between spatially concentrated actors*, often organized in localized networks of inter-organizational relationships.

Knowledge Spillovers

The last two decades have witnessed the growth of (mainly empirical) literature on the 'geography of innovation' that tries to evaluate whether knowledge spillovers exist and are geographically bounded. The starting point of these studies is the observation that innovative activities are strongly concentrated in geographic space and that firms located in certain areas are systematically more productive than firms located in other geographical regions. Due to the assumed non-rival nature of knowledge, spillovers are conceptualized as externalities. Put differently, a small group of actors investing in research or technology development will end up facilitating the innovation efforts of other organizations, thus stimulating (regional) economic growth. In this literature, it is proposed that information about novelties and innovation flows more easily among actors located within the same spatial area. Social bonds that foster reciprocal trust and frequent face-to-face communication are assumed to facilitate these flows. More specifically, this line of reasoning can be broken down into a three-step logical chain (Breschi and Lissoni, 2001: 980):

- knowledge produced by innovative firms and universities is transferred to other organizations;
- knowledge that spills over is a collective good, which is freely available to those who want to invest in searching for it (non-excludability),

and can be utilized by other organizations at the same time (non-rivalry);

- despite the above, knowledge that flows is mainly 'tacit' in nature, which means that it is highly contextual and difficult to codify, and is thus more easily transferred by face-to-face communication and personal relationships that require spatial proximity. This implies that knowledge is a public good, but a local one.

Therefore, from the point of view of the spillover literature, it is beneficial for innovating firms to be located in regions in which networks exist with high flows or stocks of both private and public R&D and academic research. As a result of leakages in these networks, these organizations are more likely to be innovative, compared to firms located in regions characterized by less resourceful networks. The reason that spatial distance matters for these knowledge spillover networks is found in the distinction between 'tacit' knowledge and information, the latter often being labelled 'codified' knowledge. As Audretsch (1998: 23) argues, 'the propensity for innovative activity to cluster spatially will be the greatest in industries where tacit knowledge plays an important role, . . . [I]t is tacit knowledge, as opposed to information, which can only be transmitted informally and typically demands direct and repeated contacts.' This quotation illustrates that the localized knowledge spillover literature combines the tacit/codified dichotomy with the use of a knowledge production function in which R&D and other innovative inputs are related to innovation output. As a consequence, local (i.e. outside the innovating organization, but within its geographical region) and distant external innovation inputs (inputs located outside the organization and outside its region of location) are distinguished. Statistically significant differences between the model parameters of the two kinds of R&D are then interpreted as evidence of the existence and the localization of knowledge spillovers. The approaches developed in the R&D spillover literature encountered severe criticism (see the Breschi and Lissoni, 2001 paper for an extensive overview). Here, we list the most important points. First, administrative boundaries are very poor proxies for the geographical levels at which different knowledge flows operate. Second, the assumption that within these geographical units common cultural backgrounds exist promoting the development of trust and the reduction of transaction costs does not hold, since no empirical evidence for it is provided. Third, the measures used to indicate innovation outcomes, such as patent counts or innovation counts, have severe flaws (e.g. firms in some sectors have a lower propensity to patent and prefer a secrecy strategy), often leading to an underestimation of regional innovative activity or a bias towards large innovating firms, underestimating the innovative performance of small firms. Fourth, this literature neglects the

fact that knowledge is not only tacit, but also highly specific, which implies that a specific vocabulary is needed to communicate and transfer knowledge. As a consequence, spatial proximity might be less important and organizational proximity (e.g. epistemic communities) might be more important for the innovation process. Fifth and lastly, the R&D spillover literature basically does not study the ways in which knowledge is transferred among actors located in the same geographic unit, a characteristic they share with the structuralistic approach in network studies.

Spatial Interaction Literature

During the 1980s, the discussion in the spatial sciences about the relationship between innovation and proximity was strongly influenced by insights from other scientific disciplines, such as the theory of industrial organization, sociology, and the (economic) network approach. The introduction of concepts such as 'transaction costs', governance structures, embeddedness, clusters and networks are cases in point. In addition, the relationship between innovation, networks and spatial economic development is given a far more prominent place on the agenda. In this context, a number of alternative theoretical perspectives have emerged.

Before discussing these perspectives in greater depth, it should be noted that much of the research conducted within this area uses different theoretical and methodological models and techniques, compared to the R&D spillover literature, which uses macro- and meso-theoretical frameworks, formal models, econometric techniques and large data sets of a quantitative nature to arrive at their conclusions. Contrary to this, with notable exceptions, the spatial interaction literature uses less formalized, micro-theoretical models, case-study approaches in which qualitative data are analysed. As a result of this, the spatial interaction literature is less mainstream and generally accepted in the broader scientific community of the regional sciences.

Below, the main characteristics of these 'new' approaches will be discussed with a special focus on the role of regional or localized innovation networks. At the end of the section, the various dimensions of these views will be compared.

The Innovative Milieu

In order to develop better theoretical and empirical insight into the effects of technological innovation and the rise of high-tech industries for local and regional economic development, a group of European researchers united in GREMI has introduced the concept of the innovative milieu.

In this approach, the firm is not an isolated innovative actor, but placed in its spatial context. The central idea is to understand what external conditions contribute to the emergence of new firms or the adoption of innovations by existing enterprises. Innovative environments are seen as the breeding grounds of innovation and innovative enterprises. Access to technological know-how, the availability of local linkages and inputs, the proximity of markets, and the presence of qualified labour are seen as factors determining the innovativeness of an area. It is therefore not surprising that the central hypothesis of the innovative milieu approach is as follows: 'it is often the local environment which is, in effect, the entrepreneur or innovator, rather than the firm . . . ' (Aydalot and Keeble, 1988: 9). The approach distinguishes three functional spaces for the organization: the production; the market; and the support space. The last space is based on three types of relationships: (a) preferred relations as to the organization of production factors; (b) strategic relations between the organization, its partners, suppliers and clients; (c) strategic relations with actors that are part of the territorial environment. It is especially the support space that qualifies the nature of innovative milieu, because it facilitates the transfer of resources important to (innovating) organizations.

Although the above may have given the impression that the innovative capabilities of firms are exclusively determined by the environment in which the firms operates, several authors also take the *characteristics* of the innovating firm into account. The nature of the production, the strategy used, intensity of R&D, or the nature of the innovation process may be mentioned in this context (Aydalot and Keeble, 1988: 12–14; Maillat, 1991: 110–13; Saxenian, 1994: 7–9).

Networks and inter-organizational interaction in tandem with the idea of apprenticeship are the core elements of the innovative milieu approach. Networks are seen as strategic devices that help regional actors to monitor environmental developments and change, enabling them to adjust behaviours. Moreover, necessary resources flow to innovating firms through localized networks. The emphasis is on relational characteristics (trust, reciprocity), whereas structural features of networks are hardly studied.

'Industrial District'

The concept 'industrial district' originates from the English economist Marshall. In his book, *Principles of Economics* (1890), two types of 'economies' are distinguished: *internal economies*, i.e. the efficiency of the production organization of an individual enterprise; and *external economies*, which refer to the cost benefits resulting from the distribution of work

among enterprises. The 'external economies', according to Marshall, can be achieved by the spatial concentration of small companies. Adding qualitative elements such as mutual trust among parties, 'atmosphere', and 'skills and knowledge', the most important component parts of an industrial district are put in place.

Hence industrial districts can be regarded as a special form of agglomeration. They are characterized by 'a local "thickening" of inter-industrial relationships, which is reasonably stable over time . . . ' (Becattini, 1989: 132). Small specialized and innovative firms operating on national and international competitive markets populate the districts. The inter-organizational relationships among enterprises in industrial districts are based on different kinds of social interaction among actors, such as cooperation, mutual dependence, and trust. These relations stimulate innovation, with ties of kinship among entrepreneurs often facilitating the spread of information. In short, the building blocks of the industrial district are the *social* links and networks among actors.

In the literature, a number of examples of successful 'districts' such as the 'Third Italy' (Benetton), Central Portugal (wooden and metal furniture) and the Japanese Sakari district are mentioned. However, Zeitlin (1992) concludes that these examples are the exception rather than the rule. Firms in these successful regions manage to apply 'best-practice' technology, which in addition to the socio-cultural circumstances in these regions are such that they foster innovation. Moreover, the emergence of this type of local production system in Emilia-Romagna, the heart of the 'Third Italy', is the result of very specific local developments originating in sixteenth-century silk production in this region (Malecki, 1991: 223). In other words, the district approach puts too strong an emphasis on the significance of successful small-scale, localized production systems in specific sectors that have developed under special historical circumstances. It very much remains to be seen whether such developments can automatically be predicted for other regions (see Hadjimichalis and Papamichos, 1991: 145–9).

In more than one sense, the industrial district approach is close to the innovative milieu line of thinking. Both stress the role of the local social–economic community, based on cooperative efforts and complementarities among functionally specialized firms. Both also put much emphasis on the relational aspects of networking. Reciprocity, trust, social and family bonds, along with knowledge and information exchange between actors, create a coordination system that outperforms other coordination mechanisms such as the market, creating a regional environment that facilitates and eases innovation. Structural network features such as centrality or density of networks are hardly taken into account.

New Industrial Spaces

During the 1980s, an approach was developed that was to exert a powerful influence on the spatial sciences: new industrial spaces (NIS). The core of the approach, which is strongly inspired by transaction costs theory, is formed by the assumed reciprocal relationship between vertical disintegration and the spatial organization of production (Scott and Storper, 1992: 8). On the one hand, there is the emergence of a disintegrated network economy causing agglomeration of economic activities in certain regions. On the other hand, these territorial production systems facilitate a further disintegration of production and a further distribution of labour.

As regards the relationship between (technological) innovation, networks and space, it is pointed out that technological innovation is often restricted to a particular area. Here, reference is made to two geographic dimensions of the innovation process. In highly innovative sectors, the knowledge bases are commonly embodied in specialized workers, who often show a strong spatial concentration and little geographical mobility. In addition, localized inter-organizational network relations in these sectors are channels through which knowledge is spread.

In the NIS framework, the relationship between innovation, network and proximity is established as follows. External economies of scale and scope are caused by production flexibility. Although there are various ways to achieve this flexibility, network production is considered to be of crucial importance. Through adaptation of inter-organizational relations, it is possible to introduce changes in the quality and the quantity of the output. More than elsewhere, spatially concentrated networks play an important role in innovation because the (tacit) knowledge necessary for innovation can be disseminated. Since in these relations there is often unstandardized and dynamic exchange causing higher transaction costs, the tendency of innovative production units towards localized networking is strong.

The NIS is criticized for its inadequate conception of the behaviour of economic actors (economic and technological determinism) and its neglect of the social dimensions of inter-organizational relations (strong focus on 'traded interdependencies'). These shortcomings, incidentally, have been recognized in more recent NIS publications. Storper (1995, 1997), for example, now makes a distinction between 'traded' and 'untraded interdependencies', the former being the input–output relations (localized or not) that together form a web of user–producer relations, which are extremely important for the exchange of information. The latter are, among other things, (regional) labour markets and conventions, norms and values and (semi-)public institutions that are connected with economic and organizational learning and coordination processes. In this line of

argument, innovation and proximity are again related. As Storper (1995: 897) puts it: 'Where these input–output relations or untraded interdependencies are localized, and this is quite frequent in cases of technological or organizational dynamism, then we can say that the region is the key, necessary element in the "supply architecture" for learning and innovation.'

Initially, NIS takes a transaction costs theory approach to (regional) networks and innovation. Innovating firms can profit from these networks because they provide opportunities to reduce the spatially dependent costs of external transactions. Thus networks are viewed as devices to increase efficiency. Localization forces are further strengthened in cases where inter-organizational relationships encompass frequent transactions, just-in-time processing, idiosyncratic and variable forms of inter-organizational transacting, and small-scale linkages with high unit costs are present. Since innovation relationships often have these characteristics, regional innovation networks can serve as efficient governance mechanisms.

Regional Innovation Systems

The central idea behind the concept of (regional) innovation systems (RIS) is that the innovative performance of an (regional) economy does not exclusively depend on the individual innovative performance of organizations alone, but is dependent on interactions with other actors. Innovative firms function in a shared, institutional context. They are dependent on, contribute to, and make use of a joint knowledge infrastructure, which is a system that creates and distributes knowledge, uses this knowledge to achieve innovation, thus generating economic value (Gregersen and Johnson, 1997: 482). Therefore, the emphasis is on collective learning processes, which are facilitated by strong cooperative relationships between system members.

Within this approach, various systems emerge. Innovation systems are defined for particular sectors or specific technologies or on the basis of (geographical) proximity. Within the (geographical) innovation systems, the concept of 'interactive learning' is central. Learning is conceived as a process in which all kinds of knowledge are (re)combined. The interactivity of this learning refers to learning that is co-dependent on the communication between people or organizations that possess different knowledge bases.

As innovations are the result of cumulative learning processes (Lundvall, 1992: 8), the performance of territorial innovation systems depends on the relations between a diversity of sources of knowledge and proximity. To formulate it simply: 'A larger territorial space may contain more diversity, but this will not lead to innovation if there is not enough proximity to support communication . . . ' (Gregersen and Johnson, 1997: 482). Besides

spatial proximity, other dimensions of proximity exist, such as, for example, economic, organizational, and cultural proximity (Lundvall, 1992; Boschma, 2005). The central idea is that interactive learning and innovation will be restrained if these distances become too great. Therefore, (geographical) proximity facilitates the innovation process.

Within the RIS framework, Lundvall (1992) developed an argument for the relation between innovation, networks and spatial proximity. Lundvall studied the relationship between the radicalness of technological change and spatial interaction. It is argued that the more radical the process of technological innovation, the less codified knowledge is. The more tacit the knowledge communicated, the more important spatial proximity between user and producer is. So a positive relationship between the level of tacitness of knowledge and the importance of spatial proximity is assumed.

In sum, in the RIS approach, innovative networks are the channels through which (new) knowledge is generated and transmitted. Moreover, network relationships are the stage on which interactive learning processes between actors in the system take place. Firms can profit from regional innovation networks because these types of networks enable the transfer of tacit knowledge. Tacit knowledge is difficult to imitate and, as a result, organizations in regional innovation networks can develop competitive advantages.

The Learning Region

The learning region approach can be viewed as an intermediate synthesis in the models on territorial innovation, since it combines several theoretical bodies of literature (Moulaert and Sekia, 2003). As Morgan (1997: 492) puts it, the purpose of the learning region approach is to 'connect the concepts of the network (or associational) paradigm – like interactive innovation and social capital – to the problems of regional development'. The approach takes the premise that knowledge is the most important resource in an economy, whereas learning is the most important process. Moreover, innovation is conceptualized as an interactive process and shaped by a variety of institutional routines and social conventions. As in the regional innovation systems approach, ties between actors in a regional innovation network facilitate the exchange of knowledge and the building of social capital. Basically, the learning region approach uses the reasoning of the new industrial spaces approach on localization; that is, where traded and untraded interdependencies are localized, the region is a key element in the 'supply architecture' of learning and innovation. Also in this approach, the transfer of tacit knowledge and spatial proximity are closely connected. As Morgan stated (1997: 495), 'tacit knowledge is

collective in nature and, because it is wedded to its human and social context, it is more territorially-specific than is generally thought'.

After this discussion of different perspectives that are part of the spatial interaction literature, we can summarize them by highlighting those elements that are central to the understanding of the regional innovation networks (see Table 8.1). The following dimensions are taken into account:

- *The core of innovation.* Since innovation is the core of regional innovation networks, the question is asked how innovation is conceptualized (e.g. as an outcome or a process).
- *The role of institutions.* Institutions, such as rules and norms, enable and constrain organizational and social behaviour in general and innovative behaviour and interaction in networks in particular. Therefore, they are an important ingredient of innovation networks.
- *The type of relations and networks.* This refers to the organizational dimension of regional innovation networks. The question is asked how inter-organizational relations and networks are conceptualized. Are they a mode of social regulation or a coordination device?
- *The relation between innovation and proximity.* This and the next dimension describe the core of regional innovation networks. As far as this item is concerned, we look at how innovation and geographical space are related.
- *The proximity mechanism.* The last dimension is about how the interaction between innovation and geographical space is conceptualized.

Most of the above approaches, as in spillover literature, assume a negative elasticity as to the transfer of (technological) knowledge in space. The level of codification matters here since spatial proximity is important, especially if tacit knowledge has to be exchanged. Moreover, in contrast to regional spillover literature, it is intended interaction between economic actors that is functioning as the mechanism of knowledge transfer. Although the approaches are heterogeneous because of their variety of concepts and perspectives, the importance of interpersonal links, of a common institutional culture among workers, entrepreneurs and politicians, and of a positive attitude towards collaboration, all facilitated by spatial proximity, stimulate interactions between actors in general and the flow of knowledge and information in geographical space in particular. They all assume that firms that tap into tacit regional knowledge flows will acquire necessary resources more easily and will therefore able to perform better or be more competitive.

Recently, however, several scholars have challenged the received wisdom on the relation between tacitness and spatial proximity. Asheim (1999: 348)

Table 8.1 Views on regional innovation networks

Features	Theoretical approach				
	Innovative milieu	Industrial district	Regional innovation systems (RIS)	New industrial spaces (NIS)	Learning region
Core of innovation	Capacity of firms to innovate through relationships with agents of the same milieu	Capacity of actors to implement innovation in a system of common values	Innovation as an interactive, cumulative and specific process (path dependency)	Innovation is a result of R&D and its implementation; application of new production technologies	As for RIS, but stressing co-evaluation of technology and institutions
Role of institutions	Very important role of institutions in the research process	Institutions are 'agents', enabling social regulation, fostering innovation and development	Institutions lead to a regulation of behaviour, both inside and outside organizations	Social regulation for the coordination of interfirm transactions and the dynamics of entrepreneurial activity	As in RIS, with a stronger focus on the role of institutions
Type of relations/ networks	Role of support space: strategic relations between the firm, its partners, suppliers and clients	The network is a social regulation mode and a source of discipline. It enables both cooperation and competition	The network is an organizational mode of interactive and collective learning	Interfirm transactions	Networks of embedded actors

Table 8.1 (continued)

Features	Theoretical approach				
	Innovative milieu	Industrial district	Regional innovation systems (RIS)	New industrial spaces (NIS)	Learning region
Relation between innovation and proximity	Depending on the nature of innovations and technology strategies of actors, the environment is a supplier of resources or a supporting production system	Through social links and networks of actors, information, knowledge, standards, etc. are communicated and distributed	Institutions, proximity and diversity of resources stimulate or restrict interactive communication, learning, and innovation in regions	Localized knowledge (labour) is an immobile resource; exchange relations with other actors are resources for innovation	As in NIS
Proximity mechanism at work	Innovative milieux are an effect of capacities of certain regions to improve organization of collective learning processes and to realize lower information costs	Districts are a way in which a production organization can compete internationally (think global, act local). Proximity eases exchange of resources	Spatial proximity stimulates interactive learning and the transmission of tacit knowledge	Vertical disintegration and characteristics of transactions between organizations generate spatial concentration. Proximity facilitates the exchange of tacit knowledge	Proximity facilitates the exchange of tacit knowledge

Sources: Oerlemans et al. (2000); Moulaert and Sekia (2003).

argues that 'localised learning is not only based on tacit knowledge, as we argue that contextual knowledge also is constituted by "sticky", codified knowledge'. This latter type of so-called disembodied knowledge is based on individual skills and experience, a collective technical culture and a well-developed institutional framework, which are all highly spatially immobile.

Torre and Gilly (2000) state that there is a frequent combination of tacit and codified within firms and networks. Lundvall and Johnson (1994) maintain that the growth of knowledge-based networks and teams may be seen as an expression of the increasing importance of knowledge, which is codified in local rather than universal codes. The skills necessary to understand and use these codes will often be developed by those actors allowed to join the network and be a part of interactive learning processes. Therefore, a social network perspective in which processes of inclusion and exclusion are important is added to the discussion.

Breschi and Lissoni (2001) develop this argument further by pointing to the existence of epistemic communities in which specific language for the exchange of technical and scientific messages is used. A lack of disclosure of these codes may function as a strong device of exclusion, even for actors in the same region. Since tacitness and codification are mutually compatible, tacit knowledge can be communicated over even large geographical distances by means of different media. The implication is that innovating firms have to tap into networks at different geographical levels in which both tacit and codified information and knowledge are transferred. Asheim (1999), Lundvall and Borras (1999), Dicken and Malmberg (2001), and Sternberg and Arndt (2001) developed comparable lines of thought.

What this all boils down to is that a majority of scholars studying regional innovation networks tends to take a somewhat simplistic approach to the proximity issue. The knowledge and information interaction processes in (regional) networks are studied through the one-dimensional lens of tacit–codified dichotomy. However, interaction in (regional) innovation networks is far more complex, as several of the authors discussed in the last part of this section have argued. This calls for an approach in which the multidimensional nature of inter-organizational relationships is recognized. In the next section, we will discuss some of the implications of this observation.

CONCLUSIONS AND DISCUSSION

In this chapter, we have tried to answer two questions: (1) why do organizations participate in innovation networks and (2) why do organizations participate in regional innovation networks?

The former question was answered by first discussing the general motives for network participation (e.g. necessity, efficiency, reciprocity). Second, we looked into motives found in the literature for participating in innovation networks. Two groups of motives could be discerned:

- incentive-based (e.g. sharing costs, reducing risks, shorter product development cycles);
- knowledge-based motives (e.g. transfer of knowledge, monitoring technology developments and opportunities).

If we compare the motives for entering innovation networks with those proposed by Oliver (1990), it can be concluded that the former sets of motives can be grouped into two 'general' motives, namely efficiency (incentive-based) and reciprocity (collective-knowledge-based). Third, the functions of networks for innovation were discussed. Innovation networks are a coordination device enabling and facilitating interfirm learning and the diffusion of new technological know-how. Moreover, these networks facilitate the exploitation and access to technological complementary assets and provide an organizational platform to combine different technological competences.

In general, there seems to be a network bias; that is, most scholars and approaches tend to emphasize the positive elements of network participation. Negative effects of participation in (innovation) networks receive far less attention in the literature. For example, negative lock-in effects, network failure and its causes, and the effects of power asymmetries are understudied topics. It can be concluded that more empirical research on these topics is needed. For instance, one could investigate to what extent the duration of ties in a (regional) network affects its ability to generate new knowledge.

The structural account dominates the research agenda in the a-spatial network studies on innovation. However, innovation is not only the production of artefacts (products or patents), but also a process. From this process perspective:

- more attention could be paid to relational and process aspects of (innovation) networks in organization studies, as some scholars in the field seem to realize;
- a process view on networks and innovation also points to the need for longitudinal research designs that will help us to come to a deeper understanding of the co-evolution of network development and innovation. An interesting research question could be how network composition and exchange patterns change while the innovation process unfolds.

Many network studies emphasize the importance of structural holes for innovation. However, an open network is not only a potential for the formation of relations; it also represents a culture in which the probability of opportunistic behaviour is higher, resulting in greater concerns for the misuse of acquired knowledge, exactly because network actors are less densely interconnected. These concerns call for countermeasures and safeguarding behaviour, causing more hierarchical governance and higher organization costs. This eventually indicates that collaboration is 'not done'. If this argument holds, the structural holes in a network can be pitfalls instead of brokerage opportunities. Moreover, organizations do not have the choice of being part of a complete network with structural holes (or a dense network). An organization is or is not part of it. This implies that a managerial view in which whole networks, including structural holes, are purposely built, does not apply. In other words, the network formation process is more 'random' than many scholars would like to admit.

The functions of networks for innovating organizations are even strengthened in a regional context. Scholars in regional economics and economic geography came up with a variety of approaches that all are combinations of three dimensions (Crevoisier, 2004):

- a technological dimension stressing innovation, learning and know-how as the most important competitive advantages of organizations;
- an organizational dimension stressing the role of networks, collaboration and competition, the rules and norms of collaboration, as well as relational and social capital;
- territory, which accounts for the role of proximity and distance and stresses the idea that competition occurs between regions.

The dominant view on the role of the region or of proximity for innovation is either that the region is a context from which innovative organization can mobilize valuable resources or that proximity eases the transmission of especially tacit knowledge. Exactly this type of knowledge is an important building block for the competitive position of organizations in general and the innovative performance of firms in particular.

In a previous section, it was argued that our second research question basically is a (spatial) specification of the first research question. Yet this specification can be done at several levels of analysis (see also Morgan, 2004):

1. The complete network level, which raises the question of which parts of the network are local or regional and which parts are national or international. This raises a related issue: how to define local versus non-local boundaries?

2. The dyad level and especially the relational features such as, for example, trust, knowledge exchange and tie strength.
3. The level of the individual network actor is also of importance. At this level, partner features or so-called attribute variables come into play.

Although the literature discussed in this paper hints at the importance of these levels of analysis for the innovative outcomes of networks, systematic theorizing on the interplay of these levels is lacking. Moreover, taking different levels of analysis into account opens up the possibility of applying multi-level analysis to empirical research on (regional) innovation networks and test theoretical models. This would result in an interesting new research direction. An example of such a study could be to assess the impact of the mobility of engineers (attribute variable) on the level of knowledge exchange (relational feature) in the innovativeness of a network (network level).

To answer the two questions posed in this chapter, we tapped into two bodies of literature: organization studies on the one hand and regional science on the other. Some interesting conclusions can be drawn when comparing this literature:

1. The network studies performed in the field of organization studies tend to have a structural approach to networks, whereas relational aspects are understudied. For the approaches developed in the regional sciences, the opposite is true. Much attention is paid to relational aspects of networks (such as social bonds, family ties, interactive and collective learning), while structural aspects of networks are often neglected.
2. Empirical and theoretical studies in both fields seem to indicate some convergence. As we have pointed out, in organization studies the relational account is emerging in an effort to get more insight in the relational determinants of network flows, whereas the discussion in regional studies on the tacit–codified knowledge dichotomy led to the understanding that innovating organizations have to be connected to networks populated by a diverse set of localized and non-localized actors, which brings us in the realm of the structural network account, studying whole network studies and applying its related analytical tools.

These conclusions point to an interesting research avenue for the regional sciences; that is, to include both relational and structural accounts in the study of regional innovation networks. Network population size is an important issue in analysing networks, because most network measures are using this as a parameter for centrality or density, for example. This could especially be applied in regional networks, because this allows the inclusion

of regional features in network analysis, whereas they are now completely out of sight. Other interesting examples of a similar approach can be found in the recent work of Reagans and McEvily (2003) and Owen-Smith and Powell (2004). The work of the latter authors is especially important, as they contend that integrating considerations of geographic proximity of network structures and the institutional demography of network nodes offer new insights in the relationship between structural network positions and organization-level outcomes. Within regional economies, linkages among spatial proximate partners stand for relatively transparent channels for knowledge transfer because they are embedded in an ecology rich in formal, informal and labour market transfer mechanisms. When the central nodes in innovation networks have institutional features (norms and values) stimulating open regimes of knowledge disclosure, the entire network structure is characterized by less tightly monitored ties, resulting in a freer flow of knowledge that could impact positively on organizational outcomes.

In sum, in this chapter we have argued that a further integration of the insights of regional and organization studies is very helpful in deepening our knowledge and understanding of (regional) innovation networks.

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