

**17TH INTERNATIONAL CONFERENCE ON MACROECONOMIC ANALYSIS
AND INTERNATIONAL FINANCE, 2013**

**TITLE: Innovation-oriented behavior and its implications for
organizational absorptive capacity**

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Abstract:

This paper looks at innovation-oriented behavior at French firms and considers, in particular, the relationship between such behavior and absorptive capacity. Special emphasis will be placed on the notion of competencies and especially on how they are linked to innovation. The objective of this study is to define the principal competencies that drive innovation. Econometric results show that R&D investments by French firms are intended not only to promote the acquisition of competencies but also to incite innovation.

Keywords:

Competencies, innovation, innovation-oriented behavior, absorptive capacity, cooperation

TITLE: **Innovation-oriented behavior and its implications for organizational absorptive capacity**

*Introduction*¹

The debate on the competencies of firms and, in particular, the role that such competencies play in innovation, has been drawn into a larger discussion on the new conception of firms and their frontiers. This new, competency-focused approach has generated a number of theoretical studies² dealing with how to identify such aspects as the diversity of competencies, their nature, role and manner of development. Thus, new theoretical literature has emerged, in which firms are viewed in terms of their resources and competencies, as authors rely on the insight offered by a long line of contributors (Penrose, 1959; Nelson & Winter, 1982; Wernerfelt, 1984; Teece, 1988; Hamel & Prahalad 1990). These works have devoted particular attention to firms' in-house competencies, their capacity to develop new activities and to tap new markets (Barney, 1986; Sanchez, Heene, 1997). Among the firm's various resources, it is its core or strategic competencies that set it apart from another firm and serve as the source of its competitive advantage (Barney, 1991; Leonard-Barton, 1992; Amit & Schöemaker, 1993). Quélin (2003:21) defines strategic competencies as being "*the basis for gaining competitive advantage*". The author also points out that these competencies "have the following four traits: *sustainability, non-transparency, difficulty of transferability* and *difficulty of replicability*." (Quélin, 2003:21). The concept of competencies has thus been addressed in descriptive studies (making it possible to look at inter-company competitiveness from a different perspective) as well as in prescriptive studies, wherein it was seen as another possible source of competitive advantage. However, although the concept appears to offer many promising strategic prospects, an observation of work practices and an analysis of literature showed that many difficulties and limits in its theoretical framework and concrete practical application were encountered nonetheless. As a result, a competencies-centered view of firms has not yet led to an in-depth look at the process entailed in new resources deployment. Indeed, the fact remains that such resources are subject to a high risk of market failure or cannot be purchased or sold under traditional contracts (Pisano, 1990; Quélin, 1996). Drawing on these insights, this study seeks to cast light on the notion of competencies

¹ This paper is a follow-up to the article "Impact of Co-operation and Competences on the Innovating Behavior: A Micro-econometric Study of the French Firms" *International Journal of Economics and Financial Issues*

² The notion of competence has attracted increasing attention in recent economic studies, essentially in work on organizational theory. (Carlsson & Eliasson, 1994).

while focusing on potential links between competencies and innovation, with a view to identify the core competencies that drive innovation.

First, in presenting an overview of the current state of understanding of key firm-specific competencies, we shall identify one of the foundations of the core competencies theory. It is a theory that suggests that a firm’s innovation-oriented behavior involves more than merely its R&D, and that its collaborative efforts are determined, notably, by its repertoire of competences. We shall also consider the various characteristics of the core competencies for innovation. Similarly, a discussion of the relationships between competences and strategies in firms will be undertaken. Then, we shall conduct an empirical study to understand the relationship established between competencies and innovation. Lastly, we shall conclude with an overview of our findings.

1. Current state of understanding

1.1. From the notion of competencies to the theory of competencies

What is a competence? What distinguishes it from knowledge? The latter question can be understood as an allusion to “procedural knowledge” (Cazal & Dietrich, 2003:242), whereas the former is concerned with “individual and collective intelligence in production situations, considered in all their complexity and their (relative) newness”. (Zarifian, 1995:18).

The concept of “competencies” has been widely debated, notably in management science, leading to the development of categories (see **Table 1**) regrouping several types of competencies: individual, collective, environmental, organizational, strategic, and territorial.

Table 1. Categories of competencies

Types of competences	Definition	Author
Individual	“A stock of resources – linked to the individual’s experience or training, but also to his work – which enable him to seize an opportunity in the context of his specific workplace situation”.	Defélix, Klarsfeld & Oiry (2006:2)
Collective	The four main attributes of collective competence are: “le common frame of reference, a common language, a collective memory and subjective commitment ”	(Krohmer & Retour, 2006 : 179-180)
Environmental	“the management of competencies of stakeholders and multiple actors not under the firms’ direct control, namely, customers, suppliers, institutional partners and all business actors whose actions may have an impact on the firm or the group ”	(Sanséau, 2009:4)
Organizational	“an organization’s capacity to complete a task successfully ”	(Michaux ³ 2009 :17)
Strategic	Strategic competencies consist of those organizational competencies that “enable the organization to achieve a competitive advantage”	(Michaux, 2009 :18)
Territorial	A territorial competence arises when there is “a combination of geographically close resources enabling a territory to have a competitive specialization”	(Defélix & al., 2009 :212)

³ In reference to Galbraith (1994)

This overview of the various types of competencies allows us to understand the difficulty of defining the concept of “competence,” which is viewed as “a complex and multi-faceted reality in that it brings together knowledge, skills, and aptitudes, etc. Moreover, as a result, competence is never achieved once and for all: it requires continual work and refinement” (Baruel Bencherqui et al., 2011:15). What link can be established between competencies, cooperation and innovation activity? The latter develops a variety of competencies, particularly those promoting relationships with third parties in order to appropriate outside knowledge and attract more resources. It is in this way, states Zarifian (1995:19) that “underpinning what may be termed cooperation, in the ‘fullest’ sense of the term, is exactly what underpins the growing use of the word “competence”: the current social conditions favoring efficient production”. The relationship between competence and cooperation leads us quite naturally to the notion of inter-organizational competence taken to mean “a combination of organizational and strategic resources enabling firms or organizations, in a specific context, to jointly complete an activity or operation successfully” (Defélix *et al.* 2009:212). The cooperative efforts between firms enable them to “acquire more rapidly a complex set of competencies, in order to produce new technologies rather than merely amass existing knowledge” (Delapierre, 1991:141). Thus, the importance of competencies lies, in particular, with the relationships formed between the firm and its outside partners. This phenomenon is described by Cohen & Levinthal (1990) as the “**absorptive capacity**”. This term can be defined as the firm’s ability (*i.e.* its competence) to tap into vital outside knowledge, enabling it to develop innovation. The firm is therefore more or less “competent” to seize technological opportunities and facilitate external interactions, with a view toward creating knowledge. What contributions, then, can be attributed to competence theory? The notion of competence and the associated theory (see **Table 2**) help give shape to a new conceptual model of strategic analysis for understanding more and more uncertain and complex competitive environments.

Table 2. The Competence-based Theory of the Firm

Basic Concepts	Objectives	Features
Firms are seen as strategic goal-seeking “open systems” (Heene & Sanchez, 1997)	There are 9 main objectives: <ul style="list-style-type: none"> - propose alternative solutions to the limits of traditional strategic thinking and to the resource-based approach - build a conceptual framework “consistent with” organizational practices (Heene & Sanchez, 1997) - integrate the “content” and “process” approaches to organizational practice (Heene & Sanchez, 1997) - focus closely on how industrial and service-sector firms are affected by dynamic market changes 	The theory takes into account organizational dynamism. In this way, the concept of competence makes it possible to analyze the various modes of interaction (between the individual and groups within the firm; between the firm and resources provided by other enterprises; between the firm and its clients; between two firms competing on one project and acting as partners on another)
The term ‘competence’ corresponds to the firm’s ability to deploy its resources to meet its strategic objectives.	<ul style="list-style-type: none"> - examine (competition versus cooperation) scenarios existing simultaneously between two firms exercising complementary activities - emphasize the systematic interdependencies between partner firms and strengthen the competency-creation process developed under the partnership 	The firm is viewed as an “open system”. Accordingly, the same amount of importance is attributed to in-house and external relationships and competencies.
The contents of a strategy should define the manner in which the firm intends to create capacities and obtain any necessary information instead of focusing solely on controlling its industrial production facilities and product distribution	<ul style="list-style-type: none"> - actively promote the growing use of inter-firm networks and alliances - promote learning as a strategic variable in competency development - develop sustainable, strategic relationships among researchers and decision-makers through “double-loop learning “ (Heene & Sanchez, 1997), with a view toward giving theoretical concepts a direct practical application (and vice versa) 	Knowledge-creation is encouraged. Major importance is placed on building new knowledge, which generates conditions favorable to creating (individual/organizational) new competencies.

Two basic competency-management models can be identified. The first consists in using firm-based competencies as “levers for organizational change” (Heene & Sanchez, 1997). That entails deploying resources without making any quantitative change in terms of the firm’s assets, capacities or means of coordination. The second model arises when the firm acquires or uses new assets, new capacities or new modes of coordination to enable it to implement a “competency creation process”. As regards the firm’s objectives (see **Table 2**), if they are actually put into practice, they will allow the competency theory to stand as a true strategic alternative. It will be endowed with its own theoretical structure and empirical methodology in line with current economic constraints. The competency theory emphasizes that the organization must learn to identify and inspire the development of new (individual/organizational) competencies. In this way, partnership, alliance or network strategies are one of the sources of building new competencies, which leads us to our analysis of these competencies.

1.2. The various types of economic competencies

By drawing on various organization-focused articles and empirical statistical studies, it is also possible to establish a typology of economic competencies (see **Table 3**). The integration of firms into a competence-based perspective is aimed at broadening the firms' fields of competency, while seeking more efficient management of technological and organizational complexities. Indeed, as the competency-based approach shows, a firm's competitiveness is tied more to its capacity to find the right mix of resources and competencies and, above all, to master the inter-firm and extra-firm knowledge-building process, rather than simply to its reliance on its capacity to adapt to environmental opportunities.

Table 3. Types of economic competencies

Type of competencies	Content
The firm's transformative capacity	The firm seeks to transform itself and develop a (learnable) core competency oriented toward transformation and thus toward innovation. What Leroy (1998) defines as "making innovation an integral part of the firm's overall strategy" covers all competencies enabling the firm to assess its potential transformative capacity
Capacity to take action on the market	"Monitor, predict and act upon change within markets" means the firm's capacity to monitor change within relevant markets and analyze competitors' products, patents and publications.
Competence at producing innovation and capacity to acquire technology	"develop innovations": this entails designing a strategy for acquiring and mastering resources and skills that will enable the firm to set itself apart from its competitors and above all, engage in innovation deployment activities
Knowledge creation capacity and capacity to evaluate and interpret knowledge production efficiency	When firms innovate, they create new knowledge (Nonaka & Takeuchi, 1997). That knowledge production cannot thrive in an atmosphere where competences already acquired are disregarded. As a result, the understanding of knowledge production and innovation processes also entails relying on the concept of organizational learning. Organizational learning centers on the production of new knowledge.
Internal R&D capacity & absorptive capacity and external R&D capacity	The ability to absorb and assimilate outside technologies (a notion borrowed from Cohen & Levinthal, 1990) considers the fact that external knowledge sources play an increasingly critical role in the innovation process, making it possible to assess the firm in light of its ability to apprehend, assess and exploit outside knowledge. That ability is known as its organizational absorptive capacity. Internal R&D capacity and absorptive capacity involve firms engaging in R&D activities, recruiting highly skilled employees, and possessing absorptive capacities. As for external R&D capacity, it is seen as involving the firm's sub-contracting/outsourcing relationships.
Capacity to assimilate innovation and innovation competency	These capabilities consist of those relating to the ability to identify knowledge, strategic know-how, knowledge strategies, and individuals possessing strategic know-how. This also entails making staff aware of the strategic and confidential nature of this knowledge and monitoring communications relating to such strategic knowledge.
Capacity to manage human resources	Identifying competencies held by employees, measuring and comparing such competencies, with a view to achieving the firm's strategic objectives and establishing an action plan to address any necessary adjustments. These efforts fall within the firm's Workforce and Competency Planning and Development (or SWP, Strategic Workforce Planning) approach.
Capacity for selling innovative products	3 competencies are featured in this regard: designing a promotional strategy, establishing the target, and investing in communication networks.

In this study, the focus was placed on firms' **absorptive capacity**. As observed by the OECD (1996), firms that produce the most rapid and sustained innovation are those that have the largest number of employees, require the highest credentials or qualifications, pay the highest salaries and offer their workforce the most stable outlook. And although a firm's absorptive capacity is determined by individuals, which explains why the focus is placed on the cognitive aspects of how an organization operates in a constantly changing environment, it is quite different from the simple act of aggregating individuals and depends on the prior knowledge at the firm's disposal (for example, technological knowledge developed by competitors or future technologies or knowledge incorporated into equipment or facilities, etc.). The success of innovative organizations would seem to be dependent as much on their capacity to acquire new internal knowledge as upon their capacity to assimilate outside knowledge. Accordingly, internal R&D and the *capacity to absorb technology* should be viewed as competencies that enhance a firm's ability to assimilate and exploit all kinds of new knowledge and not merely technological expertise (OECD, 1997). It is this approach that we will emphasize and which will lead us to define the firm's objective of seeking to achieve cooperation, innovation and learning (Cohen & Levin, 1989; Cohen & Levinthal 1990; Foray & Mowery, 1990). In that light, the innovation process may be viewed as a learning procedure guided by the firm's innovative choices and sustained by the expertise that it has acquired, resulting in the appearance of new knowledge and the acquisition of new capabilities and competencies, not to mention the development of new activities. We shall pay particular attention to (technological, strategic and industrial) *cooperation agreements* as vectors for developing resources. Thus, we shall attempt to incorporate the notion of the capacity to innovate, as a way of providing insight into innovation-oriented behavior. The questions that arise are as follows: What competencies are required to stimulate technological innovation? How are such competencies measured? Are certain competencies of greater, direct strategic importance than others, in terms of offering the potential for competitive advantage? These are questions that, until now, have received limited attention in strategy literature compared to studies on the implication of the possession of competencies.

2. Empirical Analysis of competency-based systems within French firms

The stated objective of this analysis is to show, first, the importance of competency in the innovation process and, secondly, to provide empirical results to substantiate these analytical insights. Our study deals with business firms and, in that respect, we are close to the work in

management science on competency models, where competency is attributed to firms and not to the individuals working there. However, a relationship of mutual dependence links the organization's competencies and its innovation-oriented behavior. More specifically, the firm develops innovation competency, and innovation generates still further possibilities for innovation. That is, innovation creates a feedback loop, involving inter-company and extra-company interactions, as knowledge-acquisition methods develop according to a twofold principle: knowledge is acquired while the organization capitalizes on the very competencies and skills so acquired. Thus, all competencies (including productive, marketing, human resource, and financing competencies) must be taken into account because they reflect the firm's ability to assimilate internal or external information, to create knowledge and to develop problem-solving approaches, all of which is aimed at seeking new solutions, whereby innovation is fostered. And so, two crucial questions need to be addressed: What are the competences required to innovate? To what extent do a firm's competencies have an impact on the choice of innovation? The answers will entail, in our approach, identifying the competencies underlying the development of innovation-oriented behaviors by relying mainly on statements made by companies regarding the sources of technological knowledge they draw on to innovate. Consequently, if we define a competence as a firm's capacity to perform an elementary action, then firms' statements regarding the (internal/external) source of technological knowledge, effectively express the existence of competencies. In that case, given the questions posed to firms in the various surveys (*CIS2*, *CFI*, etc.) we looked at, it is possible to detect the presence of these competencies since most questions deal with *actual behavior* and *potential behavior*. It is generally agreed that the positive effects of innovation are largely linked to the effective dissemination of that innovation into the economy. By **dissemination** we mean the manner in which innovations are spread by market mechanisms or otherwise. Without dissemination, an innovation would have a limited economic impact. The way innovation spreads into the economic system is therefore crucial for economic progress. An important aspect of the dissemination of innovation involves "organizational absorptive capacity". By **absorptive capacity**, we mean firms' ability to learn to exploit technologies developed elsewhere, often by relying on a process that entails tangible and intangible investments. Empirical studies dealing with absorptive capacity are few and far between. There are no established standards of measurement for assessing this area of competency. Contrary to research by Veugelers (1997) on Flemish firms, absorptive capacity is not identified by the existence of an R&D center. The **specific feature** of our research resides in our analysis of this particular variable. To construct our "*absorptive capacity*" (*abs*

cap) variable, we have drawn on the work of Cohen & Levin (1989). The assimilation of outside technologies is the most important competency factor in organizational projects seeking to promote innovation. One of the advantages of our *abs cap* variable is that it is constructed from a set of qualitative variables based on several competencies: (see **Table 1**, annexes). Our (*abs cap*) variable reflects both the firm's R&D activities (such as internal R&D and the recruitment of highly qualified individuals) as well the methods used to absorb outside technologies (testing of rival technologies, use of third-party inventions, monitoring of technological developments, etc.). It constitutes in some ways the aggregation of the different individual measurements. Another advantage of the notion of absorptive capacity is that it takes into account the increasingly important role of external sources of knowledge in the innovation process and makes it possible to analyze a firm from the perspective of its ability to apprehend, assimilate and exploit newly acquired knowledge. In that light, we have chosen to adopt this particular approach in our empirical model (*Model 1*: (see **Table 4**).

2.1. Statistical sources mobilized for the empirical study

To our knowledge, there are very few large-scale studies (especially qualitatively oriented ones) addressing the issue of organizational competencies on this particular subject. The firm-level "Survey on Innovation Capacity" (*L'enquête sur les capacités pour innover*) conducted by the SESSI survey and industrial statistics service in 1997, was a first in the French industry. It spanned the period 1994-1996 and covered a sample of 5000 firms out of 22000 with a workforce of more than 20 persons in the French industry. It presents cross-sectional data at the firm level, covering various categories of competencies (technological, organizational, financial, market awareness, etc.). This Survey presents certain advantages from a methodological point of view, as regards the development of the questionnaire (François et al., 1998). To avoid the problem of biased data, SESSI opted for a diversification of respondents (Chief Financial Officer, Director of Research, etc.). The firms replied to a questionnaire regarding 73 competencies (so-called "basic competencies") which were classified in a repertoire of 9 "major competencies" or "complex competencies" (incorporating innovation into the firm's overall strategy; monitoring, predicting and acting on changing markets; developing innovation capability; organizing and managing knowledge production; appropriating external technologies; managing and safeguarding intellectual property; managing human resources for innovation; financing innovation; selling innovation). This set of 73 competencies constitutes the **firm's overall competency**. For each basic competency the organization was surveyed on three levels: the exercise of the

competency - the procedures - the outsourcing/externalization of competency. The objective was to determine whether a firm possessed a competence related to the innovation process. The survey was chosen to inquire into the relationship between competencies and innovation, i.e. to determine the extent to which firms have the capability to innovate. In the framework of that study we also drew on 2 other surveys: CIS 2 (the *Community Innovation Survey*) carried out in 1997 covering the same period (1994-1996), which produced cross-sectional data. It was conducted among 5000 industrial firms with more than a 20-person workforce and offered the advantage of providing direct measurements of innovation. Lastly, we relied on the annual business survey *L'enquête Annuelle d'Entreprise* (EAE), which was conducted by SESSI and covered all industrial firms.

For the purposes of constructing our “**absorptive capacity**” variable, we drew upon the work of Cohen & Levinthal (1990) (see **Table 1.** annexes). As a result, the absorptive capacity in relation to external technologies was calculated on the basis of several competencies set out in The Firm-level Innovation Survey: (“Do you know your competitors’ technologies?”; “Do you stay abreast of future technologies (technology watch)?”; “Do you test outside technologies?”; “Do you conduct R&D activities?” ; “Do you sub-contract or acquire R&D?”; “Do you conduct R&D activities in cooperation with other firms?” ; “Do you conduct R&D activities in cooperation with public research institutions?”; “Do you use third party inventions (patents, licenses)?”; “Do you recruit *highly qualified* scientific personnel for *innovation*?” ; “Have you acquired firms, in whole or in part, to promote innovation?” ; “Do you participate in joint ventures, strategic alliances and other forms of cooperative collaborations to promote innovation?” ; “Are you a sub-contractor for high technology components?”; “Do you assimilate know-how contained in innovative equipment and components?”).

2.2. Econometric Modeling

The database information (CFI, CIS, EAE, etc.) reveals the complexity of the mechanisms under study and, consequently, suggests why it was not possible for us to apply several classic methods directly. That is why we have looked more closely at a number of new issues that arise when econometric methods are applied to our data in competency-based studies on organizational innovation-oriented behavior. A competency study offers the possibility of developing a measurement tool for evaluating the various qualitative aspects of competencies. In focusing on the manufacturing industry, and taking into account the cross-referencing of survey data (*CFI, EAE, CIS2, R&D*), our sampling includes **2547 firms**. This database provided a large part of our explanatory variables.

2.2.1. Explanatory variables for absorptive capacity

We have classified explanatory variables into two major categories: *traditional variables* (size, group membership, self-financing capacity (SFC), intensity of R&D spending) and *sector specific variables* (type of sector, which is, in this case, a multiple nominal variable with 14 modalities, based on level 36 of the INSEE classification of the nomenclature). Other variables⁴ will be included in the significance level of the endogenous variable, such as market demand (*market dem* see **Table 2.** annexes) and patent application (*patent appl*).

2.3. Description of the Model

The empirical model we have examined consists in assessing the likelihood of possessing a competency (absorptive capacity of external technologies: *abs cap*) according to several exogenous variables (viz **Table 1.** annexes). Our endogenous variable (**which is a binary variable**) possesses 2 modalities: yes/no. Taking into account the nature of our endogenous variable, a logistic regression⁵ model was used to conduct our empirical study.

Let:

$$Y_i = abs\ cap_i$$

Where: i = is the firm index.

Y_i : is an observation on the endogenous variable of firm i.

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

x_{ik} , k is the index of the exogenous variable (x) of firm i.

i.e. the variable $abs\ cap_i$ which represents the competence possessed or not possessed, so that:

$$\mathbf{P}_i = \mathbf{P} [abs\ cap_i = \mathbf{1}] = F [\beta_1 size_{ik} + \beta_2 sector_{ik} + \beta_3 caf_{ik} + \beta_4 ird_{ik} + \beta_5 market\ dem_{ik} + \beta_6 patent\ appl_{ik} + \beta_7 group_{ik}] \quad (\mathbf{1})$$

Where **F** represents the distribution whose probability distribution is known. We consider that the probability distribution **F** follows a logistic curve.

⁴ These variables are taken into account with respect to several previous empirical research studies.

⁵ Logistic: $F(X) = 1/[1 + \exp(-x)]$; $y_i = \sum_k \beta_{ik} x_{ik} + \varepsilon_i$

Whenever ε_i follows a logistic curve, we find that:

$F(-x_i b) = \exp(-x_i b) / [1 + \exp(-x_i b)] = 1 / [1 + \exp(x_i b)]$ thus: $p_i = \exp(x_i b) / [1 + \exp(x_i b)]$; this function may be inverted, giving: $\log(p_i / [1 - p_i]) = x_i b$.

$$p_i = 1 / [1 + \exp y_i].$$

β_{ik} Represent, respectively, the estimated coefficients of variables \mathbf{X}_{ik} .

In shorter form, the model reads:

$$\mathbf{P}_i = \mathbf{P}[\mathbf{abs\ cap}_i = 1] = \mathbf{F}(\beta' \mathbf{X}_i) \text{ and } (1 - p_i) = \text{prob}[\mathbf{abs\ cap}_i = 0] = 1 - F(\beta' \mathbf{X}_i)$$

The *Maximum-Likelihood Estimation (MLE) method* has been used to estimate the β coefficients. The model's likelihood function is as follows:

$$l = \prod_{i=1}^n [P_i^{cap_abs_i} (1 - P_i)^{1 - cap_abs_i}] \quad (2)$$

In taking the log of \mathbf{l} , we obtain the function log-likelihood \mathbf{L} which is maximized in relation to β :

$$L = \sum_{i=1}^n [cap_abs_i \ln F(\beta' \mathbf{X}_i) + (1 - cap_abs_i) \ln F(-\beta' \mathbf{X}_i)] \quad (3)$$

The maximization of this function yields the estimator value β' of the maximum likelihood of β verifying the equation system: $[\frac{D \log L(\beta)}{D\beta} = 0]$

According to C. Gourieroux (1989)⁶, the function is strictly concave, which makes it possible to ensure a single maximum likelihood for the *Logit* model.

3. Analysis and discussion of results

The Logit estimation method (using the maximum-likelihood method) applied to identify the explanatory factors of absorptive capacity of external technologies (*abs cap_i*) yields the results set out in **Table 4**. The latter summarizes the estimated coefficients in relation to each variable, the Wald and Student tests, as well as their levels of significance.

⁶ Gourieroux (1989 :19-20) has demonstrated that the maximum-likelihood estimator has good asymptotic properties: it is convergent to the true value of β and follows normal distribution, average of the true value of β and the variance-covariance matrix inverting Fisher's Matrix

Table 4. Estimation of the Explanatory Factors for French firms' absorptive capacity of external technologies

<u>Variables</u>	<u>Model 1-1</u> (Without interaction)			<u>Model 1-2</u> (Interaction with a general public group)			<u>Model 1-3</u> (Interaction with a university group)		
	<u>Coef</u>	<u>Student Test</u>	<u>Wald Test</u>	<u>Coef</u>	<u>Student Test</u>	<u>Wald Test</u>	<u>Coef</u>	<u>Student Test</u>	<u>Wald e Test</u>
Constant	-2.9373	12.4581	1.020***	-3.0437	12.7831	1.026***	-2.8833	12.1961	
SECTOR	0.0196	2.2902	1.117	0.0252	1.9344	1.137	0.0165	1.6193	1.017***
SIZE	0.1105	3.3361	1.000	0.1281	3.8388	1.000	0.1198	3.5428	1.127
CAF	1.315E-6	3.1968	1.007	1.686E-6	3.6292	1.007	1.513E-6	3.0894	1.000
IRD	0.0709	4.3302	29.864	0.0724	4.3278	29.498	0.0718	4.3283	1.007
market dem	3.3966	14.0374	1.566	3.3843	13.9024	1.528	3.2790	13.5011	26.549
PATENT APPL	0.4486	4.5794		0.4242	4.3108		0.3865	3.9223	1.472
Group:			2.407**						
Gr_fr	0.8784	5.9651	1.812						
Gr_usa	0.5946	3.1456							
Gr_jap	-0.8009	2.4122	0.449						
Gr_ue	0.3603	2.6149	1.434						
Gr_fr_pub				1.2437	7.9182	3.468**			
Gr_usa_pub				14.7351	ns	ns			
Gr_jap_pub				ns	ns	ns			
Gr_ue_pub				15.3694	ns	ns			
Gr_fr_univ							0.8713	6.8403**	2.390
Gr_usa_univ							13.3152	ns	ns
Gr_jap_univ									
Gr_ue_univ							13.3557	ns	ns
							1.5964	4.3697	4.935
-2 log likelihood	3356.305			3356.305			3356.305		
Maximum Likelihood ratio Test du ratio	$\chi^2 = 605.9899^*(> \chi^2 (10))$			$\chi^2 = 665.9725^*(> \chi^2 (10))$			$\chi^2 = 662.0096^*(> \chi^2 (10))$		
Concordance rate	77.9			79			79		
R ² (McFadden)	0.261			0.271			0.271		

*: Coefficient significant at the 10% threshold.

** : Coefficient significant at the 5% threshold.

*** : Wald chi-squared: coefficient significant at the of 1% threshold.

ns : whenever the variable is a multiple nominal, the joint significance criterion of the variable (all modalities taken simultaneously) is yielded by the likelihood applied to a sub-set of variables. Whenever the variable is not significant (ns), it is pointless to draw up the list of coefficients and (Student, Wald) tests on the different modalities, especially as the results table is liable to become overcrowded.

Models 1-1, 1-2, 1-3 reveal, respectively, a highly significant likelihood ratio and a strong categorization rate (i.e. **77.9%**; **79%**; **79%**). The specification of the models is therefore significant overall. In other words, all of the variables under consideration in the models point

to the presence, in all of the firms, of a capacity to assimilate external technologies for promoting innovation. Among the significant variables, **market demand** (*market dem*) has a positive effect on the likelihood of assimilating external technology. Here, we observe an idea put forward by Cohen & Levin (1989), whereby the absorptive capacity in relation to an external technology does not depend solely on the state of scientific and technological knowledge, but also on market demand. Stated otherwise, the firm will exhibit innovation-oriented behavior according to the demand expressed on the market, and that demand determines, in turn, how the firm will orient the types of innovation it pursues. We also noted the importance of the **sector** in determining the firm's capacity to acquire external technologies. Our results show that a **firm's capacity to absorb** external technologies is strongly associated with its R&D initiatives (*IRD*). As a result, firms with a capacity to acquire external technologies tend to be those that invest in their own R&D activities (significance of the variable: *IRD*). And so, as underscored by Cohen & Levin (1989), firms conduct R&D not only with a view to innovate but also to improve their absorptive capacity. A firm's capacity to **apply for patents** (*patent appl*) and safeguard its intellectual property constitutes an important variable in explaining absorptive capacity of external technologies (*abs cap*). On that point, it should be noted that the firm's capacity to assimilate external technologies increases in correlation with the firm's size. This reinforces, indirectly, the assertions made in Schumpeter's findings: technological innovation increases, first, according to the size of firms and, secondly, accordingly as they collaborate under cooperation arrangements. Absorptive capacity thus constitutes a **key element** of the firm's strategy (Cohen & Levinthal, 1990). In that regard, the econometric study based on the notion of *competency in relationship building for innovation* yielded rather interesting results. The findings take into account the variety of innovation-oriented behaviors where R&D *strictly speaking* was merely one domain of competency among others. The results also shed new light on empirical approaches centered on the indirect examination of the rapport between size and innovation. The findings showed that the variable **size** has a far greater positive impact on the assimilation of external technologies for building innovation-oriented relations. **Competencies** also stand at the same level of importance as the firm's capacity for relationship building with outside partners. The firm's capacity (or competency) for exploiting external knowledge is crucial for developing an innovation (Cohen & Levinthal, 1990). A relationship of mutual dependence ties the firm's competencies to its innovation-oriented behavior. More specifically, the firm develops competencies to promote innovation and innovation, in turn, generates new possibilities for innovation. In this way, the capacity to

absorb innovation translates into the ability to assimilate internal and external information, to build knowledge and to develop problem-solving approaches, all of which is aimed at seeking new solutions, i.e., **to promote innovation**.

Conclusion

The move to factor inter-firm relationships into economic analysis has led to a dramatic rethinking of a certain number of well-established theoretical premises and has brought about a gradual shift in the theoretical object examined, starting with the market, moving to the organization, and, ultimately, to inter-firm cooperation. Cooperation agreements are, by their very nature, plagued by conflict; however, when handled knowledgeably and efficiently, they can turn cooperation into a weapon of conquest and serve as an impetus for technical resource creation and the transfer of competences. A firm's participation in collaborative efforts is no longer merely a costing exercise, but, rather, a strategy for mobilizing and building competencies. As a result, building in-firm competencies through (external or internal) absorptive capacity is indispensable, especially when the activities underlying the firms' operations rely on a variety of technologies that no single firm can ever master in their entirety. Reliance on collaboration therefore makes it possible to gain access to certain know-how without having to develop it in-house. On this point, Quélin (1996) has stated: "a firm may want to create its new competency internally within a single domain, but doing so may leave it bound by past choices or constrained in terms of gaining access to competencies required for its future development." Whereas technological competency entails resource-based technological learning, organizational competencies are cognitive in nature and are based essentially on teamwork and an organizational learning process. In order to view collaborative relationships as an integral part of resource creation, it is necessary to recognize cooperation as an alternative means of using economic coordination to achieve innovation, thereby making it possible to put an end to the predominance of the resource-allocation-based approach. Our results have shown that firms typically enter into cooperation agreements with others in order to innovate, and they generally possess most of the associated key competencies (Patent applications; Knowledge of their Competitors' technology; Familiarity with Future Technologies (technology watch); testing of External Technologies; third party inventions (patents, licensing agreements, etc.); assimilation of equipment and installations technology). This study has made it possible to highlight the fact that firms invest in R&D not only with a view to acquire competencies but also to drive innovation.

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Annexes

Definitions of the statistical variables used in various models.

Table 1. Construction de la variable, absorptive capacity (*cap-abs*)

Variable	Name of variable	Source of variable	Calculation Method for variable	Type of variable used in models
Abs cap	Absorptive capacity	CFI (capacity for innovation)	Based on 13 competencies.	Qualitative
<i>Techconcurrent</i> [Techcom]	<i>competitors' technologies</i>	CFI	"Do you know your competitors' technologies?"	Yes or No Qualitative
<i>Techfuture</i> [FuTech]	<i>Future technologies</i>	CFI	"Do you stay abreast of future technologies (technology watch)?"	Yes or No Qualitative
<i>Techext</i> [ExtTech]	<i>test outside technologies</i>	CFI	"Do you test outside technologies?"	Yes or No Qualitative
<i>Invbrevlic</i> [InvPatLic]	Licenses	CFI	"Do you use third party inventions (patents, licenses)?"	Yes or No Qualitative
<i>Connaissance</i> [Knowledge]	Assimilation of innovative know-how	CFI	"Do you assimilate know-how contained in innovative equipment and components?"	Yes or No Qualitative
<i>activ_rd</i> [RDactiv]	<i>R&D activities</i>	CFI	"Do you conduct R&D activities?"	Yes or No Qualitative
<i>soutez_rd</i> [RDouts]	<i>R&D sub-contracting/outsourcing</i>	CFI	"Do you sub-contract or acquire R&D?"	Yes or No
<i>Rdcoopese</i> [RDcoop]	<i>R&D with other firms</i>	CFI	"Do you conduct R&D activities in cooperation with other firms?"	Yes or No Qualitative
<i>Rdccooppub</i>	<i>R&D with public institutions</i>	CFI	"Do you conduct R&D activities in cooperation with public research institutions?"	Yes or No Qualitative
<i>Emphautqualif</i> [Hqempl]	<i>High-qualified (highly-skilled) employees</i>	CFI	"Do you recruit highly qualified scientific personnel for innovation?"	Yes or No Qualitative
<i>Achatese</i> [Buyout]	<i>Acquisition of firms</i>	CFI	"Have you acquired firms, in whole or in part, to promote innovation?"	Yes or No Qualitative
<i>Jvall</i>	<i>Alliances</i>	CFI	"Do you participate in joint-ventures, strategic alliances and other forms of cooperative collaborations to promote innovation?"	Yes or No qualitative
<i>soutraintant_tech</i> [subcont_tech]	<i>Sub-contracting for high-technology components</i>	CFI	"Are you a sub-contractor for high technology components?"	Yes or No Qualitative

Table 2. Construction of the variable market demand (*market-dem*)

Variable	Name of variable	Source of the variable	Calculation Method for variable	Type of variable used in models
Dem_marche [dem Market dem]	Market demand	CFI (capacity for innovation)	Based on 8 variables.	Qualitative
<i>prod_concu</i> [comp_prod]	Competitors' Product	CFI	"Do you study competitors' products?"	Yes or No Qualitative
<i>brev_concu</i> [comp-patent]	Competitors' Patent	CFI	"Do you study the patents filed by competitors?"	Yes or No Qualitative
<i>Publica_concu</i> [comp_publ]	Competitors' Publications	CFI	"Do you study publications by competitors' engineers?"	Yes or No Qualitative
<i>besoin_clie</i> [cus_needs]	Customer needs	CFI	Do you study customer type (segmentation) and needs?"	Yes or No Qualitative
<i>reaction_clie</i> [cus_feedback]	Customer feedback	CFI	"Do you collect customer feedback from afresales service departments or distributors?"	Yes or No Qualitative
<i>Satisfaction_clie</i> [cus_satis]	Customer satisfaction	CFI	"Do you use product labels or packaging to present information about customer satisfaction surveys (surveys contained on packaging material)?"	Yes or No Qualitative
<i>test_consomm</i> [cons_test]	Consumer Test	CFI	"Do you conduct tests on end consumers?"	Yes or No Qualitative
<i>consomation_pion</i> [cons_initiators]	Initiator consumer behavior	CFI	"Do you identify emerging needs or consumer behavior by initiators?"	Yes or No Qualitative