

The Cifre PhDs: A Tool for Mediation between Laboratories and Firms in the Humanities and Social Sciences

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1. Introduction

We are witnessing the emergence of new forms of collaboration between universities or other public research institutes and industries which is often considered a new mode of the production of knowledge. In the present study, we examine the organisational modalities of one particular type of collaboration, the joint-supervision of a PhD student by an academic research institute and a private firm. Indeed, since 1981, there has been a programme in operation in France that has enabled doctoral research students to conduct their research partly in a public research institute and partly in a firm. This collaborative arrangement, known as Cifre (Convention industrielle de formation par la recherche), is a public-private research training agreement. The student splits his/her time between the research institute and a firm, which receives a subsidy from the State. The firms included in such projects are large as well as small firms, and are mainly in the industrial sector. However, increasingly service sector firms (often consultants and other sorts of knowledge intensive business services) take part in this kind of collaboration. The research fields of the research institutes included in such projects have been largely confined to computer science, physics and chemistry, but more recently Cifre has sponsored students studying humanities and social sciences.

In this study, we propose to analyse the functioning of this specific sort of collaboration between firms and academic research institutes, particularly in the field of humanities. In order to understand this par-

ticular system, we will present the results of a questionnaire sent to the various actors involved in the Cifre system: firms, academics and students. The results of this analysis show that, in this programme, the PhD student plays the role of mediator between the private and the academic communities. Through the student, the research institute and the firm initiate collaborations that continue after the contract has ended.

In the first section, we analyse the different modalities of collaborations that exist between universities and firms and the effects of these collaborations on each of the actors. The second section focuses on this particular type of collaboration between universities and firms: the Cifre PhD scheme. In order to get a more precise understanding of the organisational mechanisms behind this possible transfer of knowledge the empirical part of the report presents the results of a questionnaire sent to the various actors who have signed Cifre agreements in the humanities.

2. Collaborations between Universities and Firms

For some years, we have been addressing a number of *new* forms of production of knowledge through cooperation between universities and firms. This phenomenon is notably described in the literature as Mode 2 (Gibbons et al. 1994, Hicks/Katz 1999, Gibbons 2000). In Mode 2, knowledge is produced in the context of application by heterogeneous networks of actors and institutions (research is not only produced at universities) in a transdisciplinary and international framework. This model could be compared with the model of the triple helix, developed by Etzkowitz and Leydersdorff (2000), in which knowledge is produced by a hybrid network of universities, firms and governmental institutions. These different analyses illustrated a departure from the linear models of the production of knowledge to a system where knowledge is produced by networks of heterogeneous actors. In line with criticisms of to these models (Pestre 1997, Shinn 1997, Weingart 1997), we think that it is impossible to observe a real temporal break between the two modes of the production of knowledge. Nevertheless, it is important to present these models because they were the first ones to underline the existence of interaction between public research and industry and enable researchers to describe this phenomenon in a simple way.

The Cifre system seems to constitute a particular example of knowledge produced in a transdisciplinary and problem-solving context. Before presenting the functioning of this mode of collaboration between universities and firms in more detail, in the following paragraph we will locate

this particular form of collaboration in a global typology of the different forms of knowledge transfer between universities and firms.

2.1 The Different Modalities of Collaboration between Universities and Firms

We can actually observe an increasing number of collaborations between firms and public research organisations. Nevertheless, these collaborations are not uniform; they can take different forms and are characterised by varying degrees of interaction between the actors. As explained by Bozeman:

“In the study of technology transfer, the neophyte and the veteran researcher are easily distinguished. The neophyte is the one who is not confused.” (Bozeman 2000: 627)

Two levels of analysis must be taken into account for the examination of the modalities of collaboration: on the one hand it is necessary to define who collaborates, and on the other hand the object of the collaboration must be specified. These questions lead us to propose a third question: how is the collaboration implemented?

In order to answer the first question regarding the actors of the collaboration, the level of interaction must first be differentiated. Does the collaboration take place at the level of individuals, of groups of individuals, or at the level of the organisation? The training of a student in industry is an example of an interaction between a person (of the academic world) and an organisation (the firm). In contrast, a consortium of research constitutes an example of collaboration between institutions. To answer these questions on the subject of the collaborations, we could say, in a very broad sense that the objective of the collaboration is to increase the partners' stock of knowledge. What type of knowledge is exchanged during the collaboration? More precisely, can we differentiate collaborations on the basis of the type of knowledge which is being exchanged during the collaboration, and in particular, on the basis of the degree of codification (Schartinger et al. 2002) and formalisation of this knowledge (OECD 2002)? The functioning of these interactions also depends on the type of media which serve the collaboration. We can distinguish between the modalities of collaborations which only take place through human interactions and the modalities using the intermediary of a codified carrier of knowledge (such as scientific publications), technological artefact (such as a prototype) or a financial flux (such as payment of royalties). We can also note that some interactions are initiated by

science and directed toward industry, while others involve reciprocal exchanges between science and industry. For example, some modalities of collaborations (notably the joint-supervision of PhD students in firms) constitute a bilateral modality of collaboration between individuals and institutions who traverse a two-way bridge, to use the expression introduced by Meyer-Krahmer and Schmoch (1998).

2.2 The Effects of Knowledge Transfer between Universities and Firms

These different forms of collaborations will have an impact on the way the actors operate. One of the major aspects of this collaboration is the creation of new knowledge for both actors. But in addition to a “simple” increase in the stock of knowledge of the different actors, the development of direct as well as indirect effects for the two organisations and society as a whole can be observed, as explained by Pavitt:

“Some contributions will be direct, when academic research leads to applicable discoveries, engineering research techniques (such as computer simulations) and instrumentation. Others will be indirect, when academic research training, background knowledge and professional networks contribute to business firms’ own problem-solving in particular, to the experimental engineering research, design practice, production and operation that will be mainly located within the business firms.” (Pavitt 1998: 797)

In order to analyse these different indirect effects of the interaction between universities and firms, we base our analysis on a survey carried out by Salter and Martin (2000), in which six different types of effects were identified that could be attributed to the collaboration between university and industry. Before listing these however, it must be stated that, in their study, these authors described unilateral effects from science-based research towards industry. Nevertheless, we want to see if, in the case of an interactive and bilateral collaboration, bilateral effects are also observable.

- The interaction between academic researchers and industrialists can induce an increase in the stock of knowledge of each of the actors of the collaboration. In this case, knowledge is defined as a combination of tacit (Polanyi 1966) and codified knowledge.
- The interaction of academic research with industry can also create or improve instrumentation or methodology (Rosenberg 1992). Even in the field of humanities, as we will see later in the study, collaboration

between different fields of research can induce the development of new organisational methods of work in firms.

- Another effect on research, particularly for the universities, is the formation and development of the skills of young graduates. It is one of the main objectives of the Cifre procedure, as we will see below.
- Furthermore, scientists as well as industrialists form closed research networks; they form communities (Brown/Duguid 1998, Amin/Co-hendet 2004). It is therefore possible that the collaboration between academics and industrialists enables the exchange and transfer of knowledge between different communities. The implementation of a common research project may also lead to the birth of a new community of research around the project.
- Collaboration between academic research and industry can also contribute to problem solving.
- And, finally, one of the last effects identified by Martin and Salter is the creation of new firms by scientists, who transfer knowledge acquired at the university to industry.

In the following study we will analyse the importance of these different effects in the case of joint -supervision of a Cifre PhD student.

3. The Cifre: a Particular Modality of Collaboration between Universities and Firms

During the 80s French governments developed some systems of collaboration between public research organisations and private firms, systems that integrate the hiring of young graduates by the firm. The Cifre system concerns students who want to complete a doctorate. This procedure involves the collaboration of a PhD student, a public research institute and a firm around a common project (Quéré 1994). This study focuses on this particular system of doing a PhD in a firm.

3.1 The Cifre System

The Cifre system may lead to the launching of an innovative project for the firm and to an industrial training and a doctorate degree for the candidate, but it may also lead to the professional integration of the student in the firm in which the PhD has been made. Hence the Cifre convention links three types of actors (ANRT 1999):

- A French firm, which is committed, through the Cifre, to carrying out an innovative project in partnership with a PhD student and a research institute. In addition to a financial contribution, the firm must offer the candidate professional training. Concerning the financing contribution, the firm must hire the student for a period of three years, with a minimum yearly salary of 20,215 €. In exchange, the firm receives a subsidy amounting to 14,635 € per year from the National Association for Technical Research (ANRT).
- The student must be under 26 years old, have a French diploma (master's degree level), and no professional experience.
- The research institute may be located in a university, a school or a public research organisation in France or in a foreign country it but must be capable of providing research training to the candidate.

This system is managed at the national level by the ANRT. From 1982, when the system was created, to 2001, 10,002 Cifre agreements were signed, with a success rate of 91 % by 1998. A study made by the ANRT in 2000¹, showed that in 91 % of the agreements the PhDs were completed and that in 5 % of the cases the students chose to abandon their PhD to work in the firm. Nevertheless, this system remains in used in France: the Cifre PhDs constitute only 4 % of the total number of PhDs with public funding and around 2 % of all PhDs completed in France each year.² Although it contributes to only a small percentage of the total PhDs, this system is important in that it promotes the professional integration of the student. In a study done in 2002, the ANRT showed that 84 % of the Cifre PhD candidates found a job immediately after their PhD was completed.

3.2 The Cifre PhD: A Bridge between University and Industry

As previously stated, one of the modalities of knowledge transfer between universities and firms is the transmission of knowledge through persons who ensure the circulation of knowledge between the two organisations. They may be public researchers hired by firms for a certain period of time but also young graduates, particularly doctoral students

1 ANRT (2000): 1981/2001: 20 ans de CIFRE. Enquête sur le devenir des docteurs CIFRE, publications de l'ANRT. Additionally, we wish to express our gratitude to Philippe Gautier, who allowed us to use the ANRT database.

2 We can compare this figure with 51 (6 %) of PhDs financed by the Ministry of Research and Education in 1998 (OST 2002: 81).

who are taking a training course or are employed by a firm. Some studies (Beltramo et al. 2001, Mangematin 2000 and 2003) have shown that PhD students who went to work in a firm after doing their doctorate transferred a part of the knowledge acquired in universities to these firms. They may be considered one of the vectors of the transfer of knowledge between universities and firms.

In addition to this, our other main hypothesis is that the Cifre PhD student not only functions as a vector of transfer from universities to firms but also as a mediator between academic research institutes and firms involved in common research projects. Because they are strongly involved in both communities, the students can be considered members of the scientific as well as the industrial communities. Using the formula introduced by Meyer-Krahmer and Schmoch (1998) we could say that the Cifre PhD student is a *'two-way bridge'* which allows the exchange of codified as well as tacit knowledge between a firm and a research institute and vice versa. They form a sort of cognitive platform between the world of scientific research and industry. They can channel the different types of knowledge of each group and transfer this knowledge from one community to the other. This bridge allows knowledge to reciprocally circulate from the firm to the research institute and decreases the geographic as well as cognitive distance (Boschma 2005) which separates the two institutions. The student travels between the two institutions and exchanges knowledge with each of the two actors. Thus, he/she can transfer knowledge in the direction of either partner without the existence of a direct contact between the university and the firm. In other words, this student can be viewed as an *articulator of communities*. This concept, introduced by Brown and Duguid (1998), describes the person who is included in different communities as one who has the role of translating the perspective of one community into the language of another one.

On the basis of the results of a questionnaire sent to the different actors of the Cifre system we will perform a more detailed analysis of the organisational mechanisms at work in Cifre PhDs and test our hypothesis on the role of the PhD student as a mediator between universities and firms.

4. Empirical Results

Over 10,000 Cifre PhDs have been done in France since the creation of the system in 1982 and around 15 % of them were in the field of humanities. In order to understand the actual functioning of this type of

collaboration, the following section will present the results of a survey (questionnaires sent by electronic and postal mail) of the different actors (PhD students, firms and research institutes) involved in Cifre projects carried out in the humanities.³ We received around 500 responses to a total of 3,500 questionnaires sent, i.e. a response rate of 13 % for the various types of respondents.⁴ We will now turn to the results of the different questionnaires in order to study the organisational mechanisms that are behind the implementation of the Cifre convention in the humanities.

4.1 The Origin of the Cifre

In the majority of the cases, the Cifre agreements in the humanities were implemented following a proposal by the PhD student. Indeed, when asked who initiated the project, 59 %⁵ of the cases said that it was the student who gave impulse to the project. In a smaller number of cases (respectively 14 % and 18 % of the cases), it was the research institute or the firm which initiated the projects. The role of the student as the initiator of the project can be confirmed by looking at Table 1: around 15 % of the research institutes and firms decided to participate in a Cifre project upon the request of a student, who also played a role in the meeting between the two partners. The PhD students chose this form of doctorate in order to have the opportunity to carry out more application oriented research than a “traditional” PhD in the humanities. However, they also saw it as an opportunity to fund their studies and to have better access to the labour market. This hypothesis made by the students was confirmed by the fact that 25 % of the students who finished their PhDs claimed that they had found jobs in the firms where they had done their PhDs, and when asked directly, 85 % of them thought that the Cifre had facilitated their entry onto the job market.

3 This questionnaire is presented in more detail and has been tested on the actors of the Cifre in Alsace in a previous study (Levy 2005). The author will provide an English version of the questionnaire upon request.

4 More precisely, we have a return rate of 15.5 % (228 responses) from the PhD students, 8 % (228 responses) from the firms and 9.4 % (228 responses) from the research institutes. All of the cases, in which at least one of the three actors replied, add up to a total a return rate of 20.6 % (373 questionnaires).

5 In this example, as well as in the following study, the global set of all Cifre agreements totals 373 Cifre agreements. The figures that do not correspond to one of the tables correspond to short and open questions which the Cifre actors were asked.

Table 1: The Reasons that the Actors entered Cifre Agreements

Sample	Reasons have conducted each of the actor to enter a Cifre	Effective	Repartition (%)
PhD student	To make a PhD more applied than a classical academic one	114	49,8
	To prolong the formation, and be inserted in the labour market	99	43,2
	Absence of other PhD financing	88	38,4
	To facilitate the future professional integration	83	36,2
	Proposal of the firm	10	4,4
	On the advice of former Cifre PhDs	7	3,1
	Better access to the firm for the implementation of the project* ⁶	1	0,4
	Interest for the research project*	1	0,4
	Number of respondents	229	100
Laboratories	To initiate a collaboration with the firm	58	42
	To prolong a collaboration with the firm	43	31,2
	Following a request by the PhD student	20	14,5
	Need a PhD financing for the students	20	14,5
	To integrate the R&D networks of the firm	16	11,6
	After a first Cifre convention agreements	14	10,1
	Better access to the firm for the implementation of the Project	10	7,2
	Following a proposal by the firm *	2	1,4
	Number of respondents	138	100
Firms	To initiate a collaboration with the laboratory	47	39,8
	To integrate the research network of the laboratory	26	22
	Following a request by the PhD student	22	18,6
	Interest for the research project	20	16,9
	To prolong a collaboration with the laboratory	19	16,1
	Following a first Cifre convention	15	12,7
	In the framework of a global research project*	5	4,2
		Number of respondents	118

Table 2: The Reasons for the Choice of Partner

Sample	The reasons that guided the choice of the partner	Effective	Repartition (%)
PhD student	<i>Choice of the firm</i>		
	Informal contact with members of the firm	64	27,9
	Follow up a previous training in this firm	58	25,3
	The firm possesses some research tools necessary to the student's research project	44	19,2
	Good knowledge of the know-how of the firm	33	14,4
	Membership of the firm in a network	31	13,5

6 In this table and in the following ones the symbol: * indicates that the proposition was not proposed in the initial questionnaire, but was proposed by the actors in the category: "others".

	The fame of the firm	24	10,5
	Proposal by the firm *	17	7,4
	Existence of contacts between the firm and the laboratory*	15	6,6
	It is the only firm which accepted*	17	7,4
	The geographic proximity of the firm with the laboratory	16	7
	The activities of the firm are linked to the subject of the research*	5	2,2
	Following a previous contract in this firm	5	2,2
	<i>Number of respondents</i>	329	
	<i>Choice of the laboratory</i>		
	The student did his/her master in this laboratory	154	67,2
	The scientific notoriety of the laboratory	45	19,7
	Informal contact with members of the laboratory	43	18,8
	Good knowledge of the know-how of this laboratory	33	14,4
	The geographic proximity of the laboratory with the firm	28	12,2
	Membership of the laboratory in research network	19	8,3
	The laboratory possesses some instruments necessary to the research	12	5,2
	Follow up a previous training in this laboratory	6	2,6
	The firm has some relationship with the laboratory*	4	1,7
	<i>Number of respondents</i>	229	100
Laboratory	Informal contacts with members of the firm	56	40,6
	Good knowledge of the know-how of this firm	40	29
	The firm possesses some instruments necessary to the research	33	23,9
	Scientific or industrial notoriety of the firm	32	23,2
	Good experience of a training student in this firm	29	21
	The geographic proximity with the firm	23	16,7
	After a request of the PhD*	21	15,2
	Membership of the firm in R&D networks	21	15,2
	It is the firm which ask for a Cifre*	5	3,6
	Participation of the firm and the laboratory in a common research project*	3	2,2
	<i>Number of respondents</i>	138	100
Firm	Informal contact with members of the firm	59	50
	Scientific notoriety of the laboratory	39	33,1
	Good knowledge of the know-how of the laboratory	27	22,9
	The laboratory possesses some instruments necessary to the research	27	22,9
	After a request of the PhD*	26	22
	Membership of the laboratory in a research network	20	16,9
	The geographic proximity with the laboratory	18	15,3
	<i>Number of respondents</i>	118	100

Research institutes and firms use Cifre projects to initiate or prolong collaboration with the other partner. Therefore, we suppose that the Cifre system supports the creation or the development of research networks between firms and academic research institutes. These institutions collaborate through the Cifre. Indeed, 42 % of the research institutes and 40 % of the firms wanted to initiate a new relationship with an industrial or academic partner (Table 1) and they chose their partners with the aim of becoming part of the research networks of the research institute (22 % of the firm) or firm (11 % of the research institutes) (Table 2). Moreover, as we can see in Table 3, over 20 % of the Cifre collaborations were conducted to transfer networking knowledge from the research institute to the firm and more than 28 % of the Cifre collaborations were made to transfer networking knowledge from the firm to the research institute.

4.2 Increasing the Stock of Knowledge and Bilateral Exchange of Knowledge

We will now investigate whether, through the mediation of the PhD students, the relationship between universities and firms leads to an increase in the stock of knowledge of each of the actors. Table 3 shows that different types of knowledge have been exchanged.

In the first part of this article we explained that the knowledge exchanged between academics and industrialists can be split into four types of knowledge. We can observe an important transfer of academic knowledge (“know-what” and “know-why” in the typology of Lundvall and Johnson) from the academic sphere to industry but also from the industrialists to the laboratories. Know-how is transferred largely from the firms to the laboratories, but also vice versa. Universities and firms carry out a mutual exchange of knowledge, which traverses a “two-way bridge” (Meyer-Krahmer/Schmoch 1998). This hypothesis is confirmed by the fact that in 60 % of the exchanges, there was a bilateral exchange of knowledge: the firm transferred knowledge to the research institute and the research institute transferred knowledge to the firm. In these cases of bilateral exchange of knowledge, all four types of knowledge are exchanged between the two partners, the transfer of know-how is, however, more frequent than the transfer of academic knowledge.

Table 3: *The Transfer of Knowledge between Firms and Laboratories*⁷

Type of knowledge which is exchanged	From the laboratory to the firm		From the firm to the laboratory		Bilateral exchange of knowledge ⁸	
	Effective	Repartition (%)	Effective	Repartition (%)	Effective	Repartition (%)
Academic knowledge	183	49,10	92	24,70	29	7,80
Know-how	101	27,10	135	36,20	68	18,20
Networking knowledge	90	24,10	117	31,40	47	12,60
New methods of work	74	19,80	105	28,20	54	14,50
Others	4	1,10	17	4,60	3	0,80
Numbers of respondents	246	66	252	67,60	226	60,60
Total	373	100	373	100	373	100

We were also able to detect an important exchange of new working methods. In some cases, students in economics and management or human resources management transferred new methods of management from their research institutes to firms specialising in various sectors of activities. In other cases, consulting agencies implemented new methods of management in the research institutions through the mediation of the PhD students. Globally, this important transfer of methods from the firms to the research institutes may also be an indicator of a problem-solving oriented context of the production of knowledge within research institutions in the social sciences and humanities. The large part of networking knowledge (“know-who” in the typology of Lundvall and Johnson) which is transferred in both directions during the implementation of a Cifre agreement confirms the hypothesis that an important role of the

7 The typology proposed in this questionnaire was constructed by using a combination of the four types of knowledge proposed by Lundvall and Johnson in 1994: Know-what: this is factual knowledge that can be codified and is comparable to information. Lundvall and Johnson refer to the information learned at school or university. Know-why: this type of knowledge refers to the scientific knowledge that explains the laws of nature and society and corresponds to scientific knowledge and theories. This is more general knowledge corresponding to the functioning of nature and society. Know-how: this is competence: it is tacit and personal knowledge and sub-conscious capabilities. Know-who: this type of knowledge corresponds to knowledge concerning the person or group of persons who possess the different types of knowledge described above. It is a collective form of knowledge.

8 Bilateral exchange of knowledge is exchange of knowledge which takes place in both ways: from the laboratory to the firm, and for the same Cifre, from the firm toward laboratory.

Cifre system is to create and prolong networks of collaboration between the academic and the industrial sphere.

Concerning the repercussions of the Cifre PhDs, a large part of the Cifre projects do not lead to spin-offs (29 % of the global sample). It seems that even if a larger number of Cifre collaborations were linked to a transfer of knowledge, these transfers would not necessarily entail the codification of this knowledge as publications or innovations. In the case of bilateral exchanges, we observed that a larger part of the transfer led to spin-offs, especially in the form of publications. This confirms the importance of the bilateral exchange of knowledge made possible through the mediation of the student. The fact that a large part of the projects did not entail repercussions could also be explained by the fact that innovations in the form of new products, patents or prototypes are not frequent in services (55 % of the cases). Furthermore, researchers in the humanities generally publish less than in the other sciences.

Table 4: *The Repercussions of Cifre*⁹

	Total		Cifre finished at the moment of the survey		Cifre with bilateral exchange of knowledge	
	Effective	Repartition (%)	Effective	Repartition (%)	Effective	Repartition (%)
New products	34	9,1	26	10,2	24	10,6
New processes	91	24,4	60	23,5	68	30,1
Prototypes	30	8,0	22	8,6	24	10,6
Patents	11	2,9	8	3,1	7	3,1
Publications	212	56,8	158	62,0	149	65,9
Conferences, workshops	16	4,3	13	5,1	17	7,5
Organisational innovation	27	7,2	21	8,2	20	8,8
Internet website*	14	3,8	13	5,1	0	0,0
Networks of collaboration*	1	0,3	1	0,4	1	0,4
Organisation of conferences*	2	0,5	1	0,4	1	0,4
Not repercussions	109	29,2	59	23,1	42	18,6
Total	373	100	255	100	226	100

9 In cases in which the two partners gave different answers to the same question, we considered knowledge transfer to have taken place if one of the two partners signaled the existence of a spin-off.

Coming back to the different effects of the collaboration between universities and firms, improvement of instrumentation and methodology can be observed in Cifre collaborations: Table 2 shows that the use of new tools or news methods has had an impact on the choice of partners, principally for the firms, which chose to collaborate with a particular research institute in order to make use of their methodology or instruments (in 24 % of the cases). Furthermore, in Table 3, we can see that around 15 % of the projects were linked to a bilateral exchange of new work methods. Hence, these exchanges are also linked to the improvement of methods for each partner. In support of this idea, we note (see Table 4) that a large part of the Cifre also resulted in the introduction of new processes (24 % of the Cifre) or organisational methods (7 % of the Cifre) into the firm.

4.3 Conflicts

18 % of the Cifre gave rise to conflicts between firms and laboratories. A large part of the conflicts were linked to the difficulty of managing the time constraints of the research institute and the firm because the firm's goals may contradict the objectives of the research institute to finish the PhD in 3 years. Conflicts are also due to a communication problem between the academic world and the firm. In these cases, the student had not played the role of mediator between the firm and the research institute and the translation of knowledge from the point of view of the firm to the research institute became impossible.

Table 5: The Conflicts

Type of conflicts	Effective	% of Cifre	% of Conflicts
Difficulty to conciliate the time constraints of the laboratory and the firm	44	11.8	65.7
The firm and the laboratory have some problems to communicate	23	6.1	34.3
The method of work of the firm and the laboratory are different	15	4.0	22.4
Interest in publication and patent are not compatible	7	0.2	1.0
Number of respondents	67	18.0	100

5. Conclusion

In this study, we have analysed one specific type of relationship between universities and firms: namely the joint-supervision of PhD students within the Cifre system. We have considered the important role of bilateral relationships between firms and universities.

The role of the student appears to be essential for initiating a large majority of the projects. But these students also play a role during the collaboration, not only by writing their PhDs, but also as mediators between universities and firms and they enable each actor to increase their stock of tacit and/or codified knowledge. The student plays the role of mediator and his/her face-to-face contacts with the different partners diminish the need for direct contact between scientists and industrialists by contributing to knowledge transfer, including tacit knowledge. We also see the development and the creation of new instruments and new methodologies through this system, particularly the implementation of new organisational methods in the firms. Finally, we have noticed that some research networks linking industries and academics have emerged or have been formalised through these particular types of collaborations. The success and the interest of the actors in this system are also an indicator of the existence of new modes of the production of knowledge linked to the training of high level graduate students. Indeed, we observe collaborations between public and private researchers coming from different institutions and often different disciplines coming about through the supervision of Cifre PhD students. However, by definition, the Cifre system concerns applied research, and the majority of the topics of Cifre fellowships are proposed in order to solve problems that arise in firms. Even in the case of Cifre in the humanities we have observed a transfer of work method in public laboratories which seem to fit new mode of the production of knowledge.

This study is, however, limited by a bias due to the low return rate of the questionnaire. Indeed, it is possible that the PhD students, the industrialists and the scientists that did not benefit from this system or experienced conflicts during the collaboration did not answer the questionnaire. We are considering extending this study to the global set of Cifre fellowships since the creation of the system. We consider it necessary to encourage this system of knowledge production in partnerships between universities and firms because it appears to promote the growth of the stock of knowledge of each actor and to further the professional integration of graduates.

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