

**GEOGRAPHICAL PROXIMITY AND CIRCULATION OF KNOWLEDGE
THROUGH INTER-FIRM COOPERATION**

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in Wink R. (ed), *Academia-business links*, Palgrave, Macmillan, London, 2004.

1. Introduction

The production of scientific and technological innovations has become essential for many firms, but the latter are seldom in possession of all the knowledge needed for this activity because of the increasing complexity of knowledge bases or because R&D departments are too small. As they do not possess internally all the skills they need, firms wishing to innovate have recourse to external sources, such as cooperation with other firms or public organizations of research. However, acquiring external knowledge is not sufficient; one must also be able to use it in a specific process of production, to transform it into organizational routines, because it is important not only to integrate this knowledge, but ideally to use it to produce new knowledge.

This process of creation, re-creation or imitation of new resources is a complex operation that not only necessitates several technical and organizational adaptations, but also requires frequent relations of cooperation and partnership. The integration of new knowledge cannot be done in one go, but progressively during the course of the innovation projects, which implies that relations be sustained for a period of time. But the interests of the participants to this interactive process, as well as their opinions concerning technical issues sometimes vary

or diverge. This is why cooperations are also sources of tensions and conflicts that jeopardize the adaptation of knowledge produced somewhere else to the context of the firm or even completely hinder the innovation process.

In this article, we try to provide some answers to the following question: What is the role played by geographical and organized proximities in the context of these external acquisitions of knowledge? In other words, can they help reduce the intensity of conflicts and thus facilitate the interactive process of innovations?

The structure of this paper is as follows. First, we present shortcomings of innovation theory and works on spillovers claiming the importance of geographical proximity for circulation of knowledge without considering organizational prerequisites to reach this impact. Having explained the relevance of permanent as well as temporary geographical proximity, we will then turn to a discussion of conflicts between cooperators within innovation processes from a theoretical as well as an empirical perspective. The empirical study is based on a case study of French biotechnology firms and will serve to prove our hypothesis that temporary geographical proximity play an important role in preventing and resolving conflicts between innovators.

2. The Spatial Dimension of the External Acquisition of Competencies to Innovate

Firms, wishing to innovate, rest on a knowledge base that they possess internally and/or must obtain from their competitors, neighbors or partners (Cohen & Levinthal 1989). Studies on districts or innovating milieus (Becattini 1990, Saxenian 1994, 2000) as well as recent developments in the innovation theory refer to the spatial dimension in the relations of acquisition of external knowledge, whether they are inter-firm relations or relations with research laboratories. They postulate the beneficial effects of geographical proximity, which would seem to be due in particular, to the possibilities offered by face-to-face (F2F) relations between local actors, relations which facilitate the transmission of knowledge, in particular of tacit knowledge (Lundvall 1992).

In light of recent research and applied studies carried out on the matter (Vedello 1997, Dahl et al. 2003), this thesis needs to be seriously re-evaluated. In the following paragraphs we show the limits of the analyses in terms of localized knowledge spillovers, before presenting recent breakthroughs in the field of economics of proximity, in particular concerning the possibility of moments of temporary proximity during the interactive process of innovation. We end this section with a conclusion on the importance of relations of proximity in the process of external acquisitions of technology.

2.1 Localized Knowledge Spillovers and Their Limits

One of the characteristics of innovation is to produce externalities. Due to the peculiar nature of this activity that is sometimes compared to the production of a (semi) public good, the results cannot be totally appropriated by the innovator, as part of the knowledge is diffused into the economy without the innovator being able to prevent it, or even being aware of it. When innovation (or R&D) is likened to information, there is a leakage of results that concerns the overall economy, but the approach in terms of knowledge leads one to analyze the possibility of diffusing this knowledge, as well as the geographical area it covers. From an empirical point of view, the fact that there is a high concentration of innovative activities contradicts the hypothesis of a complete diffusion of R&D results, which would allow activities to be equally distributed throughout the territory. The polarization of innovative activities, which is even greater than the production activities (Audretsch & Feldman 1996), is then often accounted for by the characteristics of the externalities that are assumed to have a limited geographical extension. Autant-Bernard & Massard (1999) have compiled four types of studies dedicated to calculating the externalities of knowledge (or spillovers) and their spatial area, respectively based on:

- the use of patents as markers of externalities (Jaffé et al 1993),

- the geographical concentration of innovations (Feldman 1994, Audretsch & Feldman 1996),
- the geographical coincidence (Jaffé 1986, Anselin et al. 1997), and
- local interaction (Anselin et al. 1997, Wallsten 2001),
- to which one may add (Feldman 1999) knowledge incorporated in capital or investment goods.

All these works come to the conclusion that externalities exist and that their geographical extension is limited. This explains the concentration of firms in certain areas and supports the idea of geographical proximity being an important factor in the diffusion of knowledge.

However, the measurement of geographical extension of localized knowledge spillovers is still debated. Some of the above-quoted studies do not really propose an estimation of spatial externalities: the authors use a predefined geographical area, which presupposes, but does not prove the existence of externalities. Thus, the first three methods (patents, concentration, coincidence) do not offer a true measurement of externalities (no calculation of the elasticity of R&D expenditure in relation to the innovation capacity of the company of reference) and even less of the distance they are supposed to cover. Assuming that externalities exist, they model their effects and, in actual fact, measure agglomeration phenomena. These methods generally postulate the role of local dimensions by using pre-defined geographical areas: states (Jaffé 1989, Feldman 1994), metropolitan areas (Jaffé et al. 1993) and counties (Anselin et al. 1997 in their first evaluation). Notions of distance, when they are introduced into the gravity and coverage indicators used by these authors, are pre-defined. For instance, according to Anselin et al (second measurement), R&D may have been carried out within a radius of 50 or 75 miles around the county of reference.

More recent studies are making use of *Geographical Information Systems* (GIS) in order to model the range of technology spillovers provide an indication for measuring distance. Thus, Wallsten (2001) makes use of GIS to analyze the probability for a firm whose neighbors

received government support for innovation, of also benefiting from such assistance. It locates firms without using a pre-defined geographical zone and shows that firms receiving financial support are situated close to each other, in a radius of one tenth of a mile, often on the periphery of urban areas. Even if these are strategic externalities linked to information rather than R&D, and although participating in a government program is liable to introduce a different angle, one sees nevertheless, that the distance retained, if it is not pre-defined, still varies noticeably from one author to another (from 50 miles to one tenth of a mile), which allows extrapolation. Finally, it was not until the publication of Orlando's work (2000) that distances and research externalities could be simultaneously calculated thanks to these methods.

2.2 Geographical Proximity and Organized Proximity

Literature on the economy of proximity generally refers to two types of proximity (Gilly & Torre 1999, Kirat & Lung 1999, Rallet & Torre 2000):

- *Organized proximity* lies on two types of logic, *a logic of similitude and a logic of belonging*. According to the logic of belonging, actors are close when they belong to the same space of relations (firm, network...), i.e. actors between whom interactions of different natures take place. According to the logic of similitude, actors are close when they are alike, i.e. when they possess the same space of reference and share the same knowledge, so that the institutional dimension is also important.
- *Geographical proximity* refers to a great extent to the location of firms, and integrates the social dimension of economic mechanisms, or what is sometimes called *functional distance*. In other words, the reference to natural and physical constraints is an important aspect of geographical proximity but other aspects are equally important in its definition: the aspect of social structures such as transport

infrastructures that facilitate accessibility, or the financial mechanisms that allow the use of certain communication technologies.

It is necessary to take this definition of geographical proximity further by distinguishing *permanent* geographical proximity, which corresponds to the co-localization of firms, from *temporary* geographical proximity, which lies on momentary F2F interactions enabling actors to meet without necessarily requiring co-localization.

This type of proximity is related to a phenomenon that is currently spreading: the increasing mobility of individuals, information and goods. Indeed the professional mobility of individuals has increased with the development of transports (improved accessibility, increase of speed, reduction of costs) and the technological revolution in telecommunications (improved forms of long-distance processing and transfer of information in comparison with the telephone era, low costs of information transfer). The complementarities of transports and communication (the more individuals telecommute, the more they need to meet others, and vice versa) increase this mobility, so that an increasing number of actors no longer have a permanent workplace. But there are wider mobilities, which cross territories: the traveling of a sales representative, the visits of a consultant auditing a firm for several days, the participation of a researcher to a national or international congress, the temporary visit of an engineer to the laboratory of a firm or university with which his/her firm cooperates. Thanks to these developing mobilities, the constraint of geographical proximity can be fulfilled temporarily through traveling without the interaction leading to the permanent co-localization of the partners.

The need for geographical proximity is generally not permanent. It affects certain phases of the interaction: the phase of negotiation in a transaction, the definition of the organizational framework and guidelines of cooperation, the realization of its initial phase in the case of a technological alliance, the necessity to share equipment in the experimental phase of a common research project or to exchange knowledge and above all to know personally the

researchers (colloquium) belonging to a scientific community etc. Short or medium-term visits are then sufficient for the partners to exchange – during F2F meetings – the information needed for cooperation. As a result permanent co-localization is not necessary even for activities, where physical interaction plays an important role in the coordination (services co-produced by the provider and the user, knowledge-intensive activities such as innovation and R&D activities). This is what we call the need for temporary geographical proximity.

Indeed, the possibility of moments of temporary proximity puts into question one of the most widespread theses in the regional analysis, according to which firms have a strong tendency to settle near one another because of frequent and repetitive interactions requiring F2F relations. This idea can be found in particular in the research carried out in the field of innovation geography (Feldman 1999). According to some authors firms need geographical proximity to exchange knowledge concerning their production, commercialization, and above all R&D activities. The thesis is based on the tacit nature of part of the knowledge, the transmission of which requires F2F relations (learning by imitation, informal exchanges, intuitive solutions to problems etc.) whereas codified knowledge is transmitted more easily through ICT or physical supports (articles, books, instruction manuals etc.), which are independent from the individuals or organizations that produced them.

This thesis must be relativized (Rallet & Torre 2000). The equation of the sharing of tacit knowledge and geographical proximity on the one hand, and codified knowledge and long-distance relations on the other, is indeed simplistic. Firstly, it is difficult to separate the uses of both types of knowledge and therefore to translate them with different geographical terms. Secondly, F2F relations, and therefore geographical proximity, are not the only possible supports for the sharing of tacit knowledge (Freel 2002). Thanks to the collective rules and representations that they produce, organizations offer powerful mechanisms of long-distance coordination (or organized proximity). Thirdly, ICT also make the long-distance sharing or co-producing of tacit knowledge possible thanks to the technological evolution of computer

sciences, which offer possibilities such as informal or visual communication (association of the image, written support and voice) or written communication that has become close to oral communication (e-mails, forums, chats etc.). There is no denying that F2F relations remain indispensable for certain types of interactions (Dahl & Pedersen 2003), in particular to solve problems related to the heterogeneity of reasoning modes or those related to the processes of deliberation and negotiation. However, the intensity of the need for F2F relations varies according to the phase of the process (Gallaud & Torre 2003).

2.3 External Acquisitions of Technology and Their Spatial Dimension

External acquisitions of knowledge have for a long time been considered as essential for a firm's production of innovation, whether the knowledge is acquired through firm-to-firm relations or relations of an academic nature (Lundvall 1992). A firm wishing to acquire external knowledge can get information made public through conferences, trade fairs, publications, symposia, exhibitions etc. but most knowledge it wishes to acquire is private (or semi public) and can only be acquired from other firms or organizations. These acquisitions range from commercial transactions (the markets of technology) to research cooperation. The latter can be more or less formalized, whether it concerns relations with public research organizations (contracts between universities and industries) or with other enterprises (vertical cooperation, which corresponds to relations with clients or suppliers, and horizontal cooperation with the competitors, the complementary firms belonging to the same sector or other types of enterprises). In cases where knowledge is public, geographical proximity has no impact because knowledge can be acquired wherever the innovating firm is located in relation to the productive source of knowledge. Things are different when the information is not divulged: it can be beneficial for the firm that seeks to acquire it to be located in the proximity of the productive organization.

The needs for geographical proximity vary according to the type of cooperation undertaken by a firm. The latter depends mainly on the difference between the knowledge bases of the organizations that cooperate. The bigger the difference is between knowledge bases the more necessary are interactions of proximity: interactions implying temporary meetings and/or a localization of proximity.

Generally, for most cooperation projects, interactions are frequent during the phase dedicated to the search for partners and the cooperation contract negotiations. Repeated interactions allow the mutual evaluation of the initial competencies and resources as well as those, which will have to be produced during the cooperation. Later on the frequency of interactions, proximity might drop for two reasons: i) the organizations know each other better and can therefore exchange through communication technologies, ii) the closer one gets to the production process, the more information organizations possess internally, which limits the needs for exchanges.

The relations between external acquisitions of knowledge and forms of proximity can be systematically classified according to five channels generally found in literature:

- *informal interactions*

Considered as being the basis of the daily functioning of districts and milieus (Becattini 1990, Camagni 1991), they, above all, enable local actors to exchange general information and tacit knowledge, mainly through former work colleagues or fellow students (Dahl & Pedersen 2003). Because this type of knowledge transmission is not easily carried out when the actors are geographically distant, co-localization or permanent geographical proximity plays an important role in this case. As for organizing occasional meetings between geographically distant actors, this option would precisely be outside the informal nature of the type of interactions discussed here.

- *patents and licenses*

This highly codified type of knowledge transmission does not generally imply any relation of geographical, nor even organized proximity, with the exception of licenses of know-how which imply the obligation for the firm granting the license to commission the installation on the site of the client firm or to train its staff. Thus Tyres and Von Hippel (1997) have studied the purchase by firms of new machines, the installation of which necessitates on average three trips by the engineers of the innovating firm. The geographical proximity mobilized here, of a temporary nature, also proves relatively limited in time.

- *Industry-university cooperations* (Carayol 2003) concerning research operations

Informal interactions of cooperation, often used as support to development, must be distinguished from formal interactions. As shown above, geographical proximity is important in the case of informal relations. Indeed the co-localization of organizations facilitates exchanges of information concerning the techniques and competencies available (know-who). In its permanent form, it also plays an important role in situations where a firm makes use of university buildings and when material and equipment are used in common by the university and the firm.

In the case of projects of formal cooperations, interactions occur during the stage of (fundamental or applied) research. The need for geographical proximity is then only temporary, as these interactions occur less frequently than informal interactions. However, the bigger the difference between the knowledge bases of the organizations and the more frequent and necessary interactions of proximity will be.

- *formal interaction in the form of vertical cooperations*

Cooperations within a supply chain help define the characteristics of the innovations and therefore reduce the risk associated with the introduction of new products or processes of production on the market (Tether 2002). Cooperations with clients, which concern above all the stages of applied R&D, make it possible to reinforce

the adequacy between product and demand (Lundvall 1992). Defined as the lead user, a client will help – as early as the design stage – an innovating firm to adapt its innovation to the needs of the market. Interactions of proximity play an essential role in this case: interactions are frequent during the stage of research but their frequency progressively drops during the different stages of development. Cooperations with suppliers are of two types. It is important to distinguish the suppliers who participate to the production of the innovation from those who only intervene at the industrial stage (at the time of mass production):

- Suppliers who belong to the first category will have to adapt their products to the demand of the innovating firm. Interactions of proximity will therefore take place at all stages of the process, according to the modifications of the innovation project. In this case only temporary geographical proximity is necessary for the good progress of these operations.
- The suppliers of the second category only need to modify their products once the R&D process is over. The interactions – less frequent than in the previous case – occur at the stage of mass production. Here again, only moments of temporary proximity are necessary.

- *formal interactions in the form of horizontal cooperations*

Three cases must be distinguished:

- ‘classic’ horizontal cooperations, i.e. with firms belonging to other sectors of production, generally concern specific moments of the research project. Permanent or temporary, geographical proximity is used to solve development problems.
- Cooperations with competitors are regulated in order to avoid the collusion of products on the market and the formation of oligopolies.

This is why cooperation is often limited to the research stage. However, firms try to limit the leakage of their know-how in these exchanges. Indeed, Dahl & Pedersen (2003) show that in some clusters the work contracts of engineers contain a clause of non-disclosure of the information related to R&D projects to engineers of rival firms, which limits informal interactions. Firms are in this case confronted to a contradiction: they can choose co-localization in the hope of benefiting from their neighbors' knowledge while trying to limit the leakage of information concerning their own productions. This illustrates quite well the ambiguous nature of permanent geographical proximity. It is simpler to set up occasional meetings in the context of cooperation contracts during the stages of research, meetings that both limit the risks and opportunities of obtaining external knowledge.

- Cooperations with firms of the same sector with complementary activities also occur during the stage of research but can go as far as the setting up of prototypes. Because the division of labor is high, interactions of proximity occur less frequently than in the case of academic cooperation, firms trying to limit interactions to the stage when the 'modules' of the innovation are assembled.

Thus, the need for geographical proximity remains relatively important in the processes of external acquisitions of knowledge, even though temporary geographical proximity is generally needed more than permanent proximity, and therefore the co-localization of activities of innovation seldom seems essential. This result contrasts with theses of innovation theories, which tend to overestimate the role of geographical proximity and to advocate the co-localization of firms or research laboratories. Contrary to these predictions, external

acquisitions do not generally occur in the context of permanent geographical proximity but of temporary proximity, and mainly between distant organizations, which are not situated in the same geographical area. The division of labor enables innovators to individually carry out the stage of production for which they possess the most competencies and to limit interactions with other parties to the stage of assembling of the innovation. However, the density of interactions strongly depends on the respective competencies of the firms engaged in the innovation process, while all innovations do not require the same density of proximity interactions nor their concentration at the same moment of the process.

3. The Introduction of the Conflictual Dimension

Innovation theories and the works on spillovers claim that permanent geographical proximity has beneficial effects on the development of innovation at local level, because it allows a high and regular frequency of interactions. But this idea is currently disputed. The first reason for this refers, as mentioned above, to the important role of temporary geographical proximity in the process of innovation. Secondly, it has also to be considered that permanent geographical proximity produces negative effects seldom discussed in literature. In particular it is the source of conflicts of access to scarce resources (increase of the prices of plots, access to qualified labor) and conflicts of interests between co-localized actors (Saxenian 1994).

However, conflicts occurring during the interactive process of production of innovation do not only concern the disadvantages of geographical proximity. They are more related to the tensions that emerge between actors, as technical differences, interpersonal disagreements, issues of power, property rights etc. We shall see below, based on the example of French biotechnology firms, that geographical proximity plays a complex role in attempts to solve conflicts. Permanent proximity enables neighboring actors to meet and have informal relations. Temporary proximity has an important role in the prevention and resolution of conflicts

emerging during the process of production of innovations, whether they are conflicts related to the organization of labor, to technical characteristics of the innovation or to property rights.

3.1 Economic Analyses of Conflicts

Economic analysis has dedicated little time to the study of conflictual relations because this notion poses methodological problems, which often prove in contradiction with the core of theoretical elaborations. The field of analysis is generally confined to conflicts of interests or conflicts related to the distribution of wealth between actors, which excludes conflicts of passion (which are a matter for psychology) as well as the relations of power (reserved to political sciences).

Thus the classics have privileged the conflicts related to the distribution of wealth, thinking that strong inequalities led to recurring revolts (and therefore to open conflicts), while the neo-classics have focused more on the problems of conflicts of interests, proposing to solve them by designing instruments that would enable actors to represent the gains of exchange. Later on, *Game Theory* considered conflicts as a central object of analysis, its research focusing on the determination of possible solutions and resolutions depending on whether they are cooperative or non-cooperative games (Schmidt 2001). However, in these works, conflicts never reach the stage of commitment behavior (verbal or physical aggression) and do not even lead – in the non-cooperative approaches – to any communication between the actors who agree on the set of solutions, represented by artifacts such as the matrix of gains. Even credible threats do not go beyond ‘polite declarations’ calling for ‘rational’ reactions from the opponent, and never degenerate into acts of violence.

Most heterodox approaches adhere to this idea of relations without serious conflicts (i.e. not leading to acts of violence) and try above all to highlight the mechanisms of conflict prevention, just like the *School of Regulation*, which emphasizes the notion of compromise enabling the different institutional forms to build up a system (for instance the Fordist

compromise). The evolutionist approach prefers to analyze routines – defined as control mechanisms that are sufficient to prevent conflicts, and resulting from an organizational truce between managers and employees (Nelson & Winter 1982) – rather than explain how the conflict is resolved. It does not deny that intra-organizational conflicts do exist – ‘it is not however of our intention to ignore the divergence of interests between organization members’ (idem, p. 107) – and that actors can resist from automatically carrying out the task prescribed by the firm. On the contrary, it emphasizes that employees work in the framework of ‘defacto contracts’, which imply a certain propensity to not carry out their tasks being controlled by the managing staff. In itself this routine activity dissuades actors from pursuing their personal interests and keeps conflicts within limits that are bearable for firms.

Thus the economic management of conflicts concentrates generally on the search for mechanisms of conflict prevention and resolution and neglects the relations of power between actors as well as the conflicts concerning access to scarce resources. Only the *Marxist Theory* has considered conflicts as the driving force behind economic and social change, with the class struggle being a form of open and violent conflict between members of different social groups, aiming to modify the distribution of wealth. The main difficulty currently consists in producing a theory of conflict that would make it possible to take into account the heterogeneity of actors and the fact that the latter interact in order to find solutions to conflicts.

Cyert & March (1963) were among the first authors to re-introduce the notion of conflict in the analysis of the firm, by studying conflicts between shareholders and managers, i.e. between the owners of the firm and those who exercise their decision-making powers daily and whose strategies are liable to affect the distribution of the value added. Other works on management then focused on taking into account intra-organizational conflicts and something close to the common definition: interpersonal disagreements.

A conflict is defined as a process in which one of the parties in presence feels that its interests are opposed or negatively affected by the action of another party (Wall et al. 1995), a process, which goes on in time and can lead to the escalation or the reduction of tensions. But authors diverge on the identification of the very objects of a conflict, whether they are goals, values, access to resources (Putnam & Poole 1987), needs, interests (Donohue & Kolt 1992), or aspirations (Pruitt & Rubin 1986). The causes of conflicts found in literature also vary and refer to individual characteristics of the different parties, difficulties or type of communication, power-seeking behavior (Blalock 1989, Ferguson & Cooper 1987), self-fulfilling prophecies concerning the reactions of other actors in relations to one's own objectives, structure of organizations or earlier interactions, as a previous conflict is likely to re-occur, especially if it has left one party unsatisfied (Tjosvold & Chia 1989).

Nowadays, the temptation to limit conflicts is being replaced by attempts of valorization (in particular in the case of innovation projects) in order to increase the performances of the participants. Three main modes of conflict resolution have been observed (Wall et al 1995): i) in some cases solutions are found by the actors themselves – possibly because the conflict has become too expensive – with solutions ranging from compromise to the imposition of a point of view by one of the parties, including assertion through force, ii) in other situations the hierarchy imposes a solution, iii) in others a third party intervenes (mediation or arbitration): some parties may hope that their gains will be higher, if they use arbitration rather than compromise with other parties. Finally the managers might decide to wait for the conflict to solve itself. This is the so-called solution of avoidance (Gobeli et al 1998). Innovation situations, in particular when there is constructive interaction, facilitate the emergence of conflicts, the participants to one same project often having partially divergent interests or objectives that generate tensions during the process of innovation.

3.2 Conflicts in the Process of Acquiring Knowledge and Types of Proximity

One of the central limits of economic theory is that it ignores the conflicts related to the process of production (and even more of innovation). But these conflicts sometimes cause the failure of innovation projects, in particular when they are carried out in cooperation. Oppositions concerning property rights for example are an important cause of failure of technical cooperations. The mobilization of geographical and organizational proximities is an asset in the resolution of these conflicts.

When organizations exchanging knowledge are localized in the same area, interactions can be repeated. But when they are not, interactions are less frequent because of costs related to traveling, which can be divided into transport costs and the time necessary to meet the other innovators. This is why the participants to a project will then try and limit the moments of geographical proximity, by attempting to rationalize the need for temporary geographical proximity making F2F interactions only possible when they are necessary. Indeed, it is important to make the distinction between:

- *firms entering a sector (start-ups)*, who must simultaneously decide where to locate themselves and possibly choose cooperation partners. They might find it in their interest to locate in the proximity of other firms or organizations in order to take advantage of a pool of qualified labor or knowledge externalities within a single region. This case is limited – with the annual entry rate into branches being low – and also refers to the setting up of new production or R&D units.
- *firms, already localized*, wanting to cooperate with other organizations in order to innovate. These firms will not decide to re-locate in the proximity of organizations with which they wish to cooperate due to the cost of such an operation. This is the reason why surveys such as CIS (Freel 2002) find an important part of the relations of cooperation occurring between firms belonging to different regions or even different countries. The creation of a joint venture, consisting in building a new laboratory in a location approved by all participants, is not the most used solution because it is also deemed too expensive.

For these reasons, the process of innovation in the case of external acquisition of knowledge often proves different from what is predicted by *Innovation Theory* presenting the density of interactions and their regularity during the process as factors to explain performance of innovation projects. Indeed studies show that participants in a project of innovation tend to meet only once a term, and the frequency of these meetings is generally stipulated in contracts (Gallaud 2003). The division of labor between innovating firms remains high, i.e. each firm carries out the tasks for which it has the most competencies and the innovators meet essentially in order to assemble the different modules and/or to manage conflicts. Thus permanent geographical proximity is not necessarily beneficial to firms when it is associated with the idea of co-localization. Furthermore, a firm deprives itself of its competencies, sometimes for long periods of time, when it sends staff away. Temporary geographical proximity makes it possible to avoid this expensive solution when firms have the capacities to develop an innovation in common although they are not co-localized. They develop the project by only moving some staff, mostly in the context of a formal cooperation like a contract.

The analysis of benefits of (temporary or permanent) geographical proximity in the case of conflicts can be listed according to the modes of resolution of conflicts emerging during the development of innovation projects. They are first of all (Dyer & Song 1995, Gobeli et al 1998):

- *avoidance*, in which the project manager waits for the conflict to solve itself, at the risk of causing the project to fail leading to separation. If innovators do not recognize the conflicts, they will not travel to resolve it.
- *the imposed solution*, associated to a relatively low geographical proximity. It is not necessary for all the participants to the project to meet when this solution is chosen.

Two cooperative solutions necessitate geographical proximity more because they require the participants meeting in order to negotiate a compromise:

- *the 'give and take' solution*, whereby the hierarchy proposes a solution that is acceptable for all participants concerned. It differs from mediation – which refers to disagreements between an institution and a user more than to firms – in that one of the parties (the hierarchy) is both judge and party and proposes concessions elaborated with the workers. Co-localization facilitates the finding and acceptance of this type of solution.
- *the concerted solution*, in which all participants meet and find, together, a mode of resolution specific to their problems. The advantages of permanent geographical proximity are obvious here, as it enables the parties involved to hold repeated deliberations and negotiations and facilitates the quick mobilization of actors after latency periods. We shall see below that temporary geographical proximity also has merits.

But geographical proximity alone is not sufficient to solve conflicts: it is always associated to organized proximity. The relative failure of Japanese transplants into Silicon Valley shows that interactions are not generated by co-localization alone, but that institutional mechanisms are necessary (integrating a network by being introduced by an actor who already belongs to it). In other words, geographical proximity must be activated by organized proximity (Filippi & Torre 2003). The studies carried out on 'epistemic' communities (SteimueLLer 2000) also reveal the importance of standards, rules and a common culture, which enables actors to interact. These factors correspond to what we understand by organized proximity, defined by a certain degree of likeness between actors (see section 2).

While standard theories highlight the mechanisms of conflict resolution by making the hypothesis that actors agree on the set of solutions, the treatment of conflicts in innovation projects consists for the actors in building a common space, which contains the (temporary or definitive) solution to the conflict as well as the common rules, which will enable them to debate and possibly reach a compromise. The practical cases of innovation projects show that

the innovators solve conflicts of representation when they have built a common language (Latour 1989, D'Adderio 2001), or forms of organized proximity, i.e. when they are sufficiently similar to understand a problem in the same terms. From our point of view the role of organized proximity varies according to the forms of conflict resolution chosen: it is nil when the solution of avoidance is used, low when the solution is imposed, and it increases significantly when the 'give and take' and concerted solutions are mobilized. Temporary geographical proximity and organized proximity are then complementary and enable the actors to find processes of negotiation and compromise.

3.3 Conflicts and Proximity in the Biotechnology Sector

Far from being a homogeneous and coherent sector (Porter 1990), biotechnology can be defined as the set of techniques and knowledge related to the use of living organisms in processes of industrial production (Ducos & Joly 1988). Biotechnology is essentially used in chemistry, agro-chemistry, pharmaceutical and agro-food industries, and very occasionally lead to a few applications related to the environment or the control of pollution. In France, a production chain made of firms, which are specialized in these activities or complementary activities, is emerging: manufacturing of specific instruments and equipment, technical consulting and expertise, and specific modes of financing (Lhuillery 2002).

Biotechnology is characterized, generally and more specifically in France, by cooperations between distant firms, to such an extent that firms being co-localized in scientific parks do not appear much to cooperate locally. Distance does not seem to penalize these firms and does not stop them from developing their projects. But this does not mean that geographical proximity plays no role in their functioning. Indeed, although co-localization is not sought for, the benefits of geographical proximity are mobilized, but in a temporary manner through occasional meetings between the participants of the projects. Thus, most contracts of cooperation concerning innovation activities make provision for at least one meeting per term

in order to examine the progression of the project. One of the objectives of these meetings is to defuse, reduce or attempt to find solutions to conflicts that may emerge during the process of innovation.

Conflicts in biotechnology are related to property rights, to the technical content of the cooperation (disagreements concerning the objectives and /or the technical characteristics of the projects), or to the organization of labor and interpersonal disagreements. Problems related to property rights are likely to increase in the coming years because approximately 50 per cent of the patents covering the main medicines will have become public by the year 2005 (Depret & Hamdouch 2001), which is going to increase the competition between firms and probably the cooperation between big laboratories and start ups of biotechnology. Problems concerning conflicts of representation are important because cooperation takes place between different organizations, for example firms and universities. Interpersonal disagreements influence the performances of innovation projects (Souder 1987), even if arrangements are often possible. Thus, in cooperations with public organizations or universities, innovators emphasize the fact that they knew the researchers with whom they now cooperate before the cooperation project was launched. Interpersonal networks serve in this cases to reduce conflicts (Depret & Hamdouch 2000).

In the following, we refer to a questionnaire survey of 60 biotech SME of (Gallaud 2003), where people in charge of innovation projects have been interviewed. The innovation projects had to have been carried out in cooperation with other firms and/or public organizations of research. The content of the cooperation covered all forms of technical cooperation with the exception of purchases of patents and licenses. The geographic area covered by the survey included the regions of Alsace, Auvergne, Brittany, Ile de France, Rhône Alpes and Midi Pyrénées. Firms localized in science parks as well as outside any specific group were included. The firms surveyed privilege activities related to agriculture and the agro-food industry. The objective of the interviews was to look for the role played by relations of

proximity in the modalities of anticipation and resolution of conflicts emerging during processes of interaction for the external acquisition of knowledge. One of the main questions referred to different types of conflicts experienced and whether they had been solved through geographical proximity (with at least one trip of the innovators) or only by using different channels of tele-communication. The central hypothesis was that the different types of conflicts led the firms to mobilize temporary proximity with different intensities.

The results show that the types of conflicts during innovation projects in biotechnology were related to:

- *property rights of the innovation and gains drawn from future innovation.* These conflicts occur more often in cases of cooperation than for any other form of acquisition because the knowledge does not yet exist when the contracts are signed (incomplete due to the uncertainty of the innovation process, see the chapter by Blum & Müller). They oppose firms and public organizations of research more frequently; possibly because the modes of valorization of knowledge are different and French public organizations were only authorized in 1999 to create private valorization structure. Firms with experiences on conflicts of this type have a higher-than-average propensity to experience once again a conflictual relation, possibly due to a climate of distrust between participants. Temporary geographical proximity is mobilized to resolve these conflicts, the innovators travelling (generally between 4 and 5 times) in order to solve conflicts related to the distribution of gains of the innovation. The relations of power and the threats will be more effective and credible than in the case of utilizing telecommunications.
- *the objectives and/or technical characteristics of the innovation.* If innovators do neither share the same knowledge nor the same 'professional culture', they have different representations of the objectives or/and the technical characteristics of the innovation (Latour 1989). It is this type of conflict inherent to any innovation

project, which geographical proximity solves the most. It is easier for innovators to reach an agreement on the technical characteristics through F2F interactions than through distant interactions (e-mail or telephone), probably due to problems of translation between the different professional cultures.

- *the organization of labor during the project.* Conflicts of this type do not occur frequently. Temporary geographical proximity (i.e. travelling) is seldom used with most conflicts being managed through telecommunications. This might be due to the fact that the organization of labor in innovation projects remains highly divided.
- *interpersonal disagreements between innovators.* These conflicts seem to be the most frequently solved through telecommunication, but the results of our survey do not enable us to draw any clear conclusion in this regard.

Thus, whereas conflicts of access to scarce resources are partly caused by permanent geographical proximity, it is the content and the progress of the interactions themselves, which lead to conflicts during the process of innovation. Temporary geographical proximity can help solve these conflicts, through occasional meetings, facilitating discussions, negotiations and the elaboration of compromise.

Biotechnology firms use most modes of external acquisition of knowledge and above all cooperation with other firms. Most cooperation takes place between distant firms. In this case geographical proximity is temporary (one meeting per term on average). It is often mobilized before the projects are launched in order to solve conflicts related to property rights. On the other hand its role appears more limited during the project. Above all, organized proximity makes it possible to limit the conflicts related to the organization of labor and differences of representations on the characteristics of the innovation. However it is more limited than what literature predicts with the division of labor remaining high in cooperation projects.

4. Conclusion

Contemporary theories of innovation overestimate the positive effects of permanent geographical proximity by considering the co-localization of organizations as a key factor of the success of interactive processes of innovation. This article aims to examine the role played by geographical proximity in the circulation of knowledge, by focusing on those moments of the process, which more particularly imply its mobilization.

An examination of cooperation relations reveals that the firms involved in this type of project use permanent geographical proximity only moderately. This does not mean that geographical proximity plays no role in the external acquisition of knowledge, as the example of French biotechnology firms shows. Indeed, our research shows that French biotechnology firms mobilize temporary geographical proximity in order to acquire external knowledge with the help of cooperative projects. Moreover, although most cooperation takes place between geographically distant organizations, temporary geographical proximity is often used before the beginning of the project to anticipate conflicts related to property rights. It has a more sporadic role during the course of the project, because meetings are planned from the beginning of the operations. However, it plays a role in the resolution of conflicts, by enabling the participants to meet occasionally, and discuss, negotiate and elaborate compromise to solve conflicts related to the organization of labor, technical characteristics of innovation and property rights.

Notes and references

The authors would like to thank S. Paillard for her remarks on a previous version of this paper.

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