The Impact of Universities and Research Institutions Labs on the Creation and Diffusion of Innovation-Relevant Knowledge : the Case of the Upper-Rhine Valley.

Jean-Alain HERAUD[1] and Emmanuel MULLER[2]

[1]BETA, University Louis Pasteur and CNRS, Strasbourg, France

[2]FhG-ISI, Fraunhofer Institute for Systems and Innovation Research, Karlsruhe, Germany, and BETA.

Abstract

The paper focuses on **University and Research Institution labs (URIlabs)**. These institutions are attempted to exert a particular influence on other actors, especially firms, in the process of creation and of diffusion of innovation-relevant knowledge. The first section of the paper aims at giving some theoretical background elements allowing a better understanding of how URIlabs cooperate with firms and a description of the territorial aspects of those links. To this respect, the "information economics" of URIlabs is examined in exploring the regional dimension and the nature of the interactions which link URIlabs to firms. The second and third sections propose an empirical investigation of the determinants of the intensity of the cooperation with firms, the forms and the spatial characteristics of those cooperations. The investigation is based on the statistical exploitation of an ad hoc sample including labs from two different national systems. The concluding section examines the empirical results in terms of the economics of knowledge and highlights the working of the national and local systems of innovation - a useful information for regional policy makers.

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1. Introduction

Institutions like universities, public and cooperative research laboratories, technology transfer centers, etc. constitute an important factor of regional development, through different ways:

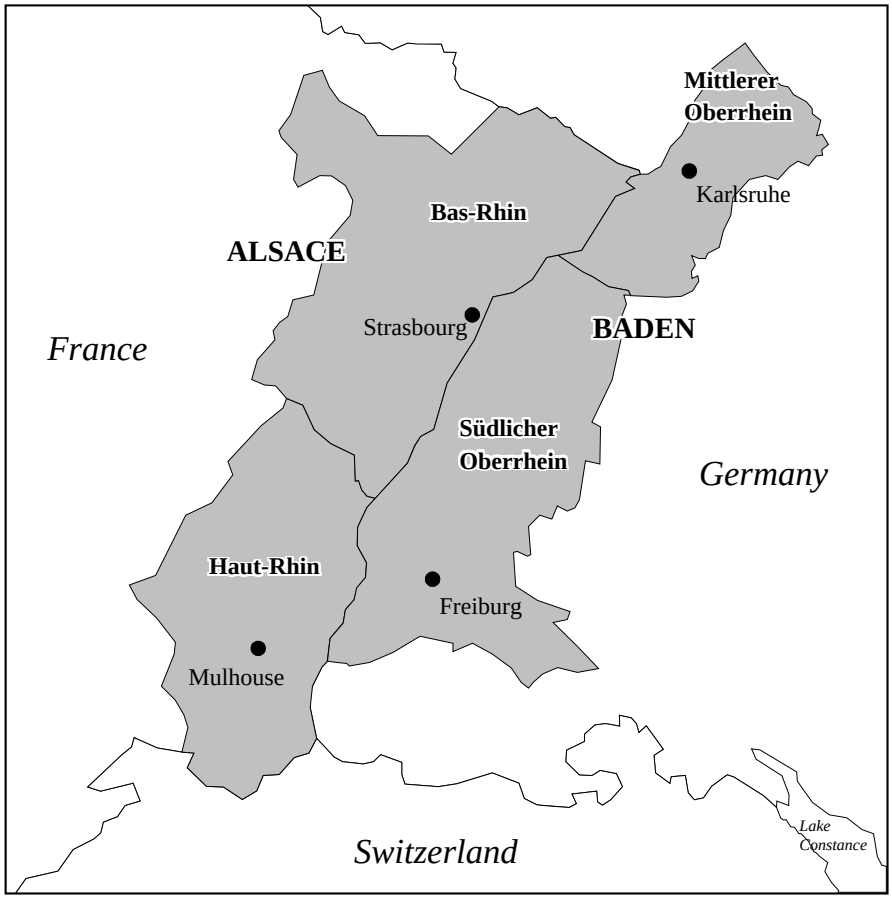
- their specific role of creating and distributing information, knowledge and personal competencies;
- their ability and willingness to perform joint actions with other actors, like establishing R&D cooperation and supplying specialised services to firms;
- their economic behaviour as consumers of intermediate goods, as well as salaries and tax payers;
- their general contribution to the attractivity of the territory (indirect impacts, image).

Such actors of the regional scene fulfil specific functions in the environment of firms: they support the research and innovation activities through their own interaction with the general scientific and technological knowledge base; they sometimes contribute to circulate information and develop interactions between firms; and they provide potential facilities to the firms for improving or developing internal knowledge (expertise). They are the core of the technological infrastructure, constituting an important specificity of the territory. Our aim here is not to address the question of the regional *Institutions of Technological Infrastructure* (ITI) in general[1], but to focus on ***University and Research Institutions labs (URIlabs)*** in their basic role of creating and distributing knowledge.

Our field will be the trans-border region called Upper-Rhine Valley, limited here to the French *région* Alsace (*Bas-Rhin* and *Haut-Rhin*) and two districts of the German *Land* of Baden-Württemberg (*Mittlerer Oberrhein* and *Südlicher Oberrhein*) constituting more or less the historical region of Baden (fig. 1).

[1] Institutions of Technological Infrastructure (ITI) can be defined as entities with legal identity (private or public), located in a specified region, having a potential technological impact within the region, and whose activities provide the input for research and innovation of entreprises. For more information on the concept of ITI and the possible measurement of their activities in a region like the Upper Rhine Valley, see ISI, BETA (1996).

Figure 1: The Upper-Rhine Valley: Alsace and Baden



2. Universities and research institutions: some theoretical background elements

In order to define more precisely the object of the study, it necessary to precise that by URIlabs institutions of the size of a university lab (not the whole university establishment) or a specialised research center are meant. In this paper, other sorts of actors contributing to the technological infrastructure of the region, like university colleges, training centers, science parks, *Knowledge Intensive Business Services*

(KIBS)[2], etc. are not studied *per se*. But the set of URIlabs is obviously in interaction with such institutions as well as with small firms and units of corporations established in the region. The global system helps firms to develop their own innovative capacity. In this paper, such a networking activity is interpreted in terms of economics of knowledge, as the ability:

- to collect and understand *information* flows;
- to develop *knowledge* bases, out of these external information flows as well as from internal learning processes;
- to apply knowledge to problem solving activities, *i.e.* to build specific *competencies*.

The "information economics" approach of URIlabs

By definition, URIlabs are devoted to information and knowledge production and management. They have their own competencies in the production process of these immaterial assets, but they can also help firms to develop technological or organisational competencies though cooperation, individual training, transfer of personnel, etc. (cf. Meyer-Krahmer, 1997). They are part of the regional environment in the sense that they contribute to the information network of firms, but that contribution is not limited to the production of pure information like scientific papers, technical documents, patents, data bases, software's, etc. For the average research laboratory belonging to a university or a public research institution, the main mission of producing science certainly generates a very limited regional impact, since the "clients" of this information are generally not specific to the region. Conversely, the important impact of URIlabs at regional level appears to be the implication in the innovative process of firms and various "catalytic" actions inside the industrial fabric.

The "pure information" side of the URIlabs' activity deals with *codified* pieces of knowledge. These information flows add to the common knowledge base, worldwide. In Polanyi's terms, they are forms of *explicit* knowledge[3]. But it is the more *tacit* information assets linked to firm's competence building that are the real stakes

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[2] For a precise definition and a description of KIBS, see Miles *et al*. (1994). Regional effects are analysed in Muller (1997a).

[3] Nonaka & Takeuchi (1995), presenting the two dimensions of knowledge creation in firms (and between firms), draw on Michael Polanyi's epistemological distinction : *"Tacit knowledge is personal, context specific, and therefore hard to formalize and communicate. Explicite or "codified" knowledge, on the other hand, refers to knowledge that is transmittable in formal, systematic language."* (p. 59).
Other characteristics of knowledge than the degree of explicit codification are distinguished by David and Foray (1995) : the degrees of *publicness* and of *disclosure*. We will not discuss the implications of these dimensions here, even if they actually play a role in regional contexts (for instance, the cost of patenting or the cost of licenses, regardless to the difficulty of mastering such codified information, does certainly not constitute the same obstacle for all types of industries and territories).

of regional development. As Nonaka & Takeuchi (1995) say , *"... the key to knowledge creation lies in the mobilisation and conversion of tacit knowledge."* (p. 56). We are interested in the sort of knowledge transfer that contributes to such a process. Here lies the real regional impact (if any) of an URIlab, because codified information is (i) available everywhere as well as on the territory it is produced and (ii) very easy to communicate, but only for people who have the code (and useless for the others, particularly most of the regional SMEs).

It must be stressed that the relevance of that question of codes (and more generally the access to science) varies following the size and the nature of the firm. It depends also on the type of R&D and technological domain, etc. But the important observation is that in a number of cases firms do their own R&D, possibly even fundamental research, as well as they look for external scientific information. Performing research and getting information from outside are here complementary actions because the former is a way to learn codes and then to deal efficiently with the second (cf. Cohen & Levinthal, 1989; Rosenberg, 1990). We can conclude that institutions like universities and research centers produce more complementary assets than intermediate goods for the process of firms' innovation. For understanding the possible catalytic role of URIlabs, one may refer to the concept of *complementary innovation assets*, as suggested by Teece (1986).

To sum up, research labs can contribute to inter-organisational knowledge creation in their surroundings, as one of their missions or, at least, as a by-product of their general activity in science and technology production. The interaction between cognitive evolution of firms, research labs (and also services like KIBS) through revolving cycles of codification/externalisation and tacit knowledge creation/internalisation can be described in the terms of the Nonaka model. But the open question concerns the territorial dimension of the process. We intend to observe the contribution of URIlabs to such interactive evolutions on the field of a regional trans-border territory.

The regional dimension

One interesting aspect of such a field is the existence of two distinct and significantly different national systems of innovation (in the sense proposed by Lundvall, 1992) within the same geographical area. It is then possible to distinguish the aspects linked to geographical proximity and those related to more institutional forms of distance : language, culture, social networks, legal settings, etc. The considerable distance between the neighbouring regions of *Alsace* and *Baden-Württemberg* in terms of firm's innovation networks has already been stressed in a previous study[4], as well as the differences in firms' innovative behaviours[5]. Such discrepancies are par-

[4] BETA (1993); Héraud & Nanopoulos (1994).
[5] Hahn, Gaiser, Héraud & Muller (1995); Héraud, Hahn, Gaiser & Muller (1995); Koschatzky (1997); Muller (1997b).

ticularly worthwhile noting in a geographical area that, for the rest, looks relatively coherent in terms of economic development, industrial specialisation, exchanges of goods and services, direct investment links, people movements across the Rhine, etc.

Jaffe (1989), considering US federal states, assesses that *"there is only weak evidence that spillovers are facilitated by geographic coincidence of universities and research labs within the state" (*p. 968). Anselin, Varga & Acs (1997), to the contrary, found spillovers of university research on innovation mainly within a range of 75 miles. In the case of the *Alsace* region, our previous studies have shown, in fact, various situations following the type of firm and the type of interaction.

In a specific study on chemistry (APR & BETA, 1995), we observed that research contracts between university labs and big firms (including PhD financing) are relatively important in the labs' budgets, but do not mainly concern *Alsace*, which ranks third after *Ile de France* and *Rhône-Alpes* as a source of industrial partnership. Contractual relations with small firms revealed almost marginal in comparison with the preceding observations, and this result is interesting in itself (notwithstanding the possible specificity of chemistry in this respect). But an other striking result is that, on the subset of SMEs contracts, *Alsace* ranked first as a partnership area. This experience needs confirmation in a larger scope of scientific and industrial relationships , but it indicates that there is nothing like a unique model of systemic interaction within a given territory (a "regional system of innovation"). In the case of *Alsace*, the region appears, for science-industry networks, too small and open to constitute a real system, except for a certain type of interactions with a certain type of small firms. It will be interesting to test on a sample of URIlabs to what extent they are devoted to the territory where they are geographically established and for what sorts of partners.

The GREMI[6] approach of *milieu* brings also an interesting perspective on the relationships between research institutions and innovative firms : the main contributions do not define the local *milieu* as dominated and strongly determined by the innovative firms located there, but rather as a territorial system that *produces* innovative firms. Aydalot (1986) speaks of "innovation incubator". Concerning small firms, it is then interesting to test if a large part of the contacts with university labs express *ex ante* links (start up firms and other sorts of individual contacts).

The nature of the interaction

On both sets of sub-regions (the two French and the two German) it is also important to describe precisely the nature of the contacts between URIlabs and firms, and how the same type of interaction is sometimes fulfilled under different institutional forms.

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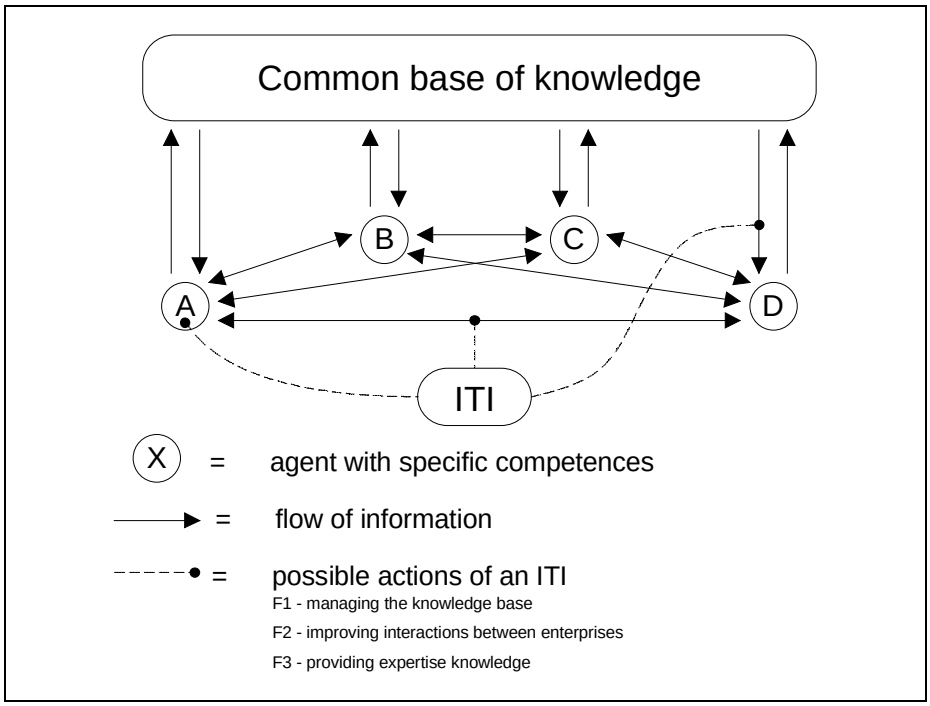
[6] GREMI is an acronym for "Groupe de Recherche Européen sur les Milieux Innovateurs". Representative of the classical GREMI approach are the following publications : Perrin (1990) and Maillat & Perrin (1992).

The most general typology of information networking of an ITI (the URIlab being a particular example of ITI) is given in the chart below (fig. 2). More precisely, the main forms of cognitive interactions between URIlabs and firms present on the territory are the following :

- Co-production of new scientific and technological knowledge (joint R&D project);
- Execution of external R&D (this item is more or less close to the preceding since a large part of the global process of innovation is under the control of the firm);
- Specific service to the firm (using any professional skill or know-how of the URIlabs, like chemical analysis, physical characterisation, mathematical modelling, etc.). In this way, the URIlab works like a KIBS;
- Personnel training (transfer of human resources for a limited period - both directions being possible);
- General information (codified knowledge; know-whom and other match-making activities.

Figure 2: Possible activities of Institutions of Technological Infrastructure (ITI)



Function 1. Managing the knowledge base

ITI aim at the development of the common knowledge base of the economic system. Starting from the production of scientific and technological knowledge, this function includes the diffusion of knowledge by educating, collecting and distributing technological information (informing) as well as by guaranteeing the accessibility of the knowledge base without discrimination (demonstrating).

Function 2. Improving interactions between enterprises
Information and knowledge are not easily marketable commodities. ITI overcome the limitations of the market mechanism in order to adjust supply and demand of technological knowledge and of know-how. In doing so, they can either improve market transactions by using the knowledge of the actors of the system, or provide non-market allocative systems by creating incentive structures. The function of intermediation consists of organising meetings, business fairs, exhibitions and of financing interaction costs in order to improve interactions.

Function 3. Providing expertise knowledge
In this case, ITI are in contact with a single actor, focusing on his very specific needs and providing training or consulting. The aim of training can be to reinforce existing skills or to develop new competencies. Individual support may be related to patenting activities (validating, appropriating) or to providing financial grants (financing).

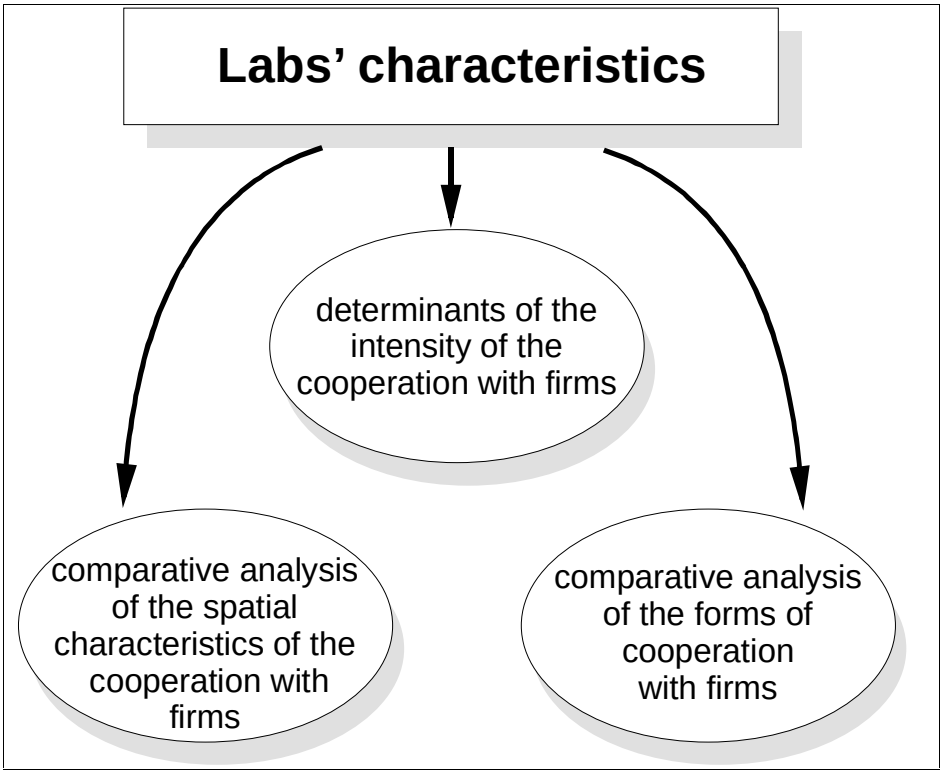
Adapted from: ISI & BETA (1996), pp. 3-6

3. The investigation

The analysis of the regional (trans-border) data base constitutes a trial of casting a light on the type of cognitive interaction between firms and URIlabs, following the size, the type (university or research institution) and other characteristics of the lab, but also the geographical and institutional setting. The type of cognitive interaction can be approached by the form of cooperation : for instance, performing joint R&D is a stronger cognitive interaction than supplying R&D services (external R&D); transfer of personnel is a more efficient way to communicate tacit knowledge than most of the forms of cooperation.

The axes of the performed empirical investigation are presented in fig. 3. As underlined above, it is supposed that **labs' characteristics** may be seen as i) potentially determining their propensity to cooperate with firms, ii) influencing the forms of cooperation with firms, and iii) explaining the spatial characteristics of these cooperations.

Figure 3: The research design



The sample

These three dimensions of the academic-industry-links have been investigated on the base of a survey of labs realised in the Upper-Rhine Valley. The sample was constituted through a postal inquiry performed in 1996 simultaneously in *Alsace* and *Baden*.

The labs included in the sample correspond to 40% of the population previously identified using different sources[7]. Each identified lab received a three pages-long questionnaire dealing mainly with its structural characteristics, with the forms and intensity its contacts with firms and with the type and location of these partners.

[7] I.e. directories of the different universities and research organisations present in the two regions, several www-ressources and the French-German-Swiss trans-border research and technology transfer data base constituted under the direction of the *IHK-Unternehmens- und Technologie-Beratung Karlsruhe GmbH*.

Tab. 1 gives the sample's constitution and composition. The differences noticeable between the two regions in terms of population reflects structural differences between French and German Universities: in the French case only constituted research teams (*i.e.* several researchers, for instance several professors and associated professors supplied with young researchers like PhD students) have been selected; in the German case chairs ("*Lehrstühle*" *i.e.* small units composed of one professor and his/her assistants) have been taken into account as well.

Table 1: Constitution and composition of the sample

Constitution of the sample	**Bas-Rhin**	**Haut-Rhin**	**Mittlerer Oberrhein**	**Südlicher Oberrhein**	**∑**
Identified labs	106	34	320	156	616
Valid answers	49	12	122	63	246
Response rate (in %)	46,2	35,3	38,1	40,4	39,9
Composition of the sample	**Bas-Rhin**	**Haut-Rhin**	**Mittlerer Oberrhein**	**Südlicher Oberrhein**	**∑**
University labs	41	10	108	52	211
Research org. labs	8	2	14	11	35

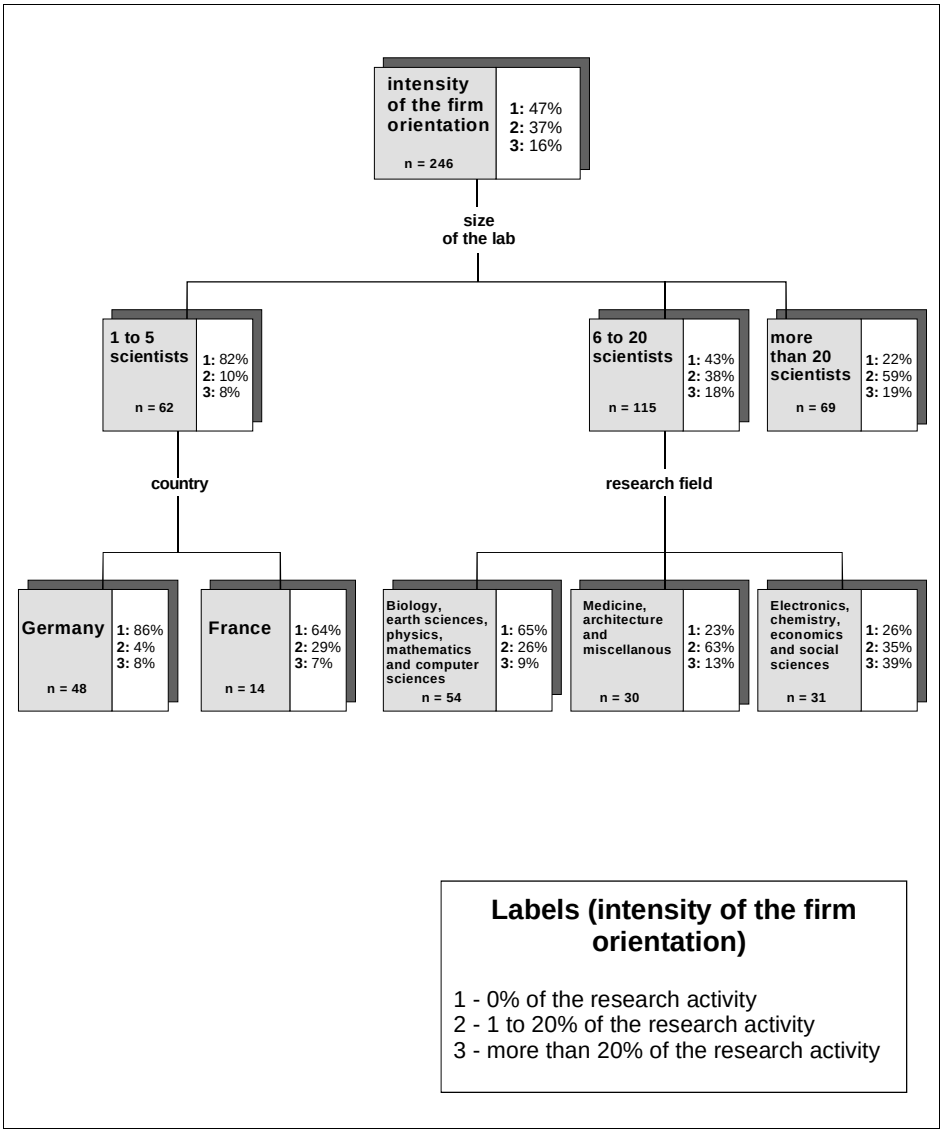
4. Empirical results

The determinants of the intensity of the cooperation with firms

The first dimension of the empirical investigation deals with the determinants of the intensity of the cooperation with firms. This aspect has been investigated with a segmentation procedure based on the CHAID algorithm. CHAID (Chi-squared Automatic Interaction Detector) is an algorithm allowing the exploration of categorised variables based on segmentation modelling. The overall goal of this procedure is to detect correlations between different variables using "repetitive and successive" χ^2-tests (in this case Pearson's χ^2). CHAID divides the investigated population (sample) into segments that differ with respect to a designated criterion (dependent variable). The segmentation of the sample into two or more distinct groups is based on the categories of the "best predictor" of the dependent variable. CHAID splits then each of the groups into smaller subgroups based on other predicator variables. This splitting process continues until no more statistically significant predictors can be found[8]. The final subgroups constitute the segments which are mutually exhaustive and exclusive. The results of the segmentation dealing with the analysis of the considered determinants are presented in fig. 4.

[8] See Magidson & SPSS Inc. (1993) for a presentation of CHAID and, for instance, Muller & Zenker (1998, pp. 191-196) for detailled examples of CHAID-based segmentation procedures.

Figure 4: Analysis of the determinants of the intensity of the cooperation with firms



The "*intensity of the firm orientation*" constitutes the dependent variable of this CHAID procedure. This indicator is defined for each lab[9] as follow :

> ***Intensity of the firm orientation** = [proportion of scientists within the lab working on contract research] x [share of the labs' contract research budget financed by firms].*

The following five explicative variables have been selected in order to determine which ones influence at most the dependent variable :

- the type of lab (university lab *vs.* research organisation lab),
- the size of the lab (measured by the number of scientists),
- the country of location (France *vs.* Germany),
- the type of local environment (location in areas characterised by a high density of research institution *i.e. Bas-Rhin* and *Mittlerer Oberrhein vs.* less density areas *i.e. Haut-Rhin* and *Südlicher Oberrhein*),
- and the lab's main research field (according to a classification distinguishing 10 scientific fields).

The "best predictor" (on the base of successive χ^2-tests performed on a 5% significance level) appears to be the size of the lab : the bigger a lab is, the higher is its propensity to devote an important share of its activity on firm oriented research. This aspect suggests the idea of a "critical mass" explaining that bigger labs seems to be more able (or are more willing) to work together with enterprises than smaller ones.

In the case of small-sized labs (1 to 5 scientists), the "second best predictor" is the country (indicator of the national system of innovation). Statistically significant differences are detected and small-sized labs in Alsace show a greater inclination to perform firm-oriented research than their German counterparts. In the case of middle-sized labs (6 to 20 scientists) the research field is selected as "second best predictor". The segmentation algorithm establishes three subgroups that differ in a statistically significant way with respect to firm orientation of the labs. The three groups of research fields may be typically presented as follow : i) "low" firm oriented fields like biology, earth sciences, physics mathematics as computer sciences, ii) "middle" firm oriented like medicine and architecture (and miscellaneous) and iii) "high" firm orientated *i.e.* electronics, chemistry, economics and social sciences[10]. The sub-group of the big-sized labs (more than 20 scientists) does not allow any additional segmentation. This means that no more statistically significant differences

[9] It must be stressed, for the interpretation of the results, that the firm orientation is measured in *proportion* and since, does not correpond to *absolute values*.

[10] That typology based on our observations may be in opposition to the intuition, and even to the results of larger scale studies, but it must be accepted as a representation of a regional situation for this size-based sub-group.

between labs (related to the country of location, the research field or other determinants) can be detected. This result pleads also for the idea of "critical mass" effects.

The explicative variables "type of local environment" and "type of lab" do not appear as predictors. This means that after selecting the above mentioned variables, the CHAID algorithm is no more able to divide further the considered sub-populations (on the base of successive χ^2-tests performed on a 5% significance level). The two variables "type of lab" and "type of local environment" do not constitute significant determinants of the intensity of the cooperation with firms. In other words, it appears that labs in areas of higher density of research institutions are not significantly different in terms of contacts with firms and that the dichotomy "university labs vs. research organisation lab" is also very weak. It can at least be concluded that these characteristics are of second order importance as compared with the size (critical mass factor), the type of research and the nationality factor.

The forms of cooperation with firms

The analysis of the cooperation forms is established in comparing relative shares of labs-firms links (each lab may be engaged parallely in cooperation with different firms and the same cooperation may show different aspects). Labs cooperating with firms have been asked which of the following forms the cooperation takes:

- performance of joint R&D programmes,
- performance R&D programmes for firms,
- realisation of consultancy and/or expertises activities for firms,
- realisation of tests and/or measurements for firms,
- provision of lab equipment and/or research instruments for firms,
- organisation training for firms' personnel,
- personal transfer from the lab to firms,
- personal transfer from firms to the lab.

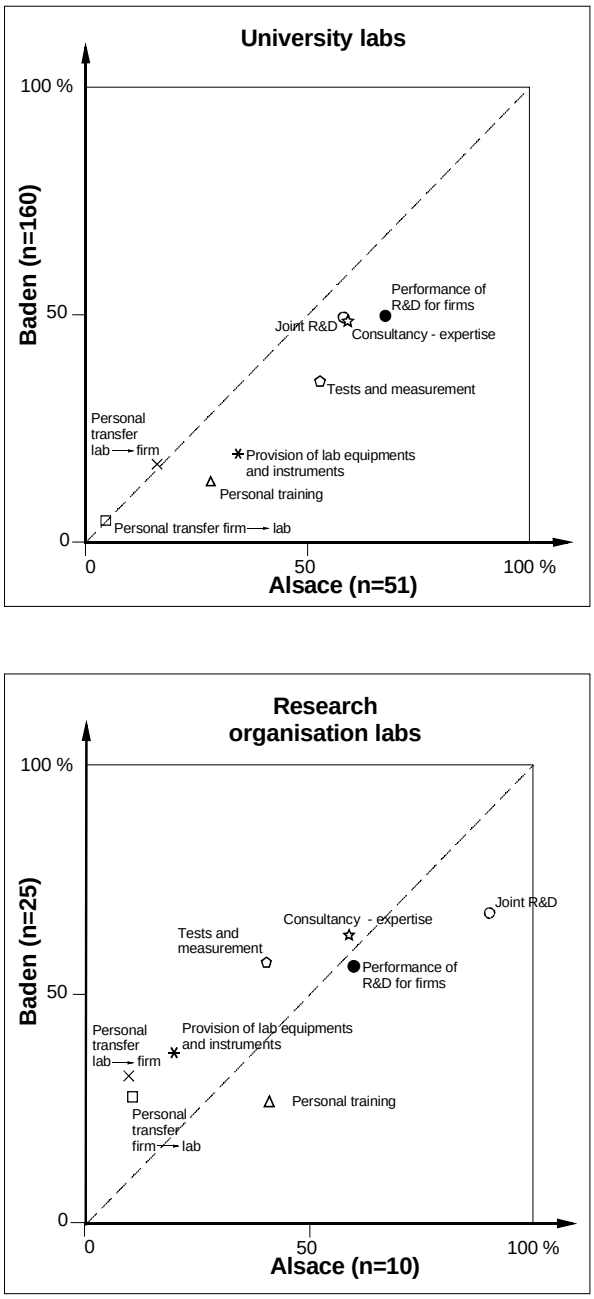
The results of the (bi-dimensional) comparison are presented in fig. 5[11]. It appears that in the case of university labs, the most current forms of cooperation are R&D programmes (realised jointly with firms or performed for firms as an external service) and consultancy and expertise activities. Personal transfer (in both directions) and training are less common. The ranking – or relative importance - of the different forms is quiet similar in the two regions. However Alsatian university labs show quasi systematically more frequent interaction with firms than their Badian counterparts.

[11] For a detailled presentation, see appendix I.

Labs of research organisations exhibit a completely different picture : the cooperations with firms appear as more "human-capital oriented" (*i.e.* more frequent personal transfer and training). Joint R&D and tests and measurement-related activities are also more developed as in the case of university labs. From a regional point of view, an important difference may be observed too. Badian research organisation labs are characterised by more frequent cooperations concerning tests and measurement and personal related activities, while Alsatian research organisation perform a lot of joint R&D activities.

To sum up, in the case of university labs, no fundamental differences can be observed on both sides of the Rhine. On the contrary, research organisations show national specificities, as if they were the more typical actors of the national systems of innovation.

Figure 5: Comparative analysis of the forms of cooperation with firms



Spatial characteristics of the cooperation with firms

The analysis of the spatial characteristics of the cooperation relates to the location of the partner firms. Cooperating firms, located in 5 areas, following the structure of the data base:

- the region of location of the lab itself (*Région Alsace* in the case of French labs, the *Land* of *Baden-Württemberg* for German ones[12])
- the rest of the country (excluding the region itself)
- the neighbouring region (*i.e. Baden-Württemberg* for Alsatian labs and *Alsace* for labs located in Baden)
- the rest of Europe
- and the rest of the world.

Observing the results[13] of the comparison presented in fig. 6, important differences can be underlined between university and research organisation labs. University labs show a clear ranking of the respective importance of the different geographical areas where the partner firms are located. The country and the region (that means more or less the national system of innovation) appear as most frequent locations. Cooperations with firms located in an other European country rank at an intermediate place and links with firms situated in the rest of the world as well as in the neighbouring region (*Baden-Württemberg* in the case of Alsatian labs, *Alsace* in the case of Badian labs) look marginal in comparison with other areas. No really significant dispersion between the two regions can be detected in the case of university labs.

On the contrary, research organisation labs reveal a great diversity : the country is still (and even more) important for those labs in terms of location of partner firms but divergences appear between Alsace and Baden concerning the frequency of cooperation within the region and with firms located in the rest of the world. The German surveyed research organisation labs are clearly more oriented to their region and less to the rest of the world and vice-versa. Frequency of interaction with firms in Europe is the same in both regions and propensity to cooperate with firms on the other side of the Rhine is somehow stronger in *Alsace*.

The most important conclusion to be drawn from this section is that, once more, university labs look very similar on both sides of the Rhine, research organisations being more typical of national system of innovation. It must be stressed, furthermore, that trans-border links play a rather marginal role.

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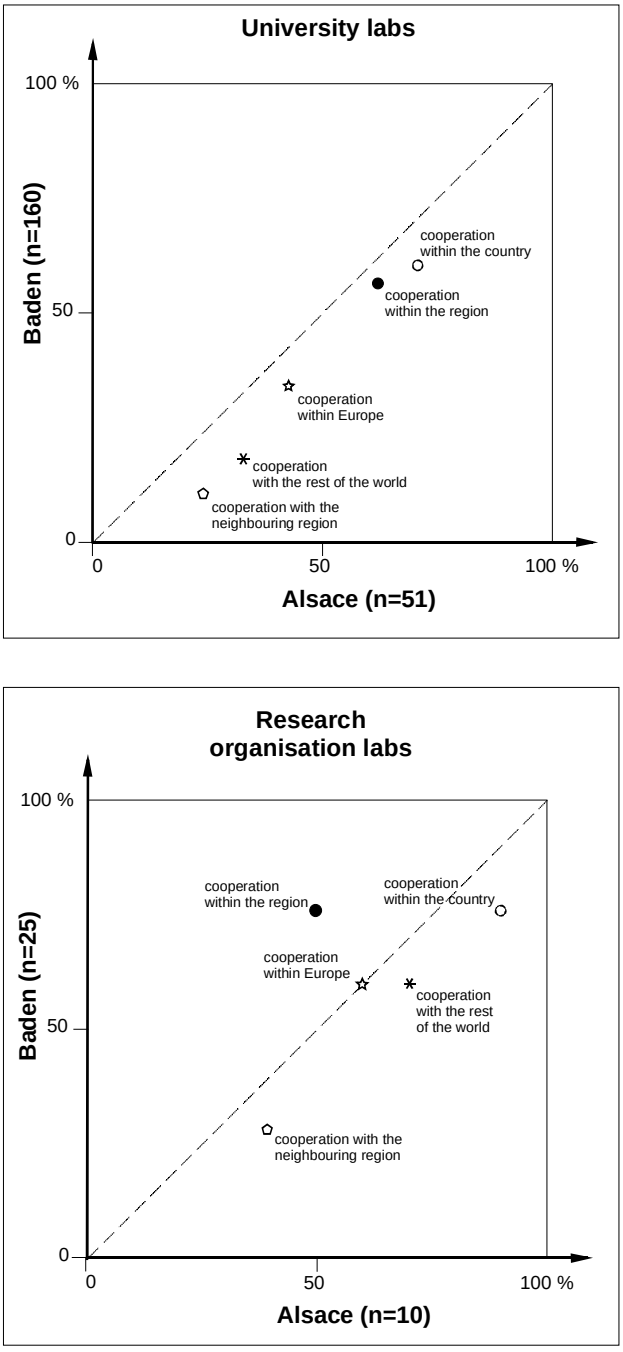
[12] The choice of whole Baden-Württemberg as "root region" instead of Baden introduces a size-distorsion in the comparison but reveals to be more convenient since they may be some diverging interpretation about the "borders" of Baden.

[13] For a detailled presentation, see appendix II.

Figure 6: Comparative analysis of the spatial characteristics of the cooperation with firms



5. Empirical and theoretical conclusions

A first information revealed by the analysis of our data base is the existence of a *critical mass* for the labs concerning their ability (and/or inclination) to develop relationships with firms. Generally, under 5 scientists, the research lab is not an organisation suited to interaction with firms. For sizes between 6 and 20, a majority of labs have cooperation links, and above 20 cooperation is a rule with few exceptions (one fifth only of the sub-sample). On that point, no big difference exists among URIlabs following the type (university or research institutions).

Another interesting point to be learned from the study concerns the *cognitive attitude* of labs on the occasion of the cooperations. If one considers that the maximum of cognitive interaction is achieved through joint R&D, research institutions fit better to the role of catalyst of knowledge creation and competence building. University labs are slightly more inclined to supply R&D services than to perform joint projects. Performance of external R&D for the firms as well as supplying consultancy services, which are important categories of university labs' interaction, amount to a transfer of relatively codified information or knowledge. Designing joint R&D projects and performing them in cooperation, a more typical form of research institutions' activity, implies various crossings of tacit knowledge, leading to build common competence.

Among the whole set of relationships with firms, both categories of URIlabs do not show off a lot of *transfer and training of personnel*. But concerning the transfer, a difference can be underlined: the university labs present the specificity of a large majority of transfer of researchers *to* the firm, the research institutions having balanced exchanges (from lab to firm and reverse). The variety of the modes of personnel exchanges in the cooperations with firms is other point in favour of research institutions in the working of national (or regional) systems of innovation.

Nevertheless, as a whole, one must admit that cooperation through the *transfer of human resources* is far from being a major activity of URIlabs. The latter cannot be blamed for treating such activities as second order priority. But this is certainly a point on which authorities should concentrate their incitative policy. It is increasingly recognised nowadays that, especially in the case of small firms, the most important factor of development is not the transfer of technology in itself, but first the transfer of managerial capabilities, the "learning to learn", the change of attitude towards innovation (not only technological innovation). For that, personal implication constitute the privileged way, by all means : exchanges of staff people, personnel training, joint actions with younger technicians or PhD students, etc.

To conclude on the differences between categories of labs, when studying the *modes of cooperations* with firms as well as the *spatial extension* of these links, there is almost no differences between university labs across the Rhine. On the contrary,

research institutions clearly show national characteristics. In other words, research organisations are typical actors of national systems of innovation, while universities follow international standards on the topics under review.

In terms of spatial characteristics of the networks, our study has shown the strong persistence of national system of innovation. Cooperations within the country, then within the region, are ranking very high. On the opposite side, trans-border cooperation appears very weak, even compared to contacts in the rest of Europe or the rest of the world. Knowing that the language obstacle is not so important between Alsace and Baden, that industrial specialisations are relatively close, that strong flows of commerce, direct investment, subcontracting, workers, residents, etc. cross the border, we can conclude that "institutional" barriers play an important role. The concept of "institution" here should be understood in a broader (sociologic) sense: it is not mainly laws or administrative norms that put constraint on neighbouring contacts across the limits of national systems, but attitudes, habits, lack of information, lock-in situations inside existing networks, etc. The geographical proximity and even (to a certain extent) the cultural one is not enough to overcome institutionalised national systems barriers.

As a benchmark for the above observation, we may consider the case of the (strict) regional cooperations. Within Alsace and within Baden, cooperations look almost as important as within the rest of the respective countries. Then, the hypothesis of the region being a very small and open system is not so much supported and, at least, does not constitute an argument explaining the weak cohesion of the Upper-Rhine Valley as a whole.

Reference

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Appendix I: Forms of cooperation (cf. fig. 5)

	University labs (in %)		Research org. labs (in %)	
	Alsace	Baden	Alsace	Baden
Performance of R&D for firms	67	49	60	56
Joint R&D	58	49	90	68
Tests and measure-ments	53	35	40	56
Provision of lab equipment and instruments	33	20	20	36
Consultancy expertise	59	48	60	64
Personal training	28	14	40	32
Personal transfer firm ⇨ lab	4	4	10	28
Personal transfer lab ⇨ firm	16	18	10	32

Appendix II: Spatial characteristics of cooperation (cf. fig. 6)

	University labs (in %)		Research org. labs (in %)	
	Alsace	Baden	Alsace	Baden
Cooperation within the region	63	56	50	76
Cooperation within the country	71	60	90	76
Cooperation with the neighbouring region	24	11	40	28
Cooperation within Europe	43	33	60	60
Cooperation with the rest of the world	33	18	70	60