How Well Do Patent Citations Measure Flows of Technology? Evidence from French Innovation Surveys*

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How Well Do Patent Citations Measure Knowledge Flows?
Evidence from French Innovation data

Patent citation data are used in a growing body of economics and business research on technological diffusion. Research in this area uses "backward" citations to measure technological knowledge acquired by the patenting entities studied. "Forward" citations (citations to the firm's patents made by other patents) have been interpreted as a measure of the knowledge diffusing outward from the patenting entity. Until now, there exists little evidence on whether or not patent citations are a good measure of knowledge flows. Our paper assesses the legitimacy of using European patent citations as a measure of technology flows. It uses information from the Community Innovation Survey (CIS) collected by the French Service des Statistiques Industrielles (SESSI), which contain firms' responses to questions about their innovative activity. We show that patent citations are indeed related to firms' statements about their acquisition and dispersion of new technology, but that the strength and statistical significance of this relationship varies across geographical regions and across channels of knowledge diffusion.

Keywords: patent, citation, Community Innovation Survey, innovation, spillovers, count data.

JEL: O34, C35.

Comment les citations de brevets mesurent-elles les flux de connaissances?
Une étude sur données françaises d'innovation

Les citations de brevet sont utilisées dans un nombre croissant d'études économiques sur la diffusion des technologies. La recherche dans ce domaine utilise les citations émises par un déposant pour mesurer le savoir technologique qu'il a acquis par les brevets. Les citations reçues par un déposant sont interprétées, elles, comme une mesure du savoir qu'il a transmis aux autres déposants. Or, à ce jour, il existe peu d'éléments empiriques permettant d'affirmer que les citations de brevets sont effectivement corrélées aux échanges de connaissances. Notre étude vise à évaluer la qualité des citations de brevets comme mesure des flux de connaissances, en combinant ces citations avec l'enquête communautaire sur l'innovation (CIS1), réalisée par le SESSI, qui comporte des informations explicites sur les modes d'échanges de connaissances entre les entreprises. Nous montrons que, globalement, les citations sont effectivement corrélées avec les différents canaux de transmission des connaissances, mais que l'importance de la corrélation varie à la fois avec la zone géographique et le mode de transmission des connaissances considéré.

Mots-clés : brevet, citation, enquête communautaire sur l'innovation, innovation, externalités, données de comptage.

Introduction

Patent citation data are used in a growing body of economic and business research on technological diffusion.[3] Listed in the patent application, citations refer to prior patents that bear similarities to the technology for which protection is sought. They help demarcate the property right conferred by a patent by indicating what is excluded from its claims. As Jaffe, Trajtenberg and Henderson (1993) put it:

> *"In theory, the granting of a patent is a legal statement that the idea embodied in the patent represents a novel and useful contribution over and above the previous state of knowledge, as represented by the citations. Thus, in principle, a citation of Patent X by Patent Y means that X represents a piece of previously existing knowledge upon which Y builds."*

Since there exists almost no other measure of this influence of inventions on one another, patent citations hold great attraction for the study of knowledge flows. Research in this area uses both "backward" and "forward" citations to measure knowledge flows. Backward citations are citations to other patents made by the surveyed firms, and have been used to measure technological knowledge acquired by the patenting entities studied. Forward citations are citations to the firm's patents made by other patents, and have been interpreted as a measure of the knowledge diffusing outward from the patenting entity. They have also been used as a proxy for patent value or importance.[4]

This interpretation of the meaning of patent citations has been criticized. Citations are often added by patent examiners, and while on the one hand this

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[3] Jaffe (1986), Trajtenberg (1990), Jaffe, Trajtenberg and Henderson (1993), Jaffe and Trajtenberg (1999), Branstetter (2000), Lanjouw and Shankerman (1999), Almeida (1996), Frost (2001), Harhoff et al. (1999), Hall, Jaffe, and Trajtenberg (2000) and Lanjouw and Shankerman (1999) among others.

[4] Harhoff, et al. (1999), Hall, Jaffe, and Trajtenberg (2000) and Lanjouw and Shankerman (1999)

may make them more objective, on the other it means that the inclusion of a given citation in a patent application does not necessarily indicate that the inventor knew about the existence of the technology embodied in the cited patent.[5] Furthermore, citations only capture knowledge flows that result in a novel, patentable technology. They cannot help us make inferences about learning via imitation or reverse engineering, or other knowledge transfers that do not always result in a patent. Agrawal and Henderson (2002), for example, point out that a significant number of the inventors citing papers by researchers at the Massachusetts Institute of Technology did not also cite the patents held by those researchers.

Despite this criticism, and despite the growing body of research employing patent citations, there exists little evidence on the validity of using patent citations as a measure of knowledge flows. The only existing research on this question is a survey of patentees undertaken by Jaffe, Trajtenberg and Fogarty (2000). The authors surveyed inventors of cited and citing patents, and found evidence of significant communication between them, "at least some of which is in forms that suggest knowledge flows from the cited inventor to the citing inventor". They also found that citations are an extremely noisy measure of communication between inventors, with about half of them lacking any relevance with regard to knowledge flows. They also found a significant correlation between citations received by patents and the inventors' perceptions about the importance of those patents.

This paper provides new evidence on the legitimacy of using patent citations as a measure of technology flows. It will use information from the CIS1 survey collected by the French Service des Statistiques Industrielles (SESSI), which contain firms' responses to questions about their acquisition and dissemination of new technologies across countries.[6] We have matched the

[5] This criticism is less damaging if one is willing to accept that inventors may be influenced by indirect exposure to antecedent technologies even if they are unaware of the patented technology in question.

[6] CIS : Community Innovation Survey.

firms' survey responses to counts of the citations made and received by their patents, by country of the cited or citing patent. By examining the relationship between firms' stated acquisition and dissemination of technologies and their country-specific patent citation counts, we will be able to provide new information on the relationship between citations and flows of new technology. We find that patent citations are indeed related to firms' statements about their acquisition and dispersion of new technology, but that the strength and statistical significance of this relationship varies across geographical regions and across mechanisms for technology diffusion.

The data about the patent citations and the innovation survey and initial comparisons of the two sources are presented in section 1. Section 2 presents the count data analysis with citation counts explained by the CIS data. The last section presents our conclusions.

1 Patent citations and the community innovation survey

1.1 Patent Citations: Technological and Geographic Patterns

The patent data with which the innovation surveys will be compared comes from the European Patent Office (EPO).[7] The dataset contains information on 776,150 patents granted by the EPO between 1978 and 1997. Among these patents, there are 477,230 citations to other EPO patents in which the country of origin of both citing and cited patents can be identified.[8]

Table 1 lists the number of citations *by* EPO patents in different regions *to* the patents in those regions. One useful way of measuring patent citations expresses them in terms of the percentage of possible citations that were actually made.[9] Let C_{gd} be the number of citations made by patents in technology class *g* to patents in class *d*. If P_g is the total number of patents in class g and P_d is the number of patents in class d, then the citation frequency would be calculated as C_{gd} /($P_g \times P_d$). The analysis of citation patterns across countries reveals that citations tend to be geographically concentrated (Tables 1 and 2).[10] Most citations are to patents from the citing patent's country of origin. The most often-cited region is the European Community, followed by the United States and then Japan. After France, French patents are most likely to cite and be cited by patents from the European Community and the United States (Table 1). The citation frequencies listed in Table 2 are normalized by French citations to French patents, and they reveal that the home-country concentration in

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[7] We are grateful to Bronwyn Hall and Dietmar Harhoff for making this data available to us.

[8] We associate patents with countries using the address of the firm that holds the patent.

[9] See Hall, Jaffe and Trajtenberg (2001). If we are interested in counting the number of times that company A's patents cite the patents of company B, we should expect that number to be related both to how many patents A has, and to how many patents were available to be cited. We can express A's citations to B's patents as a frequency – the ratio of citations that were *actually* made to citations that could *potentially* have been made.

[10] Citations are also concentrated within technology classes.

citations is below the French level in Japan, the USA, and the EC excluding France, but higher in non-EC Europe and the remaining countries.

1.2 The Innovation Survey

The Community Innovation Survey (CIS) was conducted in 1993 and refers to the period 1990-92. It provides information about the innovative activities of firms in Industry. The questions that are broken down by geographic area refer to the definition of the European Community at the time of the survey, which included 12 countries.[11]

The survey distributed by SESSI asked firms to indicate whether they had "acquired new technology via the following channels": R&D out-sourcing and sub-contracting, R&D cooperation, patents and licenses, analysis of competing products, consultation with experts, equipment purchases, recruiting qualified employees, communication with suppliers, communication with customers, mergers and acquisitions, joint ventures and alliances, and personnel exchanges. Each of these categories is further broken down by region, so that firms were asked to indicate whether they had obtained new technologies via any of the above channels from France, the European Community, Non-EC Europe, the United States, Japan, or another region. A second section of the survey asked whether the firms had themselves transferred new technologies to third parties via a similar set of channels: R&D out-sourcing/sub-contracting, patent licensing, providing expert consultation for other firms, equipment sales, departure of qualified workers, communication with other firms, mergers, and joint ventures or strategic alliances. Other questions asked whether firms benefited from knowledge acquired from sources internal or external to the firm or the firm's industrial group, from external sources such as universities or

[11] The twelve countries are, in alphabetical order: Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Portugal, Spain, The Netherlands and The United Kingdom. By convention, we will use the expression European Community instead of European Union since the latter currently refers to fifteen countries instead of twelve. In 1995, Austria, Finland and Sweden joined the European Union. Thirteen other countries are candidates.

publicly-funded research centers, consultants, patent databases, conferences, trade shows, etc. We also incorporate these survey questions in our analysis. Please see Appendix 1 for a copy of the survey questions.

The most common sources for new technology, as measured by the percentage of firms indicating that they had acquired technology through those means (Table 3), are communication with suppliers and customers, R&D outsourcing and collaboration, and analysis of competing products. The latter is the most common means of acquiring new technology from regions outside France, while French technology is more commonly acquired through R&D cooperation. Table 4 reveals that firms were most likely to say they had transferred technology to a third party through patent licensing if that party was located outside France, while communication with other firms was the most often-cited channel for knowledge diffusion to French parties. In general, firms were more likely to claim they had acquired technology than they were to indicate they had transferred it to a third party. For example, while 20% of firms said they had obtained new technologies from their suppliers or customers in France, only 4.2% said they had transferred new technologies to other French firms.

1.3 An initial comparison of citations and innovation survey responses

After merging the patent data with the CIS data, we obtain a sample of 465 industrial firms that hold at least one patent filed during 1990-92. Table 5 displays the responses to the questions of the innovation survey for firms with one or more citations to the region referred to in the survey question. This table shows that 11.5% of firms that answered “no” to the question: “Did your firm acquire new technology from France via R&D out-sourcing?” made at least one citation to a French patent, while 28.6% of firms that answered “yes” made at least one citation to French patents. The difference in these percentages is significant at the 5% level, with a p-value of 0.002. The *p-values* allow for differences in the variances. Thus, firms that cite French patents are significantly

more likely to claim to have benefited from information exchanged in R&D out-sourcing.

For almost every question, the difference between the percentage of firms with citations that answer “yes” and the percent that answer “no” is statistically significant at the 5% level. The only exceptions are the use of experts and the acquisition of technology through communication with customers, which is significant at the 5% level for Japan only. The regions for which citations appear to be the least related to the survey responses are non-EC Europe and the rest of the world, where the differences are not significantly different from zero at the 5% level for most technology sources. This is not surprising given the relatively low patenting rates in these countries.

Table 6 is similar in many ways to Table 5. The former lists the percentage of firms with at least one forward citation, sorted by their answers to the survey questions. It shows that 20.1% of the firms that answered “no” to the question: “Did your firm transfer new technology to France via R&D out-sourcing?” were cited at least once by a French patent, while 34.6% of firms that answered “yes” were cited at least once by a French patent. The difference in these percentages is significant at the 5% level, with a p-value of 0.017. Again, the likelihood of responding affirmatively to almost all the questions appears to be associated with being cited by patents from the relevant regions, with the exception of non-EC Europe and the rest of the world, where most diffusion variables are not significant.

2 Econometric results

Our analysis of the correlation between patent citations and firms’ responses to questions about diffusion of new technology starts with a regression of the number of (backward or forward) citations on the firms’ survey

responses.[12] In order to establish what matters at the firm level, we include industry dummies in the second regression. Since the number of citations is increasing in the number of patents held by the firm, and there is considerable variation in patent counts across firms in the sample, we also need to control for firm size. The correct measure of firm size in this case is clearly the number of patents since it is directly related (if not proportional) to the number of citations. Therefore, we include the number of patents held by the firm among the regressors of the second regression.

This inclusion raises an interesting econometric issue: the number of patents is co-determined with the number of citations. The "learning" that backward citations measure is likely to be correlated with the firms' productivity in research – that is, firms with higher absorptive capacity are more innovative. Furthermore, since forward citations are a proxy for the value of an invention and firms' R&D investments are a function of past revenue generated by inventions, firms that receive more forward citations after a patent is granted will also have more patents as a result of higher R&D investment stemming from the commercial success of past inventions. As a result, endogeneity is likely to be a problem. Moreover, the firm's patent count is truncated at one, because we only include firms that have at least one patent. The estimation must be modified accordingly since the distribution cannot be Poisson. We estimate a truncated Poisson for the number of patents and use the Asymptotic Least Squares method to account for simultaneity (see Crépon and Duguet, 1997; Crépon, Duguet and Mairesse, 1998).

2.1 The number of backward citations

We find that the number of backward citations is proportional to the number of patents. Moreover, Table 8 shows that after controlling for size and differences across industries, the significance of a number of coefficients

[12] Note that self-citations, or the firms' citations to their own patents, are excluded from our citation counts.

vanishes while other variables become significant.[13] We can interpret the variables whose effects vanish as correlated with the number of patents rather than with the number of citations, while the variables that remain significant after the inclusion of size and industry controls can be interpreted as influencing the number of citations per patent.

The two variables that are the most affected by the size and industry controls are the variables associated with R&D out-sourcing and joint ventures/alliances. These variables are thus associated with the number of patents held by the firm, but not the number of citations per patent. This may partly reflect the fact that only the largest firms engage in R&D out-sourcing. Small firms are more specialized, and so while they may themselves conduct contract-based research for larger firms, they do not out-source aspects of their own research.

One might expect the coefficient associated with learning from patents and licenses to be unaffected by the introduction of size and industry controls. However, we find that while the number of backward citations is positively associated with patents and licenses from France and the EC, it is negatively associated with patents and licenses from the other European countries. Therefore, the French firms appear to make use of technical information relevant to the European Common Market rather than to the European patent system.[14] The relationship between citations and learning from patents and licenses from the USA and Japan is not significant at the 5% level. It may be that the differences across countries in the strength of this relationship reflect differing economic distances from the French market. However, it is also the case that EPO citations are likely to be correlated most highly with learning from technologies patented in the EPO. Firms that learn from American or Japanese patented technologies may be more likely to cite patents filed with the USPTO or the Japanese patent office. Because our citation data comes from the EPO, we

[13] We checked that most of the changes come from the size differences rather than from the industry differences.

[14] Notice that this effect should change after more countries enter the EC as scheduled.

do not pick up these citations and this may explain the weak correlation between citations and learning from American or Japanese patents and licenses.

The second important correlate of the number of citations per patent is cooperative R&D. Firms that have acquired new technology through cooperation with foreign counterparts are more likely to cite patents held by firms from that country.[15] Our results suggest that cooperative R&D is complementary to learning through patents and licenses. While firms' citations to the residual area (the "other" countries as listed on the survey) are negatively associated with learning through patents and licenses, they are positively associated with learning through R&D cooperation. For Japan, the former variable is not significantly related to citations per patent but the latter is. These results are interesting because they could suggest the following strategy: firms that find it difficult to acquire knowledge by reading patents from another country engage in R&D cooperation with local firms to gain access to foreign knowledge. Cooperative R&D could be used to circumvent the perceived difficulties posed by foreign intellectual property systems.

The other survey questions significantly associated with backward citations per patent are those that refer to technology acquisition through equipment purchases and mergers or acquisitions. Equipment purchases are likely to involve knowledge transmission from the supplier when the good has to be adapted to the customers' needs.[16] Firms that develop product innovations or technical improvements influenced by technical information transmitted through equipment purchases would be likely to cite the patent covering the original technology that inspired the innovation. We find that equipment purchases are positively associated with the intensity of backward citations to non-EC Europe, the USA and Japan. This result reveals a complementarity between patent

[15] While it seems likely that firms engaging in R&D cooperation would cite patents held by their partners, we do not have any information on the identity of the French firms' foreign collaborators and so cannot infer this from our data.

[16] MacGarvie (2003) provides an example of an Australian firm that modified imported American farm equipment to make it compatible with the Australian soil and registered the design with the Australian patent office.

protection and equipment purchases, as citations to patents from non-EC Europe are negatively associated with technology acquisition through patents and licenses from those regions. Finally, mergers and acquisitions are also important for the transmission of knowledge: a direct way to acquire the knowledge of a firm is to acquire the firm.[17] There is a statistically significant relationship between firms' statements about new technology acquired through mergers/acquisitions and their rates of backward citation to France and in the USA.

In general, backward citations per patent are correlated with more direct means of knowledge acquisition when the economies are more integrated. The level of integration of the EC economies is reflected by the fact that French firms' citations to European patents are associated with learning from cooperative R&D, patents and licenses, and firm buyouts. In contrast, citations to patents held by American inventors are associated with technology acquisition through more arms-length, or indirect, transactions like equipment purchases and contacts with suppliers. The importance of these indirect channels of technology acquisition reflects the greater economic distance between France and the United States.[18]

We also study the correlation between citations and firms' stated sources of information about new technology as contained in survey question 3, "Technological innovation grew out of the acquisition of scientific and technical knowledge acquired via:…" (see Appendix 1, part 3 of the questionnaire). Not surprisingly, citations are correlated with firms' statements about obtaining information from data sources including published patents. There is also a significant coefficient on the variable that indicates that firms learn obtain new knowledge from other firms within their industrial groups (i.e.: other firms belonging to the same parent company), but not from within the firm itself. This is

[17] See Marco and Rausser (2002) that study the relationship between the patent portfolios of the firms and their probability of being involved in a merger in the American agricultural biotechnology industry.

likely due to the fact that we have omitted self-citations from the analysis, so we wouldn't expect to see a correlation between citations and firms' statements about knowledge flows within the firm. Citations are significantly negatively associated with knowledge acquired from trade shows and exhibitions.

2.2 The number of forward citations

Because the number of forward citations is generally proportional to the number of patents, our interpretation of the coefficients from the citation regressions will be similarly affected by controlling for the number of patents held by the firm when forward citations are the dependent variable. The results of our analysis of forward citations are found in Table 9. The coefficient most affected by controlling for size is one associated with technology diffusion through joint ventures and alliances. It is only associated with forward citations through its effect on the number of patents -- after controlling for the number of patents, participation in joint ventures does not increase the intensity of forward citations. That is, joint ventures may be associated with higher patent counts but do not necessarily lead to more citations per patents. This conclusion is similar to the one drawn from the results from the backward citation regressions, which suggests that both incoming and outgoing knowledge flows are proportional to the size of the focal firm when knowledge is shared in a joint venture.

A comparable reduction in the size of the regression coefficients is found for other sources of knowledge: contract R&D conducted for another firm and patents and licenses. R&D is generally proportional to firm size, and controlling for the number of the firm's patents lowers the coefficient associated with technology diffusion through contract R&D. The reduction in the effect of patents and licenses can be explained the same way since these technology transfers clearly come from the patents that are included in the regressions. The only effects that remain robust to controlling for size are equipment sales and, to a lesser extent, selling a part of the firm.

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[18] The hypothesis on the capital market cannot be tested for Japan since there are not enough firms declaring a

Firms that transmit technological knowledge to other firms through equipment sales are more likely to be cited by patents from the regions to which the firms claim to transmit their knowledge. This may be because equipment goods need to be adapted to the specific needs of the customer, which is associated with a transmission of knowledge resulting in citations. This result may also be related to the finding that equipment manufacturers in France perform a large part of private R&D and often perform radical innovations.[19]

Other sources of technological information are related to the number of forward citations per patent, but the significance of these sources varies across regions. Among French firms, forward citations are positively correlated with firms' perceptions of technology transfer through joint ventures and alliances. New technology disseminated through alliances or joint ventures have no significant effect on the number of forward citations to patents from the European Community, but the departure of employees does. Here it is not clear whether the knowledge is transmitted to a completely different entity or to a firm that belongs to the same group. The fact that this variable is not significantly related to forward citations from French firms may simply mean that joint ventures and alliances are associated with some degree of internal mobility, while intra-European mobility may imply that the employees leave the firm. For the other European countries, the USA, and Japan, forward citations are significantly related only to knowledge flows from sales of equipment goods. Firms that disseminate technology to Japan through joint ventures or alliances are *less* likely to be cited by Japanese patents.

Finally, forward citations from the rest of the world seem to be positively related to French firms' dissemination of knowledge through contract R&D and equipment sales, and negatively associated with technology diffusion through patents and licenses and consultation with experts. The first result could be

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buyout in the sample.

[19] Radical innovations are defined as either products that are new for the market or technological breakthroughs. Duguet (2002) shows that radical innovations are strongly correlated to IPRs while the incremental innovations are not.

explained by the difficulties that these countries have in accessing or exploiting the European patents while the second one could be the result of an intellectual property strategy. It could be that experts patent around the innovation when they feel the patents are likely to be infringed. This strategy would increase the number of patents and reduce the average number of citations since, once the competitors have detected the "true" patents, they would be the only ones cited. The fact that consultation with experts has no significant effect in the most technologically advanced regions could reveal a successful adaptation of the closest competitors while the firms in places other than the EC, the USA or Japan would still face difficulties coping with this problem.

The fact that the correlation between forward citations and firms' responses to survey questions about the outward diffusion of their inventions is weaker in general than the correlation between backward citations and firms' statements about new technology acquisition may also reflect asymmetries of information. Cited firms' technologies may be transferred indirectly, or by third parties, and they may not be aware of how these transfers influenced the patents of other firms. Citing firms are more likely to be aware of the origins of technologies that influenced their invention.[20] Thus, the fact that forward citations do not appear to bear much relation to most of the survey questions about outward technology diffusion does not refute the hypothesis that forward citations are correlated with knowledge diffusion. If firms had perfect information about how their technology was acquired by other firms, this hypothesis could be tested more definitively.

[20] Even if the inventor has no knowledge of other inventions cited in the patent application, the inventor is informed of existing prior art once the patent examiner issues the EPO search report.

Conclusion

This study assesses the validity of interpreting patent citations as a measure of knowledge flows by comparing firms' citations with their answers to survey questions about technology transfer. It finds qualified support for the premise that patent citations are associated with flows of new technology. Patent citation counts contain relevant information on technology flows for some, but not all, of the channels through which firms claim to obtain new technology. However, the validity of using citations to measure knowledge flows varies with the source or destination of the knowledge transmitted and the channel through which it is transmitted.

First, we find that the total number of backward citations is correlated with survey questions about R&D and innovation, but that this correlation is weakened by controlling for the number of patents held by the citing firm. The citation rates of French firms obtaining technology from firms located in the EC reflect their R&D activities whereas, if the source is located outside the EC, they are associated with purchases of equipment goods. Second, the total number of forward citations is related to a number of the survey questions about the dissemination of the firm's technology, but the number of forward citations per patent is significantly related to far fewer types of technology transfer. The one channel for knowledge transfers that is consistently correlated with forward citations across the six geographical regions covered by the survey is equipment sales.

These results on equipment goods deserve comment and have an interesting implication for how we should interpret the weighting of patents by citations. First, the equipment goods industry comprises a little less than the half of all European patents filed by French firms. If we add transportation

equipment, this figure increases to 60%.[21] The relationship between equipment goods sales and forward citations is therefore not surprising – it confirms that the number of forward citations per patent is related to the output (here, innovative sales) of the firm.

Second, this relationship between equipment sales or purchases and the intensity of citations (per patent) further confirms that weighting patents by their citations is indeed related to the patent value. By definition, the value of a patent is determined by the sales associated with the technology covered by the patent. Since the citation intensity (i.e., the weight) is positively correlated with those sales, weighting by citations can be considered as a proxy for the weighting by the value of patents. Of course, this finding needs to be confirmed by other sources, which will be the topic of future work. One way to assess the validity of citation weighting would be to study directly the relationship between the citations per patent and the innovative output measures. This could be pursued, for instance, through a detailed study of the determinants of innovative sales and of innovative exports.

[21] These figures are taken from Duguet (1996, table 9).

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Table 1 : Distribution of citations across regions

Percentage of the total	Cited Region						
	France	EC	Non-EC Europe	USA	Japan	Others	Total
Citing Region :							
France	2.5	2.3	0.4	1.4	0.9	0.1	7.6
EC	2.1	19.3	1.8	5.7	4.1	0.4	33.5
Non-EC Europe	0.3	1.7	1.9	0.9	0.6	0.1	5.4
USA	1.3	5.6	1.0	14.2	4.2	0.4	26.7
Japan	0.9	4.3	0.7	4.6	14.4	0.2	25.0
Others	0.1	0.5	0.1	0.4	0.3	0.3	1.7
Total	7.2	33.6	5.9	27.3	24.5	1.4	100.0

Table 2 : Citations frequencies across regions

French citations to France normalized to 1.

Percentage of the total	Cited Region					
	France	EC	Non-EC Europe	USA	Japan	Others
Citing Region :						
France	1.000	0.198	0.189	0.150	0.113	0.185
EC	0.196	0.379	0.207	0.139	0.109	0.197
Non-EC Europe	0.175	0.202	1.307	0.137	0.095	0.237
USA	0.147	0.139	0.142	0.431	0.142	0.203
Japan	0.109	0.112	0.100	0.149	0.520	0.111
Others	0.217	0.190	0.202	0.192	0.157	2.691

Table 3 : Firm's Sources of new technology (CIS1)

Percentage of surveyed firms indicating that new technology was acquired via the channels listed, by geographic origin. Sample of 465 firms in French manufacturing.

Geographic origin	France	EC	Non-EC Europe	USA	Japan	Others	All
External R&D	50.3	15.7	2.8	8.8	2.1	1.5	58.7
Cooperative R&D	58.7	24.5	5.2	11.0	3.6	1.5	68.4
Patents and licenses	17.4	12.0	3.0	10.3	4.9	1.3	30.5
Reverse engineering	33.5	36.5	11.8	22.8	19.6	3.0	52.0
Experts	14.8	4.1	1.3	1.7	1.7	0.6	17.2
Equipment acquisition	24.9	20.0	3.0	5.8	3.2	0.9	34.0
Employees hiring	35.9	6.7	1.9	3.4	1.1	0.4	37.4
Communication with suppliers	46.9	29.0	7.9	11.0	5.6	1.5	50.3
Communication with customers	46.2	29.5	11.1	13.8	5.6	6.2	49.7
Firm buyout	12.0	6.0	2.1	4.1	0.2	0.4	18.5
Joint ventures and alliances	8.6	9.7	2.4	8.6	3.0	1.9	18.9
Personnel exchange	4.3	3.9	0.4	3.0	0.2	0.0	8.4

Reading example: 58.7% of the respondents have acquired knowledge from other French firms through R&D cooperation and 11% have used this channel to acquire knowledge from the USA.

Table 4 : Firm's dissemination of new technology (CIS1)

Percentage of surveyed firms indicating that their technology was transferred via the channels listed, by geographic destination. Sample of 465 firms in French manufacturing.

Geographic destination	France	EC	Non-EC Europe	USA	Japan	Others	All
External R&D	11.2	6.7	2.8	4.5	0.6	2.1	17.2
Patents and licenses	11.4	15.9	7.1	10.7	5.8	7.9	28.8
Consulting	10.3	6.9	2.8	2.6	1.1	4.1	18.3
Equipment acquisition	7.1	7.3	4.5	4.3	2.4	6.2	13.1
Departure of employees	7.9	6.0	0.6	2.6	0.2	1.7	13.1
Communication with other firms	11.8	10.1	2.6	4.9	1.5	1.5	17.4
Firm buyout	2.6	0.9	0.9	0.6	0.2	0.4	3.6
Joint ventures and alliances	2.4	5.6	3.0	5.6	2.6	2.8	14.4

Reading example: 5.8% of the respondents declare to have transmitted knowledge to Japanese firms through patents and licenses.

Table 5: Acquisition of new technology by firms making backward citations

The figures are corrected for self citation. The p-values allow for the differences in the variances. Percentage of firms making backward citations depending on the way they have acquired new technology. n.a : less than 5 data points in one of the two categories (statistics not reported).

Origin of the cited patent:	France	EC	Non-EC Europe	USA	Japan	Others
Acquisition of new technology from:						
External R&D						
- no	18.2	25.0	11.1	20.2	18.9	5.9
- yes	30.3	38.9	30.8	58.5	50.0	14.3
- *p-value*	.0022	.0004	.1666	.0001	.0142	.5792
Cooperative R&D						
- no	16.1	26.5	9.7	19.3	18.1	5.9
- yes	30.0	52.6	45.8	56.7	58.8	14.3
- *p-value*	.0003	.0001	.0021	.0001	.0001	.5792
Patents and licenses						
- no	21.3	30.3	11.12	20.1	17.8	5.9
- yes	38.3	51.8	28.6	52.1	52.2	16.7
- *p-value*	.0045	.0013	.1885	.0001	.0042	.5467
Reverse engineering						
- no	24.6	27.5	11.0	17.5	13.6	6.2
- yes	23.7	42.3	16.4	43.4	44.0	0.0
- *p-value*	.8354	.0010	.2425	.0001	.0001	.0001
Experts						
- no	23.7	32.1	11.3	23.6	19.3	6.1
- yes	27.5	52.6	33.3	12.5	37.5	0.0
- *p-value*	.4982	.0619	.3450	.4623	.1981	n.a.
Equipment acquisition						
- no	24.1	31.7	11.5	21.0	18.4	6.1
- yes	25.0	37.6	14.3	63.0	53.3	0.0
- *p-value*	.8399	.2786	.7519	.0001	.0008	n.a.
Employees hiring						
- no	20.5	31.1	11.0	22.3	19.1	5.8
- yes	31.1	58.1	44.4	56.2	60.0	50.0
- *p-value*	.0134	.0020	.0936	.0016	.0219	n.a.
Communication with suppliers						
- no	19.8	27.9	11.0	19.8	17.8	6.1
- yes	29.4	45.2	18.9	52.9	50.0	0.0
- *p-value*	.0178	.0003	.2432	.0001	.0038	.0001
Communication with customers						
- no	23.2	31.7	10.9	22.7	18.4	6.2
- yes	25.6	35.8	17.3	28.1	38.5	3.4
- *p-value*	.5515	.3968	.2496	.3419	.0124	.5485
Firm buyout						
- no	23.2	31.3	11.2	22.0	19.4	58.3
- yes	32.1	57.1	30.0	57.9	100.0	50.0
- *p-value*	.1452	.0048	.2513	.0003	n.a.	n.a.
Joint ventures and alliances						
- no	22.3	30.0	10.8	19.8	18.6	5.9
- yes	45.0	60.0	45.4	62.5	50.0	11.1
- *p-value*	.0014	.0001	.0527	.0001	.0035	.5179
Personnel exchange						
- no	23.1	32.0	11.4	21.9	19.6	0.0
- yes	50.0	55.5	50.0	71.4	0.0	0.0
- *p-value*	.0061	.0370	n.a.	.0001	n.a.	n.a.

Reading example: Among the French firms that have cooperated in R&D with American firms, 56.7% have cited American patents, while 19.3% of the firms that have not cooperated in R&D with American firms have done so. The difference is statistically significant.

Table 6 : Diffusion of new technology by firms having forward citations

The figures are corrected for self citation.The p-values allow for the differences in the variances. Percentage of firms receiving forward citations depending on the way they have transferred their technology. n.a : less than 5 data points in one of the two categories (statistics not reported).

Origin of the citing patent:	France	EC	Non-EC Europe	USA	Japan	Others
Transfer of new technology through:						
R&D done for another firm						
- no	20.1	29.9	13.0	20.0	18.6	5.9
- yes	34.6	38.7	15.4	28.6	33.3	20.0
- *t* statistic	.0167	.3075	.8066	.3447	n.a.	.3202
Patents and licenses						
- no	18.4	26.1	12.0	17.3	16.9	5.6
- yes	47.2	54.0	27.3	46.0	28.0	13.5
- *t* statistic	.0001	.0001	.0661	.0003	.0040	.1811
Expertise						
- no	20.9	30.0	13.0	19.9	18.9	6.3
- yes	29.2	37.5	15.4	41.7	0.0	5.3
- *t* statistic	.1872	.3766	.8066	.0647	.0001	.8582
Equipment sales						
- no	20.1	27.8	11.7	19.5	18.3	5.5
- yes	42.4	64.7	42.9	40.0	36.4	17.2
- *t* statistic	.0027	.0001	0.0111	.0265	.1292	.1148
Employees departure						
- no	20.6	29.1	13.2	20.1	18.5	6.1
- yes	35.1	53.6	0.0	33.3	100.0	2.5
- *t* statistic	.0392	.0063	n.a.	.2623	n.a.	.4610
Communication with other firms						
- no	21.0	28.5	13.0	18.5	18.3	6.1
- yes	27.3	48.9	16.7	56.5	42.9	14.3
- *t* statistic	.2886	.0038	.7129	.0001	.0992	.5889
Selling a part of the firm						
- no	21.1	30.1	13.0	19.9	18.5	6.0
- yes	41.7	75.0	25.0	100.0	100.0	50.0
- *t* statistic	.0899	n.a.	n.a.	n.a.	n.a.	n.a.
Joint ventures and alliances						
- no	19.3	29.2	13.1	18.4	17.8	6.2
- yes	64.0	53.9	14.3	53.8	50.0	7.7
- *t* statistic	.0001	.0078	.8958	.0017	.0048	.8262

Reading example: Among the French firms that have transferred knowledge to American firms through patents and licences, 46% had a forward citation by an American patent, while among the firms that have not transferred knowledge to American firms, 17.3% have oneo. The difference is statistically significant.

Table 7 : Sample statistics

The figures are corrected for self-citations. Sample of 465 firms in French manufacturing.

Industry	Number of firms	Number of patents	Number of backward citations	Number of forward citations	Number of employees	
		average	average	average	average	Median
C3 : Pharmaceuticals	21	27.6	6.4	5.1	905	506
C4 : Houseware	29	19.4	5.1	2.7	924	207
D0 : Cars	19	106.2	21.4	19.5	7993	1242
E1 : Shipbuilding, aircraft, train	23	57.2	10.0	8.6	3140	740
E2 : Non electrical equipments	95	13.3	2.3	2.0	584	201
E3 : Electrical equipements	55	75.5	14.1	17.1	2327	271
F1 : Ore mining and glass	25	14.0	2.2	2.4	1339	1044
F3 : Wood and paper	20	4.9	0.6	0.8	518	186
F4 : Basic chemicals and rubber	60	30.1	8.5	5.7	1059	294
F5 : Metalworking	46	12.8	1.9	1.9	1098	453
F6 : Electrical components	45	34.5	9.1	6.1	1230	550
Other industries	27	31.8	5.2	5.2	7304	876
Total	465	32.6	6.7	6.0	1858	401

Table 8 : Number of backward citations and technology sources

Asymptotic Least Squares estimates. The number of patents is instrumented by the logarithm of sales and the industry dummies. *Asymptotic standard errors between parentheses.*

Origin of knowledge:	All countries	France	EC	Non-EC Europe	USA	Japan	Others
Log(patents) instrumented	0.80** (0.07)	0.92** (0.12)	0.70** (0.08)	0.96** (0.20)	0.80** (0.09)	1.00** (0.12)	0.86** (0.08)
Technology sources							
External R&D	0.20 (0.16)	-0.07 (0.24)	-0.40* (0.24)	-1.74* (1.07)	0.04 (0.32)	-0.42 (0.41)	0.12 (0.48)
Cooperative R&D	0.65** (0.24)	0.67** (0.31)	0.31 (0.22)	1.06* (0.61)	0.51* (0.29)	1.23** (0.35)	0.93** (0.31)
Patents and licenses	0.37** (0.16)	0.46* (0.24)	0.55** (0.22)	-2.20** (0.86)	-0.10 (0.23)	-0.49* (0.28)	-2.27** (0.92)
Reverse engineering	0.26 (0.18)	0.38* (0.21)	0.14 (0.19)	0.07 (0.46)	0.38 (0.28)	1.02** (0.24)	0.06 (0.41)
Experts	-0.01 (0.19)	0.02 (0.26)	-1.16** (0.41)		-0.55 (0.62)	-1.34** (0.49)	
Equipment acquisition	-0.17 (0.19)	-0.39 (0.25)	0.03 (0.28)	1.60* (0.97)	0.69** (0.34)	1.05** (0.29)	
Employees hiring	0.05 (0.17)	0.05 (0.21)	0.61** (0.24)	0.93 (1.01)	0.71* (0.39)		
Communication with suppliers	0.06 (0.17)	0.13 (0.28)	-0.14 (0.23)	-2.21** (0.83)	0.68** (0.25)	0.14 (0.33)	-0.87* (0.48)
Communication with customers	-0.26* (0.16)	0.02 (0.27)	-0.24 (0.24)	0.02 (0.68)	-1.13** (0.52)	0.36 (0.35)	0.39 (0.33)
Firm buyout	0.49** (0.17)	0.73** (0.22)	0.05 (0.28)	-1.79* (0.93)	0.69** (0.28)		
Joint ventures and alliances	-0.04 (0.20)	-0.22 (0.41)	-0.28 (0.24)	2.48** (0.96)	-0.21 (0.31)	0.31 (0.26)	-0.09 (0.39)
Personnel exchange	0.04 (0.27)	-0.32 (0.38)	0.31 (0.28)		0.01 (0.42)		
Sources within the group							
R&D dept :							
- moderate	0.17 (0.22)	0.16 (0.30)	0.17 (0.28)	1.58* (0.86)	-0.14 (0.41)	-0.42 (0.33)	0.14 (0.22)
- strong	0.15 (0.20)	-0.07 (0.33)	-0.02 (0.27)	1.19 (0.83)	-0.16 (0.41)	-0.67* (0.35)	-0.08 (0.21)
Other departments :							
- moderate	-0.09 (0.20)	-0.03 (0.23)	-0.11 (0.28)	0.30 (0.44)	0.14 (0.41)	-0.29 (0.25)	0.19 (0.21)
- strong	0.73** (0.33)	0.89** (0.37)	0.93** (0.35)	1.56** (0.48)	0.57 (0.59)	0.88** (0.42)	1.03** (0.31)
Other sources							
Databases (incl. Patents) :							
- weak	0.47 (0.42)	0.98 (0.62)	0.77 (0.51)	1.25 (2.00)	0.49 (0.68)	1.49** (0.43)	0.60 (0.49)
- moderate	0.87** (0.40)	1.12* (0.65)	1.01* (0.52)	3.08 (2.13)	0.69 (0.65)	1.39** (0.43)	0.98** (0.49)
- strong	0.88** (0.42)	1.24* (0.67)	1.32** (0.55)	2.45 (1.94)	1.21* (0.66)	1.81** (0.50)	1.42** (0.48)
Conferences, publications :							
- weak	0.10 (0.44)	-0.02 (0.67)	0.40 (0.55)	-1.03 (0.98)	1.21 (0.91)	-0.07 (0.49)	0.23 (0.45)
- moderate	0.41 (0.41)	0.70 (0.65)	0.33 (0.54)	-2.12** (0.81)	1.30 (0.88)	0.21 (0.42)	0.46 (0.40)
- strong	0.51 (0.44)	0.51 (0.67)	0.53 (0.55)	-2.61** (1.25)	0.96 (0.95)	0.10 (0.50)	0.03 (0.42)
Fairs and exhibitions :							
- weak	-0.85** (0.35)	-0.90** (0.42)	-0.73* (0.44)	0.90 (0.74)	-0.18 (0.73)	-1.02** (0.45)	-0.43 (0.38)
- moderate	-0.80** (0.35)	-0.82* (0.43)	-0.72* (0.45)	1.13* (0.62)	-0.76 (0.75)	-1.31** (0.50)	-0.62 (0.40)
- strong	-1.11** (0.41)	-1.24** (0.56)	-1.14** (0.48)	2.72** (0.94)	-0.80 (0.68)	-1.79** (0.58)	-0.97** (0.45)
Industry dummies							
C3 : Pharmaceuticals	0.11 (0.39)	0.35 (0.50)	-0.26 (0.50)	0.68 (0.82)	-0.70 (0.46)	0.80 (0.62)	0.02 (0.47)
C4 : Houseware	0.57 (0.40)	0.11 (0.61)	0.52 (0.48)	1.11 (0.86)	-1.32* (0.82)	0.31 (0.82)	0.65 (0.55)
D0 : Cars	1.13** (0.50)	1.46** (0.64)	1.44** (0.52)	1.24 (0.98)	0.19 (0.74)	1.81** (0.68)	1.33** (0.54)
E1 : Shipbuilding, aircraft, train	0.39 (0.41)	0.76 (0.49)	0.60 (0.42)	-0.28 (0.91)	0.04 (0.63)	1.23* (0.72)	0.61 (0.51)
E2 : Non electrical equipments	0.44 (0.38)	0.24 (0.53)	0.16 (0.52)	-0.79 (0.78)	0.22 (0.51)	0.89 (0.69)	0.23 (0.49)
E3 : Electrical equipements	0.62 (0.46)	0.53 (0.62)	0.39 (0.48)	-0.67 (0.87)	-0.11 (0.67)	2.01** (0.69)	0.88 (0.57)
F1 : Ore mining and glass	0.48 (0.38)	0.81 (0.53)	0.30 (0.60)	0.45 (1.30)	-0.42 (0.73)	1.09 (0.78)	0.33 (0.56)
F3 : Wood and paper	0.01 (0.48)	0.49 (0.77)	-0.29 (0.63)		-1.41* (0.86)		0.01 (0.59)
F4 : Basic chemicals and rubber	0.30 (0.43)	0.06 (0.54)	0.43 (0.54)	0.50 (0.82)	-0.10 (0.79)	0.42 (0.62)	0.42 (0.48)
F5 : Metalworking	0.26 (0.39)	0.59 (0.52)	0.37 (0.50)	-1.20 (1.52)	-0.35 (0.68)	1.30* (0.77)	0.45 (0.54)
F6 : Electrical components	0.71* (0.43)	0.43 (0.57)	0.84* (0.46)	-1.57 (1.34)	-0.46 (0.57)	2.09** (0.66)	0.66 (0.49)

** significant at 5%. * significant at 10%.

Table 9 : Number of forward citations and technology transfers

Asymptotic Least Squares. The number of patents is instrumented by the logarithm of sales and the industry dummies. Asymptotic standard errors between parentheses.

Destination	All countries	France	EC	Non-EC Europe	USA	Japan	Others
Log(patents) instrumented	0.89 (0.07)**	0.89 (0.08)**	0.95 (0.08)**	0.63 (0.11)**	1.07 (0.10)**	1.31 (0.11)**	0.75 (0.15)**
Technology sources							
R&D done for another firm	0.07 (0.16)	0.21 (0.24)	0.04 (0.35)	0.67 (0.59)	0.41 (0.30)		1.82 (0.45)**
Patents and licenses	0.02 (0.19)	0.01 (0.32)	0.07 (0.24)	-0.43 (0.50)	-0.16 (0.30)	-0.11 (0.41)	-1.06 (0.64)*
Expertise	-0.31 (0.18)	-0.37 (0.26)	-0.44 (0.34)	0.50 (0.64)	-0.70 (0.87)		-2.09 (1.08)*
Equipment sales	0.74 (0.23)**	0.80 (0.25)**	0.70 (0.31)**	1.72 (0.38)**	1.02 (0.32)**	0.82 (0.46)*	1.64 (0.86)*
Employees departure	0.05 (0.21)	0.27 (0.26)	0.63 (0.33)*		0.20 (0.77)		
Communication with other firms	-0.22 (0.24)	-0.43 (0.27)	-0.35 (0.33)	-0.12 (0.72)	0.38 (0.31)		
Selling a part of the firm	0.84 (0.23)**	0.43 (0.35)					
Joint ventures and alliances	0.30 (0.17)*	0.56 (0.29)*	-0.23 (0.28)		0.43 (0.29)	-1.08 (0.53)**	-0.03 (0.65)
Industry dummies							
C3 : Pharmaceuticals	0.35 (0.30)	0.65** (0.31)	0.41 (0.26)	1.05 (0.89)	-0.12 (0.37)	0.93** (0.39)	-0.93 (0.84)
C4 : Houseware	0.14 (0.31)	-0.04 (0.32)	-0.52 (0.39)	-0.39 (1.25)	-0.41 (0.73)	0.02 (0.45)	-0.15 (0.98)
D0 : Cars	0.36 (0.32)	0.30 (0.35)	0.21 (0.28)	1.06 (0.81)	-0.85* (0.49)	-0.04 (0.48)	-0.28 (0.57)
E1 : Shipbuilding, aircraft, train	-0.04 (0.31)	0.21 (0.33)	0.01 (0.26)		0.30 (0.33)	-0.29 (0.28)	-0.64 (0.68)
E2 : Non electrical equipments	-0.23 (0.33)	-0.23 (0.34)	-0.32 (0.36)	0.98 (0.80)	-0.54 (0.35)	-0.33 (0.63)	-1.39 (1.04)
E3 : Electrical equipements	-0.27 (0.30)	-0.72 (0.47)	-0.37 (0.45)	0.45 (0.85)	-0.40 (0.48)	1.27** (0.38)	-1.28* (0.78)
F1 : Ore mining and glass	0.25 (0.30)	0.70** (0.34)	0.38 (0.29)	0.86 (0.91)	-0.34 (0.60)	1.09** (0.52)	-1.57 (1.16)
F3 : Wood and paper	0.01 (0.34)	0.44 (0.59)	-0.12 (0.55)		0.29 (0.50)	)	-1.04 (0.92)
F4 : Basic chemicals and rubber	-0.20 (0.30)	0.07 (0.30)	0.08 (0.23)	-1.47 (1.12)	0.11 (0.23)	0.59** (0.28	-1.19 (0.80)
F5 : Metalworking	-0.21 (0.27)	0.20 (0.30)	-0.19 (0.35)	0.64 (0.86)	-0.60 (0.49)	-0.06 (0.61)	-0.58 (1.13)
F6 : Electrical components	0.02 (0.25)	-0.11 (0.34)	-0.18 (0.25)	0.46 (0.86)	-0.03 (0.32)	0.95** (0.29)	-1.25 (0.83)

** significant at 5%. * significant at 10%.

Appendix 1: the CIS1 Survey in France

We used the parts 4 and 5 of the questionnaire that follows. The original questionnaire has two pages.

First page of the questionnaire :

REFERENCES : B CODE APE :

S E S S I

Pour tous renseignements concernant cette enquête, vous pouvez contacter
M. Stéphane LHUILLERY
Tél : (16.1)46 34 35 40

MINISTERE DE L'INDUSTRIE ET DU COMMERCE EXTERIEUR
à l'attention de M. ROBIN
S E S S I
85 BOULEVARD DU MONTPARNASSE
75270 PARIS CEDEX 06

Tél :
Nom de la personne ayant rempli le questionnaire :

COCHEZ LES CASES CORRESPONDANT A VOTRE REPONSE

INNOVATION TECHNOLOGIQUE

Echelle d'importance : 0 : nulle, 1 : faible, 2 :moyenne ; 3 : forte, 4 : très forte

1 - Durant les trois dernières années (1990, 1991, 1992), l'entreprise a-t-elle mis au point ou introduit ?	oui	non
1.1 des produits technologiquement innovants		
1.2 des procédés technologiquement innovants		

En cas de réponse négative aux deux questions 1.1 et 1.2., répondre uniquement à la question 9.

2 - Le ou les objectifs de l'innovation technologique sont de :	0	1	2	3	4
2.1 maintenir ou accroître votre part de marché en :					
2.11 remplaçant des produits devenus obsolètes					
2.12 améliorant la qualité des produits existants					
2.13 étendant la gamme des produits					
2.14 se tournant vers de nouveaux marchés géographiques					
2.2 augmenter vos marges en :					
2.21 donnant plus de flexibilité à votre production					
2.22 réduisant les coûts salariaux					
2.23 diminuant les consommations de matériaux					
2.24 abaissant la consommation d'énergie					
2.25 réduisant le taux de rebut des produits					
2.26 réduisant le cycle de conception des produits					
2.3 réduire les atteintes à l'environnement					

2.4 améliorer les conditions de travail et la sécurité dans l'entreprise					

3 - L'innovation technologique résulte de connaissances scientifiques et techniques acquises via :	0	1	2	3	4
3.1 DES SOURCES INTERNES DE VOTRE ENTREPRISE					
3.11 Le service de la R & D, le service des études					
3.12 Autres départements					
3.2 DES SOURCES INTERNES DU GROUPE AUQUEL VOUS APPARTENEZ					
3.21 Le service de la R & D, le service des études					
3.22 Autres départements					
3.3 DES SOURCES EXTERNES PUBLIQUES					
3.31 Laboratoires publics (CNRS, CEA, INRIA etc)					
3.32 Universités					
3.4 D'AUTRES SOURCES EXTERNES					
3.41 Centres techniques de professions					
3.42 Prestataires de services de R & D					
3.43 Sociétés de consultants					
3.44 Fournisseurs de matériaux et de composants					
3.45 Fournisseurs d'équipements					
3.46 Clients					
3.47 Concurrents					
3.5 DES INFORMATIONS GENERALES					
3.51 Consultations de banques de données, brevets, modèles, etc					
3.52 Conférences, réunions, publications professionnelles					
3.53 Foires, expositions					

Second page of the questionnaire :

4 - Votre entreprise a-t-elle acquis de nouvelles technologies par les voies suivantes (y compris à l'intérieur du groupe auquel elle appartient) ?

ORIGINE (réponses multiples possibles)	FRANCE	CEE hors France	EUROPE hors CEE	USA	JAPON	AUTRES
4.1 R&D sous-traitée ou acquise						
4.2 R&D effectuée en coopération avec d'autres entreprises ou institutions						
4.3 Droit d'utiliser les inventions d'un tiers (brevets, licenses)						
4.4 Analyse des produits concurrents						
4.5 Utilisation d'experts-conseils						
4.6 Achat d'équipements						
4.7 Recrutement d'employés qualifiés						
4.8 Communications avec vos fournisseurs						
4.9 Communications avec vos clients						
4.10 Lors du rachat d'une autre entreprise, en totalité ou en partie						
4.11 Joint-ventures ou alliances stratégiques						
4.12 Echange de personnel						

5 - A l'inverse, votre entreprise a-t-elle transféré à des tiers (y compris à des entreprises du groupe) de nouvelles technologies par les voies suivantes ?

DESTINATION (réponses multiples possibles)	FRANCE	CEE hors France	EUROPE hors CEE	USA	JAPON	AUTRES
5.1 R&D réalisée pour le compte de tiers						
5.2 Droit d'utiliser vos inventions (dont cessions de brevets ou licenses)						
5.3 Conseil et expertise pour d'autres entreprises						
5.4 Vente d'équipements						
5.5 Départ d'employés qualifiés						

5.6 Communication avec d'autres entreprises						
5.7 A l'occasion de la vente d'une partie de l'entreprise						
5.8 Joint ventures ou alliances stratégiques						

6 - Dans le cas où vous avez eu recours à la sous-traitance ou coopération de R&D, quelles ont été vos motivations ?	oui	non
6.1 Besoins en recherche fondamentale		
6.2 Besoins ponctuels en R&D		
6.3 Recherches complémentaires à votre technologie		
6.4 Réaliser des projets de recherche que votre firme n'aurait pas été à même d'accomplir seule		
6.5 Disposer à moindres coûts de résultat de recherche		
6.6 Mettre en compétition votre recherche interne		
6.7 Mieux identifier les coût de R&D		
6.8 C'est la politique du groupe		
6.9 Dissuader les concurrents potentiels		
6.10 Pratiquer une veille technologique		

7 - Quels sont vos sous-traitants ou partenaires de R&D ?	oui	non
7.1 Laboratoire central de votre groupe		
7.2 Autres sociétés de votre groupe		
7.3 Clients		
7.4 Fournisseurs d'équipements		
7.5 Fournisseurs de matériaux et composants		
7.6 Concurrents		
7.7 Experts-conseils		
7.8 Centres techniques		
7.9 Universités		
7.10 Autres laboratoires publics		

8 - Part de produits technologiquement innovants (moins de trois ans d'âge, qu'ils soient réalisés à l'aide de procédés anciens ou nouveaux) dans le chiffre d'affaires et les exportations en 1992 :

	de 0 à 10%	de 10 à 30%	de 30 à 70%	de 70 à 100%
8.1 $\frac{\text{C.A. des produits innovants}}{\text{C.A. total}}$				
8.2 $\frac{\text{Exportation des produits innovants}}{\text{Exportation totale}}$				

9 - Dans les trois prochaines années (1993, 1994 et 1995) votre entreprise a-t-elle l'intention d'introduire ou de mettre au point :	oui	non
9.1 des produits technologiquement innovants		
9.2 des procédés technologiquement innovants		

End of the questionnaire