

3. Knowledge, Innovation Processes and Regions

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3.1 Introduction

The expanding field of economic literature devoted to knowledge production and diffusion strongly emphasises that knowledge is increasingly becoming a crucial resource for growth. Moreover, the issues of knowledge and innovation appear as intimately inter-related, underlining their decisive influence for the competitiveness of firms and countries, but also for the development and prosperity of regions. In fact, and this is only a paradox at first glance, despite (and even to a certain extent, due to) its intangible nature knowledge is not ideas floating in a purely abstract vacuum but is rooted in the economic reality, and is thus, at least partially, linked to territories. This paper aims at highlighting the complex relations between knowledge, innovation and regions. In the first section, a brief theoretical overview provides the key conceptual elements which allow the mechanisms of knowledge creation and diffusion and their implications for innovation and regional development to be questioned. The second section of the paper offers an illustration of how knowledge exchanges between different categories of actors may take place. The proposed typology displays some stylised facts related notably to the spatial patterns of innovation interactions. Finally, the concluding part raises several issues which can be considered from the researcher's as well as from the policy-maker's points of view.

3.2 From Knowledge to Regions: a Theoretical Overview

This first section is devoted to the theoretical aspects of the interrelations between knowledge, innovation and regions. At first, the difference between knowledge and

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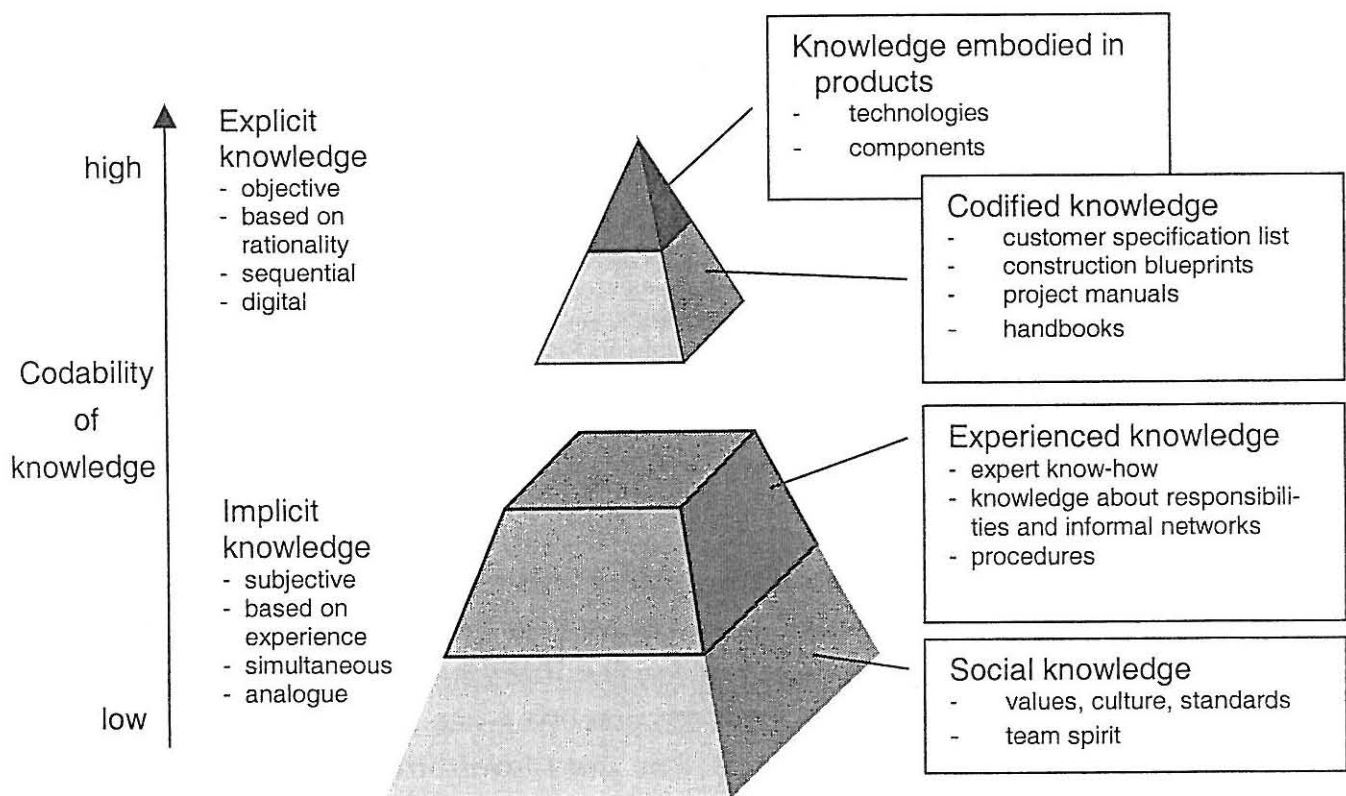
information is established, which is completed by the distinction between tacit and codified knowledge. This leads to a consideration of innovation, in line with the evolutionary approach of innovation, as a cycle associating tacit and codified knowledge within firms and between firms and further actors. Finally, the issues of knowledge sharing and innovation interactions on a regional level are addressed.

Dealing with knowledge implies a critical attempt to define its nature. In this respect, it seems particularly important to stress that knowledge is more than a sum of information. Nonaka (1994) underlines the necessity to distinguish clearly between "information" and "knowledge", although they are sometimes used as synonyms. In this respect, information can be considered as a flow of messages or meanings *which might add to, restructure or modify* knowledge. Information is thus a necessary and inseparable *medium* for establishing and formalising knowledge. More precisely, one may refer to the distinction provided by Laborit (1974), between: (i) circulating information, (i.e. routinised and repetitive information); and (ii) structuring information, (i.e. information liable to provoke or to favour an adaptation or a transformation and leading to non-routinised decisions). This distinction (cf. Ancori 1983) reviews in fact two visions of communication: the *Shannonian* approach (in which information is reduced to the status of signals, and communication consists of the transmission of these signals) and the *Batesonian* one. In this latest approach, informational flows which lead to "alterations" of the system are introduced in the analysis. Considering for instance a firm, its aptitude to organise its informational flows and to "extract them from/combine them with" its informational stock can be seen as the expression of its *knowledge-base*. This perspective allows the establishment of the distinction between information and knowledge. At the same time, it highlights the economic importance of knowledge, and consequently of learning. As Cooke (1998: 8) put it: "*Knowledge plays a fundamental role: the constitution of a firm is mediated by the knowledge possessed by the founder or "creative agent" and developed by learning. Firms learn from their own experience, but also from other firms they work with and with whom they share information, knowledge and technologies.*"

The economic understanding of knowledge relates primarily to the process of knowledge creation and diffusion within the economy. To grasp this process, it is necessary to consider the issues of codability and codification of knowledge. The distinction between tacit and codified knowledge has been established by Polanyi (1966). Whereas *codified knowledge* is easily transmittable in a formal and systematic language (comprising words, figures, etc.), *tacit knowledge* always has an implicit or individual related character (strongly based on personal experience) which makes its formalisation and exchange difficult. The "knowledge pyramid" provides a possible representation (among others) of the distinction between tacit and codified knowledge (cf. Figure 3-1). Nevertheless, it is important to keep in mind that these two forms complement rather than substitute each other. In fact, they tend to co-evolve: the process of codification generates new tacit knowledge. For instance,

the ability of an individual to understand or interpret the codes in which knowledge is articulated is itself based on tacit knowledge, which can only be acquired through practice and experience. "Any organization that dynamically deals with a changing environment ought not only to process information efficiently, but also create information and knowledge", asserts Nonaka (1994: 14). This circulation of knowledge implies its transformation along two dimensions (explicit/tacit - individual/social). Focussing on firms and on innovation activities, the knowledge-base of a firm can be interpreted as a combination of *tacit* (or implicit) and of *codified* (or explicit) knowledge. The expansion of a firm's knowledge base can be realised by the exploitation of internal search capacities or by the acquisition of external knowledge (cf. Saviotti 1998). In this respect, a firm's expansion depends on the "absorptive capacities" it develops (cf. Cohen/Levinthal 1989). To sum up, knowledge constitutes a pre-condition for understanding (new) information; and to create (additional) information. Consequently, knowledge is intimately interrelated to innovation processes.

Figure 3-1: The pyramid of knowledge

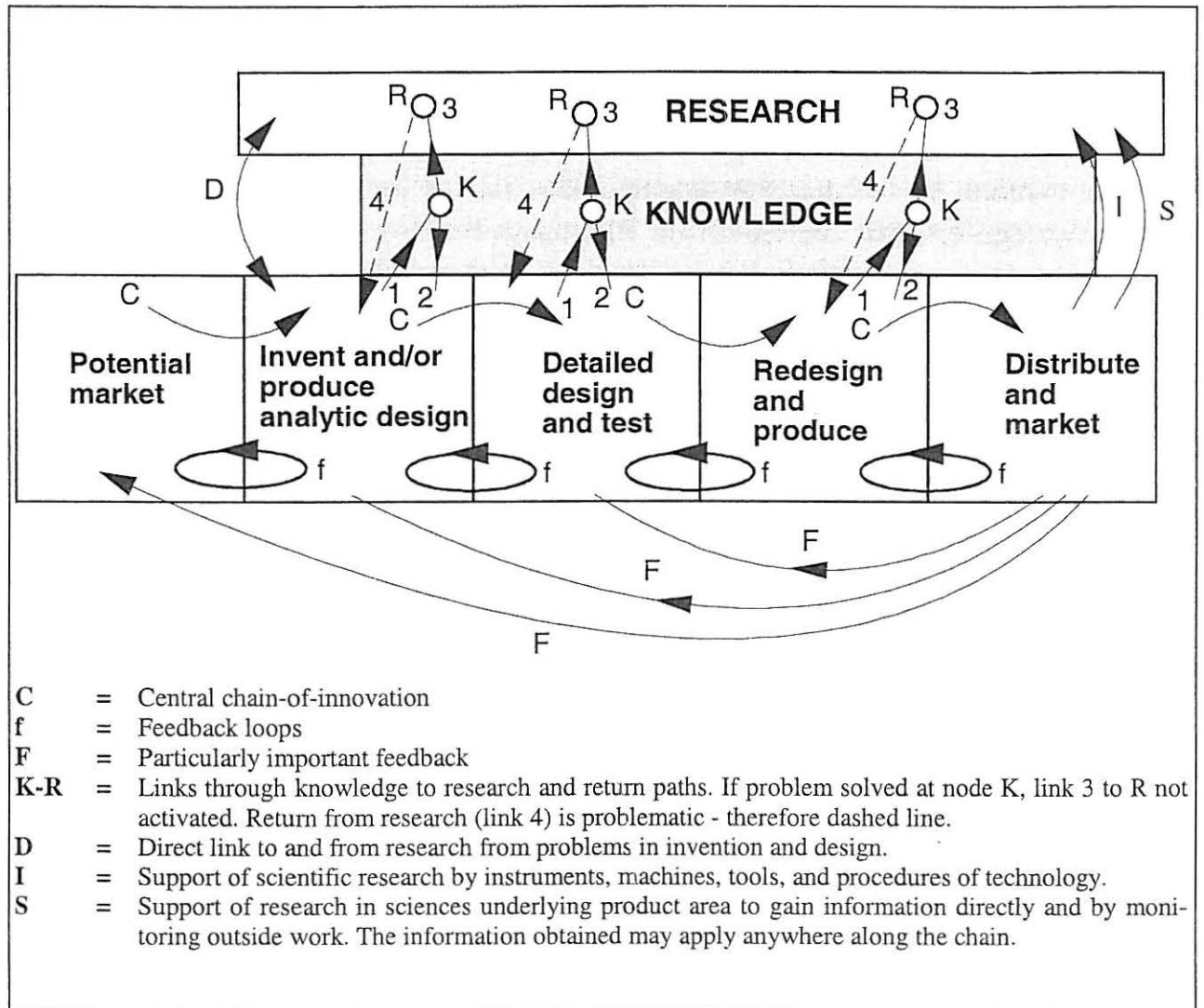


Adapted from: Gassmann (1997: 152)

The phenomenon of innovation can be conceived as an evolutionary process based on knowledge. This vision corresponds to the approach adopted by evolutionary economics (cf. Nelson/Winter 1974, 1975, 1977). The central role played by knowledge for innovation is ideally depicted by Kline and Rosenberg (1986) in their "*chain-linked model*". This model can be interpreted on different levels: while

the (traditional) linear model features only one single level, the "chain-linked model" comprises five of them (cf. Figure 3-2).

Figure 3-2: The chain-linked model



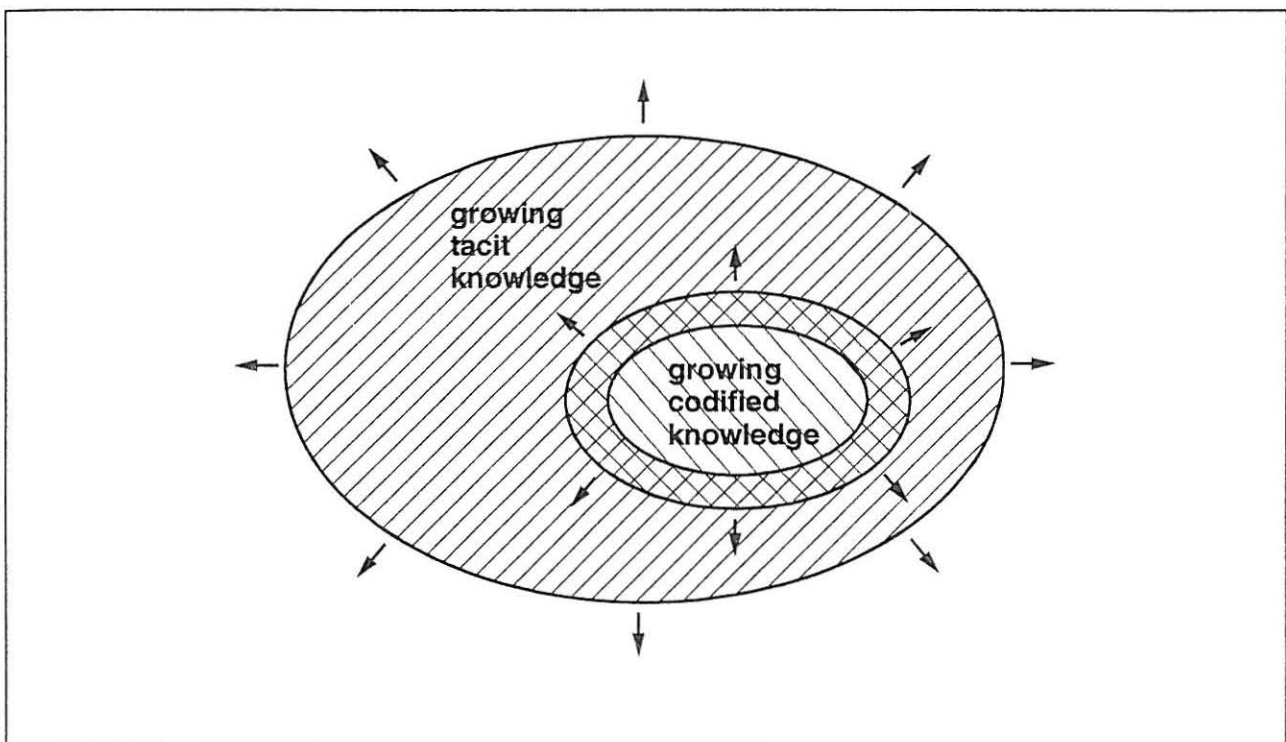
Source: Kline/Rosenberg (1986: 290)

The first level consists of the central chain which - extending from the "conception" to the "distribution" of innovation - can be seen as the integration of the linear model. The second level is constituted of the feed-back loops associating phases of the central chain: each stage is linked to the preceding one, and the last (marketing and distribution) to all the other phases. The third level links the central chain of innovation to research¹ which constitutes a kind of "knowledge-stock" likely to stimulate each step of the innovation process (and not only its beginning, in contrast to the linear model). The last levels are less frequent and feature situations where respectively: (i) dramatic scientific shifts generate radical innovations; and (ii) innovations support the expansion of scientific knowledge.

¹ The term *research* encompasses internal and external activities.

The phenomenon of innovation should be understood as a *cycle involving interaction between tacit and codified knowledge*. To make the link with the approach adopted by evolutionary economics, it is possible to assert that: (i) firms are organisations which apply different inputs, one of the most relevant for innovation being *information*; (ii) information is *accumulated in* and *processed by* the knowledge base of the firm; and (iii) *knowledge accumulation* and *knowledge processing* by firms results from learning. From a dynamic perspective, knowledge can be seen as expanding by associating in different forms, tacit and codified knowledge.² On the one hand, the codification of tacit knowledge allows an availability of knowledge which increases with time. On the other hand, the dynamic expansion of codified knowledge generates the apparition of new areas of tacit knowledge (cf. Figure 3-3).

Figure 3-3: A context of expanding knowledge



Source: Muller *et al.* (1998: 6)

Three further observations may be relevant before introducing the regional dimension in the analysis of the relations between knowledge and innovation. Firstly, the above developed conception of the knowledge base of the firm authorises (and furthermore implies) the existence of *shared learning effects*. Shared learning effects correspond to situations where learning occurs simultaneously within and outside a given organisation, for instance, when learning takes place in two firms at the same time. It can quite easily be assumed that shared learning effects may influence the innovativeness of firms. The second observation concerns *the growing possibilities*

² For a detailed analysis of knowledge creation, transformation and diffusion within firms, see Nonaka (1994).

of using new means of codification in the production of knowledge, notably (but not exclusively) due to the dramatic development of information and communication technologies (ICT). These new means of codification affect notably: (i) the generation of new knowledge by firms; (ii) the storing of and access to top knowledge within firms; and (iii) the exchange between firms and further actors. Moreover, these three are strongly inter-related and mutually reinforcing. Finally, considering that the development of a firm's knowledge base (through learning) determines its competencies (and thus its innovativeness), it appears that the *learning process is path dependent*. In fact, the development of competencies by a firm is path dependent in the sense that: (i) a firm learning consists of the combination of "knowledge items" taking different forms (for instance tacit and codified) which implies having been previously acquired or generated ; (ii) this combination refers to an application, i.e. a further step in the process. This remark seems valid even if one considers particular cases in which, for instance, organisational forgetting is a necessary step of the learning process.

Regional learning directed towards innovation is not simply the acquisition of information by firms or groups of firms located within a specific territorial unit defined as a region. It may seem more judicious to consider regional learning as a process by which information available (inside and outside the region) to regional actors becomes usable knowledge for firms located in the region. In this respect, the *role and impact of innovation systems* can be examined by distinguishing mainly two levels: the national and the regional one. Systems may be defined in this context as "*complexes of elements or components, which mutually condition and constrain one another, so that the whole complex works together, with some reasonably clearly defined overall function*" (Edquist 1997: 13). In the continuation of Freeman (1987) and Lundvall (1988, 1992) abundant literature can be found related to national innovation systems (NIS). The regional innovation system (RIS) approach (cf. Cooke *et al.* 1996; Cooke 1998) encompasses the concepts of "industrial district", "innovative milieu" and "regional learning" to the greatest extent. It allows a summary of the arguments in favour of an influence of the regional environment on firms' innovation capacities.³ RIS can be perceived as a transposition of NIS on the regional level. From both regional and national perspectives, the system of innovation is constituted by elements and relationships interacting in the production, diffusion and use of new knowledge. Thus, it provides a set of arguments highlighting why and how certain regions (and *a fortiori* some countries) are more innovative than others.

³ An alternative perception, which can be found in the literature but is not retained here, should be briefly evoked. In fact, it is possible to define a region from an economic perspective, for instance with the help of the approach in terms of clusters (in the sense of industrial clusters given by Porter 1990). From this point of view, the industrial cluster may be seen as the sum of all the economic actors contributing directly to the dominant production process of the considered region.

In fact, considering innovative regions, the previously evoked circulation and combination of knowledge is achieved by two main (non-exclusive) methods: (i) the activity and mobility of skilled personnel; and (ii) the development of formal and informal relations of co-operation among actors. In both cases, the ability to transfer knowledge within the region (and to a certain extent the aptitude to catch up with knowledge from outside the region) will depend on a common language and on a shared knowledge base. In this respect, as Keeble/Wilkinson (1999: 299) put it: "*Tacit knowledge (...) is specific to organizational and geographic locations and this increases its internal circulation but impedes its external accessibility.*" In other words, localised innovation networks favour an efficient circulation of codified knowledge since the structure of the interactions makes different segments of specific tacit forms of knowledge compatible. More generally, referring to the arguments developed by Lawson/Lorenz (1999), the processes underlying regional collective learning can be examined along three central ideas. Firstly, the overall attitude towards innovation within a region, which relies on the concept of *regional innovation culture*. A lack of innovation culture has as a consequence developed regional inertia, meaning that firms face resistance when trying to introduce, to use and to diffuse new knowledge.⁴ Secondly, the resources potentially available within a region in terms of knowledge bases and possible knowledge combination constitute the *regional innovation potential*. As exposed previously, learning, notably with respect to innovation, is a path dependent and cumulative process. The search for and access to new knowledge which becomes incorporated into the regional firm's routines in an incremental manner enables the introduction of innovations (*i.e.* mostly incremental and exceptionally radical innovations). Finally, the willingness of regional actors to be open to knowledge sharing and their ability to exchange ideas on the issue of innovation constitute the aptitude to build up *regional innovation networks*. The existence of a "common language" or, more generally, of a business and regionally rooted culture explains that such networks may resolve the problems of co-ordination/competition which inevitably arise when knowledge becomes shared on innovation issues.

Considering the *policy implications of regional learning* in terms of innovation support, it seems clear nowadays that the nature and frequency of interactions between actors, notably in the form of networks, influence regional development (cf. for instance Braczyk *et al.* 1998). Nevertheless, and this probably constitutes one of the main policy challenges for European regions, no unique way to foster regional innovation capacities and to ensure some competitive advantage can be established. In this context, the multiplication of innovation-related initiatives, notably initiated by the European Union, can be interpreted as a willingness to promote the conditions for sustained knowledge-based economic development on a regional level (for

⁴ To a certain extent, it is possible here to make the link with the GREMI (*Groupe de Recherche Européen sur les Milieux Innovateurs*) approach related to "innovative milieux" (cf. for instance Perrin 1990; Maillat and Perrin 1992).

an introduction and overview of regional innovation-related initiatives supported by the European Union, cf. for instance Landabaso, 1997, and Larédo 1995). Learning is the key component of those policy tools. In fact, such initiatives may be considered as a form of social engineering, since they aim at the establishment and development of what Landabaso *et al.* (1999) call the "social capital" of a region. *"The more a region (or a company) is in a position to learn (identify, understand and exploit knowledge [...]) the more capable, and possibly willing, it becomes to build on and increase its demand and capacity to use further new knowledge."* (Landabaso *et al.* 1999: 6). Considering the issue of regional competitive advantages, localised innovation networks (which are rooted in the region, even if those networks include actors from "outside", which can be desirable and useful) appear as even more decisive than the skills of the regional labour force (since highly skilled personnel may "escape" from the regional system). In fact, for a region, the establishment and development of a "social capital" is a way to master capabilities which cannot simply be transferred or easily replicated elsewhere. In this respect, the co-existence (within a country, a continent or even in a globalised world) of various types of regional environment, corresponding to different innovation-related infrastructural qualities, implies specific functional organisation of knowledge-related activities. Nevertheless, this does not necessarily imply that regional inequalities in terms of innovation infrastructure cannot be successfully compensated for, refuting the belief in "territorial fatality" (Muller 1999a).

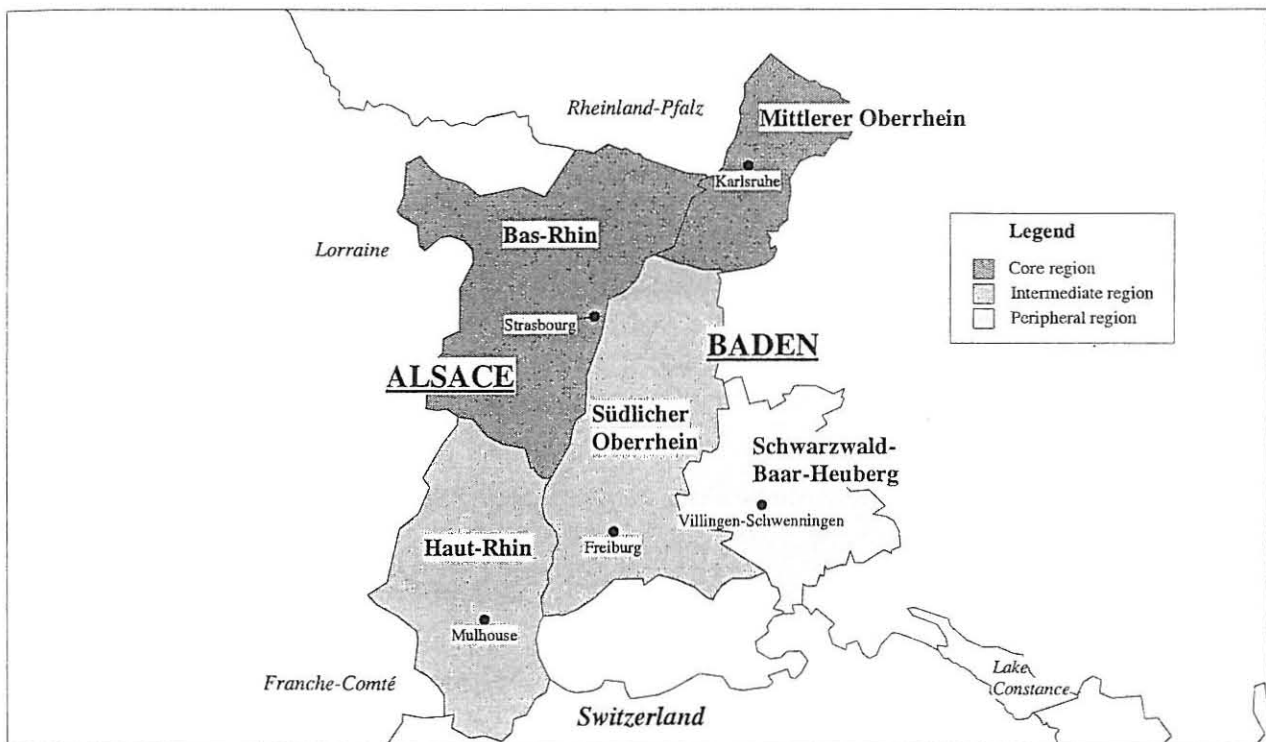
3.3 An Illustration of the Influence of Spatial Patterns on Knowledge Interactions

A comprehensive theory-oriented literature can be found concerning the links between knowledge and innovation on a regional level; nevertheless these reflections are only supported by parcelled and heterogeneous empirical studies. This second section of the paper provides an illustration of knowledge interactions and of their spatial patterns. This example is extracted from a broader body of empirical investigation dealing with regional innovation potential and focusing notably on the examination of interlinkages between three types of actors: (i) manufacturing firms (and in particular SMEs); (ii) knowledge-intensive business services (KIBS); and (iii) universities and research institution labs (also called institutions of technical infrastructure or ITI).⁵ The illustration below corresponds to a part of the survey

⁵ This operation entitled "Analysis of regional innovation potential from a European perspective" (1994-1998) was granted by the *Deutsche Forschungsgemeinschaft* (DFG, the German Research Council) and designed conjointly by four research teams. The joint research project involved the Department of Economic Geography at the University of Hanover, the Chair for Economic Policy at Technical University Bergakademie Freiberg, the Department of Economic and Social Geography at University of Cologne, and the Fraunhofer Institute for Systems and Innovation Research (FhG-ISI) in Karlsruhe. A recent special issue of *European Planning Studies* (Vol. 8, No. 4, 2000) presents different aspects of the methodology and of the results of the overall project.

performed for the border regions of Alsace and Baden. In terms of forms of knowledge involved, this area is particularly interesting for the analysis, since it corresponds to territories which belong to two different national innovation systems, and contains five (administrative) sub-units presenting different resources in terms of innovation-related infrastructures (cf. Figure 3-4). The aim here is not to display detailed results specific to this area, but to try to benefit from the empirical results accumulated in order to go one step further in the reflection about knowledge, innovation processes and regions.⁶ More precisely, the consequences in terms of innovation and the spatial patterns of knowledge interactions between different categories of actors are considered.

Figure 3-4: The surveyed regions



Source: Muller (1999b: 85)

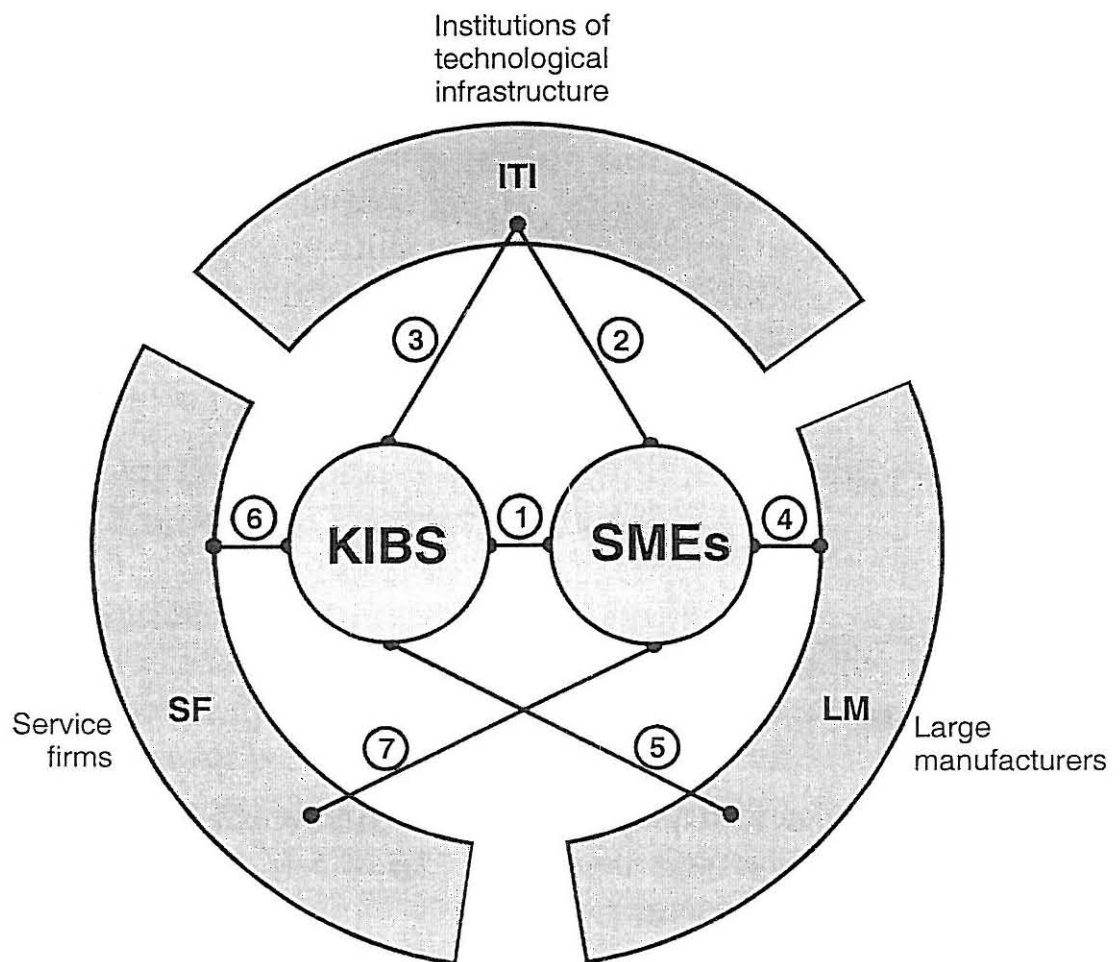
The typology of innovation interactions proposed hereby as an illustration is entitled "the wheel of knowledge interactions" (cf. Figure 3-5). It aims at featuring knowledge exchanges encompassing:

- (i) manufacturing SMEs;
- (ii) KIBS;
- (iii) institutions of technological infrastructure (ITI);
- (iv) large manufacturers (*i.e.* not small and medium-sized firms); and
- (v) further service firms (*i.e.* non-KIBS).

⁶ Detailed empirical results dealing with the case of Alsace and Baden can be found in Koschatzky (1997), Muller (1997), Muller/Zenker (1998), Héraud/Muller (1998), Muller (1999b), Koschatzky (1999, 2000).

A set of approximately 40 personal interviews performed in Alsace and Baden contributed to the establishment of this typology (cf. Muller 1999b: 154-159).⁷ The issues of the role and impact of KIBS and ITI are the object of further attention in the present literature: see notably Strambach concerning KIBS and Héraud/Bureth (already referred to in this volume) for analysis related to ITI. The "wheel of knowledge" constitutes a basic representation displaying in a speculative manner some stylised facts about knowledge exchanges. Seven types of interactions or "links" are schematically depicted according to (i) the type of knowledge involved; (ii) the spatial patterns of the considered interactions; and (iii) the influence in terms of firms' innovations.

Figure 3-5: The wheel of knowledge interactions involving KIBS and SMEs



Source: Muller (1999b: 151)

⁷ The interviews, performed during the first semester of 1997, dealt with SMEs, KIBS, research labs and regional innovation-support organisations identified mainly on the basis of a postal survey. The aim was to gain additional qualitative information supplying the mainly quantitative character of the overall investigation (cf. Muller 1999b: 77-138).

- (1) **Links between SMEs and KIBS.** This relation is characterised by the mutual impact of interaction between SMEs and KIBS on their respective innovation capacities. Considering empirical results (cf. Muller 1999b: 139-147), it can be assumed that: (i) when knowledge flows from SMEs to KIBS the knowledge transmitted is mainly of a tacit nature and proximity plays an important role; and (ii) when knowledge flows from KIBS to SMEs, proximity appears to be less important because the transmitted knowledge is mainly codified.
- (2) **Links between SMEs and ITI.** The direct links between SMEs and ITI have as their main function to support and reinforce SMEs' innovation potential. It can be assumed that knowledge exchanges are most often of a codified nature. In this context, proximity between SMEs and ITI is probably not neutral (particularly due to knowledge transmission-related costs), but is nevertheless also not determinant: the specificity of the knowledge required is in fact the main selection factor.
- (3) **Links between KIBS and ITI.** In general, the same basic assumptions can be advanced as for the relations, which are more common, between SMEs and ITI. One may even suppose that the need for (highly specialised) codified knowledge determines the links between KIBS and ITI and that, as a consequence, proximity only has little or no impact on those knowledge exchanges.
- (4) **Links between SMEs and large manufacturers.** It is possible to speculate on the nature of the knowledge exchanges between SMEs and large manufacturers by comparing two cases schematically. The first case relates to innovations corresponding to the adoption by an SME of new techniques developed by large manufacturers. In this situation, the knowledge transmitted (for instance embodied in equipment) can be seen rather as codified than tacit and proximity as exerting little or no influence on the relation. The second case relates to specific development (of products, of processes, ...) performed by an SME in order to satisfy the requirements of a large manufacturing client. This corresponds for instance typically to sub-contracting situations. In comparison to the first case considered, it can be assumed that tacit knowledge potentially plays a greater role in the transmission of knowledge (from the SME to the large manufacturer) and that proximity favours the exchange of knowledge to a certain extent.
- (5) **Links between KIBS and large manufacturers.** Three typical situations can be used to depict these relationships. The first situation is the adoption by a KIBS of artefacts produced by large manufacturers. The adoption induces associated organisational change (such as, for instance, related equipment in the case of information technologies). In such a situation, knowledge exchanges can be seen as mainly codified (strongly embodied in the artefacts) and relatively insensible to proximity effects. The second situation relates to knowledge exchanges taking the form of support (for instance managerial consultancy) provided by KIBS to large manufacturers. Such support constitutes a

potential source of (internal) innovation for KIBS. It can be interpreted as the application of knowledge which is partly tacit and partly codified. In this case, it is also realistic to consider that it only plays a marginal role. The third situation depicts KIBS resulting from the outsourcing of a specific activity initiated by a large manufacturer. In comparison to the two previous forms of relations, this type of interaction is characterised rather by the circulation of specific tacit knowledge and by the importance given to proximity between the partners.

- (6) **Links between KIBS and service firms.** Service firms represent one of the most important groups of customers for KIBS. The effects of relations with (non-KIBS) service firms on KIBS' innovation capacities rely mainly on the concept of new services or on the evolution of existing ones (in order to fulfil service firms' emerging or changing needs). These relations can mainly be considered as a process of knowledge codification: (i) which takes place in the client firms; (ii) which is based on KIBS accumulated tacit knowledge; and (iii) for which proximity is rather unimportant.
- (7) **Links between SMEs and service firms.** In contrast to the interactions involving KIBS, the knowledge exchanges which take place between SMEs and service firms correspond rather to routine services and thus have a relatively small impact on SMEs' innovation capacities. The type of knowledge involved and the role of proximity depends strongly on: (i) the degree of standardisation of the activity associating SMEs and service firms; and (ii) the importance of elements like trust for the service relation. Schematically, highly standardised services (typically based on the application of codified knowledge and by which the question of proximity is only related to cost effects) can be compared to more specific services (which imply a greater proportion of tacit knowledge and for which proximity is at least potentially important due to the necessity of a trusting relationship between the SME and the service firm).

3.4 Conclusion: Research and Policy Agenda

When trying to answer the question "what shall we do in the future to better understand the relations between knowledge, innovation processes and regions?", it seems important to proceed along three main axes: (i) the concepts on which forthcoming analyses will be based; (ii) the tools which may be useful for performing these analyses and (iii) the policies required for supporting knowledge development, notably on a regional level. New concepts are needed to respond to the challenging and complex issues raised by the drastic expansion of the place of knowledge in economic activities. It can reasonably be considered that only a reinforced movement of interdisciplinary reflections (associating notably epistemology, soci-

ology and psychology to economics) may allow new concepts to flourish. Nevertheless, new concepts need to be accompanied by new tools, destined notably to improve measuring in a satisfactory manner, and thus to better understand the multiplicity of phenomena related to knowledge creation and diffusion. In this respect, investigation instruments such as multifactor analysis, neuronal networks and fuzzy indicators seem worth examining. Finally, new challenges call for new policies: a knowledge-ruled economy offers new perspectives for innovation-based regional development. In the European context especially, due to the double pressure of a reinforced need for regional convergence within the European Union and of the emergence of requirements linked to the possible expansion of the Union eastwards and southwards, regional development policies appear more decisive than ever for the future.

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