The role of competences on patenting activities of learning regions : an empirical study on French data

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Abstract

In a learning region interactions between agents strongly determine the territorial capacities to create, develop and diffuse knowledge, and finally to innovate.. More precisely, the interactive model of innovation suggests that several different pieces of knowledge have to be mixed and shared between actors in order to win the innovative race. Indeed, in our current knowledge based economies a maximum of research inputs is not a guarantee of a high level of innovation any more. On the contrary, the entities (whatever their size) which succeed to combine efficiently different and sometimes complementary or conflicting "small" pieces of knowledge inside their borders, might reach unexpected and higher level of invention and i nnovation. But, because of the multiple facets of knowledge (tacit, explicit, individual, collective..) and of the potential barriers generated by geographic and/or cognitive distances, these knowledge combinations or re -combinations require specific abilities or competences. First of all, firms have to develop abilities to organise internally and efficiently around innovation (we call theses competences organisational and technical ones). Besides, firms try to benefit from external innovative ideas by deve loping critical interfaces (Pavitt, 1998). In other words, they try and acquire competences in collaborating with customers, suppliers, but also competitors, financers and public institutions so as to reduce their mutual cognitive misunderstandings..

So, we assume that thanks to a large range of complementary competences, firms try to cope with knowledge transmission problems and to keep as innovative as possible (exploiting every external innovative ideas). Using an original (quantitative and qualitative) data base on competences for innovation (Sessi, 1997), we precisely aim at testing this hypothesis. Concretely we run an econometric model evaluating the impact of competences mastered by firms of a region, on the innovative activity (proxied by the ratio patents/GDP) of the same region. We purposely choose to run the analysis at the regional level so as to minimize the geographic distance impact. Indeed, lots of existing articles already analyse the impact of geographic proximity on innovation. We rather a im at analysing the influence of cognitive proximity.

Our results allow us to highlight the core competences of innovative regions. We then build a typology of regions coupling the nature of competences a region has to master and its industrial specificiti es. Based on this typology we suggest some guidelines for policy makers: As regions differ in terms of industrial specificities, they also differ in the competences they have to develop and therefore differentiated innovative policies have to be run.

Introduction

In a learning region interactions between agents strongly determine the territorial capacities to create, develop and diffuse knowledge, and finally to innovate (COOKE and MORGAN, 1994). More precisely, the interactive model of innovation, developed by evolutionary theorists (ROSENBERG, 1982; NELSON and WINTER, 1982; DOSI et al., 1988), and enriched by new knowledge based ideas (ARGYRIS and SCHÖN, 1978; NONAKA, 1995; GIBBONS et al.,1997; COWAN, DAVID and FORAY, 2000), suggests that several different pieces of knowledge have to be mixed and shared between actors in order to win the innovative race. Hence, as modern economies enter the new era of knowledge and learning (MAILLAT and KEBIR, 1999) a maximum of research inputs does not appear to guarantee a high level of innovation any more. Indeed, because of the multiple facets of knowledge (tacit, explicit, individual, collective), but also because of potential geographic or cognitive barriers between the numerous actors of innovation, combining or re-combining efficiently different and sometimes complementary or conflicting “small” pieces of knowledge becomes crucial, and in the same time, requires specific abilities or competences.

Unfortunately, if this interactive dimension and the crucial role of knowledge is well acknowledged, only few empirical studies[1], as far as we know, try and isolate the qualitative determinants of innovation (NAUWELAERS and REID, 1995). Existing studies identify the various partners of innovation (Lundvall, 1992; Pavitt, 1998), but we don’t know which “interactive “ competence has to be prioritised in order to benefit from external sources of innovation. Do regions have to encourage cooperation with customers, suppliers, competitors, universities, others actors…? Neither do we find conclusions on the universality vs industrial specificity of these interactive competences for innovation. Nevertheless, at the time of the regional empowerment (both in France and Europe), tackling this point sounds useful in order to guide regional industrial policies.

In this context, our paper precisely aims first at identifying the key competences a region has to master in order to be innovative in its industrial activities. Second, we test whether these key competences are technologically specific or if they can benefit other regional industrial sectors. Indeed, if regions are perfect systems of innovation (Cooke et al, 1998), one should find positive links between innovation in a sector of a region and innovation in other sectors of the same region. Concretely, we use an original (qualitative and

[1] The literature on the impact of interactions with universities is nevertheless a noticeable exception.

quantitative) database on competences for innovation (Sessi, 1997), and run an econometric estimation of the impact of different categories of competences hold by firms of a region, on the innovative activity of the same region. Our results allow us to highlight the key competences for innovation and to sketch some guidelines for regional policymakers.

The remainder of the paper is organised as follows: first we shortly present our model. In a second step, we describe our data, insisting on their originality. The third part of the paper is devoted to the econometric results. Finally, we present the major political and theoretical implications of the study.

The model

In order to identify the significant regional competences for innovation, we choose to substitute R&D expenditures with indicators of competences in a "knowledge production function" framework (Griliches, 1979; Pakes and Griliches, 1980). Hence, we estimate the following modified Cobb Douglas model:

$$\ln I_{is} = \alpha + \sum_{k=1}^{k=7} \beta_k \ln comp_{kis} + \sum_{k=1}^{k=7} \delta_k \ln comp_{kiv(s)} + \sum_{k=1}^{k=7} \chi_k \ln comp_{kiw(s)} + \beta_m \ln pop_i + \beta_n DS_i + u_i \qquad (1)$$

where i indexes the geographic unit of observations, s indexes technological areas, v(s) refers to the set of sth neighbouring technological areas, w(s) refers to the set of sth non neighbouring technologies[2] and k indexes the category of competences. *I* stands for the level of innovation, *comp* is the number of competences *pop* refers to the population at the end of 1998 in thousands of inhabitants, *DS* is a dummy variable summarizing the impact of regional universities, and u_i the error term.

As suggested by the model, this article integrates intra regional spillovers, and do not take the potentiality for competences to spill over regional barriers into consideration. We purposely choose not to address the question of inter-regional spillovers (already well studied for France by Autant-Bernard, 2002) and to concentrate on inter-sectoral spillovers within the same region, since El Ouardighi (1997) shows that technological proximity generates higher spillovers than geographic one.

[2] See below for more details on the building and contend of these two subsets.

The data

The innovative output

We use patents[3] as indicators of innovation, keeping nevertheless in mind that " patents are flawed measure (of innovative output) particularly since not all innovations are patented, and since patents differ greatly in their economic impact" (Pakes and Griliches 1980, p.378). Actually, we choose to use patents counts as our dependent variable for several reasons: first Acs et al. (2002) recently show that "patents provide a fairly reliable measure of innovative activity[4]"; second Duguet (1999) concludes that patents are representative of [the part of] innovations which generate productivity gains, and third since it allows us to benefit from a huge and homogenous database for the French regions.

In the remainder of the study, a patent is said to belong to region i, if its inventor has a private address in region i[5]. In case of co-inventors (located in different regions), a fraction of patent (equal to the proportion of regional inventors) is attributed to each of the inventors' region.

In order to assign a patent to an industrial sector, we build a matrix of concordance between the 14 industrial sectors available in the database on competences, and the international patent classification (which distinguish 8 rough technological categories). We ground our matrix on the MERIT concordance matrix[6], coupled with the OST[7] suggestions and the INSEE[8] detailed sectoral nomenclature.

The competences

We use the database built by the Sessi (a research department of the French ministry of industry) in 1997. In this investigation (run on 5000 French industrial companies of more than 20 employees), firms are asked whether or not they master some "innovative" competences at the organisational level. 73 elementary competences are tested in the original dataset. We

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[3] Source: EPO data on European patent applications between 1997 and 2000. We are very grateful to Francesco Lissoni, Gianluca Tarasconi from Cespri for providing the data.
[4] The authors also mention that measuring innovation by patents lead to over -emphasize the effects of localized interactions, and to under-estimate the impact of local academic research spillovers. We will have to remind this biases in the interpretation of our results.
[5] We use the address of the inventor so as to cope with well known shortcomings of applicant's location (for an example of biases generated by applicant's location, see Mariani, 2000).
[6] Verspagen, Van Moergastel and Slabbers (1994)
[7] This French institution devoted to the building of databases on science and technologies has developed its own concordance matrix (OST, 2002, concordance table A5-1).
[8] The French National Institute of Statistics.

choose to aggregate the available competences into 7 broad categories[9] so as to build indicators reflecting the taxonomy created by Pavitt (1982, 1998) and empirically tested by Munier and Rondé (2001), Carrincazeaux, Lung and Rallet (1999). Indeed, these authors argue that firms can adopt different types of innovative strategies (internal research vs external research) and exploit different sources of innovation or "critical interfaces" in order to win the innovative race. We believe that exploiting an interface requires to master specific competences. Differentiating among competences appears useful so as to provide valuable advices to regional policy makers. Indeed, if we find that within the same region, sectors innovate through different logics, regional policy makers should adapt their industrial support to the industrial sectors they host and they might adopt differentiated intra-regional policies. Each of our 7 aggregated competences would then corresponds to one of the innovative sources identified in the mentioned literature and depicted in table 1.

Table 1: Typology of competences

Type of innovative strategy of the firm		Category of required competences	Description
Internal research		Organisational competences (K=1)	competences linked to human resources organisation and transversal knowledge generation - ability to focus and organise the firms around innovative projects
		Technical competences (K=2)	competences in managing and mastering in-house R&D and technologies but also in forecasting technological evolutions
External research	Technology push	Relations with public institutions (K=3)	collaborations with public institutions - scientists' hiring
		Relations with competitors (K=4)	ability to watch up its competitors but also to cooperate with other competing companies
	Demand pull	Collaborations with customers (K=5)	capacity to take the consumers' needs into consideration and to exchange knowledge and products with them
		Interactions with suppliers (K=6)	capability to choose and work with (and benefit from the knowledge of) highly innovative suppliers

[9] See appendix 1 for the exhaustive contend of each aggregated competence.

	Financially supported	Financial competences (K=7)	competences to cope with innovation costs thanks to various external financial supports

Finally, our explanatory variable $comp_{kis}$ is then the sum of all the elementary competences included in the kth aggregated competence mastered by all the firms located in region i and active in the sector s.

If the qualitative nature of the survey on competences seems quite valuable thanks to the huge information it gives on the various innovative facets of the firms, the Sessi database suffers nevertheless from some shortcomings. First, it is a declarative dataset; the answers are subjective and not checked. Our crucial assumption is then that firms do not lie when answering the inquiry. But above all, and what support our study is that firms are not allowed to give their opinion on the crucial (or useless) character of a specific competence for running an innovation. They only have to answer whether or not they master the 73 competences[10] the Sessi considers as needed when an innovation is at stake. In such a context, our study appears useful to complement this investigation and test (infirm or confirm) the innovative character of some of these competences.

Besides these data on competences, the Sessi dataset also provides indications on the regional location of firms, and on their industrial sector of activity. More precisely, the respondent firms are assigned to one of the 14 following industries: clothing and leather, printing, publishing and reproduction, pharmaceuticals and cosmetics, household appliances, car industry, shipbuilding, aeronautics and railway building, mechanical equipments, electric and electronic equipments, mineral products, textile, wood and paper, chemical industry and plastics, metallurgy and metal working and electric and electronic compounds. In order to sketch the French distribution of industrial competences, we calculate the number of aggregated competences developed by firms of these 14 industries. The results are summarised in appendix 2. This first and short description of the data on competences, supports our idea to run an econometric study at the industrial level. Indeed, all the sectors do not master the same kind of competences, and consequently, the industrial specialisation of a region might play a significant explanatory role in the link (or lack of link) between the level and the nature of competences hold by regional firms, and the innovative output of this precise geographic area.

[10] Among them, some competences do not sound specific to innovation (cf comp 703, comp 705, comp 101 in appendix 1).

The geographic unit

The geographic unit of analysis *i* coincides with the French "departments". As a consequence we have 94 regional observations per industry. A first reason for choosing this level is that data are not available at a smaller administrative division. Besides this technical argument, this choice is also motivated by theoretical reasons. Indeed, Orlando (2000) shows that inter-technological spillovers decrease as geographic distance increases. Using such a small geographical area would then be helpful for testing the impact of inter-technological spillovers.

The industrial proximity

In this study we choose to concentrate on spillovers generated by technological proximity, and neglect the effect of geographic proximity. To capture the similarity/dissimilarity of the industrial sectors, and build the technological neighbourhoods, we adopt an index freely adapted from Jaffe (1989)'s methodology. For each industrial sector, we build a "94*1" regional vector that summarizes the respective share of each region in the total amount of patents in this specific sector. Then we calculate the correlation coefficient between pairs of vectors (reflecting pairs of sectors) and use it as a measure of industrial proximities. So, a pair of sectors that have similar regional dispersion has an technological proximity index of 1, whereas sectors that are not present in the same regions score –1. Finally, sectors which exhibit an index of proximity higher than 0.6 with one another, are considered as nearest neighbours (*v*), whereas others sectors belong to the *wth* ensemble.

Thanks to this matrix of proximity, we can analyse the impact on the innovation of area I and sector s, of competences hold by firms located in region i but which are not active in sector s, but either in sth industrial neighbourhood or in technologically far activities.

The scientific impact

As a large part of the literature on knowledge spillovers insists on the beneficial role of public research for the innovative community, we add a dummy variable so as to catch the presence of hyper active universities in the region. More precisely, based on OST data, DS_i scores 1 if the number of publications per capita in the *ith* region is above the French average number, and scores 0 otherwise.

The results

The econometric estimation method

In this study we estimate our models thanks to an OLS regression. As our data on patents refer to a three-years period, we do not have to manage a high number of zero values[11] for our dependent variable. At this stage we neglect any spatial auto-correlation between the residuals and concentrate on spatial correlation of variables. In other words, if our estimators might be biased, we find them nevertheless useful to provide a first test of the economic impact of competences developed in non-s sectors on the innovative level of sector s.

Results on all industries

Table 2 summarises the results of the models we test on all industries.

[11] Anyway, in case of a zero value, 0.001 is added to all the patent data, in order to allow logarithmic transformation.

Table2: Econometric results on all industries (1316 observations)

	Model 1	Model 2	Model 3
Org Comp(s)	0.228 (0.157)	0.161 (0.146)	0.11 (0.138)
Tech Comp(s)	-0.122 (0.168)	-0.088 (0.157)	-0.123 (0.145)
Rel Cust(s)	0.246** (0.106)	0.262*** (0.099)	0.263*** (0.097)
Rel Fin(s)	0.045 (0.058)	0.051 (0.053)	0.038 (0.054)
Rel Comp(s)	-0.49*** (0.142)	-0.461*** (0.133)	-0.348*** (0.13)
Rel Supp(s)	0.121** (0.053)	0.112** (0.05)	0.124** (0.05)
Rel Univ(s)	0.209*** (0.035)	0.185*** (0.033)	0.194*** (0.033)
Org Comp(vs)	/	0.256 (0.163)	0.212* (0.128)
Tech Comp(vs)	/	-0.162 (0.2)	-0.113 (0.134)
Rel Cust(vs)	/	0.073 (0.15)	0.019 (0.123)
Rel Fin(vs)	/	-0.03 (0.068)	0.015 (0.062)
Rel Comp(vs)	/	-0.004 (0.167)	0.041 (0.125)
Rel Supp(vs)	/	0.082 (0.061)	0.071 (0.059)
Rel Univ(vs)	/	0.18*** (0.04)	0.184*** (0.038)
Org Comp(ws)	/	/	-0.153* (0.085)
Tech Comp(ws)	/	/	0.078 (0.095)
Rel Cust(ws)	/	/	0.105 (0.072)
Rel Fin(ws)	/	/	0.004 (0.058)
Rel Comp(ws)	/	/	-0.069 (0.101)
Rel Supp(ws)	/	/	-0.005 (0.047)
Rel Univ(ws)	/	/	-0.017 (0.035)
Scientific Dens	0.06** (0.025)	0.063*** (0.023)	0.074** (0.024)
Pop	0.36*** (0.029)	0.168*** (0.03)	0.159*** (0.032)
Adj R2	0.29	0.38	0.37

Whatever the econometric specification, firms located in a region benefit from the competences to innovate developed in their region but also from the regional scientific intensity. Indeed our results exhibit a positive and significant relation between 4 types of competences to innovate of regions and their innovative output (proxied by patents). Hence, substituting competences and scientific density to R&D expenditures in a knowledge production function "à la Griliches" proves sensible. Indeed, the values of the coefficient of each competence is higher than the one associated to scientific density. In other words, the impact of our qualitative[12] variables on innovation is larger than the one of our quantitative variables By stressing the significant role of the organisation of innovative means and competences in addition to traditional quantitative criteria (such as the scientific density), our knowledge production function also appears innovating *vis à vis* existing knowledge production functions, which quasi exclusively concentrate on the explanatory role of quantitative variables (RD expenditures, number of researchers…).

Besides, our results highlight the differentiated impact of each category of competences on the innovative activity of regions. More precisely, the significance of the estimators suggest that relational competences are the only crucial competences in the innovative race. What really matters is to spin close-knits relationships. Organisational and technical competences do not play a significant explanatory power in the innovative output of a territory. Hence, we confirm Asheim and Cooke (1999) and the RIS theorists' intuitions on the critical role of interactions so as to foster innovation. Our findings also corroborate conclusions obtained at the firm level, and presenting customer-supplier relationships as a major source of innovation (Nelson, Winter and Levinthal, 2001). In a word the relevance of the interactive model of innovation is empirically shown: the old and standard recipe for innovation (i.e high levels of internal R&D) does not seem valid anymore.

Among these relational competences, the one towards universities and public institutions exhibit a high and significant coefficient, whatever the econometric model. Developing *critical research interfaces* (Pavitt, 1998) with these institutions appears worth to increase regional innovative levels. By hiring scientists or running collaborations with universities, regional firms succeed to adapt the scientific knowledge to their own innovative needs. Hence, our study stresses that being located in a region which host a highly active university is beneficial per se for firms from the same region (as testified by the positive and significant coefficient of scientific density), but running active interactions with these public institutions is an additional source of innovation (cf the coefficient of rel pub(s)). These findings give twice support to the creation and development of incubators.

[12] Even if they are expressed in quantities, we consider our variables on competences as qualitative ones since they refer to different kinds of interactions

Besides and surprisingly, running technology watch, reengineering and benchmarking activities or even alliances, *vis a vis* the competitors, does not guarantee innovation (cf the coefficient of relations with competitors (s)). On the contrary it is as if firms develop their absorptive capacities (Cohen and Levinthal, 1989) so as to understand (and be able to imitate) their competitors' technology but do not put them into practice. One can imagine that these firms choose to hold these competences secret, but nevertheless ready if needed for running a strategic counter-attack.

Another point to be stressed is that competences mastered by regional firms in other industries than the sth one, do not significantly increase the innovativeness of regional firms in sector s (cf the lack of significance of the coefficient of non-s variables in model 3). Nevertheless this result need to be put into perspective. Indeed, when we split the non-s sectors into two different sets of industries (the neighbouring industries and the others), we find that intra-regional spillovers might occur between proximate industries: competences developed in non-s technologies (but by s technological neighbours v(s)) can benefit to other actors of innovation in other sectors but in the same region. For example, if the s-neighbouring industries have a strong capacity to develop relations with public institutions, they can indirectly increase the innovative output in the s-industry of their region (cf the positive and significant coefficiant of rel pub v(s)). It seems to be typically the case in biotechs: as chemical industries increase their relationships with the universities of their region, they can discover new molecules which would, in term, be used by the regional pharmaceutical industries, which would be able to apply for a new patent. To sum up, we can not exhibit integrated regional systems of innovation[13], in which all the competences of the actors of a region benefit exclusively but exhaustively to all the actors of this region. Nevertheless, some specific competences can generate spillovers within technological neighbourhood.

These first results need to be tested at the industrial level, in a second time. Indeed, appendix 2 shows that the level and the kind of competences mastered by firms are strongly industry-dependent. Moreover, the propensity to innovate is also industry dependent (Von Hippel, 1994). In such a context, we choose to test whether or not the previous findings are industry dependent. As non neighbouring technological areas have been shown as non

[13] At least we can not conclude to such an effect with our indicator of innovation.

significant to explain the level of innovation of a sector, we neglect them in the next section, and only estimate model 2 at the industrial level.

Industry by industry

The exhaustive results industry by industry are presented in appendix 3. Table 3 only summarizes the significant effect at 5%. A table of concordance between the industrial codes and the industrial activities is provided in appendix 4.

Table 3: Econometric results per industry: sum-up of significant effects at 5%

Sectors	Effects of competencies mastered within the regional sector	Effects of regional competencies in neighbouring sectors	Control variables
C1	Relations with customers(+) Financial relations (+)	Organisational Competences (+) Relations with competitors(+) Technical Competences (-)	
C2	Relations with competitors(-)	Relations with competitors (+)	
C3	Relations with suppliers(+)	Relations with universities(+)	Pop (+)
C4		Relations with universities(+)	Pop (+)
D0		Organisational Competences (+) Technical Competences (-) Relations with competitors(-)	
E1	/	/	Pop (+)
E2	/	Relations with competitors(+) Relations with universities(+)	Pop (+)
E3	/	/	/
F1	Relations with competitors(+)		Pop (+)
F2		Organisational Competences (+) Relations with competitors(+) Relations with customers(-) Financial relations (-)	Pop (+)
F3		Financial relations (-)	Pop (+)
F4	Relations with competitors(+)	Relations with universities(+)	Pop (+)
F5	/	/	Pop (+)
F6	Relations with suppliers(+)	Relations with suppliers(-)	Scientific density (+)

The first point to focus on is that the results at the level of the industry strongly differ from the ones obtained for all industries. Indeed, the level of innovation in a specific sector of a region does not systematically depends on the number of competences mastered by firms of this sector. Only 5 industrial sectors (clothing and leather, pharmaceuticals, mineral products, chemistry and electric and electronic compounds) exhibit a positive link between the level of competences in their sector and their innovative output. Within this group of 5 sectors, the categories of competences a sector has to hold in order to be innovative differ: for example, the propensity to patent in the pharmaceutical industry and in electric and electronic compounds positively depends on the capacity of firms of these two sectors to develop strong and frequent interactions with their suppliers (cf table 3). Besides, firms of the clothing and leather industry can increase their level of innovation by investing time and money in building relations with their customers and their financers. Lastly, mineral products industry and chemistry use another source of innovation within their industry: they innovate through imitation by exploiting their close-knits relationships with their competitors.

If only 5 sectors innovate thanks to their own competences, 10 industries out of the14 of our sample, innovate thanks to the competences of their technological neighbours. Indeed, the mineral products industry, shipbuilding, electric and electronic equipments and metallurgy are the only sectors whose level of innovation are not significantly (even partially) influenced by the level of competences of their industrial neighbours. Among the 10 industries which exhibit links with their technological neighbours, some common features emerge. First, relations with universities is always associated with a positive coefficient. It confirms results found in our estimations on all industries, and encourage regions to support active collaborations with universities. Indeed if firms do not directly benefit from their interactions with public institutions, they might at least generates positive feedback at the regional level (to their technological neighbours). Second, financial relations exhibit a negative sign, suggesting that when sth industrial neighbours benefit from large financial support, the level of innovation in sector s is reduced. It is as if a tough competition for financial support was at stake at the regional level. Again, regional policy makers can take it into considerations and provide their local industries with larger financial support. Lastly, relations with competitors developed by neighbours are either positive or negative for sth innovation. At this stage, we don not have any reasonable explanation for this industrial-dependent coefficient.

Theoretical and political implications

To sum up, each industry innovates thanks to different mechanisms of interactions: a first group of industries bases its level of innovation on relational competences developed within themselves, whereas industries of the second group mainly innovate thanks to inter-industrial spillovers generated by the relational competences of their neighbouring industries, and of course, these two groups are not mutually exclusive, but overlap. Consequently, as regions differ in terms of industrial specificities, they also differ in the competences they have to develop and therefore in the industrial innovative policies they have to undertake. Nevertheless, if our results conclude in favour of differentiated regional industrial policies, they also emphasise the danger for regions to adopt and support a deep industrial specialisation. Indeed, since most of the sectors benefit from their neighbours' competences, reducing the level of industrial diversity of a region can reduce or even annihilate the positive effects of inter-industrial spillovers on the innovative output of the region.

From a theoretical point of view, these results prove that the traditional interactive model of innovation is not valid for all industries. Indeed, developing interactions with the customers, suppliers or competitors within the sector, is a way to increase innovation only in 5 sectors. On the other hand, most of the sectors benefit from their neighbours' competences. In other words, rather than investing in the building of relationships within a sector, firms and territories must be encouraged to keep up or gear up their relations with their industrial neighbours. Hence, the interactive model of innovation is still accurate, but it should integrate interactions between actors of innovation of different industries.

APPENDIX 1 : CATEGORIES OF AGGREGATED COMPETENCES

Category 1 : Organisational competences

Elementary areas of competence	Variable
Inventory of areas of competence of the company	comp106
Global vision of the company for each employee	comp107
Structuring of the company around innovativ e projects	comp301
Implication of all the services from the earliest phase of innovation	comp302
Joint work to innovate	comp304
Mobility between the services	comp305
Incentives to formulate new ideas	comp401
Autonomy of the individuals to innovate	comp402
Valorisation of the originality and the creativity of the individuals	comp403
Acceptance of creative behaviours that are not directly productive	comp404
Rewarding the original ideas that have been selected	comp405
Pooling of knowledge	comp407
Evaluation of the contribution of each one to the production of the knowledge	comp409
Identification of the knowledge and strategic know -how	comp607
Identification of the persons holding strategic know -how	comp608
Motivation of the persons holding the stra tegic knowledge	comp611
Localising the current and future specialists	comp701
Evaluation of the propensity to innovate during the recruitment procedure	comp702
Transparency of the evaluation for everybody and reward of the best	comp704
Transparency of the mobility rules	comp705
Assessment of the needs in training programmes (all personnel)	comp706
Making everybody aware of the need for adapted training	comp707
Evaluation of the impact of training on the innovation process	comp709
Reward for useful training	comp710

Category 2 : Technical competences

Elementary areas of competence	Variable
Effectiveness and quality control of the production	comp101
Technological evaluation of the products which the company is likely to produce	comp102
Evaluation of the processes the company is likely to adopt	comp103
Evaluation of the organisations the company is likely to adopt	comp104
Carrying out a technological assessment of the company	comp105
Test of innovating products and processes in their operational contexts	comp303
Analysing flaws and breakdowns of the new processes	comp306
R&D	comp504

Category 3 : Competences in collaborating with customers

Elementary areas of competence	Variable
Analysing the nature (segmentation) and the needs of the custome rs	comp204
Collecting customers reactions at after -sales services or retailers	comp205
Using the product as a source of information about the customers satisfaction	comp206
Testing the ultimate consumer	comp207
Identifying new behaviours and pioneering consumers	comp208
Special offers for new products	comp901
Determination of the target, the media, and the type of message for advertising new products	comp902
Company's innovation image	comp903

Category 4 : Competences in finance

Elementary areas of competence	Variable
Anticipation of the whole set of the costs of innovation	comp801
Ex post evaluation of the cost of old innovations	comp802
Knowing the private and public modes of financing innovation	comp803
Communication strategy towards potential financial partners of innovation	comp804

Category 5 : Competences in relations with competitors

Elementary areas of competence	Variable
Analysing competing products	comp201
Analysing patents of the competitors	comp202
Analysing publications of the competitors' engineers	comp203
Comparative evaluation of the collective production of knowledge (*vs* competitors)	comp408
Knowing competitors technologies	comp501
Technology survey	comp502
Test of external technologies	comp503
R&D alliances with other companies	comp506
Using external inventions (patents, licences)	comp508
Partial or total purchase of companies (motivated by innovation)	comp510
Joint-ventures, various strategic alliances and forms of co -operation	comp511

Category 6 : Competences in interacting with suppliers

Elementary areas of competence	Variable
Fast adoption of the technologically new equipment	comp307
Fast adoption of the technologically new supplies	comp308
Subcontracting or acquisition of R&D	comp505
Subcontractor of highly technological components	comp512
Absorption capacities of the knowledge incorporated in the innovating equipment and components	comp513

Category 7 : Competencies in relations with public institutions

Elementary areas of competence	Variable
R&D partnerships with public organisations	comp507
Recruitment of employees of high scientific qualification to innovate	comp509

APPENDIX 2 : INDEXES OF SECTORAL COMPETENCES

	Organisational	Technical	Customers	Finance	Competitors	Suppliers	Public institutions
clothing and leather	4303	1710	1090	402	965	371	98
printing , publishing and reproduction	4093	1757	1190	406	1205	405	63
pharmaceuticals and cosmetics	3239	1539	1118	330	1161	421	227
household appliances	4609	2037	1461	463	1427	545	141
car industry	2986	1343	742	311	966	361	125
shipbuilding, aeronautics and railway building	1750	805	462	215	597	239	96
mechanical equipments	10331	4823	2767	1189	3254	1135	413
electric and electronic equipments	5248	2319	1495	574	1824	753	299
mineral products	4104	1927	1079	427	1356	412	144
textile	3712	1736	1004	415	1126	410	104
wood and paper	4052	1897	1176	428	1308	403	124
chemical industry and plastics	8408	3851	2291	878	2879	1026	411
metallurgy and metal working	9806	4533	2075	1019	2835	1090	323
electric and electronic compounds	4188	1921	1015	450	1336	552	170

Data source: Sessi (1997)

APPENDIX 3 : ECONOMETRIC RESULTS AT THE INDUSTRIAL LEVEL (94 OBSERVATIONS PER INDUSTRY)

	C1	C2	C3	C4	D0	E1	E2	E3	F1	F2	F3	F4	F5	F6
Org Comp(s)	-0.562*	-0.175	-0.921	1.155	0.153	-2.4	0.803	-1.477	-1.462	-0.167	1.449	0.129	0.078	-0.42
	(0.294)	(1.265)	(1.509)	(1.016)	(1.92)	(1.861)	(0.839)	(2.523)	(1.166)	(0.964)	(1.255)	(0.474)	(0.365)	(0.578)
Tech Comp(s)	0.539	0.827	-0.075	-0.153	0.091	3.61	-0.877	1.249	-1.311	0.315	-0.071	-0.846	-0.143	1.385
	(0.466)	(1.218)	(0.495)	(0.613)	(2.155)	(2.371)	(0.902)	(2.701)	(1.115)	(0.439)	(1.611)	(1.113)	(0.447)	(0.885)
Rel Cust(s)	0.926**	0.384	0.987	0.084	-0.423	-0.137	-0.262	-0.82	0.275	0.381	0.122	-1.298	-0.015	-0.405
	(0.389)	(0.275)	(1.305)	(0.422)	(1.022)	(0.515)	(0.38)	(0.516)	(0.395)	(0.299)	(0.503)	(0.961)	(0.274)	(0.37)
Rel Fin(s)	0.356**	-0.103	0.091	-0.058	0.058	-0.419	-0.333*	0.193	0.035	-0.181	-0.031	-0.027	0.024	-0.115
	(0.178)	(0.166)	(0.221)	(0.189)	(0.215)	(0.453)	(0.194)	(0.353)	(0.180)	(0.222)	(0.235)	(0.275)	(0.219)	(0.207)
Rel Comp(s)	-1.026*	-0.991**	-0.654	-1.078	0.44	-0.974	0.659	0.638	2.289***	-0.524	-1.492	2.291**	-0.083	-0.808
	(0.522)	(0.428)	(0.516)	(0.975)	(0.486)	(2.178)	(0.41)	(0.795)	(0.859)	(0.971)	(1.149)	(1.132)	(0.478)	(0.88)
Rel Supp(s)	0.051	-0.13	0.837**	0.058	-0.082	0.286	0.122	0.374	0.056	0.195	0.026	-0.171	0.247	0.604***
	(0.163)	(0.168)	(0.343)	(0.189)	(0.288)	(0.383)	(0.157)	(0.279)	(0.173)	(0.16)	(0.236)	(0.184)	(0.175)	(0.192)
Rel Univ(s)	-0.07	0.171	-0.047	0.076	-0.02	0.085	0.061	0.106	0.066	0.22	0.162	0.121	0.161	0.051
	(0.12)	(0.112)	(0.167)	(0.126)	(0.125)	(0.153	(0.119)	(0.238)	(0.124)	(0.133)	(0.135)	(0.117)	(0.109)	(0.1)
Org Comp(vs)	2.715**	0.022	0.571	0.746	1.492**	-0.037	-0.217	0.657	1.35	1.032**	0.777	0.063	-0.607	-0.582
	(1.084)	(0.73)	(0.833)	(0.785)	(0.661)	(0.71)	(0.687)	(0.616)	(1.09)	(0.493)	(0.623)	(0.9)	(0.589)	(0.697)
Tech Comp(vs)	-3.22***	-0.094	0.418	-0.16	-1.436**	-0.502	-0.84	-0.418	-1.167	-1.463	-2.025	-0.138	-0.517	0.917
	(1.187)	(0.789)	(0.787)	(0.709)	(0.631)	(0.803)	(0.713)	(0.628)	(1.208)	(1.229)	(1.383)	(0.969)	(1.101)	(0.793)
Rel Cust(vs)	-1.435	-0.772	-0.401	-0.534	0.429	0.148	0.165	-0.458	0.696	-2.306**	0.526	0.168	0.659	0.316
	(0.735)	(0.651)	(0.545)	(0.536)	(0.493)	(0.655)	(0.45)	(0.547)	(0.859)	(1.051)	(1.222)	(0.502)	(0.44)	(0.614)
Rel Fin(vs)	-0.075	-0.186	-0.504	0.523	0.23	0.397	-0.276	-0.277	-0.37	-0.634***	-0.74**	-0.108	-0.162	0.499**
	(0.186)	(0.233)	(0.428)	(0.431)	(0.208)	(0.254)	(0.198)	(0.455)	(0.266)	(0.307)	(0.363)	(0.21)	(0.244)	(0.198)
Rel Comp(vs)	2.167***	1.536**	-0.549	-0.741*	-0.697**	0.659	1.432***	0.464	-1.055	3.465***	1.247	-0.198	0.75	-0.593
	(0.81)	(0.634)	(0.558)	(0.408)	(0.307)	(0.421)	(0.522)	(0.69)	(0.76)	(1.229)	(1.423)	(0.353)	(1.04)	(0.616)
Rel Supp(vs)	0.022	-0.204	0.237	-0.032	0.237	-0.505	-0.323*	-0.106	0.09	0.152	0.135	-0.045	0.135	-0.717***
	(0.173)	(0.246)	(0.411)	(0.347)	(0.194)	(0.308)	(0.165)	(0.425)	(0.293)	(0.201)	(0.248)	(0.251)	(0.225)	(0.22)
Rel Univ(vs)	-0.012	0.045	0.353**	0.32**	0.183	-0.037	0.296**	0.224	0.189	0.088	0.222	0.299*	-0.019	0.463***
	0.157)	(0.205)	(0.164)	(0.152)	(0.162)	(0.142)	(0.127)	(0.17)	(0.168)	(0.134)	(0.153)	(0.161)	(0.117)	(0.172)
Scientific Dens	0.063	-0.036	0.162*	0.028	0.059	0.094	0.023	0.139	0.097	0.037	0.037	0.063	0.158*	0.144*
	(0.098)	(0.102)	(0.085)	(0.093)	(0.091)	(0.102)	(0.065)	(0.09)	(0.099)	(0.091)	(1.104)	(0.08)	(-0.09)	(0.075)
Pop	0.343***	0.189	0.361**	0.505***	0.12	0.46***	0.494***	0.359*	0.726***	0.244**	0.321**	0.542***	0.271**	0.201
	(0.128)	(0.187)	(0.173)	(0.153)	(0.141)	(0.149)	(0.109)	(0.183)	(0.158)	(0.109)	(0.135)	(0.132)	(0.129)	(0.123)
Adj R2	0.37	0.28	0.49	0.39	0.41	0.28	0.69	0.48	0.33	0.46	0.24	0.54	0.42	0.60

, **, * represent significant values at respectively 1%, 5% et 10%.*
Data : SESSI (1997), EPO (1997-2000)

APPENDIX 4 : CORRESPONDENCE TABLE BETWEEN INDUSTRIAL CODES AND INDUSTRIAL SECTORS

Code	activity
C1	clothing and leather
C2	printing , publishing and reproduction
C3	pharmaceuticals and cosmetics
C4	household appliances
D0	car industry
E1	shipbuilding, aeronautics and railway building
E2	mechanical equipments
E3	electric and electronic equipments
F1	mineral products
F2	textile
F3	wood and paper
F4	chemical industry and plastics
F5	metallurgy and metal working
F6	electric and electronic compounds

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