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The Innovativity of Global Firms: Evidence from French Manufacturers

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Abstract

This paper investigates to which extent exporters, importers and multinational firms have a greater propensity to start innovation activities. To do so, we merge two different French Community Innovation Surveys (CIS) and use the model of Crépon *et al.* (1998), which allows us to estimate the impact of internationalization on the decision of investing in R&D, the intensity of R&D (ratio R&D expenses/sales) and knowledge output. The model is applied to a sample of first-time innovators, which are compared to a sample of firms that do not engage in innovation activities. The first result is that global firms are more likely to start investing in R&D: indeed, they have to face tougher competition and this seems to be an additional incentive to invest in R&D. However, R&D intensity is not affected by international activities and seems to decrease with size, which could mean that the first investment in R&D is always a cautious one, which takes the form of a fixed cost. Finally, international activities are found to increase the capacity of innovating, regardless of size, industry, and R&D intensity. In particular, outward FDI seems to be an asset for developing new products for the market. This could be due to the access to new information sources and/or a more efficient use of these sources.

Introduction

The current economic crisis brought new attention to industrial firms and Small and Medium Enterprises (SMEs). Supporting these firms is one of the top priorities of the French "big loan", a government-backed spending program aimed at boosting France's strategic investments. This specific action aims to articulate with a broader policy supporting research and innovation. Indeed, given the rise of emerging economies, innovation is considered as a crucial tool for preserving and developing industrial activities in developed economies.

In this context, this paper aims at identifying the factors that could contribute to strengthen manufacturers' innovation activities. We use a sample of French first-time innovators (here called "switchers") and firms that do not engage in R&D activities. Following the model of Crépon, Duguet and Mairesse (1998), we set up an econometric model that describes switchers' innovation process in three steps: deciding to invest in R&D, estimating R&D intensity, and producing knowledge. The main contribution of this paper is to introduce a dynamic dimension in the model and to focus on the impact of international activities on firms' innovation process. Indeed, firms that export, import and/or own affiliates abroad are expected to access specific knowledge and skills, which can increase their innovation capacities; they are also expected to have a greater incentive to invest in R&D, since they have to face tougher competition. Therefore, international activities might both affect inputs and outputs of innovation activities.

The first result is that regardless of size, industry and ownership, firms which export, import and eventually engage in FDI have a greater propensity to start investing in R&D. However, switchers' R&D intensity, meaning the share of R&D expenses in total sales, is not affected by international activities, and is found to decrease with size. Finally, firms that both export and import and multinationals are found to have a greater capacity of becoming innovators, regardless of size or R&D intensity. Engaging in FDI seems particularly important for developing new products for the market. Therefore, while most papers confirm that innovating boosts international activities, this paper demonstrates that the reverse causality is also true.

Section I gives a literature review. Section II presents the methodology. Section III describes the data and the variables that we use. Section IV gives some descriptive statistics of our sample. Finally, section V presents the results of our model.

Section I: Literature review

A growing literature describes the process by which firms innovate and are able to increase their productivity. Griliches (1979) is the first to provide an analytical framework connecting investment in R&D to knowledge production then productivity growth. But we have to wait for Crépon, Duguet and Mairesse (1998) to provide a unified model which is adapted for empirical research. Hall and Mairesse (2006) summarize the three main contributions of this model (noted CDM):

- First, it gathers several separated fields of empirical research in a global model, which successively estimates the decision of investing in R&D, the level of this investment (R&D intensity), knowledge production and firms' productivity, using a recursive system of equations.

- Second, it allows the use of new informative on innovation activities. For instance, the European Community Innovation Surveys (CIS) provide new information on knowledge output (share of sales due to new products for example) and the contribution of different information sources.
- Finally, this model allows to correct several bias that arise when analyzing the link between innovation and productivity, such as selection bias (not all firms choose to invest in R&D), the endogeneity of regressors, and the qualitative nature of the dependant variable.

More and more papers rely on the CDM model. Its success is partly due to its flexibility, since all variables and equations can easily be adapted to answer a specific issue. As stressed by Hall and Mairesse (2006), this lack of harmonization in the model specification, which goes with great heterogeneity in the results, does not allow to give clearcut conclusions concerning the link between innovation and productivity. However, these papers set some stylized facts. First, the decision of investing in R&D is positively correlated with size and market shares (Crépon *et al.*, 1998 ; Benevante, 2006 ; Griffith *et al.*, 2006 ; Lööf and Heshati, 2006). This is consistent with the Schumpeterian theory, which predicts that the incentive to invest in R&D increases with market power, as it guarantees higher returns on investment. However, the influence of size and market share on R&D intensity (R&D expenses per employee) is more ambiguous and depends on the specification of the model, some authors finding a positive correlation (Benavente, 2006), some a negative one (Lööf and Hesmati, 2006), and some no correlation at all (Jefferson *et al.*, 2006). Finally, as expected, knowledge output increases with R&D expenses, and has a positive impact on firms' productivity, regarless of size or industry (Crépon *et al.*, 1998; Lööf and Hesmati, 2006 ; Jefferson *et al.*, 2006). It is important to precise that all these studies show evidence for correlation only, not causality.

The model of Helpman *et al.* (2004) allows extending the link between innovation and productivity to international activities. This model with heterogeneous firms predicts that only the most productive firms can have international activities. Indeed, exporting, and to a larger extent investing abroad, imply high fixed costs, and only a minority of firms can meet the requirements in terms of size, productivity, skilled workers, knowledge of foreign markets etc. Therefore, exporters and multinationals exhibit a productivity premium, which is already well documented by many papers (see the review by Greenaway and Kneller, 2007). This premium was initially considered as exogenous: each firm draws a random level of productivity, which determines its degree of internationalization. However, several papers now try to understand how firms can increase their productivity and consciously self-select on foreign markets. Especially, Yeaple (2005) constructs a model where firms are initially identical then have the possiblity to choose different technologies, which affects the level of their fixed costs: in this framework, innovating increases productivity and therefore helps to overcome the barriers for entering foreign markets[4]. This theoretical link between innovation and the propensity to export is confirmed by empirical studies: using Belgium data, Van Beveren and Vandenbussche (2010) show that first-time exporters anticipate their entry on export markets by innovating. Using German data, Becker and Egger (2007) confirm that innovation (and mostly product innovation) significantly increases the propensity of exporting, using matching techniques.

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[4] However, the productivity premium of exporters is not entirely explained by innovation activities. Indeed, Bellone *et al.* (2009) show that export premia remain significant even after controlling for product or process innovation. These premia could also come from other specific characteristics of exporters concerning organization or management.

According to the theory of multinationals, there is a more direct link between innovation and FDI, that does not go through the level of productivity: firms invest abroad because they own specific assets (Markusen, 1995). This strategy is known as "asset-exploiting" (Dunning and Narula, 1995): firms seek to exploit their competitive advantage on new markets. Their innovation activities remain located at home in the parent company, while their affiliates abroad just adapt products to local consumers and distribute them without adding any major modification. This strategy implies that innovation activities precede FDI, since the aim of investing abroad is to exploit a pre-existing competitive advantage.

Although most papers examine whether innovation contributes to the degree of internationalization of firms, some papers also consider the opposite causality: being an exporter or a multinational firm could boost innovation activities. Concerning exporters, this is the "learning by exporting" hypothesis. According to Clerides *et al.* (1998), these learning effects might come from foreign buyers by giving some technical expertise to exporters. Following the same logic, Crespi *et al.* (2008) show that exporters learn more from their clients and suppliers, and that this could be a source of their productivity. Damijan *et al.* (2008) show that exporters are more likely to innovate in process and therefore increase their productivity.

Although the same mechanisms could apply to multinational firms, the idea that firms could become more innovative by investing abroad is also inherent to "asset-seeking" strategies (Dunning and Narula, 1995). Here, firms do not invest abroad in order to exploit their own assets but in order to acquire new ones. Their objective is to extend their network and acquire technologies and knowledge they could not access before. The incentive for such strategies is especially high when knowledge is tacit and can be assimilated only through local presence. Assets acquired abroad might be combined with the firm's own assets in order to create new ones. One good illustration is the investments in research centers, which are associated to knowledge externalities. In this spirit, asset-seeking strategies might result in innovations both in the investing and the invested country when the parent company and its affiliates abroad enjoy complementarity between their assets.

Section II: Methodology

In order to estimate the probability of starting innovation activities, we set up an econometric model which is largely inspired by the CDM model, and describes firms' innovation process in three steps:

- First, each firm decides whether to invest in R&D or not ;
- Second, the firm determines the level of its investment ;
- Finally, the firm produces knowledge using all inputs of innovation (R&D expenses, other information within the group etc.).

The CDM model adds a final step where firms' productivity is determined by their innovation activities and other classic inputs, such as labor and capital. However, our data provides no information on capital and does not allow to build a robust measure of productivity, so we have to skip this step.

The model consists in a recursive system of three equations. The first one describes the probability that firm i invests in R&D at period t:

$$\text{RD}_{it}^* = C + \beta_{it}X_{it} + u_{it} \qquad (1)$$

Where *RD** represents the expected utility of investing in R&D, *X* is a vector of regressors (including international activities), and *u* is the error term. Given that we can only observe if firms have effectively invested in R&D (with the dummy *RD*), equation (1) becomes:

$$RD_{it} = \begin{cases} 1 \; if \; R_{it}^* = C + \beta_{it}X_{it} + u_{it} > A \\ 0 \; if \; R_{it}^* = C + \beta_{it}X_{it} + u_{it} \leq A \end{cases} \quad (2)$$

One firm decides to invest in R&D if the expected utility reaches a certain value *A*. Then the second equation of the model estimates R&D intensity (noted *IRD*, often defined as the ratio R&D expenses –number of employees), conditionally to the decision of investing in R&D:

$$IRD_{it} = \begin{cases} IRD_{it}^* = C + \gamma_{it}X_{it} + \varepsilon_{it} & if \; RD_{it} = 1 \\ 0 & if \; RD_{it} = 0 \end{cases} \quad (3)$$

Equations (2) and (3) are jointly estimated with a generalized Tobit model by maximum likelihood, using the "Heckman" command in STATA (where (2) is the selection equation). The main advantage of this method is that R&D intensity is not estimated only for firms which invest in R&D, but for all firms in the sample. Therefore, the estimation of (3) does not suffer from a selection bias.

Finally, we estimate the probability of innovating with a knowledge production function:

$$INNOV_{it} = C + \delta_{it}X_{it} + \alpha_{it}IRD_{it}^* + \varphi_{it} \quad (4)$$

Where *INNOV* is a dummy indicating whether the firm innovates or not (see the definitions further), *X* is a vector of firms' observable characteristics, and *IRD** is the R&D intensity estimated in (3). Considering these estimates and not the R&D intensity which is effectively observed allows to account for selection (because the equation is estimated for all firms and not only innovative ones) and endogeneity (the R&D intensity estimated in (3) accounts for the fact that investing in R&D depends on firms' characteristics, like size, international activities and ownership).

As mentioned before, the literature initiated by Crépon *et al.* (1998) finds evidence for correlation between performance, investing in R&D and knowledge output, but does not allow to discuss causality. This is mostly due to the fact that these studies only use one survey, and therefore do not include any dynamic analysis. The main contribution of this paper is to identify the factors of becoming an innovative firm (therefore give some evidence for causality) by adapting the CDM model in the following way:

- We only consider firms which are surveyed two consecutive times, and restrict the sample to firms that were not engaged in innovation activities during the first period. Therefore, our model compares first-time innovators with firms which never engage in innovation activities.
- All regressors in (2), (3) and (4) are lagged (except the estimated R&D intensity in (4)), in order to introduce some dynamic in the model.

Section III: Data

Our sample is the merge of two consecutive French Community Innovative Surveys (CIS), CIS4 and CIS6, which respectively cover the periods 2002 – 2004 and 2004 – 2006[5]. These surveys question firms about their innovation activities in the following way: first, each firm gives some basic information on its activity (industry, sales, employment), then indicates if it had product innovation (i), process innovation (ii), if it engaged in a R&D activity still ongoing (iii), or finally abandoned (iiii). If the firm is in one of these four cases, it has to report its R&D expenses, indicate whether it engaged in cooperations for innovation, and evaluate the sources and the effects of innovation activities (increase of market shares, cost reduction etc.). The method for cleaning the sample is detailed in appendix I.

The sample is merged with the LiFi (« Liaisons Financières » or financial links) survey from the French office of statistics (INSEE). First, this survey allows adding information about ownership: we are able to identify independent firms[6], parent companies and group affiliates; for the latter, we can determine the nationality of the group[7], so we can distinguish French- from foreign-owned affiliates. Second, we can identify which firms are engaged in outward Foreign Direct Investment (FDI), meaning firms that own at least 10% of the capital of a foreign company.

Finally, we use data from the French customs in order to identify exporters and importers of goods. With this information, we can define several groups of firms according to their degree of internationalization:

- Domestic firms, which have no exports, no imports, and no affiliate abroad. This is the reference group.
- Firms that export only ;
- Firms that import only ;
- Firms that export and import (without FDI) ;
- Finally multinational firms, which nearly all happen to be importers and exporters in the sample.

We want to identify which factors encourage starting innovation activities, so we have to use a balanced sample. We restrict the sample to firms which do not engage in innovation activities in the first period (CIS4). As often mentioned in the literature, choosing the indicators for innovation activities is not a trivial issue. Indeed, several indicators are available for knowledge output (product innovation, process innovation, products new for the market, sales of new products for the market, patents, marketing or organizational innovation etc.), which may use several inputs (expenses of internal R&D, external R&D, acquisition of equipments and softwares, co-operation, training etc.). This brings questions about the definition of innovative firms: we can distinguish firms which invest in R&D without concrete innovation, those that invest in R&D and produce knowledge, and those that innovate without investing in R&D. The advantage of the CDM model is to consider several steps in the process of producing knowledge, so our analysis can cover these three types of firms. However, we still have to set some definitions:

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[5] Note that only industrial firms are surveyed both by CIS4 and CIS6.
[6] Firms which are not surveyed by LiFi are considered as independent.
[7] We consider that the nationality of business groups is determined by the location of its heading company.

- We only consider two indicators for innovation output: product and process innovation. We also make a focus on firms that introduce a new product for the market[8], that we separate from simple imitators. All these measures of innovation are self-reported. One could consider a more objective measure such as patents but we find it too restrictive. We prefer not to use the share of sales due to new products for the market because of the asymmetry of the distribution.
- For R&D expenses, we consider both internal and external expenses. In practice, internal expenses essentially gather wages of employees doing R&D activities, whereas external expenses also cover the acquisition of machinery and softwares (which is not linked to internal R&D) as well as the acquisition of external knowledge.
- R&D intensity is the ratio of R&D expenses on total sales. Most papers consider R&D expenses per employee, but we consider that firms do not determine their investment in R&D according to their number of employees, but according to their revenues. Moreover, innovation activities do not necessarily rely on firms' own employees (for example, firms may turn to a consulting group or a university to make a specific study), so R&D expenses per employee do not seem to be a comprehensible measure of the effort in R&D.

The sample is restricted to firms which are neither innovative, neither investing in R&D in the period (2002 – 2004). We define "switchers" as firms becoming innovators in the second period (2005 – 2006). They will be compared to firms which invest in R&D without concrete results, and firms that still do not invest in R&D.

Section IV: Descriptive statistics

The sample gathers 753 firms, with 220 switchers. These switchers are composed of:

- 153 innovators in product ;
- 158 innovators in process ;
- 91 innovators in product and process ;
- 101 firms that introduce new products for the market.

Innovation activity often implies R&D expenses, with some exceptions. Indeed, the proportion of firms investing in R&D is close to the proportion of firms becoming innovators, regardless of the size class (see table 1). There are only 37 switchers that do not report R&D expenses at the end of the period (but 88 that do not report internal expenses). Inversely, only 12 firms engage in R&D expenses without reporting any product or process innovation.

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[8] Note that firms might not use the same benchmark in order to define their product as "new to the market". Especially, exporters and multinational firms might compare their products to a wider range of goods than domestic firms, as they can see more directly what is being made abroad. Therefore, domestic firms might more easily consider that they introduce a new product to the market than global firms.

Table 1: Innovation activities according to size

Innovation activities	Sales					All
	Less than 5 million euros	5 - 10 million euros	10 - 20 million euros	20 - 50 million euros	More than 50 million euros	
% of innovative firms	21%	22%	27%	34%	39%	**29%**
% of firms introducing a new product for the market	10%	10%	10%	16%	20%	**13%**
% of firms investing in internal R&D	12%	13%	18%	26%	25%	**19%**
% of firms investing in R&D	18%	19%	25%	32%	35%	**26%**
Ratio R&D expenses - total sales (median)*	1,1%	1,1%	1,3%	0,6%	0,7%	**0,8%**

* Computed for firms investing in R&D only.

Sample : 753 French manufacturers that do not innovative over the period 2002 - 2006, or start innovation activities in 2005 - 2006 only (switchers).

Sources : CIS4 and CIS6 - Author's calculation.

As expected, the share of firms becoming innovators increases with size. This is probably due to the fact that larger firms also appear more likely to invest in R&D. However, they do not necessarily exhibit a higher R&D expenses – total sales ratio. This first finding suggests that larger firms do not become innovators because they allocate more resources to R&D, and that other factors could also increase their innovativity.

Comparing the characteristics of switchers and firms that do not innovate over the period reveals that switchers exhibit more international activities (see table 2). They are more likely to belong to business groups, especially foreign ones, but do not appear more oriented in technology-intensive industries[9]. Switchers which introduce new products for the market have the particularity of having more connections with foreign entities, either by belonging to a foreign group or by owning affiliates abroad.

Table 2: Firms' characteristics in 2004 according to their innovation activities in 2006

	Non-innovative firms	Switchers	
		Product and/or process new for the firm only	New product for the market
Number of firms	533	119	101
Sales (% of firms)			
Less than 5 million euros	24%	16%	16%
5 - 10 million euros	20%	13%	14%
10 - 20 million euros	17%	18%	12%
20 - 50 million euros	18%	23%	23%
More than 50 million euros	21%	30%	36%
Workforce (% of firms)			
More than 50 employees	29%	19%	21%
50 - 100 employees	28%	21%	18%
100 - 250 employees	15%	21%	16%
250 - 500 employees	21%	29%	27%
More than 500 employees	7%	9%	19%
Industry's technological intensity (% of firms)			
Low-tech	52%	48%	55%
Middle-low tech	17%	18%	13%
Middle-high tech	22%	24%	24%
High-tech	9%	10%	8%
Ownership (% of firms)			
Independent	27%	19%	14%
French business group	55%	57%	54%
- small group (less than 250 employees)	23%	14%	15%
- medium group (250 - 5 000 employees)	24%	29%	30%
- large group (more than 5 000 employees)	8%	14%	10%
Foreign business group	18%	24%	32%
International activities (% of firms)			
Domestic firms	17%	5%	6%
Only exporters	7%	3%	4%
Only importers	13%	8%	4%
Exporters and importers (no FDI)	54%	77%	67%
Multinational firms	9%	7%	19%

Reading : 19% of firms that introduce a new product for the market are multinationals.

Sample : 753 French manufacturers that do not innovative over the period 2002 - 2006, or start innovation activities in 2005 - 2006 only (switchers).

Sources : CIS4 and CIS6, LiFi, French customs - Author's calculation.

Switchers largely consider their group as their first information source for innovating, followed by suppliers, clients and competitors (see table 3 and details about its construction in appendix II). Innovation activities are mostly driven by demand: they especially aim at conquering new market shares, through increasing the range of products and/or improving their quality. The optimization of

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[9] Industries are ranked according to their technological intensity using the OCDE/eurostat nomenclature based on NACE rev. 1.1 at 3-digit level. There are four levels of technological intensity: low, medium-low, medium-high and high.

production processes, through cost reduction, increased production capacities or improved production flexibility, seems to be a secondary objective[10].

Table 3: Sources and effects of innovation activities for switchers

Number of firms	**220**
Information sources (% of firms giving a higher score to this specific source than the average score for their sources)	
Internal (firm and group)	87%
Suppliers	65%
Clients	55%
Competitors	40%
Universities or other higher education insititutes	5%
Government or private non-profit research institutes	5%
Professional associations	17%
Conferences, fairs, exhibitions	35%
Consultants, commercial laboratories, R&D enterprises	17%
Journals, reviews	31%
Effects of innovation (% of firms giving a higher score to this specific effect than the average score for the effects)	
Increased range of goods or services	68%
Increased quality in goods or services	60%
Increased market shares	64%
Improved environment impact or health and safety aspects	25%
Met regulations or standards	33%
Improved production flexibility	36%
Reduced labor cost per produced unit	36%
Reduced materials and energy per produced unit	22%
Increased production capacity	39%

Reading : 87% of firms that become innovators over the period 2005-2006 estimate that their group was a more important source of information than average.
Sample : 753 French manufacturers that do not innovative over the period 2002 - 2006, or start innovation activities in 2005 - 2006 only (switchers).
Sources : CIS4 et CIS6 - Author's calculation.

Section IV: Results

The decision of investing in R&D and R&D intensity

The first step of our model is to estimate the decision of investing in R&D at the next period (the selection equation), then conditionally to this decision, R&D intensity (share of total sales allocated to R&D expenses). These two equations are jointly estimated with a generalized Tobit model, in order to avoid selection bias and estimate R&D intensity for all firms. This system is estimated using the Heckman command on Stata. We use the same regressors in both equations, meaning:

- Size, estimated by sales. Firms which invest in R&D are expected to be larger than the others, since innovation activities implicate high fixed costs and do not generate immediate revenues. Since the relationship between size and investment in R&D could be non-linear and extreme values could affect the results, we do not use the logarithm of sales but a series of dummies, which correspond to the size classes used in table 1[11].
- Ownership affects the extent of the firm's network, therefore its access to specific knowledge and skills. This stock of knowledge is supposed to increase with the group's size. Thanks to LiFi, we can approximate the size of the French part of groups, using the total number of employees[12]. Moreover, we suppose that foreign-owned affiliates access specific

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[10] It would be interesting to discuss these results according to switchers' degree of internationalization, but we do not have enough observations to do so.

[11] Using the logarithm of sales does not change the main results, especially regarding the impact of international activities.

[12] We define three classes of French business groups: small groups employ less than 250 employees, medium groups employ between 250 and 5 000 employees and large groups employ more than 5 000 employees. They

knowledge and can more easily overcome different obstacles in the innovation process (see Dachs and Ebersberger, 2009), so we mark them with an additional dummy. Independent firms are the reference group.
- Industry, using the French nomenclature of activities (NAF) at 2-digit level.
- International activities: we separate domestic firms (reference group) from exporters only, importers only, exporters and importers, and multinational firms.

All regressors are lagged, as we are interested in the determinants of starting to invest in R&D. In order to match with the CIS timeframe, regressors are dated from 2004, whereas the dependant variable is investment in R&D in 2006. Results of this first system of equations are reported in columns (1) and (2) of table 4.

The propensity of starting to invest in R&D does not seem to be affected by size. In fact, size seems to be the condition to access to a network, since it does become significant when ownership and international activities are dropped from the model. The group's size and nationality matter: only foreign-owned affiliates and firms which belong to large French business group are more likely to start investing in R&D. Finally, international activities are significant factors only for firms that both export and import, and those that engage in FDI. Their incentive to invest in R&D might come from greater exposition to foreign competition, which accelerates the need to renew their products and reduce their costs.

However, ownership and international activities do not seem to affect R&D intensity. Conditionally to the decision of investing, we find that switchers' R&D intensity decreases with sales. This could mean that the first investment in R&D is always a cautious one, regardless of size: for example, it will consist in employing a small number of researchers, and will evolve progressively, according to the research' first results. In that case, the initial investment will take the form of a fixed cost, which mechanically appears smaller for large companies.

Table 4: Estimation of the decision of investing in R&D, R&D intensity and knowledge output for switchers

REGRESSORS	Investment in R&D		Knowledge output	
	(1) Decision of investing in R&D	(2) R&D intensity	(3) Product and/or process	(4) New products for the market
5 - 10 million euros	-0.212	-0.360	-0.135	-0.0871
	(0.187)	(0.395)	(0.205)	(0.258)
10 - 20 millions euros	-0.142	-0.145	-0.170	-0.287
	(0.195)	(0.398)	(0.192)	(0.247)
20 - 50 million euros	-0.0258	-1.024**	0.0242	0.0312
	(0.203)	(0.460)	(0.341)	(0.417)
More than 50 million euros	-0.101	-0.792	-0.0199	0.0271
	(0.216)	(0.483)	(0.307)	(0.372)
Small French group	0.145	0.162	-0.0141	0.119
	(0.170)	(0.396)	(0.171)	(0.222)
Medium French group	0.311*	0.637	0.240	0.274
	(0.179)	(0.444)	(0.242)	(0.297)
Large French group	0.468**	1.112*	0.265	0.212
	(0.220)	(0.573)	(0.351)	(0.432)
Foreign-owned firms	0.365**	0.561	0.273	0.407
	(0.186)	(0.508)	(0.238)	(0.295)
Only exporters	0.278	0.167	0.275	0.230
	(0.289)	(0.740)	(0.282)	(0.348)
Only importers	0.00272	-0.181	0.172	-0.0827
	(0.254)	(0.578)	(0.242)	(0.329)
Exporters and importers (no FDI)	0.742***	0.285	0.734***	0.553**
	(0.200)	(0.525)	(0.208)	(0.260)
Multinational firms	0.698***	0.135	0.700***	0.789**
	(0.259)	(0.571)	(0.257)	(0.309)
log (R&D intensity)			0.131	0.169
			(0.254)	(0.298)

Legend : *** means significativity at 1%, ** at 5% , * at 10%.
Sample : 753 French manufacturers that do not engage in innovation activities over the period 2002 - 2006, or start innovation activities in 2005 - 2006 only (switchers).
Sources : CIS4 and CIS6, LiFi, French customs - Author's calculation.

respectively gather 153, 191 and 71 firms of our sample. The choice of these size classes is based on the French definition of small, medium and large enterprises (decree n°2008-1354), which takes into account the size of the group.

The propensity of becoming an innovator

We now estimate the propensity of becoming an innovator. To this end, we use the R&D intensity estimated in the previous step, which allows accounting for selection and endogeneity, and all other regressors from previous estimations. First, we include all switchers in the regression (production and process innovation, results in column (3) of table 4), then only include those that introduce new products for their market (results in column (4)).

All things being equal, becoming an innovator essentially depends on international activities. This result is independent from the fact that international activities are mostly handled by large firms and encourage these to invest in R&D: it seems that the greater capacity of these firms to become innovators also relies on access to new information sources (elsewhere, only firms which exhibit several forms of internationalization are concerned) and/or on a more efficient use of these sources. Moreover, owning affiliates abroad especially increases the probability of introducing new products for the market. This could come from a closer contact with foreign clients, which helps developing products that are adapted to local demand.

Conclusion

This paper shows that if innovation activities are important to penetrate foreign markets, the inverse causality is also true: firms that both export, import and eventually have affiliates abroad, are more likely to start investing in R&D. Regardless of size and R&D intensity, these same firms have a greater capacity to become innovators. Outward FDI especially appears as a decisive asset for developing new products for the market. While the French government offers premia for firms which relocate their activities in France, this paper shows that yet, outward FDI can be a vector of competitiveness for French manufacturers.

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APPENDIX I: CLEANING THE DATA

Merging CIS4 and CIS6 provides a balanced sample of 2 561 firms. The sample is restricted to manufacturers (NACE codes 15 to 17), which results in dropping 136 firms. We also drop joint-ventures (44 observations), firms that have zero weight in one of the two surveys (11 observations), and missing or zero values for sales and workforce (only one observation). The sample then counts 2 377 firms : 546 firms that never develop product or process innovation (neither in CIS4 nor in CIS6), 1260 firms that innovate in both periods, 253 firms that only innovate in CIS6, that 318 firms only innovate in CIS4.

The analysis is limited to firms that have no innovation activities (meaning no product or process innovation and no investment in R&D) in CIS4, which leaves 765 firms. Among these, 229 become innovators in CIS6. Because of the asymmetry of the distribution of R&D intensity (ratio R&D expenses – total sales), we drop the top 1% of observations.

APPENDIX II: COMPARING SOURCES AND EFFECTS OF INNOVATION ACTIVITIES

The CIS survey provides interesting information about sources and effects of innovation activities. However, inter-respondent comparisons might be difficult as the evaluation of these sources and effects is self-reported and uses likert scales (with three levels (low, medium, and high)). Following Crespi *et al.* (2008), we have to transform these scores in two steps:

- First, we have to account for the fact that two firms may learn exactly the same thing from their information sources, but attribute them different scores depending on their optimism or individual scale. Therefore, what really matters is not the absolute score but the deviation from the mean score given for the firm. If $SCORE_i^j$ is the score given by firm i for information source j (J being the total number of sources), we have to make the following transformation:

$$SCORE_i^j - \overline{SCORE_i} \quad \text{where} \quad \overline{SCORE_i} = (1/J) \sum_j SCORE_i^j$$

- However, we cannot directly compare these relative scores because this would suppose that the different levels of the scale are linearly related. For example, one firm rating its clients with a relative score of 2 does not necessarily learn twice as much as a firm rating its clients with a relative score of 1. Therefore, we prefer to transform the deviation from mean score into an indicator function:

$$\begin{cases} I\left(SCORE_i^j\right) = 1 & \text{if } SCORE_i^j - \overline{SCORE_i} > 0 \\ I\left(SCORE_i^j\right) = 0 & \text{otherwise} \end{cases}$$

In other words, each firm attributes the value 1 to a specific source/effect of innovation activities if its score is higher than the mean score given by the firm. Table 3 summarizes the results of this transformation for all firms becoming innovators in CIS6.