KNOWLEDGE PRODUCTION AND PATTERNS OF PROXIMITY: French sme's of biotechnology.

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Abstract :

Are innovative networks local, i.e. bounded in space? This question of the expansion of networks has not only to be challenged about the diffusion of innovation, but also in the case of its production. The most important problem for innovative firm is to "embed" new knowledge into routines. So we propose a pattern that links this "embeddedness" with the nature of the innovation process. Innovation in exploitation leads to use a large geographic space but a bounded space of action, geographic proximity is temporary and organizational proximity is logic of "belonging". Innovation in exploration leads on the contrary to a bounded geographic space, but to a large space of action, geographic proximity is permanent and organizational is logic of "similarity".

Key words: knowledge production, networks, routines, geographic and organizational proximity, and biotechnology.

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Introduction :

Economics of innovation, in the one hand, underlines the importance of networks to improve innovative performances. But public policies adds to this notion the importance of local networks that are supposed to allow face to face interactions needed to transmit knowledge (especially in its tacit shape). So its encourage the creation of cluster, science parks… to develop innovation. On the other hand, spatial analysis has tried to demonstrate positive effects of interactions inside small geographic areas, since twenty years. But are these interactions really a guarantee of innovative performances? Do firms create spontaneously local networks?

We define innovative networks as structures of coordination that implicate agents who belong to different organizations (Universities, research centres, firms) during the fulfilment of an innovative project, to reduce uncertainty. These structures allow knowledge production in cooperation or its exchange, in function of the project. They exist only during the fulfilment of the project. The notion of project does not define the "organization by project" of large groups but any way of designing innovation in cooperation.

To search if networks are bounded or not, we have to define the kind of "space" we will consider in the analyse and the frontier of this space. We have found two kinds of "space»:

- the existing geographic space, which defines the location of agents;
- the space of action of the agents. This space results of the interactions between agents, (as in the models of competition of techniques (Arthur 1990 and Dalle 1995, or in the "small worlds" Cowan and Jonard 2000).

These two kinds of spaces are complementary: interactions between agents are located in geographic space. Taking account only the location raises any problems to understand how innovation is produced. The notion of proximity translates this complementarity between the two kinds of spaces (Gilly et Torre 2000).

The notion of proximity is based on a relational approach of economy and on the existence of a separation between agents (Gilly and Torre 2000), so interactions are central in the definition. Interactions concern markets interactions (as inter-firms relationships Scott and Storper, 1987) as well as spillovers (Autant-Bernard and Massard, 1999). The separation between agents can take two main shapes: geographic and organizational.

Geographic proximity is based on the separation of agents in space, it covers notion of distance between agents and the representation about the way of perception of this distance, and the access to infrastructure (transport and telecommunications that modify both distance and its perception.

Organizational proximity corresponds to economic separation between agents, it divides in two logics: "similarity" and "belonging".

- " similarity" supposes that agents build common representations for their actions and common knowledge and know–how in term of learning. This logic is stronger than "belonging".

- "belonging,» indicates that agents have worked out an innovative project, that requires a minimal way of coordination to manage to fulfil the project.

First section is a survey of literature on the part played by geographic proximity. But this literature presents only the diffusion of innovation; the problem of production and its consequences on routines will be the object of the second sections. The third section presents our main hypotheses and a pattern that links routines and proximity. The fourth section is an application to the activities of biotechnology in France. Finally, the last section concludes.

I .The part of geographic proximity in contemporary litterature.[1]

Even if the concept of proximity as such, is not always directly referred to, contemporary literature regarding the transmission of knowledge in a spatial framework continually alludes to this notion. Although everyone agrees on the importance of geographic proximity in the process of the diffusion of knowledge, the main aim of the systemic type of analyses is to highlight the real or assumed qualities of groupings of technology firms, and to define the LPS (Localized Productive Systems) that hold the promise of a potential local technological development. A more econometric approach, on the other hand, aims to investigate the role of proximity in the process of the transmission of knowledge, based on the modeling of geographical externalities in regard to innovation and technology.

In the eighties and nineties, the relation between geography and technology became the focus of attention in regard to the institutional framework of the production of innovations, as differences had appeared between countries or regions that had a comparable level of development but were characterized by unequal innovation rhythms (Lung and al.,1999). Since then, research has been dedicated to various subjects such as innovatory circles (Ratti and al., 1997, Crevoisier, 2001), technological districts (Antonelli, 1986), urban research centers or science parks (Monck and al., 1988, Longhi, 1999) and, in general, to localized systems of production and innovation (Lundvall, 1992, Maskell and Malmberg, 1999), so as to highlight the complex connection between spatial concentration and technological advantage, and then to reveal the organizational component underlying this type of local operation. These different approaches have two common characteristics: they postulate the effectiveness of local operations and highlight the importance of the organizational component through the use of networks. So it is, that studies concerning innovatory circles have underscored the importance of connections between the different local actors as regards the technological development of a given region or geographical area, particularly when they have technology supplier-user type relations that can help to reduce technology leakages and promote the implementation and development of local learning opportunities. Research concerning urban research centers, which is often of a less theoretical nature, systematically attempts to highlight the advantages of grouping local high tech firms on the same territory, especially in regard to the production of innovations, not only because of the concentration of potential for research or innovation, but also because of the synergetic effects arising from the collaboration between local firms. Most of these characteristics can be found in the analyses of regional innovation systems, that include the setting-up of a local network based on technological complementarities, as well as an institutional dimension illustrated by implementation policies undertaken by the public authorities in terms of aid to innovation or the training of engineers or scientists, and where the relation between science and industry occupies a central position.

All in all, and as the most recent syntheses on innovation clusters have shown (Porter, 2000), the idea that firms and productive systems benefit from the spatial concentration of their research and innovation activities, is widely accepted nowadays: geographic proximity is seen as an essential condition for technological success, particularly in the case of Sme's. Nevertheless, serious doubts are now being voiced, as to the characteristics themselves, or even the merits, of the process of spatial concentration that has been engaged in, particularly in

[1] This paragraph is extract from « Are innovative networks local ? »
communication to troisièmes journées de la proximité Paris 13 et 14 décembre 2001, www.proximitydynamics.net

regard to the ability to transfer knowledge that is often termed as tacit knowledge, without cost and without any particular effort (Rallet and Torre, 2001)

Whereas this research takes it for granted that geographic proximity plays a part in the process of innovation and the transmission of knowledge, studies on geographical externalities attempt to verify the role of this proximity in the transmission of knowledge by calculating the maximum distance that a technological externality could cover.

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 economy being able to prevent it, or even being aware of it[1]. When innovation (or R&D) is likened to information, there is an unlimited 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, which would allow activities to be equally distributed throughout the territory. The over-concentration of innovative activities, which is even greater than the production activities (Audretsch and Feldman, 1996), is then often accounted for by the characteristics of the externalities that are assumed to have a limited geographical extension.

Autant-Bernard and Massard (1999) have compiled four types of studies dedicated to calculating the externalities of knowledge (or spillovers) and to their spatial area, respectively based on:

- The use of patents as markers of externalities (Jaffe and al., 1993);
- The geographical concentration of innovations (Feldman 1994; Audretsch and Feldman, 1996);
- geographical coincidence (Jaffe 1986,Anselin and al., 1997);
- local interaction (Anselin and al., 1997; Wallsten, 2001); to which one may add (Feldman, 1999);
- knowledge built into capital or investment goods.

All these approaches 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 that geographic proximity is an important factor in the diffusion of knowledge. However, there are two factors that limit the significance of this research: the calculation of the geographical extension is still much debated, and the analysis of the channels for the transmission of externalities modifies the role of proximity. (Autant-Bernard, 1999).

1. the calculation of geographical extension is still much debated

Some of the above-quoted studies do not really propose an estimation of spatial externalities: the authors use a predefined geographical district, 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, they measure phenomena related to urban areas. These methods

[1] We can't enter here into the debate about the definition of externalities, we use here the notion of knowledge spillovers.

generally postulate the role of the local aspect by using pre-defined geographical areas: States (Jaffé, 1989; Feldman, 1994), metropolitan areas (Jaffé and al., 1993) and Counties (Anselin and 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 and al (second measurement), R&D may have been carried out within a radius of 50 or 75 miles, *i.e.* around the County of reference.

More recent studies, that make 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 in order to analyze the probability for a firm whose neighbour received government aid 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 outskirts 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 leaves room for many extrapolations. Lastly, it is not until the publication of Orlando's work (2000) that these methods present a simultaneous calculation of externalities and of distance.

2. The channels of transmission of externalities

Zucker and al. (1994) are the first to highlight the role of effective interaction in the diffusion of knowledge, by showing that geographic proximity is not sufficient to enable one to benefit from the externalities of technology, a finding also put forward by Cockburn and Henderson (1998), who consider that externalities can only be received if firms stay in contact with scientists (especially by co-authoring articles). Audretsch and Stephan (1998) continue in line with these studies, showing that 70 % of the contacts that are maintained between Sme's and scientists are not local but vary according to the main tasks assigned to the scientists (the transfer of knowledge, a sign of quality for investors and participating in the scientific committee of Sme's). These results should be considered with caution, as it is only the transfer of knowledge that is concerned in the analysis of innovation networks.

Zucker and al (1998) measure the impact of relations with the most productive scientists (the « star-scientists », thus defined by the number of articles published) and the innovation output of firms, which is assessed by three indicators: the number of products being developed, the number of products on the market and the net growth of employment, that all express the stages in the process of innovation, from invention to economic performance (Autant-Bernard, 1999). They conclude that only the influence of researchers linked to firms by research cooperation has a significant impact on innovation performance. It is therefore not enough for firms to be situated near the Universities, they must also effectively cooperate with the local scientists in order to apprehend the externalities and express them in terms of an increase in innovative results. Thus, the notion of interaction shows that the effectiveness of geographic proximity is limited, as it involves a certain organization of the proximity.

So the works on geographic spillovers allow concluding that innovative networks are bounded in geographic space, even if the distance covered by spillovers is still at stake. It's an important drawback because this distance characterizes the frontier, the spatial expansion of networks. But more important are the critics of Zucker and alii, these authors underline that the interactions inside cooperation are more efficient to diffuse innovation. So the important question is the one of the expansion of networks of cooperation.

2 . **Knowledge production and routines.**

There are very few works about knowledge production probably because it implicates to explicit the process that lead to the creation of knowledge, now these process can seem at the boundary of the economy. Any authors have studied this point, often from the epistemological point of view (Hayek, Polanyi, 1967; Paulré, 1997).

Simon is one of the first authors who have described the production of knowledge. He begins with the distinction between science of nature and science of artificial (1969, quoted by Perrin 2001). “The goal of natural science is to describe how things are, whereas artificial science are interested in how things should be to reach any objectives”. Computer science, and above all science of engineer can be classified into this category, whereas physics and social science are in natural science. Obviously, any results of natural science are applied in artificial science, but the main point here is that the two kind of science lead to distinct mode of knowledge production. Research activities are central in natural science, whereas, design activities are central for the production of technological knowledge. Besides Perrin proposes to assimilate innovative activity with artificial science. So the production of knowledge related to innovation is assimilated to the production of technological knowledge. Technological knowledge is never produced per se, but is always oriented by technological goals. Scientific knowledge can be produced only in reference to a lack of prior knowledge.

So design is the central activity for innovation. It can be defined as “a creative activity, which starts from the needs of any users and from existing knowledge manage to the definition of a new product or process that the industry can manufacture.” (AFNOR 1988). Innovation is assimilated to design as in “chain linked model of Kline and Rosenberg (1986). Central path of innovation distinguishes three stages of design.

This difference of nature of production of these two kinds of knowledge has to be linked with the debate about the nature of technological change. Any evolutionists scholars give more importance to radical innovation and breakthroughs that offer new technological opportunity, others underline the part played by incremental innovation that inscribe innovation into technological trajectories and into dominant design (Utterback and Abernathy, 1978).

Perrin reminds that design plays a central part in innovation, but economist of knowledge (Foray 2000) also share this idea. Indeed they think that knowledge comes from two directions. On the one hand R&D is an activity explicitly dedicated to the production of new knowledge, on the other hand knowledge come from the regular activity of production of any worker of the firm. This learning is known as learning-by- doing, or by interacting (Arrow, 1962 Lundvall, 1992) or the socialization process (Nonaka, 1994). These works have allowed the construction of varied typologies about knowledge and know-how (Hatchuel and Weil, 1996), but their main drawbacks are that they describe the articulation of different existing bodies of knowledge. Indeed, they give very few information about the production of new knowledge. Cohendet (1999) for example, is illustrative of this kind of work. The authors propose in fact an analysis of the coordination mode of the firm. Develop the core competencies of the firm is very costly, so the governance structure is at stake to assure long run competition. Cohendet, defines the firm as a dual structure, core competencies depends on creation and internalization of knowledge, it is determined before any other competencies by the firm. So core competencies have to be managed in a specific way oriented to an efficient production of knowledge. But in a context of uncertainty, which mode of coordination is concerned? For Cohendet, routines are still efficient modes of coordination; he quotes Coriat,

Dosi (1994) “routines are a way of codifying constraints and incentives at micro-economic level”. This point will be discussed in section 3. Secondary assets are managed in a traditional allocative way. As the firm owns a dual structure the main point concerns the articulation of the two modes of coordination. So, again it’s the articulation of different bodies of knowledge, which is at stake and not their production. Besides, we think that this pattern of coordination does not explain well the very process in detail, many points remain not clear.

To conclude production of knowledge is still few studied. Prior works have build varied typologies, of how articulate different bodies of existing knowledge. So we would like to propose a pattern of production. But works about learning conceal an important problem for the firm.

The main point is not to learn or to produce new knowledge, because firms don’t learn just to learn as in the hypothesis of evolutionist “learning without limit” “Rallet (1999). New knowledge is useful for the firm only if it manage to convert it into new skills. Firms must have sufficient incentives to learn; otherwise they don’t learn anything. We are in a perspective of bounded rationality so incentives are a certain threshold of profit (different from the one resulting of a maximization behavior). When a firm has sufficient incentives to learn because of situation of the competitive environment, it has to make a choice between two kinds of action exploration or exploitation (March, 1991). This choice depends on a trade off made by the firms facing different environment of selection. Exploitation consists in using existing knowledge, in varied situations to gain scale and a scope economy, for Lévèque, this innovation process is defined as “routinised”. Exploration tends to create new knowledge, in context of wide uncertainty, to gain a temporary monopoly.

Now, we want to examine what are the consequences for the firm, especially on its routine of every process. There are many definitions of routines, we shall use the one of the evolutionist, Nelson and Winter (1982) defined them “at the organizational level as equivalent of individual skills”. They are models of behavior, which allow the firm to take decisions without deliberation. For Coriat and Weinstein (1995, p 120) “organizational routines are models of interaction which constitute efficient ways of problem-solving in determinate situations”. Routines can be static they tend to a “satisfying” behavior, or dynamics they tend to search and innovative behavior. The articulation between these two kinds of routines remains at stake nowadays.

A second point that can be challenged is the contradiction between the bounded rationality of agents and the fact that routines would be worked out during “organizational truces”. Work out a routine, ie a model of interacting and behavior suppose an agreement of all agents of the organization, if rationality is bounded, agents perceive the environment differently and consequently it’s hard to believe that they agree on the definition of the routine. Moreover, sociologists of techniques have demonstrated the importance of divergence and conflicts between agents in term of representation of final user of the innovation, for example (Callon, 1991, 1992) Divergences offer good possibility for problem solving. But the conflicts are based on the divergence of representation; we think that these conflicts don’t resolve on an agreement about the definition of specifications of the new technical object. We think that these conflicts modify deeply the process of learning and the kind of routines that are worked out. Conflicts about technique induce learning by selecting a subset of knowledge produced during the innovation process. This selection lead to convert any pieces of knowledge in useful know-how, ie to embed the new knowledge into a sequence of productive actions (as a sequence of instructions in an algorithm). This process is all except easy and can lead to conflicts of routines between the set of existing routines, which constitutes a “portfolio of answers” and the routines working out during innovation.

This process can produce too much disorder; in this case innovation can fail. But if it succeeds, new routines can substitute to the “old” and replace them totally or partially. Partially

it should indicate an incremental change, totally, it should be a technological breakthrough, and a change in innovative trajectory. The second case should be possible only if there are enough new routines to replace the "old" one, and if they modify secondary assets.

Evolutionist approach has studied the effects of innovation on isolated firms. But on the other hand scholars underline the importance of cooperation to innovate successfully. We would like to introduce a pattern of production of knowledge within cooperation, and focused in the notion of "conflicts of routines". We shall be interested only on the conflicts related to the production of new knowledge; working out routines to manage the cooperation is not our main point (Avadikyan and alii (2001)).

Cooperation potentially induces more conflicts of routines than an innovative project fulfilled by an isolated firm. But nowadays firms have to cooperate because they can't master all the knowledge they need to innovate. Cooperation is a trade-off benefits/drawbacks which constraints can sometimes be reduces by geographic proximity (Oerlemans, 2001).

To sum up, produce new knowledge is not the most important point for firms. But they have to convert it into new skills. This conversion process can lead to conflicts with prior routines and disorganize the firm. Cooperation has many advantages, because it allows sharing costs of innovation and gaining time. Its main drawback is it produces more conflicts of routines between and inside organizations. We shall see now if proximity can prevent disorder and conflicts of routines.

III. Knowledge production and proximity. [3]

Cooperation leads to more conflicts of routine than an innovative process developed in an isolated firm. We begin by describing the innovative process, and then we challenge the part of proximity. Can proximity reduce the conflict of routines?

Lévèque and alii (1996) link two kinds of R&D with two kinds of external agreements. Firms that fulfill R&D of exploration have a portfolio of agreements including varied and numerous partners, above all Universities or public research. Firms that lead exploitative R&D use only users and suppliers agreements. The important point is that we can demonstrate relationships between a kind of project and a kind of cooperation. The main drawback of this text is that the activity of innovation is assimilated with the existence of a department of R&D. Many Sme's have not this kind of organization, but declare themselves as innovative firms. So we propose to use the notion of **project** of innovation. This project is not the organization by project of large firms, but it's a plan whatever shape of the organization is adopted to fulfill it.

The second limit is the text thinks in term of substitution between the two kinds of proximity. On the contrary, we shall use a hypothesis of complementarity.

We want to describe more precisely the innovation process and its consequences on the routine of the firm. The activity of **design** seem central to us, so we use here the three stages of the model of Kline and Rosenberg (1986), but we introduce the distinction between exploration and exploitation. We want to analyze the innovation process by analyzing its effects on the routines of the firms. We hypothesize that the production of new knowledge is difficult for the firm and lead to conflicts of routines. At last, the two processes induce different logics of proximity.

[3] the pattern of knowledge production comes from a paper presented at the DRUID summer conference « Industrial Dynamics of the new and old economy. Who is embracing whom?" Copenhagen june 6-8.

- **Cooperation in explorative projects of innovation.**

1. I*nvention and or analytic design.*

This stage is a stage of invention, in cooperation with Universities or public research organisms (Lévèque) and/or users or suppliers. (Lévèque makes no distinction in the part played by users or suppliers, whereas Oerlemans points out a distinction, there would be more cooperations with users than with suppliers). Firms use a portfolio of agreements in order to reduce uncertainty, of research that is often fundamental (Kline and Rosenberg). Dominant activity of this stage is research activity (as defined in section 2). So conflicts of routines are not crucial in this stage, the staff implicated in this stage has the same skills (scientists from University or from private laboratories have the same degrees). This stage seems quite characterized by an increase of the stock of knowledge. The amount of routines increases in a similar way, if the new knowledge is "embedded" into new productive practices and skills. So this stage is characterized by a diversity of routines that co-exist without conflicts. But any conflicts of routines can exist about the management of the cooperation (Cassier and Foray 2001, on the biotechnology consortias). As we indicate before, we are not interested here by this kind of conflicts even if they may influence the conflicts of the next stage, by orienting the knowledge that should be "embedded".

2. Detailed design and tests of prototypes.

This stage raises more problems for innovation. Kline and Rosenberg indicate that if there were cooperation with Universities, it would be in development research. As in the first stage, there are co-operations with users and suppliers. This stage is above all characterized by inter-organizational conflicts of routines. The main difficulty here is to take over the analytic design to produce a prototype. Technical constraints may enter more often in contradiction with the results of prior stage. In this stage many technical solutions are tested and only one or two will be translated into prototypes. So the conflicts of routines appear between innovators of the firm and the other participants of the project, because of bounded rationality, and path dependency in the production of innovation in each organization, agents are used to produce innovation in different ways. Cooperation can either strengthen or cut down conflicts of routines, it depends of how each participant perceives its technological trajectory, and of its capacity of learning. This stage reaches an end when the firm makes a choice between all the technological opportunities and translates the solution into a prototype. But doing so, any routines are destroyed and, or replace b new ones, at the end of a conflict.

3. *Re-design and production.*

Two kinds of conflicts exist during this stage: inter and intra-organizational. We are interested in cooperation defined as joint R&D (organizations share human or financial means of cooperation, but don't create a new plant for production. So cooperation is bounded to research. We are not analyzing the case of joint venture).

If the invention reaches the level of production, conflicts of routines can appear between agents who have designed the invention and the agents responsible for production. Routines worked out by a small number of agents from different organizations should be translated and use by a great number of agents. To be a commercial success innovation must diffuse the routines, which are used to produce it into the all firm. So contrary to the pattern

introduced by Cohendet and alii (1999), routines can be modes of coordination only, when they have been embedded into the regular practice of agents of production. They can't improve coordination before the end of the process of "embeddedness", when a sufficient number of agents use them. The idea of Callon (1992) of recruitment of new agents describes well the possibility for routines to be a way of coordination, and the process that lead them to this situation. But it can last long time before routines succeed in coordinating all the agents.

- **Exploitative projects in cooperation.**

1. *Invention or analytic design.*

Lévèque and alii, demonstrate that in this kind of project one should expect only cooperation with users and suppliers. Innovation process is "routinized". This stage is not a stage of invention (because the principles of innovation is still known), and the analytical design, is reduced. This kind of project are inscribed into technological trajectories, so knowledge needed to fulfill the project still exist, it often belongs to the partners of the cooperation. So knowledge has not to be produced, contrary to the case of exploration project. In this stage the innovative firm has to learn form the organizations that own the knowledge, using its absorptive capacity.

2. *Detailed design and prototypes.*

If the knowledge has not to be produced, the difficulties for firms are the same. The innovative firm has to "embed" the knowledge into new static routines. If the project is routinized, one can hypothesize that knowledge, is not too distant from the basis of the firm, it is inscribed in the technological trajectory of the firm. So the firm should perceive quickly the potential use of the knowledge and convert it into new static routines. As in exploratory project, routines are worked out by all the innovators participating to a project, but with asymmetrical participation. One of the participants will define himself the selection of the subset of knowledge that will be convert into routines. The conflicts of routines is also inter-organizational here, but with an asymmetry, it is stronger for the firm which have the large technological distance with the innovation, i.e. the conflict of routines is stronger for the firm which try to absorb the knowledge.

3. *Re-design and production.*

This stage is not fulfilled in cooperation, so it's the innovative firm that is responsible for the production. So the main conflict of routines results from the introduction into the production process of routines worked out in the prior stage. This problem can stand in the way of the development of "flexible production", or a mode of production totally oriented to the need of users, especially if they have too different needs. Above all because, the firm should risk to loose the benefits from the scale and scope economies.

This innovation process is less complex than the exploratory, because knowledge needed still exists. But in term of organization, the innovation process is the same. Agents are working out routines together, but with an asymmetry in favor of the one who owns the knowledge needed.

The innovation process is separated into stages but is not a linear model, we use the framework of Kline and Rosenberg, and describe an innovation process which functions through interactions between stages and agents. We have described the innovation process in detail to show in which stages the conflicts of routines should be more critical for the innovative firm. Then we hypothesize that the conflict of routines could be reduced by proximity (geographic and organizational). As Oerlemans and alii (2001), underline, any drawbacks of co-operations are supposed to be reduced by geographic proximity. We agree with this argument but add that, the conflict should be also reduced by organizational proximity. Indeed the two kinds of proximity are complementary (Gilly and Torre 2000).

« Embed" knowledge into routines challenges the organization of the innovative firms, and needs face-to-face interactions. The two processes of innovation differ both in nature and in the degree and duration of the conflicts of routines. Consequently the need of geographic proximity differs in the two cases, and the "embeddedness" is done through different logic of organizational proximity.

Projects in exploitation are inscribed into the technological trajectory of the firm, so innovation should be less complex than in exploration. So the conflicts of routines should be less difficult to manage for the firm and should last less time than for explorative projects. There are less face-to –face interactions and only in the second stage. So geographic proximity exists only in this stage, is temporary. This kind of project needs knowledge that still exists in at least one of the organization participating. They are part of the knowledge base of this organization. The project builds an organizational proximity defined as logic of "belonging". At the end of the project organizations have still different knowledge basis. On the contrary, in exploration, geographic proximity is permanent. Indeed, these projects are more complex than the prior one and the "embeddedness" raises many problems. Especially, the bounded rationality of agents raises problems. Agents could disagree on the selection of the subset of knowledge during any time. The project lead to an organizational proximity defined as logic of "similarity". Indeed all participating organizations belong common routines at the end of the project. Consequently, long run competition is at stake, in this pattern. One can notice that proximity and innovation co-evolves during the project (Latour 1989, Mangematin 1996).

To sum up, we have distinguished two innovation process lead in cooperation and try to explain the logic of proximities that result from the process of the « embeddedness" of knowledge into static routines.

- Projects of exploration in cooperation ⇔ cooperation in each of the three stages, partners may change between the stages. Partners in all stages work out new routines. Each stage needs face-to-face interactions to work out new routines.
- Project of exploitation are oriented to scale and scope economies ⇔ cooperation exists only in the two first stages, with asymmetry between participants. Routines are worked out by all partners only during the second stage.

Can proximity reduce the conflicts of routines?

- exploitative projects correspond to a large geographic space but to a bounded space of action. Indeed the conflict of routines takes place in the second stage, but need not much time to be reduced so geographic proximity is only temporary. Cooperation is asymmetric, with one of the partner that owns the knowledge needed for the project. So organizational proximity tends to a "technological transfer" and to logic of "belonging";

- exploratory projects have a small expansion in geographic space, but a large space of action. Conflicts of routines also appear in the second stage, but knowledge has to be produced during the project by all the participants. So more conflicts of routines should take place in this kind of project, and they should last longer. Geographic proximity is needed in all stages to reduce the conflicts. Organizational proximity tends to be logic of co-construction and sharing of common routines (logic of "similarity"). We want to test this pattern in the French biotechnology industry.

IV Sme's of biotechnology in France:

Biotechnology is the "use of techniques created in life science to produce goods" (Lemarié, Mangematin, 1999). So biotechnology is not a sector but a set of practices and techniques. It is used in existing sector as pharmaceuticals, chemicals, food processing and agriculture; it completes existing techniques or replaces the too old. Effects are more important in pharmaceuticals, indeed, they shift a sector based on return scales, on a science-based sector. Scientific knowledge is quickly translated into innovation, (new drugs). In the other activities, biotechnology consists in innovation process, which rationalizes the production. In chemicals, activities changed are above all the production of synthesis aromas. For Tourte (1998) this production must growth quickly. Biotechnology replaces an experimentation process, and a costly production by reducing costs. In agriculture, changing activities are the one of "ag-biotech", the suppliers of farms, ie any chemicals firms (suppliers of herbicides and diagnostics kits for GMO for example) and any seed firms. In this case contribution of biotechnology is a better scientific knowledge, added to practical knowledge of agronomy, and a way to reduce selection cycles. Indeed they are reduced of 10 years to 7 or even 5. But as Arundel points out, biotechnology does not replace "traditional" ways of selection. Many seed firms still use a mixed method to obtain elite variety. Agricultural biotechnology seems to be more distant from market than pharmaceuticals. The interest of such innovation is less clear above all, with the "fear" of GMO, justified by a lack of public control. Agricultural biotechnology could be an opportunity of improving quality and reducing "productive agriculture", but social choice has not been expressed on the question. However, today, the main risk for citizens is to let multinational patent all new seeds variety, because, seed is still the basis of food.

To sum up agricultural biotechnology are more distant from market than pharmaceuticals but because of social choice. Today, one can note a parallel of these two applications with the creation of plants "producing drugs". But, pharmaceuticals firms are likely to develop these new applications. So the winning activity should be pharmaceuticals, and the risk is to increase the gap between the two subsets of activities.

It is important to make a distinction between sectors producers of these new biotechnology and users. Food processing for example is not a producer but most of the firms are users (because of the importance of aromas).

Lemarié, Mangematin (1999) give any characteristics of these firms. Sme's specialized in biotechnology have quite large basis of skills. Indeed, the average firm masters 4 techniques, that is much more compared to the average Sme's of manufacturing sector. Besides these techniques are often specifics. A hierarchical classification (on 194 firms) shows that only 14% of firms use the generic techniques of these activities. These techniques are PCR, recombinant DNA, and monoclonal antibodies for example. On the contrary 25% of these firms are specialised in improving process (purification, fermentation and enzymology). Lemarié, Mangematin define markets groups too. Their result is that few firms are mono-market, most of them are multi-market. They increase the value of their products in many markets (usually 4).

Pharmaceutical sector is dominant with 40% of firms, versus 13% in food processing and agriculture. Besides, 32% of the firms quoting agricultural market as outlet are specialized in process of production. Pharmaceuticals firms are the only one, which have a growing turnover. So public policy's goal to create start- up is not reached.

As far as networks are concerned, the author underlines important links with public research (INRA especially is present) but with University too (54% of the firms announce research agreements in cooperation). Besides two public research programs exist Genhomme and Genoplante whose goal is transfer research results to industry. Biotechnology is considered as a key technology by public policy, so it seems important to evaluate the capacity of the public program to improve innovation. Public commitment is important (Génoplante for example, have received important endowment) but results are still disappointing and the debate on social impacts is hold up. In consequence the conditions of transfers are still topical.

We want to compare the innovation process in the two subsets of activities (pharmaceuticals and agriculture). We expect that pharmaceuticals develop more exploratory projects and agriculture more exploitative. Our goal is to test the pattern proposed in section 3 by a survey in Sme's (in Alsace, Bretagne and Ile de France).

Our first goal, to test the pattern of the section III, will to check the location of innovative networks into clusters. As Swann and Prevezer (1996) asked are clusters really attractive for firms, above all in the long run? To check this hypothesizes they built an indicator of entry, dependent on activities of biotechnology. Therapeutics firms are the most attractive firms. When they grow, they induce entry of equipment and diagnosis but discourage entry of new therapeutics firms. So, clusters of biotechnology should be based on differentiation of activities. So one can expect in France to find some areas specialized in biotechnology, but in varied activities, and a lower concentration than in other sectors (Audretsch, Feldman 1994). Besides as Swann and Prevezer underline that inter-industrial linkage in biotechnology were not established within clusters, at the beginning of the industry, (for pharmaceuticals firms because of the development between large groups and Sme's). We expect a difference for food processing sector and agricultural activities (except those of the agrochemical sector which have the same profile than pharmacy) we expect that links will be more local in this case.

Our main goal will be to compare the innovative networks of pharmaceuticals firms and agricultural and food processing, to propose different public measurement. We expect that pharmaceuticals will develop exploratory projects where connection with science should be important, whereas the other activities should develop exploitative projects. In the second case, links should be more important with buyers and suppliers.

Conclusion:

Our main goal is to check in if innovative networks are local, bounded in space or not? To do so, we have defined two kinds of space: geographic space and space of action. The two are complementary. We were interested in the production of innovative knowledge, in cooperation, which is few studied. The question is, what is the expansion of networks of production? We point out that the most important thing for firms is not the production of new knowledge but its "embeddedness" into new routines. It's the "embeddedness" that raises many problems, but leads to two kinds of proximity. The knowledge production is function of the kind of innovative project of the firm, the "embeddedness" occurs in the two cases, but it produces conflicts of routines more or less difficult to manage for organizations. Difference translated into the kind of proximity that is built during the project. One must notice that proximity and innovation are co-built during the project.

We propose a pattern linking the "embeddedness" of routines with the logic of proximity. In exploitation, innovative networks use a large geographic space but a bounded space of action. There are few interactions to "embed" routines, geographic proximity is temporary. Organizational proximity leads to logic of transfer, (logic of "belonging").

In exploration innovative networks use small geographic space, but a large space of action. "Embeddedness" needs many interactions because the conflicts of routines are difficult to solve. All participants work out routines so the organizational proximity corresponds to logic of "similarity".

Then we propose to test this pattern in the biotechnology industry in France, in three regions. Our goal will be to compare innovative networks for two subsets of activities.

Future work should analyse the part of proximity in the creation of industry, and in the industry life cycle. If the need of geographic proximity evolves in time, we could expect that concentration of industry may be reduced in the long run. Zucker and alii (1994) have found any indication of this trend for biotechnology, analysing the location of the most recent entrants, they demonstrate that any firms locate remote from cities and Universities. We still need further measures of the degree of concentration of the industry.

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