Genesis and Geography of University–Industry Partnerships in France: When Interpersonal Ties Matter

Genèse et géographie des partenariats science-industrie en France : Quand les liens interpersonnels comptent

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GENESIS AND GEOGRAPHY OF UNIVERSITY–INDUSTRY PARTNERSHIPS IN FRANCE: WHEN INTERPERSONAL TIES MATTER

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1. INTRODUCTION

Considering that innovation is no longer a solitary process, partnerships have been the object of numerous studies over the past ten years. Collaborations between academic laboratories and industry players are often regarded as major sources of innovation (Mansfield, 1991; Salter et al., 2001; Cohen et al., 2002), and spatial proximity has been considered as a key factor in the emergence of such partnerships that facilitates the exchange of tacit knowledge (Feldman, 1994). While some authors continue to explore the effect of spatial proximity on University-industry (UI) collaborations, others have revisited this thesis, showing that spatial proximity only plays a secondary role, second to interpersonal relationships (see
for instance Lanciano-Morandat et al. (2009)). Zucker et al. (1998), Almeida and Kogut (1999) or Breschi and Lissoni (2001) have observed that interpersonal relationships are used by star scientists to form industrial partnerships and are associated with a greater probability of local partnerships, suggesting that the spatial proximity effect results from the use of (local) interpersonal ties. These studies have greatly advanced our understanding of the geography of innovation, showing that the relationships used to form partnerships are a key factor; more generally, they suggest the structuring role of the channels that facilitated the linkage between partners. However, an in-depth empirical measurement of the role of interpersonal relationships in the formation of UI partnerships is required to reveal the magnitude of their spatial impact: what is the weight of interpersonal ties in the formation of such partnerships (in comparison with other channels of linkage)? Does the use of interpersonal relationships bring a higher probability of forming local partnerships?1

To progress in this direction while taking into account the empirical challenges attached to this goal (Giuri and Mariani, 2007; Berne la and Levy, 2015, etc.), this study builds on a methodology proposed by two earlier research papers. Grossetti and Bes (2001) and Ferru (2010) have collected relational data on an individual level to measure the importance of interpersonal ties in the genesis of partnerships. Nevertheless, the findings of both studies suggested the need to expand the scope of the case study and to perform more thorough tests. Indeed, while both papers converge as to the weight of interpersonal relationships in the formation of partnerships, they diverge as to their spatial impact: Grossetti and Bes (2001) show the link between interpersonal ties and local partnerships, whereas Ferru (2010) points out the varying spatial impacts of interpersonal relationships.

The present study, based on a larger dataset, aims to verify the stable weight of interpersonal relationships in the formation of partnerships and to capture these relationships’ spatial impact. It also integrates precisions concerning the nature of such interpersonal relationships and the partners’ characteristics, in order to test their potential influence. Can any significant differences be noted in terms of spatial impact depending on the

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1 In this regard, it should be noted that the term “local” refers to collaborations where both partners are located in the same region of France.
specific nature of these interpersonal relationships? Can we observe stable results when integrating the characteristics of each university partner? More precisely, to collect and process the qualitative information required to answer these questions, we compiled relational data on an individual level by conducting semi-structured interviews directly with researchers involved in 244 UI partnerships. A quantitative treatment of this qualitative data (chi-squared tests and logit model) was then conducted to obtain systematic results. The findings indicate that: 1) 43% of partnerships were made possible by interpersonal ties; 2) this weight remains particularly stable regardless of the scientific field or location of the partners; 3) non-professional relations significantly influence local partnerships (multiplying the likelihood of forming local partnerships by a factor of 14), contrary to professional and educational ties.

The article is organized as follows: it begins with an overview of existing research in this field and highlights the main issues (Section 2). The analytical framework is then presented, as well as the methodology used to collect relevant data (Section 3). The next section (Section 4) presents the empirical work conducted and the structure of the relational database thus created. This is followed by a description of the case study, associated sample and first descriptive statistics (Section 5). Finally, the findings obtained from the quantitative treatment of the data are summarized (Sections 6 and 7) and discussed before delivering the conclusions of the study (Section 8).

2. PARTNERSHIP FORMATION, INTERPERSONAL RELATIONSHIPS AND THE GEOGRAPHY OF INNOVATION

In the 1990s, studies on the geography of innovation shed light on the role of spatial proximity, based on the observation that the exchange of (tacit) knowledge between partners requires face-to-face interactions (Feldman, 1994). While these studies raised relevant questions by taking into account the collective dimension of innovation processes, they neglected the factors that come into play before the actual exchange of knowledge. However, the geography of innovation can also be influenced by constraints that arise while the partnerships are being set up, which shows the need to
focus on partnership-building. In other words, the process of forming a collaboration implies coordination issues (choice of partners) that affect the partnerships’ spatial patterns.

In most cases, given the increasing complexity of industrial products, project leaders want to collaborate in order to gain access to a particular resource. The cognitive problem posed by the identification of relevant partners is not the only issue faced when building collaborations: project leaders also need to have the means of connecting with potential partners. The ability to get in touch with a partner may even play a structuring role when a company decides to collaborate with a laboratory, even if this choice is not the most appropriate resource-wise (for instance when a former PhD student from the laboratory has been recruited in this company, or when the two entities have already collaborated). Autant-Bernard et al. (2010) confirmed that “a better understanding of the mechanisms of knowledge production and dissemination has given rise to questions about the importance of deliberate individual actions in connecting people” (our translation, 223-224). Interestingly, some authors have stressed more precisely the importance of relationships formed by “star scientists” in the building of research collaborations (Zucker et al., 1998; Almeida and Kogut, 1999; Breschi and Lissoni, 2001, etc.). The spatial conglomeration of innovative activities could be explained by such interpersonal relationships, since most of these collaborations are formed locally. Relationships may be formed more easily between persons located in the same region, since people tend to interact primarily with those who live in close proximity to them (Wellman, 1996; Grossetti, 2007; Sorenson, 2018). The role of interpersonal ties in the formation of partnerships and its interaction with spatial proximity has been also studied through the concept of social proximity (Autant-Bernard et al., 2007; Balland, 2012; D’Este et al., 2012; Cassi and Plunket, 2014)².

² The proximity approach (Rallet and Torre, 2005; Boschma, 2005) has been developed using the concept of proximity to test the role of spatial and non-spatial proximity on the likelihood of new partnerships emerging. A relative consensus emerged around the idea that social proximity matters in the geography of innovation given the structuring role of the partners’ personal relationships in network formation processes.
With regard to the most recent investigations on the subject, precautions need to be taken to avoid some empirical issues attached to the analysis of interpersonal relationships. First of all, due to the lack of individual data (Giuri and Mariani, 2007), some studies have been based on relational data derived from “output data” (co-patents, co-publications, etc.), using the results to identify the existence of interpersonal ties between partners (see for instance Balconi et al. (2004)). Other scholars have worked from consortium data such as European projects or clusters (see for instance Balland, 2012), or have deduced the existence of an interpersonal relationship from the output of a collaboration (see for instance Crescenzi et al. (2017)). However, interpersonal relationships between partners who work together on patents, publications or projects may be assumed but they do not necessarily exist (Graf and Henning, 2009): partners can join a partnership without having met and/or worked together, as is commonly observed with large projects. Lastly, papers that focus on interpersonal ties between partners tend to overestimate these ties by adopting an exclusively social perspective (i.e. neglecting alternative channels of linkage with partners).

Overall, it is essential to develop an in-depth analysis of pre-existing interpersonal relationships in order to grasp these relationships’ spatial impact. The next section attempts to fill this gap by proposing an analytical framework and a consistent methodology, in order to identify the role of interpersonal relationships in the formation of partnerships.

3. RE-ASSESSING INTERPERSONAL RELATIONSHIPS IN THE PARTNERSHIP FORMATION PROCESS

History is key: the very first moments of the collaborative process have a major impact on the geography of UI partnerships. The “pre-linkage (…) characterized by the identification of individuals or teams as potential research partners” remains a structuring factor, as stated by Lemos and Ferraz Cario (2017). In this context and following Granovetter (1973), it

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3 If industrial economics generally considers the organization (laboratory, company, public institution, intermediary, etc.) as the relevant scale of analysis, economic
is essential to consider the actors’ embeddedness in pre-existing interpersonal relationships—regardless of how the partnership later evolves. Granovetter (1973) supported the idea that economic activities depend on interpersonal relationships between actors, and called this dependence embeddedness. This proposition has several implications. First of all, economic activity is dependent on more general social structures that are not social groups or categories but networks (Wellman and Berkowitz, 1988). Secondly, the relevant level of economic activity is not only that of companies or organizations in general, but that of individuals and their relationships. In his study of the labor market, Granovetter distinguished between different ways of obtaining a job: “personal contacts” (56% of cases), “formal means” (placement agencies, etc.) (19%), “direct approaches” (spontaneous applications) (19%) and miscellaneous other means (6%). Granovetter (1973, 1361) also made a distinction between interpersonal ties based on their strength. The strength of ties is defined as “a (probably linear) combination of the amount of time, the emotional intensity, the intimacy (mutual confiding) and the reciprocal services which characterize the ties”.

Applied to the formation of partnerships, the social embeddedness theory makes it possible to take into account the use of prior interpersonal ties, both direct and indirect, in the construction of new collaborative pairings. The assumption for this paper is that a categorization of interpersonal relationships could add value to this analysis, by enabling us to consider the varying impacts of such relationships on the geography of innovation. According to Granovetter (1973), Filieri and Alguezau (2014) or Arza and Carattoli (2017), the strength of ties could have a predictive capacity on the potential contents and exchanges that characterize a particular relationship. More specifically, Filieri and Alguezau (2014) argue that the link between the strength of a tie and the efficiency of the knowledge exchange it facilitates is mediated by the type of knowledge that is being exchanged (i.e. tacit or codified). Based on studies by Uzzi (1996) and Burt (2005) amongst others, weak ties appear more effective in disseminating codified knowledge, whereas strong ties are more conducive to the
exchange of tacit and complex knowledge, since they imply trust and reciprocity (Arza and Carattoli, 2017). More specifically, Ferru (2010) proposed to distinguish amongst interpersonal relationships between educational, professional and nonprofessional ones, showing that the use of non-professional relations is associated to a higher probability of forming local partnerships than professional or educational relations. This latter typology was adopted for the present study, as it had already been tested and implemented in similar cases.4

While it is well established that personal relationships are crucial for inter-organizational collaboration, it was also necessity to integrate the existence of other more traditional channels of linkage (Ferrary, 2010). For example, the very first contact between partners can result from a meeting at a trade event or a conference, from publicly available information obtained through the Internet, or from a public organization dedicated to connecting researchers. These channels, besides interpersonal ties, include all the systems and organizations that make it possible for project leaders to get in touch with their counterparts. Within these channels, we can distinguish between two subcategories.

1. “Market” channels, which include all the resources that can be accessed by people involved in research projects or interested in innovation and science such as conferences, reputation, scientific publications, etc. (see for instance Carayol, 2003; Levy et al., 2009).

2. Specific organizations and resources dedicated to facilitating networking activities between innovative projects, including “knowledge and technology transfer intermediaries” (Howells, 2006; Leroux et al., 2014; Villani et al., 2017), professional bodies or communities (Cohendet et al., 2001), innovation agencies, theme days, etc.

To conclude, to connect with partners and create new partnerships, project leaders rely either on interpersonal relationships, market resources or dedicated organizations (see table 1). Of course, some actors may combine all three channels, but in most cases the main factor can be identified by focusing on the first contact between partners, or by using appropriate narrative methods (see below).

4 This typology was also used and observed for innovation partnerships, clusters or communities (see for instance Leroux et al., 2014).
The goal of this study is to identify precisely the key channel that allowed two entities to form a new partnership, in order to assess the importance of interpersonal relationships and to deduce how it can impact the spatial dimension of partnerships.

The first step consists in collecting relevant data. The aim was to gather relational data about the formation of new UI partnerships on an individual level. We therefore focused on the genesis of collaborations and sought to obtain information on the initial conditions that spurred the decision to form a partnership for the very first time. This means that if two partners renew a partnership, we need to understand how the partners got in touch for the very first time and look back to the origin of this collaboration. For this purpose, we applied methods used in history such as life stories. More specifically, we conducted semi-structured interviews with the scientific leader involved in each project. The analytical unit for this study is the partnership between a laboratory and a company. For each partnership, the interviewee was asked to describe the story of this collaboration with as few interruptions as possible. The interview was designed

<table>
<thead>
<tr>
<th>Channels of linkage</th>
<th>Subcategories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interpersonal relationships</td>
<td>Professional ties (research colleagues, business colleagues)</td>
</tr>
<tr>
<td></td>
<td>Non-professional ties (family, childhood acquaintances, associations, friendships)</td>
</tr>
<tr>
<td></td>
<td>Educational ties (students, teachers)</td>
</tr>
<tr>
<td>Market resources</td>
<td>Reputation</td>
</tr>
<tr>
<td></td>
<td>Seminars, conferences, trade shows, fairs</td>
</tr>
<tr>
<td></td>
<td>Media (press, Internet, publications, etc.)</td>
</tr>
<tr>
<td></td>
<td>Research market (calls for tenders)</td>
</tr>
<tr>
<td>Dedicated organizations</td>
<td>Projects (competitiveness clusters)</td>
</tr>
<tr>
<td></td>
<td>Public and semi-public structures (knowledge and technology transfer intermediaries)</td>
</tr>
<tr>
<td></td>
<td>Closed meetings and invitation-only theme days</td>
</tr>
<tr>
<td></td>
<td>Professional bodies (clubs, technology associations, commissions of experts)</td>
</tr>
</tbody>
</table>

4. METHODOLOGY: ASSESSING THE ROLE OF INTERPERSONAL RELATIONSHIPS IN THE FORMATION OF PARTNERSHIPS

The goal of this study is to identify precisely the key channel that allowed two entities to form a new partnership, in order to assess the importance of interpersonal relationships and to deduce how it can impact the spatial dimension of partnerships.
to reveal the history of the collaborative project in its chronological order, starting with the background of its genesis. We first used open-ended questions such as: “Could you describe this innovative project?” “When did it happen?” “Who was involved in this project?”. Then, to reveal any prior interpersonal relationships that might have been actively drawn upon to connect with a partner, we used the relational chains method, based on Granovetter’s seminal work (1973). Whenever a person’s name was cited, we asked whether this was someone he or she knew beforehand, in what context they had met this person, and for how long: “Had you already collaborated with these partners before this project?” “How did you meet him/her for the first time?”

In order to avoid as much as possible the potential bias attached to this method (incomplete memories, false re-constructed memories, etc.), we used complementary sources of information (documents found in the media or provided by organizations) and cross-referenced the data through interviews (conducted by phone in most cases) with the industrial partner or other participants (another researcher, doctoral student funded as part of the partnership, external body involved in the project, etc.). A case of UI partnership studied according to this qualitative data collection method is described in Appendix 1.

The second step involved the coding and categorizing of qualitative data for each collaboration story. Relevant qualitative information was coded in a database where one line corresponds to one dyadic collaboration and the columns correspond to the qualitative information converted into a dichotomous variable. The channels of linkage used to form partnerships were coded according to the conceptual framework. The first category covers interpersonal ties where a contact results from the existence of a prior relational chain linking the leaders of the collaborative project. To code this information, we used $\text{interpersonal}_{\text{tie}} = 1$ if the laboratory (or company) used interpersonal ties to make initial contact with its partner, and 0 if it initially resorted to another channel of linkage. In the second category, called “dedicated organizations”, $\text{orga}_{\text{res}} = 1$ if the contact was established under the aegis of an external organization that promotes, willingly or not, interactions between members of organizations that might subsequently collaborate, and 0 if the leaders initially resorted to

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5 If it was not the interviewee who initially made contact with the partner, he/she was asked who initiated the first contact and we attempted to interview the relevant person directly.
another channel of linkage. Finally, in the third category, called “market resources”, $\text{market}_{\text{res}} = 1$ if the contact resulted from the initiative of one of the partners who relied on available information resources (directories, databases, Internet sites) or from an encounter at a collective event (conference, trade show), and 0 if the leader initially resorted to another channel of linkage. As explained in the framework, we distinguished between different interpersonal ties and coded them according to their specific nature: professional, non-professional and educational ties. Data related to a partners’ location and scientific specialism was also coded and turned into a dichotomous variable, and integrated into the database to control partnerships features in the statistical treatment. We also deduced each partnership’s spatial dimension and used the same coding procedure to distinguish between local (within the same region), national (between different regions of France) and international partnerships (between different countries). It has to be noted that the term “local” refers to the scale of a French region (i.e. NUTS 3 in the European classification), as a round trip and a meeting with a partner based in the same region in France can be completed in a single day. The variables used and the procedure name are presented in Table 2.

Once this database was built, we were able to carry out cross-tabulations and tests of independence, and to develop an econometric model. This enabled us for instance to measure the weight of interpersonal ties in comparison with market resources and dedicated organizations. Independence tests were performed between the channels of linkage used and the various characteristics of the partners (laboratory’s area of research and city size) and partnership (geography of the collaboration). This enabled us to verify whether the actors’ characteristics impacted their use of interpersonal ties, and whether this use was significantly associated with local partnerships. We also created a logistic regression model so as to clarify the links of dependency that proved significant. This enabled us to verify the effects of the use of interpersonal relations by testing whether this type of connection had a real correlation with the partnerships’ local dimension. More specifically, we tested a binary logit. In the model that we tested, the explained variable is associated with the local dimension.

Unfortunately, we have not been able to integrate other control variables such as the budget, size and nature of the organizations involved or the type of funding, since this data was either not available in the two datasets of interviews or confidential.
of the collaboration, noted as LOC$_k$, while the explanatory variables are associated with the various potentially determining factors: the nature of the connection and the partners’ characteristics. More specifically, the latent variable is noted as LOC$_k^*$ and the associated binary variable as LOC$_k$, which takes on the value 1 if the $k$th collaboration is established on a local level, and the value 0 otherwise.

$$LOC_k = \begin{cases} 1 & \text{if } LOC_k^* \geq 0 \\ 0 & \text{otherwise} \end{cases}$$

with $LOC_k^* = \alpha + Z_k \beta + \mu_k$

$Z$ is the matrix of explanatory variables and $\beta$ the vector of the associated parameters.

The associated probability is therefore written as:

$$P(LOC_k = 1 \mid Z_k) = \frac{\exp(\alpha + Z_k \beta)}{1 + \exp(\alpha + Z_k \beta)}$$

We tested two versions of this model to measure the influence of the networking process on the local dimension of partnerships on a level that was more or less disaggregated from interpersonal ties.

In addition, we used the non-coded parts of the interviews, applying discourse analysis methods to better understand the genesis of partnerships and to interpret quantitative results. This method, based on a combination of qualitative and quantitative approach, is part of what is called a “mixed method”\textsuperscript{7}: the qualitative approach allows for a more in-depth under-

\textsuperscript{7} Initially used in the social sciences in the 1950s in psychology, this method was developed in the 1980s and spread to other human and social sciences. It is based on variation in data collection and is used for research that involves collecting, analyzing and integrating quantitative and qualitative research and data in a single study. This method uses a combination of qualitative and quantitative approaches in order to exploit the strengths of each: statistical and systemic results but risks of misinterpretation on the quantitative side vs. “decoding” of complex processes, behaviors, or trajectories but illustrative and contextual analysis on the qualitative side (Starr, 2012).
standing of the genesis of partnerships, while the quantitative approach enables us to perform a statistical and econometric treatment to verify the association between the use of interpersonal relationships and the local dimension of partnerships. Appendix 2 sums up the operationalization of the mixed method we used.

5. PRESENTATION OF THE CASE STUDY, SAMPLE AND FIRST DESCRIPTIVE STATISTICS

The method has been applied to French UI partnerships. It has to be noted that the French innovation system has its own specificities, which include the important role played by the Centre National de la Recherche Scientifique (CNRS), France’s leading government research agency (see Mustar and Laredo, 2002, 64 for more details). In France, the 1990s saw the introduction of public policies to foster innovation, taking into account its collective patterns. A first group of national instruments was created to favor technology transfers: for instance, the 1999 law on research and innovation, known as Loi Allègre, seeks to “facilitate collaborations between science and industry”. From the 2000s, a second wave of public policies were implemented to promote research partnerships between local actors through the creation of dedicated networking organizations: in this respect, the key measure is undoubtedly the national system of competitiveness clusters, which was created in 2004 (for a critical analysis of this policy see Bouba-Olga and Ferru (2008)).

Relational data was collected through two separate sets of interviews. The first, conducted between 1999 and 2001, involved laboratories from the CNRS’ engineering department. The second, conducted between 2007 and 2009, addressed the contracts entered by the laboratories of University of Poitiers, whether they belonged to the CNRS or not. The creation of the sample relied on two databases: one covers all research contracts signed by CNRS units with external bodies (between 1986 and 2005), and the second compiles all the information collected by the Poitiers Research and Development Unit regarding research contracts signed by academic laboratories from University of Poitiers (from 2004 to 2007). It should be noted that the innovation projects studied in the first set of interviews took place during the first phase of public innovation policies (aimed primarily
at technology transfers) while those of the second group were set up during the launch of the second phase of public recommendations (in favor of local collaborations). The implementation of these two phases of public policies would be expected to have had an impact on the partners’ networking, and therefore appear in the results, possibly in different ways depending on the corpus studied. This study makes it possible to assess how the influence of dedicated organizations may have increased in comparison with interpersonal relationships. This question is all the more interesting that existing studies on public-sector networking bodies have generally focused on the role of such dedicated organizations (see for example Leroux et al., 2014 about the competitiveness cluster VEGEPOLYS) without analyzing it in relation to other networking channels (such as interpersonal ties).

Based on these two databases, we selected researchers who held scientific responsibility for research contracts. 65 initial interviews were conducted with scientific leaders. Each interviewee gave the details of around 4 different research projects, which made it possible to reconstruct 244 partnership stories. These initial interviews were complemented with 129 new ones in order to verify or clarify the initial stories: 83 with industry partners and 46 with other researchers or participants. Data collection was based on the method presented above, and involved formal collaboration contracts (either under way or completed) between a laboratory and a firm.

The results from these two set of interviews have already been analyzed and published separately (see Grossetti and Bes (2001) and Ferru (2010)). However, new insights can be gained from the aggregation of the two sets of interviews: we can thus expand the scope of the case study by covering various regions of France, and carry out more thorough tests thanks to the larger size of the dataset. This makes it possible to specify the weight of interpersonal relationships according to the context, and to check the stability of past results. These advantages over database aggregation are offset by the challenge posed by the fact that all the same data is not available in both databases, which reduces the amount of information available. Table 2 shows the data available in each of the two sets of interviews.
The projects studied are relatively long-term (the average duration of the contracts is about three years) with an average value of 70,000 euros. Some types of partners are overrepresented. On the industrial side, a major portion of the manufacturers are large-scale industrial groups (61%). As for laboratories, they are specialized in engineering sciences (ES) or information technologies (IT) in respectively 51% and 33% of cases. Laboratories are located in six cities\(^8\): Poitiers (53%), Toulouse (20%), Bordeaux (11%),

\(^8\) The Île-de-France region is not representative of the rest of the territory due to France’s historical and scientific centralization. We therefore chose not to include this region in the study, and to focus instead on a diverse range of French cities (in terms of economic and scientific size).

\(^{a}\) \(N=1\) refers to the number of occurrences whose value is 1.

\(^{b}\) Regarding the number of projects per research area, it appeared necessary to aggregate the data under three categories: 1) Information technology; 2) Engineering sciences; 3) others (biological sciences, chemical sciences, humanities and social sciences, physical sciences).

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**Table 2.** Data used, coding procedure and first descriptive data

<table>
<thead>
<tr>
<th>Variable name</th>
<th>Variable meaning</th>
<th>Procedure name</th>
<th>Procedure meaning</th>
<th>(^{a}N=1)</th>
<th>Weight (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(SCdomain_{k})</td>
<td>Laboratory’s scientific domain</td>
<td>IT</td>
<td>Information technology</td>
<td>80</td>
<td>33%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ES</td>
<td>Engineering sciences</td>
<td>126</td>
<td>52%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>others*</td>
<td>Biological sciences, chemical sciences, humanities and social sciences, physical sciences</td>
<td>38</td>
<td>16%</td>
</tr>
<tr>
<td>(city\text{_}\text{size}_{k})</td>
<td>Laboratory’s city size</td>
<td>large_city</td>
<td>Toulouse, Bordeaux, Grenoble</td>
<td>122</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>medium_city</td>
<td>Poitiers, Clermont-Ferrand</td>
<td>122</td>
<td>50%</td>
</tr>
<tr>
<td>(loc_{k})</td>
<td>Spatial dimension of partnership</td>
<td>non_local</td>
<td>Non-local partnerships</td>
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<td>76%</td>
</tr>
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<td></td>
<td></td>
<td>local</td>
<td>Local partnership (same region)</td>
<td>59</td>
<td>24%</td>
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<td>(linkage_{k})</td>
<td>Channel of linkage</td>
<td>interpersonal_tie</td>
<td>Interpersonal relationship</td>
<td>101</td>
<td>41%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>market</td>
<td>Market resource</td>
<td>57</td>
<td>23%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>or ga_res</td>
<td>Dedicated organization</td>
<td>77</td>
<td>32%</td>
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<td></td>
<td>undetermined</td>
<td>undetermined</td>
<td>9</td>
<td>4%</td>
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<td>(typo\text{_}\text{tie})</td>
<td>Type of interpersonal ties</td>
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<td>Professional ties</td>
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<td>47%</td>
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<td>nonprofessional_tie</td>
<td>Non-professional ties</td>
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<td></td>
<td></td>
<td>undetermined</td>
<td>undetermined</td>
<td>1</td>
<td>1%</td>
</tr>
</tbody>
</table>
Montpellier (9%), Clermont-Ferrand (9%) and Grenoble (2%). The city where a laboratory is based is associated with significant discrepancies in terms of size and scientific output (see appendix 3). We therefore chose to group cities into two categories: medium-sized cities (Clermont-Ferrand and Poitiers) and large cities (Bordeaux, Toulouse, Grenoble, Montpellier).

With regard to the geography of partnerships, around 1 out of 5 partnerships are conducted “locally” (22% of partners are located in the same region and 18% in the same département). As for “non-local” partnerships, they are generally conducted with a French partner (international partners only account for 5% of the total number of partnerships) and primarily with a partner located in the Ile-de-France region (53% of French non-local partnerships). In light of these first descriptive statistics, the partnerships studied appear relatively representative of the global scientific and spatial distribution of French UI partnerships. Bouba-Olga et al. (2012) examined over 30,000 French University-industry partnerships between 1986 and 2005, and Grossetti and Nguyen (2001) assessed 13,827 French UI partnerships between 1986 and 1998. Both noted a similar overrepresentation of certain research areas to that of our sample (mainly engineering sciences (19.3% and 32.8% respectively) and chemistry (26% and 34.4%)) and a similar spatial distribution (22% for the département scale, and an overrepresentation of partners located in the Ile-de-France region).

6. THE NON-MAJOR BUT STABLE WEIGHT OF INTERPERSONAL TIES IN FORMING NEW PARTNERSHIPS

Our data gives a precise measure of the role of interpersonal ties in forming University-industry partnerships: 43% of partnerships were made possible by a range of interpersonal ties between partners (see table 2), confirming that “university employees are likely to use their personal social relationships to recruit collaboration partners” (Drejer and Østergaard, 2017). By precisely measuring interpersonal ties in comparison to other channels of linkage, this result highlights the major role of market resources and dedicated organizations, which is less emphasized in the literature. Market resources or dedicated organizations facilitated initial networking between partners in 57% of partnerships studied.
More precisely, market resources are used in 23% of cases (see table 2). Conferences are an example of this, as illustrated in Appendix 2. In addition, many partnerships are established simply because one of the two partners has received information about the other through media such as the Internet. Contact between a university and the industry can also be initiated through a dedicated networking organization: this is the case with 32% of partnerships. If we look at the nature of these dedicated organizations at a more detailed level, it appears that professional bodies are one of the most commonly encountered organizations dedicated to networking. In one case for instance, an academic and an engineer working in an interprofessional group were members of the same theme-based committee in a governmental body. As a sideline to the committee’s activity, they decided to start a collaboration between their respective teams. Another example involves an engineer with an electrical manufacturing company; when tasked with establishing relations with engineering schools and laboratories, he joined the “Arc Électrique” club of Électricité de France. At a club meeting, he met a researcher with whom he began a collaboration that encompassed three different subjects and continued for some twenty years. The role of technology transfer organizations is less significant than might be expected and no significant increase in their role can be observed over time. In the first set of interviews, such regional structures did not exist; 2 cases mentioned the role of national bodies dedicated to research and technology (the national research promotion agency and the General Delegation for Scientific and Technical Research) in the partners’ networking, and 1 case mentioned the role of a local public authority. Regarding the second set of interviews, only 6 cases (out of 130) mentioned the role of an interface organization dedicated to knowledge dissemination: 5 partnerships were initiated thanks to a “regional center for technology transfer”, and one thanks to the “research promotion unit” of the University of Poitiers. In addition, researchers from University of Poitiers laboratories never mentioned the role of a competitiveness cluster as a factor in meeting their partner: this reveals the weak role played by instruments promoting local collaboration in the linking of innovation partners.

The data obtained downplays the role of interpersonal relationships in the formation of partnerships, but also provides us with more detailed insights into the specific nature of the interpersonal relationships that went into forming partnerships. In this regard, we first noted that
strictly professional relations between former colleagues or people who have worked together on projects account for the largest share (47%). For example, in one case, an engineer who became the director of a laboratory was able to negotiate contracts with his former colleagues, enabling his team to grow quickly. Another frequent situation (39%) is the use of educational ties. The importance of educational relations, and especially relationships with former doctoral students, is well known, as already stated by Lemos and Ferraz Cario (2017): “For the pre-linkage phase, the common situation for establishing contacts with firms is through students, ex-alumni, or professors who already have ties to such firms. Typically, students or former students know the expertise of the field in question, know the professors, and know what the university can offer when approaching a firm. Professors also identify—while in contact with these professionals—approach opportunities”. In an interview, one researcher states that “former PhD students are a key means”, while another adds that “they facilitate contact with the manufacturer, because they are familiar with the laboratory’s know-how”. In one of our partnership stories, after completing his training, an engineer started to work in a company that regularly carries out partnerships with one of the laboratories from his former school. After a few years, he moved to a new position. Asked by his new employer to set up a central R&D department, he immediately contacted the director of his former school’s laboratory and negotiated funding for a doctoral student: “I’ve known the laboratory director for thirty years, it saves time, it made it possible to get started more easily”. One researcher explains that one of his partnerships with a foreign firm would not have been possible without this educational relation: before this former doctoral student was recruited into the company, the laboratory was already interested in the firm’s know-how and wanted to collaborate with it. It had tried to contact it via the Internet to propose collaborative projects, but the firm had never followed up. Giuliani et al. (2010) have already noted the importance of the recruitment of former doctoral students into companies for the establishment of UI partnerships. Finally, we observe the existence of nonprofessional relationships: among partnerships formed using interpersonal ties, 14% are based on nonprofessional relationships. In one of our histories, a collaboration between a laboratory and a large firm was established at the initiative of a doctoral student whose father had worked for the firm.

9 Verbatim quotes have been translated by the authors.
in question. It was the doctoral student’s father who facilitated his son’s and the laboratory’s contact with the head of the department that subsequently joined the collaboration.

By cross-tabulating the three connection channels with the various partners’ characteristics, we find that the weight of interpersonal relationships remains relatively stable regardless of the scientific field to which the researchers belong. Likewise, the weight of interpersonal ties remains the same whether the researcher is located in a large or medium-sized city. The independence tests allow for a more thorough testing of the links between the channels of linkage and the various characteristics of the partners involved in the partnerships.

The chi-squared tests confirm the independence between the variables and the stability of the channels used to connect with partners: partners always use the same channels, regardless of their spatial and disciplinary characteristics. The partners’ geographic or disciplinary characteristics have no significant impact on the way in which UI partnerships begin:

**Table 3. Channels of linkage and scientific domains**

<table>
<thead>
<tr>
<th>Scientific domain</th>
<th>Market resources</th>
<th>Dedicated organizations</th>
<th>Interpersonal ties</th>
</tr>
</thead>
<tbody>
<tr>
<td>IT</td>
<td>23</td>
<td>16</td>
<td>36</td>
</tr>
<tr>
<td>ES</td>
<td>28</td>
<td>48</td>
<td>49</td>
</tr>
<tr>
<td>Others</td>
<td>6</td>
<td>13</td>
<td>16</td>
</tr>
</tbody>
</table>

\(X^2=7.50, p=0.11\), noted that \(X^2\) is the sum of differences between theoretical values and observed values, and \(p\) is the likelihood of an associated error.

**Table 4. Channels of linkage and city size**

<table>
<thead>
<tr>
<th>City size</th>
<th>Market resources</th>
<th>Dedicated organizations</th>
<th>Interpersonal ties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large city</td>
<td>28</td>
<td>43</td>
<td>51</td>
</tr>
<tr>
<td>Medium city</td>
<td>29</td>
<td>34</td>
<td>50</td>
</tr>
</tbody>
</table>

\(X^2=0.74, p=0.69\), noted that \(X^2\) is the sum of differences between theoretical values and observed values, and \(p\) is the likelihood of an associated error.
city size is not associated with a greater use of interpersonal relationships, nor is belonging to a specific scientific field associated with a greater use of dedicated organizations. The researchers’ scientific specialism has no impact in terms of their relying on a particular channel of linkage.

Even when analyzing the channels of linkage at a more detailed level, the type of interpersonal relationships mobilized remains stable: it does not vary according to the size of the city. This result has to be taken with caution given the amount of data at this level of refinement; nevertheless, it appears that laboratories based in cities like Poitiers or Toulouse have the same behaviours in their use of interpersonal relationships: partners rely on professional and teaching ties more than on family ones.

It is nevertheless questionable whether these different types of interpersonal relationships allow partners to build as many local partnerships as non-local ones. By simply crossing the nature of the relationships with the geography of collaborations, it appears that non-professional relationships are more associated with local partnerships than others.

Table 5. Nature of interpersonal ties and city size

<table>
<thead>
<tr>
<th>Interpersonal relationships</th>
<th>Medium city</th>
<th>Large city</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional relation</td>
<td>23</td>
<td>49%</td>
</tr>
<tr>
<td>Non-professional relation</td>
<td>6</td>
<td>43%</td>
</tr>
<tr>
<td>Educational relation</td>
<td>21</td>
<td>54%</td>
</tr>
</tbody>
</table>

Table 6. Nature of interpersonal relationships and geography of partnerships

<table>
<thead>
<tr>
<th>Interpersonal relationships</th>
<th>local</th>
<th>Non-local</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educational relation</td>
<td>12</td>
<td>27</td>
</tr>
<tr>
<td>Non-professional relation</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>Professional relation</td>
<td>9</td>
<td>38</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>69</td>
</tr>
</tbody>
</table>
7. THE SIGNIFICANT BUT VARIABLE IMPACT OF INTERPERSONAL TIES ON THE GEOGRAPHY OF PARTNERSHIPS

To advance the analysis of the geography of partnerships and to grasp the relationships’ spatial impact, we used a logit-type econometric model in which the explained variable equals the partnership’s local dimension (i.e. partners are located in the same region) and the explanatory variable equals the initial channel of linkage. The partners’ field and location are integrated into the model as control variables, to take into account the potential impact of the partners’ location (medium-sized cities vs. large ones). In this respect, a logit model makes it possible to push the analysis further than cross-tables or chi-squared tests, and appears more relevant to test the impact of one variable on another.

The first version of the logit reveals the positive influence of the channel of linkage used on the local dimension of partnerships: the use of interpersonal relationships multiplies the likelihood of forming a partnership within the region by 2.5. This important result confirms the studies by Zucker et al. (1998), Almeida and Kogut (1999) or Breschi and Lissoni (2001). On the contrary, dedicated organizations appear to have no significant influence on the geography of partnerships.

Lastly, we find that being located in a medium-sized city is a significant disadvantage in terms of local partnerships: this factor divides the probability of forming a local partnership by 2, as it is more challenging in a city of this size to find a potential partner in the region (see in Appendix 3 the concentration of companies and researchers in medium-sized cities). Along with channels of linkage, these results confirm the existence of effects related to city size on the propensity to collaborate locally. Regions are indeed heterogeneous in their size, specialization, reputation and scientific quality, which tends to suggest that some regions collaborate more than others on a local level (Bouba-Olga et al., 2012; Hoekman et al., 2010). Likewise, Grossetti and Nguyen (2001) showed the existence of such effects in France (the importance of local collaborations differs depending on the regions the partners belong to) regarding the spatial distribution of IU contracts.
### Table 7. Result of the binary logit model

**Explained variable:** $loc_k$

<table>
<thead>
<tr>
<th>Tested variables $linkage_k$</th>
<th>1st version</th>
<th>2nd version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market resource</td>
<td>Ref</td>
<td>-</td>
</tr>
<tr>
<td>Dedicated organisation</td>
<td>0.18</td>
<td>-</td>
</tr>
<tr>
<td>Interpersonal tie</td>
<td>0.91**</td>
<td>-</td>
</tr>
<tr>
<td>Educational relation</td>
<td>-</td>
<td>Ref</td>
</tr>
<tr>
<td>Non-professional relation</td>
<td>-</td>
<td>2.64***</td>
</tr>
<tr>
<td>Professional relation</td>
<td>-</td>
<td>-0.14</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Control variables $city_{size_k}$</th>
<th>Medium city</th>
<th>Large city</th>
</tr>
</thead>
<tbody>
<tr>
<td>$SCdomain_k$ ES</td>
<td>0.72*</td>
<td>0.64</td>
</tr>
<tr>
<td>IT</td>
<td>Ref</td>
<td>Ref</td>
</tr>
<tr>
<td>Others</td>
<td>0.87</td>
<td>0.73</td>
</tr>
</tbody>
</table>

\[
N = 235 \quad 101 \\
\text{Log-likelihood} = -121.67 \quad -115.40
\]

Notes: *P<0.1, **P<0.05, ***P<0.01. t-statistics in brackets

* Chi squared statistic for the hypothesis that the difference of the marginal effects of non-professional relations and professional relations is zero
The second version of the model, using a finer typology of interpersonal relationships, makes it possible to further clarify the link between spatial proximity and channel of linkage. Only non-professional relations positively and significantly influence local partnerships by multiplying the likelihood of establishing partnerships at this spatial scale by a factor of 14. On the contrary, professional relations or teaching ties do not significantly influence the geography of partnerships. Finally, not all interpersonal ties favor spatial proximity effects, but only friendly and family relations. Moreover, when taking into account the specific nature of interpersonal relations, the effects related to city size are far more limited, with an odd ratio of around 2. Considering the size of the sample and in particular the number of non-professional ties, this result is only a premise for conducting new surveys to test this result in a robust way.

The results delivered by this model complement and qualify existing literature on the geography of innovation. It appears impossible to systematically associate interpersonal relationships with local partnerships. Our work underscores the need to differentiate between interpersonal ties according to their precise nature to understand their spatial impact; nonprofessional ties favor the formation of partnerships that are more geographically circumscribed than relations associated with education or professional activity. This last finding confirms results previously obtained by Ferru (2010) in one specific area, and can therefore be generalized to France. Last but not least, this new insight does not conflict with—and even supports—Arza and Carattoli’s thesis that associates strong/weak ties with the diffusion of tacit/codified knowledge. According to Granovetter’s (1973) definition of tie strength, strong ties are approximately equivalent to family or friendship relationships and weak ties to professional and educational relations. In this context, this would suggest that the use of nonprofessional (i.e. strong) ties facilitates the development of more risky partnerships (i.e. based on an exchange of tacit knowledge?), through face-to-face interactions, and favors the formation of local partnerships; on the contrary, professional/educational (or weak) ties appear to be used to form partnerships that are more trustworthy (i.e. based on more codified knowledge?) and formed at a distance, which would lead to the formation of non-local partnerships.
8. CONCLUSION AND DISCUSSION

We do know from the research of Zucker et al. (1998), Almeida and Kogut (1999) and Breschi and Lissoni (2001) that interpersonal relationships are used by star scientists to form industrial partnerships and are associated with a greater probability of local partnerships. In other words, observed social proximity interacts with spatial proximity in the formation of partnerships. However, there are still few studies that precisely measure the role interpersonal ties and the extent of their spatial impact. Considering empirical challenges, this paper proposes a coherent methodological strategy to collect relevant data to identify precisely the key channel that allows actors to form new partnerships. It is thus possible to assess the importance of interpersonal relationships, and to deduce how this factor can impact the spatial dimension of partnerships.

The quantitative analysis of 244 collaborations allowed us to evidence three new insights. 1) 43% of partnerships were made possible by interpersonal ties; 2) this weight remains particularly stable regardless of the geographical (city size) and disciplinary characteristics of the laboratories involved; 3) non-professional relations significantly influence local partnerships by multiplying the likelihood of forming such partnerships by a factor of 14.

Regarding the existing literature, this study confirms the existence of a link between interpersonal ties and local partnerships, while clarifying this link through a detailed observation of interpersonal ties. It reveals that not all relationships but only non-professional relationships significantly impact the geography of partnerships by fostering regional partnerships. This last finding is a significant contribution to the analysis of the geography of innovation: not only because it is an original result, but also because it confirms the crucial importance of the methodology used to capture the specific nature of interpersonal ties. This result also supports Arza and Carattoli’s (2017) intuition by showing the crucial importance of the specific nature of interpersonal ties, and their potential impact on the nature of the knowledge exchanged.

In addition to this first important result, this study considerably qualifies the role played by interpersonal ties, by indicating the relevance of the other two channels of linkage: market resources and dedicated
organizations. However, despite the creation in France of bodies aimed at fostering local partnerships, we observe the relatively weak role of such dedicated networking organizations, even for the most recent partnerships. We should remain cautious about the generalization of this result, since only the projects studied in the second corpus were implemented after these public-sector instruments had been established. It would be interesting to conduct new interviews, not only to examine the increased role of competitiveness clusters in science-industry collaborations, but also to verify the role of more recent incentive structures—such as Technology Transfer Acceleration Companies (Matt and Schaeffer, 2018). However, our result is in line with previous work on a former public-sector instrument set up in the late 1980s to help companies identify their technological needs and the partners likely to solve them. In their analysis of “Technology Diffusion Networks”, Rallet and Torre, (2001) and Filippi and Torre (2003) have highlighted the difficulty of constraining synergies between different types of actors in the innovation process, and have shown the firms’ preference for partners, even distant, with whom collaborative habits have been established. Dedicated bodies have their limits and cannot force collaborations, not even local ones. Regarding our study, project leaders have the possibility to connect with a partner through channels that are more advantageous than dedicated organizations; they have little interest in relying on competitiveness clusters if they know partners with the required skills, for instance through their colleagues. Similarly, it may be faster and therefore cheaper for a researcher to attend a congress bringing together industrialists working on the laboratory’s research theme (Bernela, 2015).

Based on these results, recommendations could be proposed to managers of research centers on the use of their employees’ interpersonal relationships. To foster the formation of new partnerships, managers can ask their staff to use their address book, to maintain relationships and especially educational ones thanks to alumni directories or associations, virtual social networks, etc. They also need to facilitate the temporary mobility

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10 It should be noted that although the projects studied in the second corpus were implemented at the time of the creation of these organizations, it is reasonable to assume that the implementation of these policies and incentives was quick, since the national policy carried out a formal evaluation to assess the performance of each competitiveness cluster in 2008 to decide whether to renew or not the cluster’s label.
of their employees (congresses, research trips, etc.). Policies can encourage these behaviors with post-doctorates, mobility funding, European programs, etc.

Last but not least, this research needs to be completed. A first gap resides in the limitations of the data sample size (101), with only 14 observations for non-professional relationships; additional surveys are needed to confirm the present findings. Secondly, this research would need to be completed by integrating additional variables related to the characteristics of innovation projects. First of all, the size of the project but also the budget allocated and the nature of the funding need to be investigated, to test whether the spatial dimension of partnerships is related to the “value” or “size” of the project. Secondly, in line with proximity studies, this research could be enriched by integrating other forms of proximity to test for instance how technological (or cognitive) proximity and interpersonal network relations can, separately or in combination, affect the formation and geography of collaborations (Cassi and Plunket, 2014). Lastly, it could be interesting to integrate past network effects by taking into account the fact that some partnerships can be the product or the continuation of past partnerships (see Ferru, 2010).
Appendix 1. A partnership story: 
the collection of qualitative information

The partnership was implemented between an automotive manufacturer located in Paris, and an engineering science laboratory located in Poitiers. The two partners had already had one prior partnership some years earlier. Therefore, to identify the key channel of linkage between partners, we focused on the genesis of the partnership and went back to the very first time partners had been put in contact. The academic researcher interviewed explained that he went to a congress and presented findings from his current research. The Scientific Director of a company approached him, as “he had been impressed by the findings”, explained the researcher. The scientific director needed to conduct research on this subject (automotive brakes) and proposed to work together. The chart below sums up the genesis of this collaboration.
Appendix 2. Operationalization of the method

Projects database (CNRS, CVR) ➔ Collection of qualitative data ➔ 244 in-depth interviews ➔ Selection of relevant parts ➔ « Coding » process ➔ Discourse analysis ➔ Quantitative treatment

Collection of qualitative data ➔ « Collaboration stories » ➔ Discourse analysis ➔ « Verbatim »

Appendix 3. Economic and scientific size of studied cities

<table>
<thead>
<tr>
<th>Large city</th>
<th>Toulouse</th>
<th>Bordeaux</th>
<th>Grenoble</th>
<th>Montpellier</th>
<th>Clermont-F</th>
<th>Poitiers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population number (Insee, 2014)</td>
<td>1 024 517</td>
<td>921 668</td>
<td>758 956</td>
<td>700 241</td>
<td>375 518</td>
<td>128 449</td>
</tr>
<tr>
<td>Number of companies (Insee, 2015)</td>
<td>107 741</td>
<td>101 723</td>
<td>76 863</td>
<td>87 417</td>
<td>34 002</td>
<td>11 868</td>
</tr>
<tr>
<td>Number of employees in R&amp;D (CLAP, NAF88, 2015)</td>
<td>7876</td>
<td>580</td>
<td>9599</td>
<td>5697</td>
<td>732</td>
<td>269</td>
</tr>
<tr>
<td>Ranking number of researches (MENSR, 2011)</td>
<td>4/22</td>
<td>7/22</td>
<td>2/22</td>
<td>5/22</td>
<td>13/22</td>
<td>14/22</td>
</tr>
<tr>
<td>Mean number of scientific publication (three-year moving average on 2012-2014) (Sciences citation index expended)</td>
<td>2832</td>
<td>1889</td>
<td>3044</td>
<td>2207</td>
<td>819</td>
<td>522</td>
</tr>
</tbody>
</table>
REFERENCES


