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**“Innovation and Space: Theoretical Perspectives”**

by

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## 1.1 Introduction

In economics, the discussion on innovation and technological development and their meaning for economic development has become increasingly important in recent years. The spatial (economic) sciences have also contributed to this discussion.

It is generally agreed that innovation and technological development are important factors in explaining economic growth and development. Time and again, production, diffusion, and implementation of knowledge have proven to be crucial processes in this context. The meaning of the knowledge factor compels scientists to further study the theoretical and empirical relation between the firm and its (spatial) environment. Firms often need to use their immediate surroundings as regards both production and diffusion and implementation of knowledge. This idea is contained in various theoretical approaches, such as Williamson's (1975) theory of transaction costs and the economic network approach developed by Håkansson (1992, 1993). The evaluation of these approaches by Oerlemans (1996) showed that the spatial economic element is often absent or difficult to trace. Theoretical approaches in which the spatial aspect does form an important element are often characterized by insufficient attention to technology and innovation.

The spatial dimension of the relation between the firm and its environment will be addressed in the present paper within the framework of the study of innovation. The central question of the paper is: What are the relations between innovation and environment? This question will be elaborated as follows. In section 1.2 some observations on the relation between organizations and their environment in general regional economic theories are put forward. Focussing on the relation between innovation and the environment, regional theory development until 1980 is discussed in section 1.3. During the 1980s a number of new theoretical perspectives on the relation between innovation and space emerged. Section 1.4 deals with the most important developments. Finally, the theoretical perspectives discussed in section 1.4 are evaluated in section 1.5.

## 1.2 The relation between organizations and their environment in general regional economic theory

In our view, on the basis of the interaction between actor and structure, there are two approaches regarding the relation between a firm and its spatial environment (cf. also: Vaessen, 1993, Chapter 2). In the first approach, the action of organizations is a function of the spatial environment in which an organization is located. In other words, the characteristics of the spatial environment to a large extent determine the origin, action, and performance of an organization. Little or no attention is given to the influence of the firm on its environment: the primacy of this approach is in the spatial context.

In the second approach, more or less the opposite is argued. The spatial environment in which a particular organization is located is seen as a result of the action and activities of the firm. A great deal of attention is paid to the decisions and actions of entrepreneurs and firms and their influence on the spatial environment. In this approach, organizations are conceived as 'area organizing institutions'. In other words: in this approach, firms determine to a great extent their (spatial) environment; the primacy is with the organization.

Regional economic development theories, which can be considered as the exponents of the first approach, all emphasize the importance of the spatial environment, based on the concept of agglomerate economies.<sup>1</sup> It is supposed that these agglomerate economies mainly occur in urban areas. Initially, it is supposed that the advantages of geographical concentration of economic activities can predominantly be achieved through lower transport costs in the delivery of material input. In the course of time, the content of the concept of agglomerate economies is broadened. It not only comprises the (costs of) material relations, but it is also applicable to various immaterial relations, such as the exchange of knowledge, the delivery of services, and labor market relations.

Summarizing, these theories conclude that agglomerate economies in urban areas are higher because the costs of information, communication, and transaction are lower than those in non-urban areas as a result of spatial concentration of economic activities. Moreover, urban areas offer more than cost efficiency. They also have higher information density, a differentiated supply of better-qualified labor, and more possibilities to contract out. In other words: 'agglomeration economies are not only expressed in lower production costs but also in so-called differential advantages' (Vaessen, 1993: 19-20). The effect of agglomerate economies is that urban economic activities are more dynamic, innovative, and, expectedly, profitable. In short, the characteristics of the local production environment expressed in agglomerate economies to a large extent determine the functioning and results of an organization.

In the second perspective on the relation between organization and environment, the emphasis is on features and behavior of enterprises and their influence on their spatial environment. On the basis of the work of Simon, the behaviorist approach in economics took shape in the second half of the 1960s. As a reaction to a number of flaws in classical economic thinking, more attention is now being paid to the economic processes of choice and to personal motives and the behavior of the entrepreneur. In the spatial sciences, this means that there is more interest in the

underlying (individual) factors that explain location behavior and in the spatial effect of the behavior of firms. In light of the relation between an organization and its spatial environment, two approaches are relevant within the behaviorist view: behavioral location theory and the ‘geography of the enterprise’ approach.

Proponents of behavioral location theory criticize a number of assumptions of classical location theory. The fully informed, profit maximizing entrepreneur is succeeded by a restrictedly rational ‘satisfier’. Therefore, in this approach, the motives of manufacturers and consumers and the extent to which they acquire and are able to process that information are important elements in choosing a location. The work of A. Pred (1967) was of great influence in developing this theory.

The ‘geography of the enterprise’ approach can also be seen as a spatial-economic approach which opposes the principles of classical and neo-classical location theory. Especially the fact that classical location theory chooses the small ‘single-plant family firm’ as an object of study and the idea that a company's choice of location is completely determined by the characteristics of the spatial environment has been rejected by a number of authors. They refer to the effect and importance of large, often multinational, enterprises for the modern Western industrial economy. They are also of the opinion that (large) enterprises in fact influence their (spatial) environment to a considerable extent. In other words: they reject the mechanistic location behavior that is used in the traditional theory.

Within the ‘geography of the enterprise’ approach, two trends arose (Vaessen, 1993: 26).<sup>2</sup> One trend concentrates on the way in which firms adapt to the influence of their environment. In this view, the (spatial) environment is considered to be a precondition for organizations to act. The other trend mainly focuses on the impact of the structure and behavior of large companies on regional-economic developments. Here, the spatial and regional environment is the output, the result of decisions of (managers within) enterprises.

If we take a critical look at the ‘environmental approach’ and the ‘geography of the enterprise’ approach’, both approaches appear to have their weaknesses. This is shown in Table 1.1. In the ‘environmental approach’, the different regional conditions of production seem to come out of the blue. This theory can give no adequate answer to the question of how strong regions have developed better or more differentiated conditions of production. Acting as devil's advocates, McDermott & Taylor (1982) point out that some locational advantages (for instance, services and infrastructure) materialize *after* a concentration of economic activities has developed. Therefore, the environmental approach does not appear to be capable of giving a satisfactory explanation of spatial-economic dynamics. Vaessen (1993: 23) attributes this failing to the fact that ‘these theories conceive of regions as predefined spatial units, having dynamics in and of themselves and existing in isolation from the rest of the economy.’ In addition, the approach can be called one-dimensional. This makes the theory inflexible and vulnerable. It can only make statements on a given spatial (center-periphery) distribution. A third criticism involves its disregard of the individual organization. McDermott & Taylor (1982: 7) argue that spatial science ‘has tended to disregard the individual organization and treats all decision-making units in much the same manner as black boxes, capable of a limited number of actions determined by particular environmental contexts.’ Little scope is given to the economic behavior of actors, that behavior being completely determined by the spatial environment. It therefore comes as no surprise that critics have coined terms like ‘spatial determinism’ or ‘spatial fetishism’ to typify this situation.

There are also a number of theoretical problems with the ‘geography of the enterprise’. Firstly, this approach suffers from a too one-sided emphasis on the large multinational and multilocal enterprise, ignoring the relevance of small and medium-sized enterprises for the functioning of spatial economies. As a result, one of the central problems of the spatial economy, *viz.*, the interaction between the origin and development of enterprises and the spatial environment is lost.<sup>3</sup> Secondly, an enterprise or a region is usually treated as an isolated phenomenon. Such an approach does not enable one to draw conclusions about, for example, the economic achievements of comparable enterprises under different spatial conditions. Thirdly, we may remark that in this approach, an inadequate conceptualization of the notion ‘environment’ is employed. The environment is mainly seen as the result of the actions of organizations. As far as the environment is used as a condition for the actions of organizations (input), it only regards the influence of general socio-economic developments, such as changed consumer demand, on the manner in which the organization functions. In other words, this approach fails to take due note of the influence of spatially dissimilar circumstances of production on the behavior of firms.

Table 1.1: Theoretical problems of the environmental approach and of the ‘geography of the enterprise’

Environmental approach	Geography of the enterprise
The existence of ‘strong’ and ‘weak’ regions is not explained.	Great emphasis on large, multinational enterprises
Theories are one-dimensional. Only the cumulative discrepancy between center and periphery can be explained.	Approach usually concentrates on one single company or region.
The individual organization is treated as a ‘black box.’	The business environment is not clearly conceptualized.

*Elaboration of: Vaessen (1993: 23-24, 31-34).*

Briefly summarizing the above, we may say that in the main theoretical approaches in the spatial sciences, the relationship between enterprise and spatial environment is at least problematic. Both approaches are characterized by one-sidedness. In one, the emphasis is on the influence of the spatial environment, and economic actors are reduced to 'puppets on a string.' In the other, the actions of (large) enterprises occupies a central position, with the environment really remaining a 'black box.' The discussions and conclusions in the spatial sciences show a strong resemblance to those in the organization sciences (see Oerlemans, 1996: 39ff).

### **1.3 The relationship between innovation and environment in the spatial economic sciences in the period until 1980**

To Vaessen's critical evaluation, we may add that (the spatial aspects of) technological development in general, and (those of) innovation in particular, receive only scant attention in the approaches mentioned above. Malecki (1991:72) states, 'Technology is one of the principal factors behind regional dynamics, but is dealt with least satisfactorily by either conventional or Marxist approaches'. This does not mean that technology and innovation have received no attention at all in theory formation in the spatial economic sciences.

In neo-classical models of regional economic development, technological development is introduced via a Cobb-Douglas production function, which looks upon capital as a flexible and manipulable production factor. Capital can appear in various forms and embody new technologies. Since labor and capital are substitutable, and productivity is measured in terms of output per unit of labor, laborsaving investments are generally preferred when the aim is to increase the amount of output. This neo-classical model of regional development is both a growth theory and a theory of factor mobility, because, if the assumption that production functions in all regions are identical is correct, labor will migrate from low-wage regions to high-wage regions. Conversely, capital will move in the opposite direction. Eventually, these regional economic growth processes will lead to converging per capita regional incomes. In this sense, neo-classical models of regional-economic growth are in essence reallocation models, which consequently contribute little to an explanation of spatial economic inequality. Malecki's judgement about the role of technology in neo-classical theory hits the bull's eye (1971: 79): 'And, significantly, technical progress is accorded surprisingly little recognition of its importance'.

The theories building on the concept of agglomeration economies can also be said to pay some attention to technological development. In a variant on Myrdal's principle of cumulative causation, Siebert (1960) argues that a higher regional turnover leads to higher investments in R & D ('demand pull' hypothesis). The resulting innovation and knowledge yields a number of initial advantages for the region in question. In turn, these advantages lead to higher regional turnover and R & D. Although knowledge has a certain geographical mobility; it tends, in Siebert's view, to polarize in certain locations in space. This technological polarization goes hand in hand with a polarization of capital and labor resulting from the initial advantages of innovation mentioned before (higher profits and wages). These polarization effects are even reinforced if in a region economic advantages of scale present themselves, i.e., internal advantages of scale and agglomeration economies. Siebert argues (op. cit.: 40): 'The more mobile capital and labor, the stronger are the polarizing effects which technical knowledge induces'. The result is that cumulative causation processes are reinforced by the spread of new technologies first introduced in big cities and regions. In other words, what this type of regional economic growth model addresses is the way in which the size of a certain geographic area, often an urban area, plus the internal and external advantages of scale obtained there, and the spread of innovation are associated, with innovations spreading in accordance with the urban hierarchy (the 'trickle-down-effect'). In order to emphasize the subordinate role of technology in this kind of approach, Malecki (1991, 87) sighs, 'Agglomeration economies, rather than technology, become the driving forces behind regional growth in these models'.

### **1.4 The relationship between innovation and spatial environment 'revisited'**

#### **1.4.1 Introduction**

We have now seen that in important areas of the theory formation in the spatial sciences of the pre-1980s, the interaction between organization, technology, and innovation on the one hand, and the spatial environment, on the other, is problematic.

During the 1980s, the discussion in the spatial sciences about the relationship between innovation and region was strongly influenced by insights from other scientific disciplines, such as the theory of industrial organization and sociology. The introduction of the concept 'transaction costs' or the use of such concepts as embedding, clusters and

networks are cases in point. In addition, the relationship between innovation and spatial economic development is given a far more prominent place on the agenda. In this context, a number of theoretical perspectives, such as the theory of the 'new industrial spaces,' the 'district' theory, the innovative milieu approach, and 'regional innovation systems' emerged.

Before briefly going into these theoretical perspectives, we must first elaborate on the concept of innovation. More than any other economic activity, innovation depends on knowledge, knowledge that can come in a variety of shapes. In an iterative process in which invention, development, and introduction or implementation are important steps, attempts are made to realize new or improved products and processes through the (re)combination of heterogeneous resources.

At this juncture, it is important to contrast the traditional view on technological knowledge with what may be called a 'modern' view (Smith, 1995: 75). In many economic theories, especially those taking a neo-classical perspective, technological knowledge has a number of specific features that are often left implicit. According to these theories, technological knowledge is:

- *Generic knowledge*. This means that general applicability and transferability often characterize technological knowledge;
- *'Codified' knowledge*. The general applicability and transferability of technological knowledge implies that knowledge is codified in economically usable forms;
- *Freely available*: The cost of transferring or obtaining technological knowledge is negligible or identical for all enterprises;
- *Context-independent*. The general applicability and transferability ensures that all enterprises have the opportunity to harness this knowledge for their production process. This is independent of the nature of the product produced, the production techniques employed, or the sector to which the enterprise belongs.

In view of these features, innovation is not really anything problematic. Neither the use of existing technology, nor the introduction of new technology confronts the organization with severe problems. In this view, the environment of the organization consists exclusively of inputs of exogenously given technology on which the firm can draw at will.

This view on technology and technological knowledge has not remained without its detractors, who have labeled it as very unrealistic (Rosenberg, 1994). Smith (1995: 78-81) systematizes the characteristics of technological knowledge in what he calls a 'modern' view. He argues that enterprises innovate on the basis of a specific set of internal resources, called the 'knowledge base'. These sets of resources have the following characteristics:

- *Resources are 'differentiated and multi-layered'*. A specific set of resources consists of various forms and levels of knowledge. The knowledge in question may, for example, be coded scientific knowledge or uncoded ('tacit') knowledge embodied in the experience and skills of employees or other actors;
- *Resources are specific*. The technological resources an organization has at its disposal are partially specific to the enterprise. Firms possess knowledge about, and have experience with, one or more technologies that affect their competitiveness. This means in the first place that, while innovating, enterprises can reach the limits of their competence. In other words, innovating is not an unproblematic process. In the second place, the limited sizes of the internal knowledge base forces firms to acquire specific forms of additional knowledge from outside the organization. In this sense, innovation is also interwoven with the environment;
- *The development of resources is expensive and cumulative*. Improving resources (innovation) is an expensive search process in which firms, through learning and adapting, gain experience with the use of specific technologies. The gaining of experience underscores the cumulative character of the innovation process;
- *Resources are 'internally systemic'*. Innovation is not only a technical process, but is, within the enterprise, interwoven with other (economic) activities. This means, among other things, that innovating also implies exploring technological or market possibilities; that innovations must be financed; and that employees must be trained to handle the new technologies;
- *Resources are 'interactive and externally systemic'*. Innovating often requires structured interaction with other economic actors. Through this interaction, the organization learns and acquires and exchanges knowledge.

In summary, we can conclude that in this 'modern' view, technological development is far from unproblematic. Innovation is an expensive learning process in which specific resources are improved using various kinds of knowledge. The environment is seen as a collection of institutions and resources with which the innovating actor interacts. This interaction takes shape through the structured exchange of resources and through learning processes. To a greater or lesser extent, all these characteristics of resources and the underlying view of the innovation process are present in what will be discussed below, viz., the new insights into spatial economics with respect to the relationship between innovation and space.

#### 1.4.2 'New Industrial Spaces'

During the 1980s, an approach was developed that was to exert a powerful influence on the spatial sciences. Strongly inspired by neo-Marxist theories about unequal spatial development and Piore and Sabel's 'Second Industrial Divide,' authors like Scott, Storper, Harrison and Walker managed to create a theoretical framework that shed a new light on the economic dynamics of regions. Within this framework, the regulationist interpretation of capitalist development is interwoven with elements from Williamson's transaction-cost approach and labor economics.

The core of the 'new industrial spaces' (NIS) is formed by the assumed relationship between vertical disintegration and the spatial organization of production (Scott & Storper, 1992: 8). This relationship is a reciprocal one. On the one hand, we are reminded of the emergence of a more disintegrated network-economy causing agglomeration of economic activities in certain regions (Silicon Valley, Third Italy). On the other hand, these territorial production systems facilitate a further disintegration of production and a further distribution of labor.

The effects of external economies of scale and scope mainly trigger this process. The emergence of new technologies and especially of flexible production techniques enables firms to abandon the Fordistic mass-production system. This system is partly replaced by a post-Fordistic production system in which firms achieve a high degree of specialization. The external economies of scale resulting from this are further supported by improved possibilities of (tele)communication between firms and the development and use of common production factors like the local labor market and supporting institutions.

As regards the relationship between (technological) innovation and space, it 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 sectors characterized by high innovativity, the knowledge bases with which the technological development is realized are often embodied in specialized workers, who in their turn often show a strong spatial concentration and little geographical mobility. In addition, localized relations between firms in these sectors are channels through which knowledge that is indispensable for innovation is spread.

Storper & Harrison (1991) systematically developed a framework of analysis that accommodates localized production systems. When formulating this framework, they distinguished two dimensions: the extent of the internal economies of scale and scope of a *production-unit*, and of those of the entire *input-output system*. The existence of external economies of scope depends on the degree of fragmentation of the production process. Strong fragmentation means that the input-output system consists of highly specialized production units, which increases the chances of external economies of scope emerging.

By constructing a 2-by-2 matrix on the basis of the distinction between high and low internal and external economies of scale and scope, we arrive at four types of production systems. If, subsequently, we include into the system the spatial distribution of the production units as a third dimension, we get Table 1.2.

The question of which factors determine the spatial concentration of production units is answered as follows: 'In general, it is evident that in industrial complexes marked by much inter-linkage at least some producers will have a tendency to converge around a territorial center of gravity, especially where linkages are small in scale, unstandardised with respect to substance, and rapidly changing in time and space, and hence incur high unit costs. In this manner, the external economies created by disintegration are transformed into and consumed in the form of agglomeration economies' (Scott & Storper, 1992: 8). What this boils down to is that characteristics of transactions between production units are the cause of spatial agglomeration.

In Storper & Harrison's framework of analysis, the relationship between innovation and space is established in the following manner. External economies of scale and scope can be associated with production flexibility. Although there are various ways to achieve this flexibility, Storper and Harrison consider network production to be of crucial importance. It is precisely through adaptation of interorganizational relations that it is possible to introduce changes in the quality and the quantity of the output. This enhances the ability of the system to cushion external shocks and stimulates internal change like innovation. More than elsewhere, spatially concentrated networks play an important role in innovation. Via the relations, the knowledge necessary for innovation can be disseminated. Since in these relations there often is unstandardized and dynamic exchange, the tendency of innovative production units towards agglomeration is strong.

What makes the theory of 'new industrial spaces' attractive is the fact that it constitutes a plausible attempt to link structural developments like internationalization to changes at the local and regional level. In addition, we may follow Morgan (1997: 494), who calls this a successful marriage of two scientific disciplines, namely, spatial and innovation sciences.

In spite of the strong influence exerted by the NIS approach, it has also attracted criticism. Lagendijk (1997: 7), for example, points out that the approach uncritically combines a timeless principle of cumulative causation in explanation of spatial agglomeration with a fundamentally a-spatial theory on structural economic development in explanation of the emergence of new forms of industrial organization.

Table 1.2: Types of input-output systems

The system: External Economies of Scale and Scope (Social Division of Labor in Production)	Territorial dimension	Units: Internal Economies of Scale and Scope	
		Low	High
Low		Isolated Workshops	Process Producers
High	Territorial Dispersion	Dispersed Network Production <i>mostly small units</i>	Dispersed Network Production <i>some large units</i>
	Territorial Agglomeration	Agglomerated Network Production <i>mostly small units</i>	Agglomerated Network Production <i>some large units</i>

The NIS is also criticized for the inadequate conceptualization of the notion ‘actor’ and the neglect of the social dimensions of interorganizational relations. Firms are reduced to passive actors who do nothing but enter into transactions. Since there is such an emphasis on economic transactions (‘traded interdependencies’), the social and institutional aspects of transactions are lost sight of as well.

These shortcomings, incidentally, have been recognized in more recent NIS publications. Storper (1995), for example, now makes a distinction between ‘traded’ and ‘untraded interdependencies,’ the former being the input-output relations (localized or not) which together form a web of user-producer relations, and which are extremely important for the exchange of information. The latter, according to Storper, are, among other things, (regional) labor 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 region are again involved with one another. As Storper (1995) puts it, ‘Where these input-output relations or untraded interdependencies are localized, and this is quite frequent in cases of technological or organizational dynamism, than we can say that the region is the key, necessary element in the “supply architecture” for learning and innovation.’

In our view, the ‘untraded interdependencies’ should be looked upon as a form of ‘tacit knowledge.’ Since this form of knowledge is often restricted to one area, sector, or even firm, the (core) region comes to occupy a far more central position in the analysis of technological development, and, in line with this, of economic development.

### 1.4.3 ‘Industrial district’ approach

The concept ‘industrial district’ originates from the English economist Marschall. In his book ‘Principles of Economics’, which was published in 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 Marschall, can be achieved by the spatial concentration of small companies. If we add to this (see also Lambooy, Wever and Atzema, 1997: 114) qualitative elements like mutual trust among market parties, ‘atmosphere,’ and ‘skills and knowledge,’ we have the most important component parts of an industrial district.

Hence, industrial districts can be regarded as a special form of agglomeration. They are characterized by ‘a local “thickening” of interindustrial 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. In contrast with the NIS approach, according to which the characteristics of economic transactions and structures lie at the root of specific forms of economic coordination, the interorganizational relationships among enterprises in industrial districts are based on cooperation, mutual dependence, and trust. These relations among enterprises stimulate innovation, with ties of kinship among entrepreneurs often facilitating the spread of information among enterprises. In short, the building blocks of the industrial district are the *social* links and networks among actors.

In this context it may be pointed out that the social character of the ‘industrial district’ approach is based on the work of the sociologists Weick (1976) and Granovetter (1985). They regard networks as ‘loosely coupled systems.’ These are institutions that coordinate the actions between organizations without restricting the autonomy of the individual organization more than is strictly necessary. Based on this social division of labor, a picture emerges of an economy consisting of a number of ‘industrial districts’ that on the basis of their flexible production systems manage to operate on international competitive markets.

Although in the literature there are a number of examples of successful ‘districts’ such as ‘Third Italy’ (Benneton), Central Portugal (wooden and metal furniture) and the Japanese Sakari district, Zeitlin (1992) concludes, in an overview article, that these examples are the exception rather than the rule. The fact is that firms in these successful regions manage to apply ‘best practice’ technology, while in addition the socio-cultural circumstances in these regions are such that they stimulate innovation. Then there is the fact, as Malecki (1991: 223) points out, that the emergence of this type of local production system in Emilia-Romagna, the heart of ‘Third Italy,’ is the result of very specific local developments originating in the 16th-century silk production in this region. 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 circumstances. It very much remains to be seen whether such can automatically be predicted for other regions (see also Hadjimichalis & Papamichos, 1991: 145-149).

#### **1.4.4 The innovative milieu approach**

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,<sup>7</sup> has introduced the concept of ‘milieux innovateurs’ or the innovative milieu. The approach is part of the renewed discussion on the economic dynamics in the regions. According to Aydalot & Keeble (1988: 7), these new dynamics are an effect of the rise of new technologies and new spatial concentrations of industrial activity in formerly less developed regions.

In this approach, the (innovating) firm is placed in its local or regional 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. Firms are considered products of their environment. 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 labor are seen in this approach as factors determining the innovativity of an area. It is therefore not surprising that the central hypothesis of the innovative environment approach is as follows: ‘it is often the local environment which is, in effect, the entrepreneur or innovator, rather than the firm’ (Aydalot & Keeble, 1988: 9). However, as a consequence, the difference between the actor and the environment is blurred in this hypothesis. After all, it remains unclear under what conditions the environment becomes the ‘innovator’.

In this approach, it is furthermore assumed that there are spatial differences in the costs of innovation. If one or more of the above-mentioned factors are missing or insufficiently available, the innovative firms will be faced with higher costs and/or lower returns. On balance, innovative firms must put more effort into acquiring the necessary resources.

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 or is established, several authors also take the *characteristics* of 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 & Keeble, 1988: 12-14; Maillat, 1991: 110-113; Saxenian, 1994: 7-9). Maillat's contribution is particularly important because he sees direct links between the innovation process and the local production environment. He does not see the innovative environment as a department store from which the innovative company merely obtains its resources. In his view, the production environment must be seen as a spatial complex of economic and technical interdependencies, which is able to generate synergetic processes.

Maillat argues that the importance of the local environment for the innovation process is dependent on the type of innovation, on the one hand, and on the innovation systems of the firms, on the other. For incremental innovators, the local production environment is of little importance. According to Maillat, the resources necessary for incremental innovation can in many cases be found in the firm itself. Radical innovators, however, develop more relations with the local production environment if they have an insufficient supply of internal resources to realize this type of innovation. In addition, Maillat sees links between the spatial environment and innovation strategies. He distinguishes two types of strategies: exploitation of a technological trajectory and ‘technology creation.’ In the first case, innovation is to be seen as a process involving the use of an already existing technology. Companies which innovate using such a strategy see the production environment as ‘an external datum whence the firm derive[s] its inputs’ (Maillat, 1991: 111). In the second case, innovation is seen as a process that, for example, involves designing a new production method without it being known how it should be realized. For companies with this innovation strategy, the local environment is an essential part of the innovation process. Maillat (1991: 111) states: ‘Indeed, the creation of technologies presupposes that the environment becomes an essential component of innovation, that these various resources be used and combined to generate a new form of localized production organization. The enterprise is then no longer isolated in a territory which represents to it only an external component, it helps to create its environment by setting up a network of partnership-style relations, both with other firms [...] and with public or private training and research centers, technology transfer centers and local authorities.’

Although the distinctions used by Maillat do better justice to the various dimensions of the innovation process, they

are at the same time problematic. In our view, especially the radicalism of innovations strongly resembles 'technology creation': if a company generates radical innovations, this usually involves the creation and application of (entirely) new knowledge. This means that both concepts have approximately the same content and that the distinction is therefore not significant.

#### 1.4.5 Regional Innovation Systems

The central idea behind the concept of (regional) innovation systems is that the innovative performance of an economy does not exclusively depend on the individual innovative performance of companies and research institutions, but are also dependent on the way in which these organizations interact with each other and with the public sector as regards production and distribution of knowledge. Innovative enterprises function in a shared, institutional context. In this sense, they are dependent on, contribute to, and make use of a joint knowledge infrastructure. This infrastructure is viewed as a system that creates and distributes knowledge, uses this knowledge to achieve innovation, and thus generates economic value (Gregersen & Johnson, 1997: 482).

Within this approach, various systems may emerge. Innovation systems are defined, on the one hand, for particular sectors or specific technologies or, on the other hand, on the basis of (geographical) proximity.<sup>8</sup> Within the (geographical) innovation systems, the concept of 'interactive learning' plays an important role. Learning is conceived as a process in which all kinds of knowledge are (re)combined to form something new. The interactivity of this learning applies to the fact that learning is co-dependent on the communication between people or organizations that possess different types of required knowledge.

If innovations are considered to be the result of cumulative learning processes (Lundvall, 1992: 8), the performance of territorial innovation systems depends on the relations between 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 & Johnson, 1997: 482). In this context, proximity does not merely involve physical distance measured in kilometers, but also in terms of time. However, other dimensions of proximity exist. Within this framework, Lundvall (1992) mentions economic, organizational, and cultural proximity.<sup>9</sup> The central idea is now that interactive learning and, as a consequence, innovation will be a restrained if these distances become too great. Putting it differently, in this approach, (geographical) proximity facilitates the innovation process.

Within the framework of National Systems of Innovation, Lundvall (1992) also developed a line of thought that is of importance in the discussion about the relation between innovation and space. Lundvall studies the relationship between the character of technological change and the spatial interactions. Three types of technical change are discerned, namely stationary technology, incremental innovation, and radical innovation that are each associated with specific patterns of spatial interaction between users and producers.

In the case of stationary technology, the technical opportunities as well as the needs of users are fairly constant. There are norms, standards, and terminologies available giving a near complete description of the technology involved. In other words, knowledge is highly codified. Such a high degree of codification means that communication between users and producers can be performed over long distances. If this is the case, industries virtually become footloose with respect to technological innovation.

For incremental innovation, codes and channels of communication must be flexible in order to include technological opportunities and changing users needs. Recurrent changes in product specifications, functions and qualities of artefacts constrain standardisation. Consequently, codification of knowledge is more difficult. This means that messages are relatively complex and information cannot easily be translated. In this case space will play a role of importance. The proximity of advanced users plays an important role in the adaptation process of an artefact to local conditions. Such firms and industries, often a part of national industrial complexes, or clusters, are not footloose. Comparative advantages are often based on spatial proximity.

In the case of radical innovation, codes developed to communicate a constant, or a gradually changing, technology become inadequate. Producers who follow a given technological trajectory will have difficulties in evaluating the potentials of the new paradigm. Users will have difficulties in decoding the communications coming from producers, developing new products built according to the new paradigm. The lack of standard criteria for sorting out what is the best paradigm implies that 'subjective' elements in the user-producer relationships – like mutual trust and even personal friendship – will become important. These subjective elements are not easily shared across regional borders. So, here spatial proximity is extremely important for user-producer interaction in networks.

In sum, 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, Lundvall assumes a positive relationship between the level of tacitness of knowledge and the importance of spatial proximity.

Although the innovation systems approach may initially seem applicable at various geographical levels, authors are

divided on the question of whether the approach yields useful results at the level of (small) regional economies. This is particularly owing to the importance attached to institutes in this approach. The argument is as follows. By definition, innovative activities almost always involve a considerable degree of uncertainty. Institutions, which, incidentally, are characterized by stability, are brought into action by actors to be able to operate and survive in this uncertain world. In this context, institutions are defined as 'the humanly devised constraints that structure human action. They are made up of formal constraints (e.g., rules, laws, constitutions), informal constraints (e.g., norms of behavior, conventions, and self-imposed codes of conduct)' (North, 1994: 360).

The question is now whether these institutions operate on the local or the regional level. Gregersen & Johnson (1997: 483), for example, let the national level prevail over the regional or local level. They point out that institutional changes that are important for the process of technological innovation often involve governmental interference. This usually concerns e.g. intellectual property law, standards, or the contract law. In addition, an important part of the knowledge infrastructure is regulated and funded at the national level. Finally, they argue that the performance of innovation systems depends on effective communication and interaction between people possessing different knowledge and skills. This communication and interaction are more effective if they take place in a joint culture. In their opinion, especially this cultural homogeneity can be achieved to a considerable extent within a national state rather than at the regional level.

The proponents of 'Regional Innovation Systems' are of the opinion that the region is a very relevant factor within the innovation systems approach. In this context, Lagendijk (1997: 18) quotes Howells, who argues that, where regional innovation systems are concerned, the way in which the national institutional environment (for instance, education and legislation) affects the local or regional level is of importance. This mainly depends on the so-called local institutional capacity. In Howells' view, the regional innovation system is the place for localized learning, unexpressed or implicit ('tacit') knowledge playing an important role.

## 1.5 Evaluation

It can be concluded from the above that in the 'modern' theoretical approaches, the geographical environment is a relevant factor for innovation processes. However, there are clear differences in emphasis in the way in which this relation is given shape. The most important characteristics of the various approaches are summarized in Table 1.3.

The four theoretical perspectives discussed above have several aspects in common in the sense that they are the exponents of a number of differences in emphasis within the framework of spatial economic development. The most important theoretical perspectives developed before 1980 concern the description and explanation of general patterns of unequal spatial development. After 1980, the perspective shifted. Currently, more attention is paid to economic performance of specific regions in an economy that becomes increasingly internationalized. Here, economic performance is explained on the basis of specific characteristics of (regional) production, innovation, and coordination systems.

Table 1.3: Innovation and space: a summary of theoretical perspectives

Subject	New Industrial Spaces	District theory	Innovative Milieu	Innovation systems
Concept of the actor	Actors are passive mechanisms for economic exchange	Actors are independent flexible organizations	Actors are Schumpeterian entrepreneurs	Actors are learning organizations
Concept of the spatial environment	Environment consists of localized or spread production systems coordinating exchange	Environment consists of other actors to establish social links with	Environment consists of resources which facilitate the economic process	Environment is a macro- and meso-economic system of institutions
Relations between innovation and environment	Localized knowledge (labor) is an immobile resource; Exchange relations with other actors are resources for innovation	Through social links and networks of actors, information, knowledge, standards, etc., are communicated and distributed	Depending on nature of innovations and technology, environment is a supply of resources or a supporting production system	Institutions, proximity and diversity of resources stimulate or restrict interactive communication, learning, and innovation in regions
Spatial concentration mechanism	Vertical disintegration and characteristics of transactions between organizations generate spatial concentration	Districts are a way in which a production organization can compete internationally (think global, act local)	Innovative milieus are an effect of capacities of certain regions to better organize collective learning processes and to realize lower information costs	Spatial proximity stimulates interactive learning as a result of the characteristics of technological change. The meso-institutional system supports the emergence and the application of new forms of production
Criticism	Insufficient conceptualization of economic action of actors	Too harmonious a picture of the relation between local and global economies	Too strong an emphasis on success stories and high-tech companies; difference actor-system unclear	Development of theories esp. at a regional level insufficiently developed
New developments	More emphasis on importance of 'untraded interdependencies' and conventions	Study of more different types of districts	Strong emphasis on institutional factors	More applications at regional and sectoral level

Elaboration of: Lagendijk, 1997: 23.

A second shift in emphasis that can be observed is the greater importance attached to the (industrial) web of the regional economy. Although in different ways, each of the four approaches discussed pay a great deal of attention to patterns of economic or social relations (networks, interorganizational relations) which either stimulate or restrict economic processes in general and innovation in particular.

The meaning of knowledge for the economic functioning of regional economies is strongly emphasized in all four approaches. This is the third shift in emphasis, which we want to point out. Knowledge is no longer seen as generic, precipitated, and available free of charge, or context-independent. The way in which the role of knowledge is presented links up much better with the things we mentioned in section 1.4.1 on the modern view on technological knowledge. The role of 'tacit knowledge' and the interactive character of the development of knowledge are especially striking.

The emphasis on interorganizational relations and the knowledge bases of firms has also consequences for the way the relation between innovation and space is conceptualized. All the four theoretical perspectives stress that localized networks of economic actors are important facilitators of innovation. Therefore, proximity between actors in networks

is viewed upon as an important stimulus for innovation. Although the perspectives have this view on the importance of interorganizational modes of co-ordination in common, they stress different aspects of networks. In NIS the emphasis is on the results of vertical disintegration and the characteristics of localized economic transactions between actors in networks, whereas in 'district theory' the social bonds between actors in local networks are the channels through which communication that is beneficial for innovation takes place. In the 'innovative milieu' approach and in the 'innovation system' approach, spatial proximity stimulates (collective or interactive) learning processes and communication in regions and between firms.

Although the four theoretical perspectives have refueled the thinking on and study of spatial economic development, a number of evaluating remarks are in order. First, it may be pointed out that the 'new' theoretical perspectives fail to give an adequate solution to the actor-structure problem. In section 1.2, it was concluded that one of the most important theoretical problems of the 'environmental approach' and the 'geography of the enterprise' approach was situated in the insufficient conceptualization of the relation between the company and its spatial environment. Both perspectives were too strongly deterministic. This problem resurfaces in different forms in the 'new' approaches. Thus, the actors in 'New Industrial Spaces' are reduced to passive mechanisms for economic exchange, basically making actors 'black boxes' again, which exclusively react to developments in their environment. In the innovative milieu approach, the distinction between actor and structure becomes blurred.

Although innovation and knowledge, in the second place, occupy an important place in the 'new' theoretical perspectives, the multiformity of the two phenomena, in our view, are insufficiently theoretically underpinned. In most cases, looking for, e.g., sectoral differences in innovativity, different technologies, and types of innovation processes and innovations, the inferred correlations between the various theoretical models will be in vain.

In the third place, we cannot avoid the conclusion that the spatial economic sciences are characterized by a 'weak tradition in advancing its own conceptual and theoretical foundation' (Lagendijk, 1997: 20). We want to answer the question of why this is so as follows. Most of the time, the work of the theoreticians is not sufficiently cumulative and is even slightly subject to trends. Moreover, in our view, too little conscious use is made of the theoretical results of other scientific disciplines, especially as regards the organizational sciences. In particular the 'resource dependency' theory (Pfeffer & Salancik, 1978) and the 'social exchange theory' (Turner, 1974; Cook & Whitmeyer, 1992), to our mind, offer useful elements with which spatial scientists can considerably improve their theoretical models and hypotheses.<sup>10</sup>

## Notes

1. Agglomerate advantages (or disadvantages) can be considered as a special form of external economies of scale. **External** economies of scale refer to the phenomenon that companies can profit from the division of labor between companies. If these economies occur in a geographically confined area, we call them agglomerate economies. See also: Ter Hart & Lambooy (1989: 39-45) of Saxenian (1994: 173).
2. He calls these trends 'adaptation corporate geography' and 'regional development corporate geography,' respectively.
3. After all, also large multinationals once started out as small or medium-sized enterprises.
4. Low returns on capital mean high wages, while high returns on capital can be achieved in regions with low wages.
5. Storper & Harrison (1991: 408) define an input-output system as 'a collection of activities which lead up to the production of a specific marketable output'. This also includes a situation in which the activities of the units in a system are involved in more than one input-output system.
6. Networks as 'loosely coupled systems' are here compared to the organization or enterprise that is seen as a 'strongly coupled system.'
7. GREMI is the acronym of Groupe de Recherche Européen sur les Milieux Innovateurs.
8. Various geographical levels are taken into account: local, regional, national, continental, and global innovation systems.
9. B-Å Lundvall (1992b: 55-56) distinguishes four dimensions of space or proximity: <1> Economic space: this concerns the way in which various economic activities are positioned in the production system (input-output table); <2> Organizational space concerns the level of horizontal or vertical integration; <3> Geographical space: concerns the distance between activities at various spatial locations; <4> Cultural space: concerns, amongst other things, the context, such as norms and values, within which communication takes place.
10. In an in-depth discussion of exchange theories, J.H. Turner comes to similar conclusions as regards the development of theories. He argues that the Emerson-Cook program 'Exchange Theory and Network Analysis' contains a direct relation between 'resource dependency,' exchange theory, and network analysis.

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