

## **Impact of Co-operation and Competences on the Innovating Behavior: A Micro-econometric Study of the French Firms**

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**ABSTRACT:** The analysis of innovative behavior is suited to several ways of comments. The economic literature emphasizes, in many cases, different effects of innovation in products and processes on international trade, growth, employment and the firms performance. However, little knowledge about the impacts of competence and inter-firms co-operation on the innovative behavior (products or/and processes). According to a more empirical approach, incorporating both the “cooperation’s effect” and “competence’s effect”, we have tried to explain such innovative behavior. The results which led this article can qualify some gains with regard to incentives for innovation on the one hand, and put into perspective a new approach to innovative behavior (cooperation / competence, which by joint analysis of co-operation agreements and skills can explain the development of these innovative behaviours, on the other. Based on our results and on limits and extensions associated with them, it appears that the innovative behavior of the firm (products, processes, or products & processes) is not only a reflection of motivation strategic businesses, but also their types of skills underlying any engagement in a co-operation agreement. Thus, innovation policy unveils partly the interest shown by business groups (government, university) with respect to the co-operation agreements in R & D.

**Keywords:** Innovative behaviour; Innovation; Co-operation; Competence; R & D

**JEL Classifications:** C23; O43; O47

### **1. Introduction**

Teece et al., (1986) underlined the role of the complementarities of credits in the development of innovations, by showing that these complementarities could justify to develop a co-operation to reach credits held by the partner. However, Cohen and Levinthal (1990) insist more on the function of training (which they associate to function of absorption) of the in-house R&D developed by the firm. In particular, they note that it gives firms the capacity to identify and to exploit knowledge coming from its environment. This work thus not only insists on the possibility with choosing its partners to improve cooperation, but also identifies the future links to be woven between in-house held competences and those of the partners. More precisely, it appears necessary to hold specific competences to be an attractive partner in a co-operation. In the same way, the question of the creation of knowledge, resources and competences raised few considerations in the literature dedicated to the agreements of R&D. But, in this case, it is crucial to get a well-understanding of which types of competences are created jointly, as well as to know which organisational form is more adapted to the development of such resource or competence.

Precisely, we will try to answer the following questions:

-Have all companies’ capabilities to take part in industrial alliances and strategies (private or public), to carry out R&D projects and to innovate? Cohen and Levinthal (1990) indicate, are the firms all "equitably well placed", to take part in such relations of co-operation?

-Do firms have the same chances to join some partners to carry out efficiently R&D projects and innovation?

-Which competences are necessary or held by the company to innovate and benefit from its innovations? The link Competence- Co-operation -innovation is essential to design an agreement of alliance satisfying technological competences of each firm.

The aim of this article is to enrich an apprehension by an alliance under the angle of competences which plays a role in determining the co-operative behaviour of firms. It is not only useful to see how an alliance ensures the transfer and the acquisition of new technologies, but also to show that the involvement of a firm in an agreement of alliance relies on a mobilization of competences technological specific to this same firm. In a second section, we will briefly review the literature on the innovating behaviour. The third section describes the data and the sample of French companies will be elaborated. The last section reports our results.

## 2. Literature Review of the Triptych Competences - Strategic and Industrial Alliances – Innovation

Some previous works identified the complementarities between the contractual approaches and those founded on competences. The analysis of the co-operations already raises some consideration among researchers. Many authors argue that the co-operations are used by firms to acquire or create new resources (Hamel and Prahalad, 1990; Quélin, 1996). They confirm the need for firms to widen their basis of competences to make their technological development successful. Thus, their attention has been orientated to the analysis of what motivate firms to create inter-firms alliances:

- To obtain economies of scale in R&D area;
- to allow an acceleration of innovation, either in its minor or incremental form (improvement of products and known processes), or in its major or radical form (appearance of a new product or process), within the allied firms;
- to measure the contribution of knowledge of the users with accumulation of technological credits carried out within the company (learning by searching and learning by doing). Arrow (1962) wrote that profits of productivity can result from a better knowledge of built-in technology. Another technical knowledge is also added on the products: learning by using, through a long-term and repetitive use. This type of knowledge is different from the one acquired in a laboratory, which explains alliances between users and producers.
- to reduce the risk of uncertainty,
- to result in adapting other complementary credits (access to specialized credits);
- to adjust regional and environmental externalities.

More precisely, the firm develops competences to innovate and the innovation generates news competences. Thus, the innovation implies interactions between intra- and inter-firms, and it generates a double principle of increasing and capitalizing in competences. Therefore, the whole competences determine the innovative as well as how a firm adapt to its environment. Productive competences, marketing, human resources, financing must be thus taken into account. They express the possibility of assimilating internal and external information, creating knowledge developing capacities, and raising new questions and bringing new answers there to innovation process (Heene and Sanchez, 1997).

The innovation leads to a dynamic of competences (Dosi and Winter, 2003). Thus, the recourse to the co-operation gives access certain know-how without having to develop them in-house. In this connection, Quélin (1998) wrote: *"a company can wish to develop its new capacities on one only intern bases, but risk to be locked up in the coherence of its choices passed, or limited in its access to competences necessary for its future development"*.

The link between competences and innovations has a double influence and takes various methods. On the one hand, competences play a role determining in the development of the complex innovations requiring the specific resources and the cognitive practices. On the other hand, the technological innovations are also source of reinforcement of existing competences or development of new competences. This last step finds its origin in the process of "creative destruction": if the technological innovations are nothing other than ruptures with practices and technologies former, they also allow the creation of new competences (or at least modification of those which exist).

The relation between co-operation and innovation often marks a bond of causality of the co-operation towards the innovation. The technological co-operation is perceived at the same time like:

- i) a vector of minimization of the costs and risks related to the increasing complexity of the projects technological (compromise logic of allowance of the resources) and,
- ii) a vector of creation of new technologies by the means of the pooling of the complementary credits (logic of creation of resources).

Competences of the firm are not homogeneous and are of different nature. As the source of differentiation of the firms, competences are gathered in two sets. If technological competences rest mainly on the resources specific to technological character, organisational competences have a cognitive dimension and primarily find their gasoline in evolutionary work. It is thus, for example, which Arora and Gambardella (1994) seek to establish a links between internal competences of the firm and its capacity to be engaged in cooperation agreements. They show that in the case of the industry of biotechnologies in the United States, the intensity in R&D (regarded as revealing of the capacity of the firm using external knowledge) exerts a positive effect on the number of cooperation agreements concluded with other firms. The intensity in R&D improves technological competences of the firm and their capacity to use new knowledge. The analysis of Rosenberg (1990) comes to corroborate the idea according to which fundamental research inter-firm. This idea is essential to the monitoring and the control of scientific flows of information in the external world. In the same line of reflexion and being interested more particularly in the problems of imitation, the model developed by Levin et al., (1987) show that the independent R&D carried out in-house is considered by the managers of R&D of the large American firms the most effective mechanism of the imitation. The econometric study in our second section will explore how organisational competences, technological competences, competence gone, competence in human stock management, co-operation etc. influence the involvement of the firms in a process of innovation and if they cause organisational advantage for the firms which innovate.

### **3. Data and Methodology**

In spite of the theoretical recognition of a more or less direct relation between the strategy of alliances and competences to innovate of the firms, the empirical studies are rare or unsatisfactory. The objective of this work is thus to bring an empirical study by using French companies dataset. The idea that we defend here should contribute to enrichment on the theoretical and empirical level of this novel design of the firm and the relations of alliances. Mowery et al., (1998) underlines it, many of the theoretical work on the concept of alliances -competences- innovations lack empirical validation. Our work intends to fill this gap in order to explain to the relation between alliances strategic and industry, according to the approach of competences. For this purpose, the investigation into competences of the firms to innovate realized by the service of the industrial statistics (SESSI) in 1997 (minister of the economy, industry and finances), constitute our principal source of information.

#### **3.1. Data**

Our dataset results from an investigation carried out by the SESSI during 1994-1997. This one was carried out with around 5000 French industrial companies of more than 20 employers. The rate of answer is 83% in a number of units and more than 95% in terms of sales turnover.

Retake the terminology suggested by the SESSI, the companies answered a bearing questionnaire on the detention of 73 competences (known as "elementary competences") gathered according to "great competences "or" complex competences". All 73 competences constitute the total competence of the company. The competences measured in the investigation are those on the level of the company, i.e. organisational competences. It is a question of knowing if a company has a competence related to the process of innovation. The choice of the investigation thus consists of exploring the relation between competences and the innovation, i.e. up to what point the companies are qualified to innovate. Thus, the question concerning the link between innovation and competence (i.e. the fact that the innovation makes it possible to develop competences) are not approached. Being given the qualitative nature of the data, it will then act to explain the probability of carrying out technological innovation of the products or processes, according to engagement of a company in relation of an industrial and strategic co-operation and competences (technological and organisational). The logistic models are particularly suitable to estimate this probability. The results of the logistic regressions will show that the capacity of absorption of external technologies, the capacity of innovation as well as organisational competences are the fundamental competences by increasing the probability of technological collaboration.

#### **3.2. Methodology and Expected Effects of the Co-operation and Competences on the Innovation**

The information which we lay out is statistical data related to a unit of companies observed in 1997. With the data, the number of observations can be significant and the diversity of the individual situations of the companies offers, when the variables are available and necessary, the economic

possibilities of investigation differently more precise than on aggregate series. The number and the detail of information, reveal the complexity of the phenomena to be studied and an impossibility of applying several traditional econometric methods directly. It is thus a motivation for us to look further in the problems of application of the econometric methods to our data in this context. The empirical analysis is based on a model of Logit regression determining the probability of carrying out technological innovation of the products or processes in function:

- of the type of co-operation (in R&D with other companies; cooperation agreements in R&D with institution public; strategic joint-ventures, alliances and other forms of cooperation to innovate).
- of Technological and Organisational Competences
- of the variables of intellectual Property

The links which are generally explored between innovation and competences is about causality. Which competences a process of innovation develops it within the company? the innovation is a condition of survival of the company, i.e. when it evolves/moves in a context "Schumpeterian" where each dominant position on a market can be called into by a concurrent innovation (process known as of creative destruction) (Nelson and Winter, 1982).

A distinction is usually made between innovations of products (corresponding to the marketing of a new product) and the innovations of processes (corresponding to the development and the adoption of methods of production or distribution news or notably improved). Compared with these definitions, Gaffard (1990) notices that an innovation of product for the firm can be an innovation of process on the level of the sector (when the innovation is bought and used in the same sector), and an innovation of process for the firm can be an innovation of product on the level of the sector. On the other hand, this definition cannot account for the technological qualification level acquired by the firm. Nothing says if an innovation of product, compared with innovations of process, requires more (or less) technological competence or if it is at the origin of their development (or of their stability, even their destruction). An alternative classification of the innovations, according to their nature at least radical in comparison with the changes than they cause, seems to give an idea relatively clearer to their impacts on competences of the firm. An innovation is known as radical (or major) when the technological characteristics or the envisaged uses present significant differences compared to that produced before. Such innovations can rest on new technologies or the association of existing technologies in new applications. On the other hand, an innovation is known as incremental when it is a question of an improvement of the performances of a product or an already existing process. The innovation, in this last case, slightly modifies the already established practices.

**Table 1. The list of variables**

<b>Endogenous Variables (Innovation)</b>		
Y1: Innovation in product and/or process		Y2: Innovation in product
<b>Exogenous variables</b>		<b>Expected effects</b>
RDCOPESE	R&D in co-operation with other companies	+
RDCOOPUB	R&D in co-operation with Public institution	+
JVALL	Participation in joint-ventures, with strategic alliances and other forms of cooperation to innovate	+
INVBREVLIC	Use other's inventions (patent, licences)	?
EMPHAUTQUALIF	Recruitment employees of high scientific qualification to be innovated	?
ACHATESE	Buy companies, entirely or partly, to innovate	?
CONNAISSANCE	Absorption to it knowledge incorporated in the equipment and the innovating components	?
TRAVEQUIPE	Support you team work or joint to innovate	?
MOBILEMP	Support of mobility between the services to innovate	?
TECHCONCURRENT	Know you to them technologies of the competitors	?
TECHFUTURE	Know you to them technologies of the future (survey technological)	?
TECHEXT	Test them external technologies	?
DEPOBREV	Choose to settle (or not to deposit) an industrial document of title according to the total benefit of the company	?

The model (table 1) consists of estimating the probability of carrying out an innovation in products or processes according to the cooperation agreements and competences. Let's consider,

$$X_{i_k} = [RDCOPESE, RDCOOPPUB, JVALL, INVBREVLIC, EMPHAUTQUALIF, ACHATESE, CONNAISSANCE, TRAVEQUIPE, MOBILEMP, TECHCONCURENT, TECHFUTURE, TECHEXT, DEPOBREV]$$

Where:  $i = 1, \dots, N$  (is the index of the companies), and;  $k=1, \dots, K$  (index of the exogenous variables).

$Y_i$  : is observations on the endogenous variable of company  $i$ .

Its general formula is:  $y_i = \sum_k \beta_{ik} x_{ik} + \varepsilon_i$

Our endogenous variable with 2 methods, yes/no, is a dichotomic variable. In comparison with the nature of our endogenous variable, a logistic regression<sup>1</sup> consists the method to make our empirical study.

That is to say the **Inno** variable which represents the innovation such as:

$$P_i = P [\text{Inno}_i = 1] = F [ \beta_{RDCOPESE} X_{RDCOPESE} + \beta_{RDCOOPPUB} X_{RDCOOPPUB} + \beta_{JVALL} X_{JVALL} + \beta_{INVBREVLIC} X_{INVBREVLIC} + \beta_{EMQUALIF} X_{EMQUALIF} + \beta_{ACHATESE} X_{ACHATESE} + \beta_{CONNAISSANCE} X_{CONNAISSANCE} + \beta_{TRAVEQUIPE} X_{TRAVEQUIPE} + \beta_{MOBILEMP} X_{MOBILEMP} + \beta_{TECHCONCURENT} X_{TECHCONCURENT} + \beta_{TECHFUTUR} X_{TECHFUTUR} + \beta_{TECHEXT} X_{TECHEXT} + \beta_{DEPOBREV} X_{DEPOBREV} ] \quad (1)$$

where  $F$  indicates the function of distribution of a law of known probability.

$\beta_{ik}$  represents respectively the estimated coefficients of variables  $X_{ik}$ .

All the variables (table 1) are dichotomic variables<sup>2</sup>. Value 1 for the innovation variable indicates that the company has this innovation (0: so not). In more condensed form, the model is written:

$$P_i = P [\text{inno}_i = 1] = F(\beta' X_j) \text{ et } (1 - p_i) = \text{prob}[\text{inno}_i = 0] = 1 - F(\beta' X_j) \quad (2)$$

and with  $j$  representing the types of co-operation and technological and organisational competences and  $\beta' = (\beta_{ik})$

We consider that the probability distribution  $F$  follows a logistic law. The equation (1) defines the Logit model thus.

The estimator of the  $\beta$  coefficients is obtained by the method of the maximum of probability. The function of probability of the model is written

$$L = \prod_{i=1}^n [P_i^{\text{inno}_i} (1 - P_i)^{1 - \text{inno}_i}] \quad (3)$$

By taking the log of  $L$ , one obtains the function log-probability  $L$  which is maximized compared to:

$$L = \sum_{i=1}^n [\text{inno}_i \ln F(\beta' X_j) + (1 - \text{inno}_i) \ln F(-\beta' X_j)] \quad (4)$$

<sup>1</sup>Logistic law :  $F(X) = 1/[1 + \exp(-x)]$  ;  $y_i = \sum_k \beta_{ik} x_{ik} + \varepsilon_i$

If  $\varepsilon_i$  is a logistic law, :  $F(-x_i b) = \exp(-x_i b) / [1 + \exp(-x_i b)] = 1 / [1 + \exp(x_i b)]$

so :  $p_i = \exp(x_i b) / [1 + \exp(x_i b)]$  so :  $\log(p_i / [1 - p_i]) = x_i b$  . ,  $p_i = 1 / [1 + \exp y_i]$ .

<sup>2</sup> In a dichotomic model,  $y_i$  can take only 2 values

The maximization of this function gives us the value of the estimator of maximum of probability of  $\beta$  checking the system of equations:  $[\frac{D \log L(\beta)}{D\beta} = 0]$

According to Gourieroux (1989), the function is strictly concave, which makes it possible to ensure a maximum of probability single for the Logit model.

#### 4. Results and Interpretation

Our purpose is to study the impact of these variables on innovating behaviour, the case of products and processes. The description of the model, the method of estimation and the criteria of statistical significance (test of the report/ratio of the maximum of probability, test of the Wald) constitute a preliminary stage to present and interpret the resulting estimates. All the estimates under consideration in this article are carried out on the basis of software SAS (version 9.0).

**Table 2. Estimate of the explanatory factors of behavior innovating in product of the French companies**

<i>Variables</i>	<i>Coefficients</i>
<i>Constante</i>	0.5956 (8.2227)*
<i>RDCOPESE</i>	0.4355 (8.8652)
<i>RDCOOPUB</i>	0.0604 (0.1542)
<i>JVALL</i>	0.1902 (1.1667)
<i>INVBREVLIC</i>	0.2467 (2.8607)
<i>EMPHAUTQUALIF</i>	0.6874 (17.3794)
<i>ACHATESE</i>	0.3217 (2.2679)
<i>CONNAISSANCE</i>	0.2288 (2.4701)
<i>TRAVEQUIPE</i>	0.4788 (7.2314)
<i>MOBILEMP</i>	-0.1721 (1.7061)
<i>TECHCONCURENT</i>	-0.0911 (0.2184)
<i>TECHFUTURE</i>	-0.3991 (8.2697)
<i>TECHEXT</i>	0.3043 (5.2940)
<i>DEPOBREV</i>	1.0452 (47.9452)
<i>-2 log vraisemblance</i>	1776.550
<i>Test du ratio de max de vraisemblance</i>	$Khi2=225.37 > Khi2(12)$
<i>Percent concordant</i>	73.4

(\*) :  $Khi2$  of Wald : significant coefficient with the threshold of 5%. / \*\* : significant coefficient with the threshold of 1%.

Two models are tested (table 2): model 1 holds account only companies innovating in products and/or process (1884 companies), model 2 include companies innovating in products (1673 companies). For each model, are presented the total tests indicating the quality of total adjustment of model (the test of the report/ratio of probability), as well as the coefficients (coef), the test of Wald and the estimates of the reports/ratios of dimensions (odds ratios) associated each variable.

Model 1 (table 2) testifies to a largely significant report/ratio of probability ( $\chi^2 = 225.3744 > \chi^2(12)$ ). All the explanatory variables in this model explain the innovating behaviour of firms, the case of products

The companies have strategic behaviour of co-operation or of race to the innovation (Combe, 1998). The variable RDCOPESE is significant (coef = 0.4355; test of Wald: 8.8652, significant coefficient with the threshold of 5%). The companies which carries out R&D in co-operation with other companies have 54.6% (odds ratios: 1.546) of chance to make an innovation products some more than the companies which does not carry out a R&D with other companies. The agreements in R&D, with other firms, have a positive effect not only on the innovating behaviour but also on the capacity for absorption of external knowledge and technology.

The importance of competences depends on the level of relationship that each firm has with its external partners. Cohen and Levinthal (1990) introduce the concept of capacity for absorption to describe this phenomenon. The capacity of the firm (or its competence) to exploit external knowledge is crucial to develop an innovation. The company is more or less qualified to seize technological opportunities and to support external interactions in order to create knowledge. If organisational competences propose the interactions between agents, the collective dimension of knowledge as well as the dynamic ones of organisational training, those in technological matter are associated the efforts of engaged R&D, the innovations carried out and the accumulation of the technological credits. Among technological and organisational competences considered in the model, the team work or joint to innovate (travequipe) and external technologies (Techext) exert a significant influence on the probability to innovate. From moment when information circulates easily (Travequipe) inside the company, the capacity to acquire knowledge of the firm is likely to develop positively (Connaissance). On the other hand, a negative relationship between the membership and the probability of innovating rehabilitate the assumption of difficulties encountered by the independent companies to innovate in an autonomous way. More the firm develops its own competences (as regards team work, of implication of the services in projects of innovation, to facilitate mobility, etc), more it will carry out innovation products some within the firm or with other external partners. Among the general characteristics of the companies, the membership is very significant (ACHATESE).

Variable ACHATESE is significant (coef = 0.3217; Khi2 of Wald = 2.2679 significant coefficient with the threshold of 5 %.). The companies which carries out purchases of another companies entirely or partly have 98.9% (odds ratios = 1.989) of chance to make an innovation products some more than the companies which does not carry out purchases of the companies. As Lhuillery (1998) underlines it, "membership of company to often a significant influence on the innovating activity of the firm". Not only the companies belonging to a group have access easier to the various networks of co-operation to undertake their activities of R&D and innovation, but also they benefit from research intra- group (Lhuillery, 1998). An analysis combined with results obtained by the variables (Rdcoopub; Jvall; Invbrevlic; Achatese; Connaissance; Travequipe; Techext; Depobrev\_var) enables us to note a positive significance on the innovation in product. On the other hand, a negative relation between the innovation in product and mobility between the service within the company (Mobilemp), the knowledge of technology of competitor (Techconcurrent), and the test of future technology (Techfuture). The logistic regressions show that two principal factors occupy a significant place in the explanation of innovating behaviour of the companies, namely the cooperation agreements to innovate (RDCOPESE; RDCOOPPUB), capacity for absorption of technologies outside and capacity of innovation (Knowledge: CONNAISSANCE; Membership: ACHATESE). On the other hand the use of the patent data (Patel and Pavitt, 1996; Mowery et al., 1998) installation problem since they are subjected to certain skews since any innovation is not forcing not patented. Mowery et al., (1998) add that a change in the request and the behaviour of the consumers represents a change of the innovating behaviour of the companies. The activities of innovation depended partly on knowledge scientific and technological are carried out only insofar as they answer a market demand.

Model 2 testifies to a largely significant report/ratio of probability overall significant specification of model thus. All the variables in the model explain the behaviour innovating in process of the companies. Variable RDCOPESE is significant (coef = 0.1939; Khi2 of Wald = 2.8377: significant coefficient with the threshold of 5 %.). The companies which carries out R&D in co-operation with other companies have 21.4% (odds ratios = 1.214) of chance to make an innovation in

process more than those which does not carry out a R&D with other companies. Respectively the same positive effect of the following variables notes (Rdccooppub; Jvall; Invbrevlic; Connaissance; Emphautqualif; Mobilemp; Techfuture; Techext) on the innovation in process. The Techfuture1 variable is significant (coef = 0.5128; Khi2 of Wald = 20.7901 significant coefficient with the threshold of. 5 %.). The companies which know future development of technologies (technological survey) have 67% of chance (odd ratios= 1.67) to make an innovation in process more than the others. On the other hand, a negative relation between the innovation in process and the team work (Travequipe) and the patent filling (Depobrev). The able firm is to engage in relations of technological co-operation, the more it has a strong capacity of innovation. The behaviour innovating associated primarily and in the order with the innovations with products and processes, with the patent filling and the radical and incremental innovations reflects technological competences of the firms.

## 5. Conclusion

This empirical work constitutes a first step of a more thorough study dedicated to the relationship between the cooperation agreements and competences (technological, organisational) and their impacts on the innovation and the innovating behaviour of firms. Resulted remain modest but allow nevertheless to confirm the influence of variables such as the agreement in R&D, the purchase of company, knowledge, the team work, etc., on the capacity to be innovated of the firms. The logistic regressions also show that the capacity of innovation of firms is in a descending order: of innovation in product, innovation in process and patent filling. This work will give place to an additional work introducing some of the qualitative variables on the efforts financial in R&D, the membership of a sector, the request for market, etc.

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