Inter-firm cooperative agreements and innovation-oriented behavior: an intersectional approach

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Abstract

This study aims to examine the relationship between business strategies for innovation and cooperative arrangements while seeking to determine, in particular, whether such arrangements can also be incorporated into innovation-oriented strategies within all companies. To that end, a micro-econometric analysis of French firms was undertaken. The findings allow us to suggest that the degree of reliance on cooperative arrangements differs from one sector to the next and increases proportionately to the size of the firm. Moreover, the fact that a firm belongs to a group increases the likelihood that it will collaborate with another firm to drive innovation. The econometric analysis revealed that the firms with the highest probability of bringing about innovation, comparatively speaking, are those that own patents. Accordingly, the R&D and innovation intensity level (in terms of products and/or processes) has a positive impact on the probability of finding ways to collaborate and innovate.

Lastly, this study also focuses on the form of collaboration sought by innovation-oriented companies. Here, it was found that firms tend to favor three types of cooperative arrangements: R&D cooperative agreements with other firms, cooperative agreements with public institutions, and cooperative innovation agreements (e.g. joint-venture agreements)

Introduction

In recent years corporate behavior has been greatly impacted by the sharp rise in cooperative agreements. Indeed, inter-organizational cooperative arrangements have been seen as "one of the most significant innovations in management organization of the past 20 years" (Guillouzo & Thenet, 2007:131). And a cooperative agreement, which has been defined as "a contract made between two or more partners, for a certain duration, entailing their coordinated efforts to achieve one or a set of goals collectively" (Delapierre, 1991:141) is one of the means whereby a business is able "to offset its strengths and weaknesses" (Hamel & Prahalad, 1989:71). However, "although a cooperative arrangement is based on establishing stable game rules in a world of uncertainty, it does not preclude engaging in competition" (Arlandis, 1987:228). That is because it is also "a search for domination and a sharing experience" (Froehlicher, 1998:15). In fact, "cooperation is a posture taken vis-à-vis action or interaction, characterized by a search for mutual benefits that is motivated by goodwill behavior" (Blanchot & Fort, 2007:165). And so, by relying on innovation strategies, companies try to allocate the associated costs between "several partners, thereby creating a new organizational structure" (Guilhon & Gianfaldoni, 1990: 105).

As Manant (2010) points out, cooperation enables firms to not only internalize technological spillover but also to share R&D-related costs. To track this company-driven initiative, economic theory (and its various offshoot approaches) has had to conduct empirical observations of the fast-changing world of inter-firm cooperative agreements and assess the impact of these agreements on the market and on the type of organizational structure chosen. In practice, the theoretical interest in inter-firm cooperative arrangements is directly linked to an evaluation of its empirical importance.

This study focuses, in particular, on the organizational arrangement and value-creation choices arising from cooperative agreements. We have therefore examined cooperative agreements and corporate innovation-oriented strategies in light of the following question: Are cooperative agreements incorporated into the innovation-driven strategies of all firms? The first part of this study consists of a theoretical approach to cooperative agreements. An array of inter-firm cooperative arrangements was also devised, and the distinctive or essential characteristics required to implement cooperative agreements have also been examined. The second part will address a micro-econometric study that was conducted, as well as the characteristics of the research sample. In the third part, which is devoted to a discussion of the findings, we will examine the link between cooperative arrangements and innovation within French firms as a whole.

Part One: A theoretical approach to Cooperative Agreements

In studies on inter-firm cooperation, two distinct approaches are generally noted: a transaction cost approach focusing on the fact that cooperation is motivated by a cost-reduction effort, in contrast with the technology diffusion approach, which aims to mitigate the effects of technological diffusion. In this light, cooperation becomes a vector for globalization of technological externalities[1]. In recent decades, a number of studies have made a great effort to conduct empirical tests on the theories pertaining to cooperative agreements, which has led to the emergence of various fields of research (in this study 5 major fields were identified). The first deals with technological cooperative arrangements and, more specifically, the study of the creation of new technologies and new know-how through R&D joint ventures (Von Hippel, 1988; Combe, 1995, 1998; Hagedoorn, 1996; Brousseau, 1997; Quélin, 1998; etc.) or the study of the creation of an R&D joint-venture and inter-firm cooperative arrangement as alternative means of cooperation (Teece, 1990). The second field of study focuses on the prerequisites for achieving stability and sustainability through agreements by looking at the conditions determining the success or failure of inter-firm cooperative agreements, depending on the various forms and methods adopted, notably, vertical agreements (Kogut, 1989; Blodgett, 1992; Baudry, 1995). The third field of study is devoted, more specifically, to measuring the correlation between market mechanisms and cooperative agreements, that is, the relationship between cooperative agreements and competition policy (Jorde & Teece, 1990; Jacquemin, 1988; etc.).

The fourth field of study focuses on the very phenomenon of inter-organizational cooperation based on studies aimed at understanding the "why" of cooperative arrangements (Combe, 1995, 1998; etc.). Lastly, the fifth and final field of study entails an assessment of the forms and methods of inter-firm cooperation while relying on research based on countries' levels of development, that is, by comparing developing and developed countries (Chan &

[1] For a summary of works highlighting this assumption, see Combe (1998)

Kogut, 1991; Brousseau, 1997, etc.). Accordingly, a cooperative arrangement is seen as enabling partnerships to not merely internalize technology spillover but also to share R&D costs (Manant, 2010: 839). In fact, the purpose of pursing a cooperative arrangement is to bring about the "pooling of certain skills and resources, coordination (behavior matching) and the sharing of results and profits between partners" (Guillouzo & Thenet, 2007: 134). Such pooling leads to the creation of new competencies and innovation (Prévot, 2007:186) because, as Patel & Pavitt point out (2000:330) "inter-organizational alliances are complementary to internal learning and not merely substitutes reflecting change in transaction costs". Ultimately, these research and learning activities, which have been characterized by Prévot as interactive (2007:190) offer the advantage of giving insight into tacit components of competencies."

In this study, only the closed collaboration model will be studied. Under this type of collaborative arrangement the group members are identified and selected (Pisano & Verganti, 2008) by firms wishing to implement a cooperative agreement. And so, after looking at the purpose, objectives and stakes involved in cooperative agreements, we shall then present, in the subsequent section, our empirical assessment while focusing on cooperative arrangements.

Part Two: Cooperative alliances aimed at driving innovation: a micro- econometric study of French firms

It is important to bear in mind that, when we speak of cooperative arrangements, a distinction should be made between vertical and horizontal cooperative networks. The former are entered into with suppliers (seeking a better fit with the new requirements of innovation-oriented firms) or with end-users (as when the innovation-oriented firm seeks to achieve a better alignment with its clients' needs) (Lundvall, 1993). In the case of horizontal cooperative networks, the relationships involve partners that engage in different areas of activity (in hopes of taking advantage of the synergy between two different fields of technology) or with competitors – "cooperative competition" (Prévot, 2007:184) – (the goals being, in this case, entirely strategic in nature) (Doz *et al*., 1989; Garrette, 1989). Finally, it should be remembered that one of the key aims of cooperative agreements is to facilitate the transmission of tacit knowledge *versus* explicit knowledge.

The objective of this section is, more specifically, to look at French firms and determine if they are more or less likely to rely on innovation-driven cooperative arrangements, while classifying basic information on enterprises (i) by their size, (ii) their membership in a national or international group, (iii) their presence in a specific sector. To that end, while conducting our empirical study, we have relied on surveys carried out by the *Service des Statistiques Industrielles* (SESSI) and, namely: (1) the Community Innovation Survey (CIS) from 1990 to 2010. The study entails 5000 industrial firms with more than 20 employees. One of the benefits of the survey is that it gives direct measurements of innovation according to various criteria (products/processes, radical/incremental). The different indicators considered include (i) innovation expenditures, (ii) internal and external sources, (iii) innovation-driven cooperation, (iv) innovation goals and (v) innovation barriers; (2) the ABS, or Annual Business Survey (*l'Enquête Annuelle d'Entreprise*, or *EAE*) conducted by SESSI[2]; (3) the annual survey of resources devoted to research and development (R&D). In order to identify innovation-driven cooperative

[2] SESSI Annual Business Survey, Volumes I and 2, published by the French Ministry of the Economy, Finance and Industry (« L'Enquête Annuelle de l'Entreprise », Tome 1 et 2, Ministère de l'Economie, des Finances et de l'Industrie français).

arrangements, a wholly qualitative criterion was used, namely, the fact of whether of not the company participated (reply: yes/no) in one or more cooperative agreements in order to engage in innovation activities.

It was possible to examine innovation-oriented behavior, as promoted by cooperative agreements, by cross-tabulating variables from the different surveys (*ABS, CIS, R&D*). The emphasis will be placed in particular on ***the concept of cooperation and the possible link between the different types of cooperative arrangements and innovation-oriented behavior***. In explaining the cooperation model, two categories of explanatory variables are used: **traditional variables** (which reflect the general company profile): size, group membership, self-financing capacity and R&D expenditures intensity level, together with **sector-related variables** (industrial sectors), which offer insight into the discriminating characteristics of the different industries. Indeed, a consideration of the company's core business affords the possibility to identify the general features of the different sectors. The business activity is defined by a multiple nominal variable with fourteen different modalities (French classification of business activities (*NAF*) 36). The modalities are specified according to the INSEE classification (corresponding to level 36 of the classification). Other variables are also introduced in the significance of the endogenous variable, which are taken into consideration in various empirical studies.

2.1. Sample studied and variables used in the empirical analysis

2.1.1. Analysis of the study sample

The SIREN identification system made it possible to undertake a cross-tabulation of the individual data items supplied by various studies (Annual Business Survey [ABS], the Community Innovation Survey [CIS], and R&D), to make a qualitative versus qualitative data comparison.

2.1.1.1. The firms' sector of business activity

The firms included in the sample belong to level 36 of the SEC, or Summary Economic Classification, adapted by INSEE (see **Chart 1**). This French classification of business activity offers the advantage of being relatively well detailed and comprised of 14 sectors, which are used to identify the main manufacturing activities engaged in by firms.

Tableau 1. Sectors included in the "SEC" Summary Economic Classification

Sector	Manufacturing Activity	% of firms
Sector 1	Clothing and leather industry	2
Sector 2	Publishing printing or copying products	1
Sector 3	Pharmaceutical, cosmetic and personal health products	8
Sector 4	Household equipment	6
Sector 5	Automobile Industry	5
Sector 6	Vessels, aircraft, trains, motorcycles	4
Sector 7	Mechanical equipment	16
Sector 8	Electrical and electronic equipment	11
Sector 9	Mineral products	5
Sector 10	Textiles	3
Sector 11	Products of timber, papers and paperboards	3
Sector 12	Chemical, rubber and plastics products	17
Sector 13	Metals and fabricated metal products	10
Sector 14	Electrical and electronic components	9

The chart shown above gives an overview of firms by business sector. Four sectors are relatively highly represented in the sample (**54**% of the total sample of firms): (1) the chemical, rubber, and plastics sectors represent **17**% of the firms; (2) the mechanical equipment sector **16**%; (3) the electrical and electronic equipment industries represent **11**% of the firms; (4) the metals and fabricated metal products industry represents **10**% of the firms. **18**%, **17**%, **10**% and **10**% of the firms in these sectors, respectively, engage in cooperative alliances with a view to drive innovation.

2.1.1.2. Study of firms by size and group membership

Research into the impact of firm size as a determining factor for innovation-driven cooperation tends to lean in two main directions: first, there is the focus on the effect of the firm's size on its market power, as exemplified by the Schumpeter/Arrow debate on the impact of market structures, and the second approach focuses mainly on the changing conditions for the adoption of products/process innovation activities: in both instances the theoretical models showed that there was a bias among large companies with high market power toward innovative behavior in terms of products and processes) depending on firm size. 76% of the study sample (see **Chart 2**) is comprised of firms with 250 to 5000 employees. Thus, based on criteria introduced under Decree n° 2008-1354 of 18/12/2008, which make it possible to better identify the category to which a firm belongs, we were able to classify firms according to MSE (Mid-Size Enterprises) categories. As regards measurement of company size, this new classification system consists of 4 categories: micro enterprises (employing fewer than 10 people), SMEs (Small and Mid-sized Enterprises, with 10 to 249 employees), MSEs (Mid-Size Enterprises, with 250 to 4999 employees) and Large Enterprises (LEs, which do not fall into any of the other three categories). The specific nature of the enterprises we surveyed (with more than 20 employees) means that we have not considered micro enterprises in this paper.

Chart 2. Firm breakdown by size

Size	*%*
Size 1 (20-249 employees)	*21%*
Size 2 (250-4999 employees)	*76%*
Size 3 (+ 5000 employees)	*3%*

Source: Authors' calculation from sample of 2547 firms (ABS, R&D, CIS surveys)

Group membership (see Chart 3) is analyzed while relying on the European survey on innovation known as the Community Innovation Survey (CIS). According to the CIS, firms belonging to a group are classified into two categories: (1) firms that are 50% or more owned by another industrial or non-industrial enterprise, whether French or not; (2) firms with a 50% or more controlling interest in another firm in France (foreign-based branches and subsidiaries of French firms were not taken into account). Group membership was revealed to significantly affect a firm's innovation-oriented behavior. As Lhuillery and Templé (1994) have pointed out, belonging to a group often has a major impact on a firm's innovation-oriented activities through intra-group financing of *R&D*. The Group membership variable is supplied by the ABS survey, as are the various group types (French, gr_fr; American, gr_usa; Japanese, gr_jap; European, gr_ue).

Chart 4. Breakdown of French firms (in cooperative alliances) by type of Group

Groups having participated in innovation-driven cooperative agreements	*Freq.*	*%*
1) French groups	*513*	*35.11*
2) American groups	*342*	*23.41*
3) Japanese groups	*81*	*5.54*
3) European groups	*519*	*35.52*
Groups having participated in innovation-driven cooperative agreements	*Freq.*	*%*
5) French public groups	*510*	*34.90*
6) American public groups	*30*	*2.05*
7) Japanese public groups	*0*	*0*
8) European public groups	*126*	*8.62*
Groups having participated in innovation-driven cooperative agreements	*Freq.*	*%*
9) French university groups	*729*	*49.89*
10) American university groups	*84*	*5.74*
11) Japanese university groups	*15*	*1.02*
11) European university groups	*234*	*16.01*

Source: Authors' calculation from sample of 2547 firms (ABS, R&D, CIS surveys)

Nearly 28% of our study sample is made up of stand-alone companies, whereas 72% are part of a group. By merging the different surveys we were able to classify standalone companies and firms belonging to a group according to their size and identify (a) the subsidiaries of a French group and (b) the subsidiaries of a foreign group (American, Japanese, or European). Alongside the traditional size-related and group membership variables were added self-financing capacity (SFC) indicators - that is, values providing an indication of the financial resources available to the firm as reflected in the ABS survey, and levels of R&D expenditures. Regarding the SFC indicator, the SESSI (using a definition adapted from OECD guidelines, 1993) has stated that "experimental research and development (R&D), whether internal or external to the firm (including in relation to another member firm within the business group) consists of creative work undertaken on a systematic basis in order to increase the stock of knowledge and the use of this stock of knowledge to devise new applications, or to install new products and/or processes."

2.2. Empirical model and main criteria of statistical significance

Empirical studies and the analytical model that has been developed (see **figure 1**) are intended to serve as tools to support the new concept of innovation-oriented behavior. Such behavior is seen, more specifically, as the cooperative efforts undertaken by companies with a view toward driving innovation. The two (dichotomous) endogenous variables in this model are "yes" and "no". The nature of this variable led us to run a logistic regression, which served as the approach to the empirical investigation based on the SESSI survey. Here, 3 firm-size categories have been used[3]. Also, we took into account the business sector in which each firm operates (based on 14 business sectors defined under the NAF French classification of business activities, adapted from INSEE).

As regards the model's likelihood function, it is strictly concave (Gourrieroux, 1989). In this configuration, relying on a Logit model, there is an assurance that the maximum likelihood

[3] Former ABS survey classifications: *Size 1*: 20 to 49 employees, *Size 2*: 50 to 99 employees, *Size 3*: 100 to 249 employees, *Size 4*: 250 to 499 employees, *Size 5*: 500 to 999 employees, *Size 6*: 1000 to 1999 employees, *Size 7*: 2000 employees or more//New INSEE classification (2008): *Size 1*: 20 to 249 employees, *Size 2*: 250 to 4999 employees, *Size 3*: +5000 employees

estimates are unique. As for the numeric values of coefficients, they have no direct interpretation; but we can deduce the marginal effect of given characteristics on probability Pi. However, by examining the sign and statistical significance of the coefficients we can determine if likelihood is an increasing or decreasing function of the corresponding characteristic.

Figure 1. Analytical model

Y_i = *cooperation*$_i$

i = 1…, n is the index of firms .

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

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

x_{ik} , is the index of exogenous variables (size, sector, group membership, ...) of firm i.

k, size, sector, group membership, innovation kind .....

Coop $_i$ is the variable that represents the cooperation detained or not as :

$\mathbf{P}_i = \mathbf{P}[Coop_i = 1] = \mathbf{F}[\beta_{ik} X_{ik}]$ (1)

Where F is the distribution function of a known law of probability. β_{ik} Represent the estimated coefficients of the $\mathbf{X}_{ik}$.

All variables are dichotomous variables. The value 1 for the variable cooperation indicates that the company makes cooperation (0 if not).

In a more condensed form, the model is written:

$\mathbf{P}_i = \mathbf{P}[Coop_i = 1] = \mathbf{F}(\beta' X)$ et $(1 - p_i) = prob[coop_i = 0] = 1 - F(\beta' X)$

$\beta' = (\beta_{ik})$

We consider the probability distribution F follows a logistic law. Equation (1) defines the logit model.

The estimator β_{ik} of the coefficients is obtained by the method of maximum likelihood. The likelihood function of the model is written:

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

By taking the log of the log-likelihood function L :

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

Maximizing this function gives the value β' of the maximum likelihood estimator of β checking the system of equations::

$$[\frac{D \log L(\beta)}{D\beta} = 0]$$

As for the main criteria of statistical significance (see **Chart 5**), some are general (when related to the overall adjusted goodness of fit of the model) or more specific in other instances (when used to isolate the effect of each exogenous variable on the endogenous variable). Moreover, these criteria make it possible to make a statistical assessment of two levels of outcomes. The first level shows whether the overall model is significant (relying on criteria such as a classification table, the pseudo R2 and the maximum likelihood ratio test). The second level makes it possible to examine an array of dependent variables and determine whether they play a significant and preponderant role when taken individually. In this way, the main criteria of statistical significance in our logistic regression model (see **Figure 1**) enable us to see if the results of the estimated model are significant.

Chart 5. Main criteria of statistical significance that were used

Test Name	Target	formula
Maximum likelihood	Examine whether the model is globally significant in relation to all the dependent variables taken together. The null hypothesis to be tested is: H0: all coefficients β k (apart from the constant course) included in the model are equal to 0 (k = 1 ..... K, K being the number of parameters to be estimated).	$D = -2\log\left(\frac{L0}{L1}\right) = -2(\log L0 - \log L1)$
Pseudo coefficient of determination R2	In the linear regression model it provides information on the proportion of the variance of the endogenous variable explained by the exogenous variables. For logit models there are no statistics with comparable interpretation available (Aldrich & Nelson, 1984). However, proxy measures are available for logistic models (pseudo R2). Thus, the R2 of McFadden (1974) provides a comparable measure.	$R_L^2 = 100(L_0 - L_k)/L_0$
Classification tables	They are used to provide an estimate of the percentage of subjects correctly classified using a technique of external validation (1-exclude all observations a test sample 2 - fit the model to the remaining observations 3 - validate the model to the using observations of the test sample).	
Test OF Wald	Its objective is to test the influence of each of the coefficients separately (Amemiya, 1981). When the calculated value of W exceeds the critical value, the null hypothesis is rejected.	$W = \frac{\hat{\beta}_k}{\hat{SE}(\hat{\beta}_k)}$

Part Three: Innovation-oriented Enterprises and Cooperative Alliances. Presentation and Discussion of findings

Cooperative alliances (see **Chart 6**) are widely accepted by the firms included in our sample, insofar as 57% of them have relied on them. However, beyond the issue of cooperation, our study sought to examine how cooperative arrangements could be integrated into firms' innovation-driven strategies. Along that line of inquiry, the question that was posed was as follows: Do all types of firms incorporate cooperative agreements into their innovation strategies? Our examination of this issue is structured around three leading sub-questions: (**1**) Does the type of cooperative alliance implemented affect the potential benefits/returns gained from inter-firm cooperation? (**2**) Do cooperative agreements make it possible to draw a distinction, from an innovation perspective, between firms that take part in them and those that do not? (**3**) Does cooperative behavior vary according to a firm's business characteristics? The last question has led us to undertake a deeper analysis of firms' business characteristics: (*3.1.*) Does the firm's **business sector** have any bearing on its cooperative behavior? (*3.2.*) Is there a **group effect** (international firms *vs.* non international firms) in terms of reliance on cooperative agreements? (*3.3*) Does a firm's **size** affect its propensity to rely on cooperation as a significant element of its corporate strategy?

Chart 6. Reliance *versus* non-reliance on cooperative alliances among French firms

Variables	*Freq.*	*%*
Cooperative alliance: 1	*1461*	*57*
If no: 0	*1086*	*43*

Source: Authors' calculation from sample of 2547 firms (ABS, R&D, CIS surveys)

When examining innovation-driven cooperation (Model 1) the objective is to look at various explanatory variables and compare their contribution toward increasing the likelihood of relying on innovation-oriented cooperative agreements. Three models were tested (see **Chart 7**). The first (Model 1-1) does not take into account the main effects of the different exogenous variables. The second (Model 1-2) includes the "public or state-owned group" effect. As for the third (Model 1-3), it incorporates the "university group" variable. The purpose of these

interactions is to improve the quality of Model 1-1. The three Models (1-1; 1-2; 1-3) are largely significant and have a considerably high classification rate (87.7%; 81.7%; and 85% respectively). In that light, we can conclude that, overall, the specification of the models is significant (i.e. the variables considered in the 3 models explain the firms' commitment to innovation-oriented cooperative agreements). The Logit estimation model (see **Chart 7**) makes it possible to identify explanatory factors behind innovation-driven cooperation ($coop_i$).

Chart 7. Firms' participation in cooperative agreements to drive innovation (estimation of explanatory factors[4])

Variables	Model 1-1 (Without interaction)			Model 1-2 (With interaction Public Group)			Model 1-3 (With interaction academic group))		
	Coef	*Test OF student*	Test OF Wald	*Coef*	*Test OF student*	Test OF Wald	*Coef*	*Test OF student*	Ttest OF Wald
Constante	*-2.6192*	*8.0121*		*-2.7666*	*2.3663*		*-2.6024*	*8.7164*	
INNOPROD	*0.4682*	*2.6324*	*1.597****	*0.3542*	*2.7421*	*1.425****	*0.4473*	*2 .7461*	*1.564****
INNOPROC	*0.0473*	*1.985*	*1.048*	*0.1073*	*3.8319*	*1.113*	*0.1302*	*1.1325*	*1.139*
SECTEUR	*0.0423*	*2.6729*	*1.043*	*0.0388*	*4.6912*	*1.040*	*0.0226*	*2.4520*	*1.023*
TAILLE	*0.0109*	*2.015*	*1.011*	*0.1769*	*2.3848*	*1.193*	*0.2074*	*5.0086*	*1.230*
CAF	*6.554E-7*	*1.4517*	*1.000*	*1.312E-6*	*2.5122*	*1.000*	*9.074E-7*	*1.5111*	*1.000*
IRD	*1.228E-6*	*2.4373*	*1.546*	*1.695E-6*	*9.4751*	*1.350*	*0.000253*	*2.0325*	*1.100*
DEPOT_BREV	*0.9376*	*7.7974*	*2.554*	*0.9927*	*2.7112*	*2.699*	*0.7804*	*7.0522*	*2.182*
TECHCONCURENT	*0.2471*	*0.9592*	*1.280*	*0.3566*	*0.0328*	*1.429*	*0.1175*	*0.2969*	*1.125*
TECHFUTURE	*0.2010*	*1.9640*	*1.223*	*-0.0221*	*2.0402*	*0.978*	*-0.2511*	*1.9654*	*0.778*
TECHEXT	*-0.0235*	*2.0386*	*0.977*	*0.00132*	*1.7855*	*1.001*	*0.0642*	*2.3396*	*1.066*
INVBREVLIC	*-0.0513*	*0.1853*	*0.950*	*-0.1394*	*9.3177*	*0.870*	*-0.00552*	*0.0026*	*0.994*
CONNAISSANCE	*0.2259*	*3.7825*	*1.253*	*0.3090*	*3.9859*	*1.362*	*0.3199*	*2.9766*	*1.377*
Groupe:									
Gr_fr	*16.5251*	*2.0069*	*1.243***						
Gr_usa	*15.7963*	*1.9712*	*1.015*						
Gr_jap	*14.7075*	*0.0012*	*ns*						
Gr_ue	*16.6242*	*2.8972*	*1.150*						
Gr_fr_pub				*16.8352*	*1.9859*	*1.154***			
Gr_usa_pub				*14.3503*	*1.0004*	*0.846*			
Gr_jap_pub				*ns*	*ns*	*ns*			
Gr_ue_pub				*15.4518*	*1.0017*	*0.821*			
Gr_fr_univ							*16.9532*	*1.808*	*0.985*
Gr_usa_univ							*12.9147*	*1.009*	*0.754*
Gr_jap_univ							*-0.7938*	*1.054*	*0.452*
Gr_ue_univ							*15.0183*	*1.028*	*ns*
-2 Log likelihood	3475.478			3475.478			*3475.478*		
Ratio test max likelihood	χ^2 =1560.9562*(> χ^2 (12))			χ^2 =997.0607*(> χ^2 (12))			χ^2 =1271.2174*(> χ^2 (12))		
Percent concordant	87.7			81.7			85		
R2 (McFadden)	*37*			*31.1*			*34.4*		

**: Coefficient is significant at the 10% level.*
***: Coefficient significant at the 5% level.*
****: Wald chi-square statistic: coefficient is significant at the 1% level.*
ns: when the nominal variable has multiple levels, the significance of cross-classification of criteria for variable selection (all modalities taken simultaneously) was calculated by the likelihood test applied to a subset of variables. Whenever the variable is not significant (ns), it was not deemed worthwhile to draw up a list of coefficients and tests (Student, Wald) relating to the various modalities, especially as the results table risks becoming too crowded.

3.1. Do all types of firms incorporate cooperative agreements into their innovation strategies?

As we saw above (**Chart 6**), firms that rely on cooperative agreements represent 57% of the total sample (2547 firms). It is important to note, however, that there are several types of innovation-driven cooperative alliances (Model 2). Three types of agreements were identified (see **Chart 8**) as favoring innovation (Model 1).

Table 8. Three types of cooperative agreements observed

Firms having participated in	*Freq.*	*%*
1) R&D cooperative agreements with other firms	*1572*	*61%*
2) R&D cooperative agreements with public institutions	*1467*	*57%*
3) Innovation-oriented cooperative agreements (joint ventures, strategic alliances, etc.)	*1095*	*42%*

Source: Authors' calculation from sample of 2547 firms (ABS, R&D, CIS surveys)

[4] All planned estimates were calculated on the basis of the SAS software (version 9.0)

The data shown above reveals the predominance of R&D cooperative agreements (i.e. in alliances with other firms: 61% of the sample; with public institutions: 57% of the sample). As regards the type of cooperative alliance (private/public) it is worth noting that no hard and fast conclusions could be drawn. Essentially, there are two lines of thinking: one based on the free dissemination of knowledge (in alliance with public institutions), in contrast with a logic (embraced in the private sector) motivated by a concern for the cost effectiveness of research initiatives. Yet, as Corbel *et al.* (2011:159) have pointed out, public/private cooperation has a "zone of common interest: the application of inventions (innovations)". And so, as the authors state, projects carried out jointly become "centralizing forces" for innovation.

The issue that interests us, here, is to determine whether firms that participate in these three types of cooperative agreements (see **Chart 8**) differ, in terms of innovation, from those that do not participate in them. (see **Chart 9**)

Chart 9. Estimate of Factors Explaining innovation activities among French Firms participating in various types of Cooperative Agreements

Variables	Model 1-1 (Without interaction)			Model 1-2 (With interaction Public Group)			Model 1-3 (With interaction academic group)		
	Coef	***Test OF student***	***Test OF Wald***	***Coef***	***Test OF student***	***Test OF Wald***	***Coef***	***Test OF student***	***Test OF Wald***
Constant	*-0.5601*	*3.9684*		*-0.5880*	*4.4262*		*-0.4925*	*3.0294*	
INNOPROD	*0.2895*	*3.3885*	*1.336****	*0.2038*	*1.7132*	*1.226****	*0.2241*	*2.0390*	*1.251****
INNOPROC	*0.2554*	*3.9097*	*1.291*	*0.2882*	*5.0129*	*1.334*	*0.2989*	*5.2565*	*1.348*
SECTEUR	*0.00288*	*0.0329*	*1.003*	*0.00831*	*0.2752*	*1.008*	*0.00458*	*0.0820*	*1.005*
TAILLE	*-0.0892*	*4.2515*	*0.915*	*-0.0499*	*1.3975*	*0.951*	*-0.0758*	*2.9108*	*0.927*
CAF	*3.626E-7*	*0.5749*	*1.000*	*7.797E-7*	*2.3356*	*1.000*	*1.178E-7*	*0.0324*	*1.000*
IRD	*0.0283*	*2.0299*	*1.270*	*0.0324*	*2.0394*	*1.190*	*0.000137*	*0.0067*	*1.000*
DEPOT_BREV	*0.2269*	*3.3057*	*1.255*	*0.2831*	*5.2443*	*1.327*	*0.1765*	*1.9688*	*1.193*
TECHCONCURENT	*0.4919*	*5.7914*	*1.635*	*0.4282*	*4.5533*	*1.535*	*0.4208*	*4.4001*	*1.523*
TECHFUTURE	*0.7920*	*6.0575*	*2.208*	*0.7429*	*5.7697*	*2.102*	*0.7036*	*28.9277*	*2.021*
TECHEXT	*0.1230*	*6.8199*	*1.131*	*0.1316*	*1.2147*	*1.141*	*0.1416*	*1.3750*	*1.152*
INVBREVLIC	*0.8945*	*6.0407*	*2.446*	*0.8713*	*6.6925*	*2.390*	*0.8607*	*42.9414*	*2.365*
CONNAISSANCE	*0.8026*	*5.6534*	*2.231*	*0.876**0***	*6.6420*	*2.401*	*0.8498*	*40.6821*	*2.339*
Groupe:									
Gr_fr	*1.5989*	*2.4753*	*4.948***						
Gr_usa	*0.4363*	*3.0230*	*1.547*						
Gr_jap	*-0.7418*	*ns*	*0.476*						
Gr_ue	*0.3713*	*3.8191*	*1.450*						
Gr_fr_pub				*0.7928*	*3.5822*	*2.210***			
Gr_usa_pub				*12.9817*	*1.0009*	*ns*			
Gr_jap_pub				*ns*	*ns*	*ns*			
Gr_ue_pub				*0.7201*	*1.4002*	*2.055*			
Gr_fr_univ							*1.5160*	*4.3178*	*1.554***
Gr_usa_univ							*13.0120*	*ns*	*ns*
Gr_jap_univ							*11.9761*	*ns*	*ns*
Gr_ue_univ							*1.0839*	*3.2043*	*2.956*
-2 Log likelihood	2299.981			2299.981			***2299.981***		
Ratio test max likelihood	χ^2 = 386.9582*(> χ^2 (12))			χ^2 = 346.7931*(> χ^2 (12))			χ^2 =412.1126*(> χ^2 (12))		
Percent concordant	77.5			76.2			***78.5***		
R2 (McFadden)	*15.5*			*14.7*			*16.5*		

**: Coefficient is significant at the 10% level.*
***: Coefficient significant at the 5% level.*
****: Wald chi-square statistic: coefficient is significant at the 1% level.*
ns: when the nominal variable has multiple levels, the significance of cross-classification of criteria for variable selection (all modalities taken simultaneously) was calculated by the likelihood test applied to a subset of variables. Whenever the variable is not significant (ns), it was not deemed worthwhile to draw up a list of coefficients and tests (Student, Wald) relating to the various modalities, especially as the results table risks becoming too crowded.

The results presented above show that active participation in at least one of the three types of technological cooperative agreements requires that the firm be able to acquire additional technologies and equipment (Knowledge). Exchanges of knowledge (between partners) and teamwork are indispensible to these types of cooperative agreements. Typically, firms that view technological cooperation as a means of resource generation are characterized by the fact that they encourage individual creativity initiatives and the pooling of knowledge. Moreover, the research suggests that the firm's ability to absorb outside technology is highly correlated to its R&D efforts (by promoting cooperative research and development activities):

firms that participate in these types of cooperative agreements tend to invest in their own R&D (significance of the IRD variable). These results support the findings of other studies, which have shown a dramatic increase in inter-firm R&D collaborations over past decades, (Caron, 2010; Hagedoorn, 2002). In the end, firms have become acutely aware that R&D enables them to develop organizational knowledge (Lane *et al.*, 2006) and that knowledge is "conducive to the development of partnerships which will, in turn, feed and broaden that knowledge base" (Loilier & Tellier, 2011:74). Cooperative agreements, especially those centering on R&D, are integrated *de facto*, by firms into their innovation strategies. Indeed, the various results of the study show that the R&D and (product and/or process) innovation intensity have a positive effect on the firms' likelihood of cooperating to drive innovation. According to the Wald test, companies that make investments in R&D while collaborating with other firms have a 54.6% greater chance of innovating than firms that do not engage in collaborative R&D projects. The type of cooperative arrangement implemented definitely has an impact on all potential advantages or drawbacks derived from inter-firm cooperative alliances. Not only do R&D activities generate innovation, they also contribute to firms' knowledge absorptive capacity (Cohen & Levinthal, 1989, 1990, 1994).

3.2. Does cooperative behavior vary according to a firm's business characteristics?

In addressing this question, we examined firms through the lens of a set of characteristics (sector, size, group effect) (see **Chart 7**) while relying on our line of research questions.

Does the firm's business sector have any bearing on its cooperative behavior? As regards the firm's business activity (*sector*, according to the French Classification of Activities, or NAF 36), the effect of the sector-related variable (*sector*) seems to be significant. Participation in innovation-driven cooperative agreements differs from one sector to the next. That is probably explained by the fact that specification of the variable (sector) reflects sector-specific characteristics.

Does a firm's size affect its propensity to rely on a cooperative arrangement as a significant element of its corporate strategy? The effect of the *size* variable is also significant. Participation in cooperative agreements to pursue innovation increases proportionally to the firm's size. In other words, firms within the detailed classification of our sample were more likely to participate in cooperative agreements to carry out innovation activities. These findings are consistent with most empirical research on the subject[5]. In addition, R&D intensity and firm size appear to be related. And so, as Munier has pointed out (2002:108) "closer empirical analyses, taking into account sector-related effects, confirm the existence of a proportionality between size and R&D".

Is there a group effect (internationalized *versus* non internationalized firms) in terms of the use of cooperative agreements? There is indeed a positive relationship between a firm's membership in a group (*gr_fr, gr_usa, gr_jap, gr_ue*) and the likelihood of collaborating to drive innovation, a fact which rehabilitates the assumption that standalone firms enjoy a certain facility for pursuing innovation with outside partners. Moreover, this group effect can be verified by looking at different types of groups (partnerships with public institutions or universities). It was also noted that there is a highly significant correlation between group membership (*gr_fr, gr_usa, gr_jap, gr_ue*) and the likelihood of engaging in at least one of the three different types of innovation-driven cooperative alliances (an R&D initiative with other firms; an R&D initiative with public institutions; as part of a strategic alliance). Compared to

[5] It should be noted that our empirical research focuses on French firms. Certain studies have produced results that contradicted our findings. Kleinknecht and Reijnen's empirical study (1992) of Dutch firms found the size variable not to be significant.

standalone firms, companies that belong to a group tend to cooperate with other firms or organizations to carry out their R&D and innovation activities. Not only did firms belonging to a group enjoy greater facility for engaging in at least one of the aforementioned types of cooperative arrangements, they also benefited from intra-group research (Lhuillery, 1996) even if, generally, the likelihood of engaging in R&D activities grows proportionately to group membership, as shown by Lhuillery (1998).

Two other variables (patent applications; SFC) were incorporated into the Model. **Patent applications** (PAT_*APPL*), viewed from the firms' perspective, constituted a significant variable. Companies that jointly file patent applications (DPI) in cooperation with other firms have a 70% chance of engaging in more innovation activities than do firms that do not seek patent protection for their inventions. As for **SFC** (Self-Financing Capacity) this type of effect did not prove significant, which may be explained by the biased definition of financial resources in the ABS database. Indeed, this variable takes into account the firm's financial structure and level of indebtedness but not its financial resources devoted to innovation activities.

Lastly, it should be stressed that one of the main motivations for firms to seek out collaborations to drive innovation is that cooperative alliances offer the possibility of reducing risks and costs through joint research efforts. Firms undertake technological collaborations in order to produce knowledge, which might not otherwise have been yielded were it not for the combination of in-house research efforts and external resources obtained from public or private laboratories, given the additional costs, uncertainty and assets required to bring projects to fruition. Consequently, as Wejnert has stated (2002: 302), direct or indirect innovation-related costs can stifle a firm's commitment to pursue innovation, especially when the associated costs far exceed the firm's potential resources. Thus, cooperation has an induced effect, namely, the desire to "share *R&D* costs" (Manant, 2010: 839).

Conclusion

The aim of this study was, first, to examine organizational innovation-oriented behavior, as revealed thorough cooperative alliances and agreements. Firms do indeed consider cooperative arrangements as drivers of innovation. In this regard, our statistical analyses yielded an array of findings. As for the firms themselves and their participation in cooperative arrangements, three points stood out. First, it was noted that innovation and R&D exert an influence on firms' participation in cooperative agreements, but these knowledge flows are caught in a vicious circle: R&D has spillover effects on innovation, which, in turn, makes it possible to undertake R&D activities. In fact, firms that make R&D investments in collaboration with other firms have a much higher chance of innovating than firms that do not engage in cooperative arrangements. Secondly, the firm's business sector has an impact on its participation in innovation-driven cooperative alliances and agreements. Indeed, firms exhibit differing cooperative behavior depending on the business activity they engage in. Third, our research showed that a firm's likelihood of relying on cooperative arrangements as part of its corporate strategy is highly conditioned on firm size. As regards the concept of cooperative arrangements, it is worth noting that it is regularly put forward not only as a means of resource generation but also as a way of explaining firms' innovation-oriented behavior. Our research has helped to shed light on three types of cooperative arrangements (in the form of R&D activities undertaken with other firms or with public institutions; innovation-driven cooperative agreements such as joint ventures or strategic alliances), which are used by French firms to drive innovation. It remains

for future research to pursue this line of investigation by comparing, in particular, the role of cooperative agreements on innovation-oriented behavior within foreign firms (e.g. in Japan or in the US).

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