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EFFECTS OF USER'S COOPERATION AND LOCATION ON INNOVATION ACTIVITY OF FIRMS: AN *INPUT-OUTPUT* APPROACH

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Abstract: The present study analyses the profile of firms cooperating with users and estimates the effect of this cooperation on firms' innovation activities. This issue is particular novel and important as users provide information that will be very useful for generating new products and making the innovation process more efficient. The findings confirm that cooperation with users is a tool for progress and development as it has a positive influence on both *input* and *output* of firms' innovation process. This paper makes three important contributions to the literature. First, we analyse the effect of cooperation with users on how firms distribute their R&D expenditures (basic research, applied research and technological development) in order to make clear how this tool can affect the different strategies for generating knowledge. Second, we also study the impact of this kind of cooperation on the degree of novelty of new products, with the aim of explaining how it affects the productivity of R&D activities. Third, to estimate these effects, the study analyses these relationships and explore the role of proximity in the cooperation with users taking into account the location of this agent (domestic *versus* international users). Results confirm that cooperation with users increases investments in activities that generate knowledge with a specific practical objective and which are near to firms' technological domain (applied research and technological development). Independently of user's location, firms increase their investment in technological development to act quickly in the market and to obtain profits. The study also concludes that cooperation with users has positive effects on innovation *outputs* and its degree of novelty (radical *versus* incremental innovations). Nonetheless, these effects are different according to user's location. Cooperation with domestic users stimulates the sales of radical innovations and cooperation with international users increase sales of incremental innovations.

Keywords: Cooperation with users, basic research, applied research, technological development, degree of novelty, location.

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1. INTRODUCTION

Currently the interest in studying cooperation with users and its impact on firms' innovation activity has been significantly grown. The advantages deriving from cooperation with these agents are manifold. Users may provide the firm with highly useful information for the generation of ideas with a high degree of novelty (Meyers and Athaide, 1991; Amara and Landry, 2005). Besides, these agents offer information on new technologies and evolution of markets (Rothwell, 1994; Whitley, 2002). So, it is an important source of scientific and technical information complementing that held by R&D staff (Rothwell *et. al*. 1974; Rosenberg, 1990).

This type of cooperation also helps the firm to identify unsatisfied needs which in some cases the user is unaware of having them (von Hippel and Katz, 2002). In this way, more attractive and better products and services can be developed (Thomke and Nimgade, 1998; Lilien *et. al*. 2002; Franke *et. al*. 2006), with a good chance of success when they are commercialised (Atuahene-Gimma, 1995; Souder *et. al*. 1997). The user's active participation in the innovation process reduces the cost of the process of developing and implementing new products and services (Herstatt and von Hippel, 1992; Thomke and Nimgade, 1998; Lilien *et. al*. 2002; Jeppesen, 2002).

Despite the importance attributed to cooperation with users, the study of its effects on firms' innovation process is found to be at an early stage. Though there have been separate analyses of the impact of this cooperation on the *inputs* and *outputs* of this process, it is not clear how it affects the firm's innovation strategy as a whole. There are many reasons that justify the need for an integrated perspective.

Firstly, in the *input* case, evaluating the impact of cooperation on firm's innovative effort, using the traditional approach, does not satisfactorily register the effect on the early phases of the innovation process. As a result, it is not known how the information provided by users influences different types of R&D activities. These activities increase the firms' stock of technological knowledge and give them the necessary base to create a competitive advantage. In the *output* case, the literature has focused the analysis on the likelihood of developing different types of innovations (von Hippel, 1988; Kline and Rosenberg, 1986; Rothwell, 1994; Miotti and Sachwald, 2003; Tether, 2003). However, there are very few studies that have analysed the effect of cooperation on the economic figures or on improving firms' competitiveness (Amara and Landry, 2005; Nieto and Santamaría, 2007).

Secondly, the role and importance of technological knowledge in economic activity has changed. Firms invest less in physical capital and more in

knowledge. As a consequence of this behaviour, it is a determining factor to know the role played by cooperation with external agents in generating new knowledge and in the economic results of the firm. However, in general, the literature has not jointly analysed the effect of cooperation on both *inputs* and *outputs* of the innovation process. Nevertheless, it is important to adopt an integral *input-output* view since these two aspects of the innovation process are closely related.

Thirdly, we have taken into account that the results of the innovation activity do not depend exclusively on the resources and capabilities that the firm has used, but also on its ability at combining and managing the most valuable of them. Therefore, it is important to jointly analyse the effect of cooperation on the "ingredients" used in the process and on the obtained results, because this combination determines the technological level of the firm.

Finally, when analysing innovation activity it must be taken into account that there is not a sole indicator of these activities but a wide range of them. These indicators can be grouped into two categories: variables that represent the *inputs* and variables that represent the *outputs*. However, all of them show strengths and weaknesses. Thus, it could be valuable to use several indicators simultaneously in order to offer a more reliable and objective perspective, as other authors have done (Hagedoorn and Cloodt, 2003; Jensen and Webster, 2005). So for all these reasons, an integrated perspective is quite advisable.

The main contributions of this study to literature are threefold. First of all, this study presents an *input-output* approach of the effects of cooperation with users on firms' innovation activity, specifically in the area of in-house R&D activities and in the economic results, in order to make clearer how this tool can affect the whole innovation strategy of firms. Second, unlike previous studies, this paper combines a series of indicators of innovation activity to have a better awareness of the different benefits of cooperation with users. For this purpose, there has been an analysis of the manner in which firms distribute their R&D expenditure, distinguishing among three different activities: 1) basic research, 2) applied research and 3) technological development, thus enabling us to understand how cooperation with users affects the different strategies for generating knowledge in the early phases of the innovation process. Additionally, the impact of this cooperation on the firm's economic performance is examined through the sales of innovative products. The study uses the dichotomy between products that are new for the firm and products that are new for the market in order to determine the contribution of cooperation to the degree of novelty of innovations.

Thirdly and in a complementary fashion, we explore the role of proximity in cooperation with users through the analysis of these effects taking into account the location of the user. For this purpose, a general sample and two sub-samples have been used on the basis of the user's origin –domestic users (Spain) *versus* international users (other countries)-. To our knowledge there is no other previous study which has considered location in the analysis of this type of relationships. The literature analysing the geography of innovation points out that accumulated technological knowledge in a region may influence the level and success of innovation activity (Fritsch, 2000). Likewise, the appearance of new technological opportunities will be more feasible in regions that accumulate technology and where the proximity among different agents increases knowledge spillovers (Acs and Armington, 2006; Kirchhoff *et. al.* 2007).

The paper is structured in the following way. In section two there is a review of the literature focused on the effects of cooperation with users on *inputs* and *outputs* of the innovation process and the implications of user location. In section three details are given of the methodology used and in section four the sample of data and the variables of the study are described. In the fifth section the findings of the analysis are presented. Finally, section six summarizes the conclusions and presents some managerial implications.

2. EFFECTS OF COLLABORATION WITH USERS ON INNOVATION ACTIVITY

Traditionally, economists in studying innovation processes used the premise that product manufacturers were the starting point of these processes. In opposition to this, researchers on technological and organisational change have shown that if the manufacturer is assumed to be the only source of innovations, this considerably limits the view of the innovation process (von Hippel, 1988, 2005). For example, in the evolutionary view of technological change a modern innovation process is assumed, characterised not just by the need for feedback among the different stages, but also by the multidisciplinary nature of *inputs* and the many sources of relevant information for firms (Rosenberg, 1976, 1982). Similarly, in the literature on strategy it has been shown that agents from outside the firm constitute an important resource in the present-day competitive framework, particularly as far as the development of new products and processes is concerned (Penrose, 1959; Rumelt, 1984; Wernerfelt, 1984; Barney, 1991; Peteraf, 1993).

It has also been pointed out that firms need to open themselves up to external networks and relationships because firms that are too internally focused may miss a lot of opportunities (Chesbrough, 2003a; Laursen and Salter, 2006). Nowadays, firms need to complement their internal resources

and capabilities with imported ideas from outside, interacting with a wide range of actors inside the innovation system (von Hippel, 1988; Szulanski, 1996; Laursen and Salter, 2006). This idea is the central point of the so called "Open Innovation" model (Chesbrough, 2003a, b). According to this model, the advantages that firms obtain from internal R&D expenditures have decreased due to different factors such as the increased mobility and availability of knowledge workers or the increasing scope of capable external suppliers (Christensen *et. al.* 2005; Laursen and Salter, 2006). This model emphasizes the interactive character of the innovation process, suggesting that firms need not and indeed should not rely exclusively on their own R&D but should also use ideas coming from outside in order to exploit the potential of their innovation capabilities and investments (Chesbrough, 2003b; Dogson *et. al*. 2006; Chesbrough and Crowther, 2006). Laursen and Salter (2006) suggest that the more widely and deeply the firm uses search strategies, the greater will be its ability to adapt to change and therefore to innovate. So, what is happening now is a change from "close" to "open" innovation models that firms must see as a way to exploit new opportunities instead of a threat.

On the other hand and despite the fact that literature on innovation has made considerable advances on analysing the effects of cooperation in general, the studies which take into consideration the specific effect of concrete external agents are less common. However, the choice of a partner is vitally important and must be consistent with the aims and strategies of the firm (Sorensen and Reve, 1998; Miotti and Sachwald, 2003), since the impact on innovation activities could be different on the basis of which partner is chosen (Whitley, 2002).

This paper focuses on the analysis of cooperation with users as a new managerial strategy for carrying out the innovation process. Previous studies in this field have separately analysed the effect of this cooperation upon the *inputs* and *outputs* of the innovation process. However, we consider it important to link both aspects in order to offer a more reliable and objective perspective.

2.1 *Inputs* and cooperation with users

In the case of *inputs*, the most common indicator is the so called "innovative effort" or "innovation intensity". This effort is usually measured by means of R&D expenditures or the number of people involved in R&D activities. Studies are not conclusive as to the influence that collaboration with users might exert on how intensely the firm is involved in innovation activities. On the one hand, there are studies such as that carried out by Lilien *et. al.* (2002), which find that, when firms collaborate with these agents, innovation expenditures rise, or that of Tether (2002)

who observes a positive relationship between collaboration with users and innovation intensity.

There are others which point in the opposite direction when they put forward the theory that this type of collaboration during the development of innovations reduces the expenditures related to these activities (Herstatt and von Hippel, 1992; Thomke and Nimgade, 1998; Jeppesen, 2002, 2005; Henkel and von Hippel, 2004; von Hippel, 2005; Lettl *et. al.* 2006) and lead to higher degrees of efficiency in the innovation process (Tether, 2002; Bayona *et. al.* 2003; Santamaría and Rialp, 2007a). This implies that firms which collaborate with these agents devote less effort, in terms of time and money, to achieve a particular innovation (Lettl *et. al*. 2006). For example, thanks to this collaboration it is possible to reduce time and costs of trial and error processes (Jeppesen and Molin, 2003; Lettl *et. al.* 2006), the efforts devoted to information seeking and designing tasks (Jeppesen, 2002, 2005), or the number of faulty prototypes before the desired product is obtained (Lettl *et. al.* 2006).

Thus, so far it is not possible to state with certainty what the effect of collaboration with users may be on innovation activity, since there is a diversity of works which point in both directions.

Additionally, it is well known that cooperation with users influences the level of commitment that the firm has with innovation activities. However, the traditional approach of evaluating the impact of cooperation on innovative effort does not adequately capture the effect it may have on the process of generating technological knowledge. The literature points out that there exists a positive relationship between cooperation with users and R&D investment (Fritsch and Lukas, 2001; Belderbos *et. al.* 2004; Santamaría and Surroca, 2004; Motohashi, 2005) but to our knowledge, no previous work has shown how this kind of cooperation affects the distribution of expenditures among basic research, applied research and technological development.

R&D activities provide knowledge with a different strategic value for firms and enable them to create competitive advantages. The most contemporary approach of the innovation process suggests that these activities do not follow a linear sequence since the appearance of a technology could motivate the emergence of new technological knowledge and *vice versa* (Kline and Rosenberg, 1986). Thus, firms invest in basic and applied research to extend their frontier of scientific knowledge and maintain a competitive advantage (Refferty, 2003). In addition, they invest in technological development to find solutions for specific problems affecting the central business areas and to extend their survival (Corsten, 1987). Analysing the effect of cooperation with users in the way firms distribute their R&D expenditures will make it possible to determine whether

cooperation contributes to expanding the base of a firm's technological knowledge or, if, on the contrary, it stimulates the exploitation of existing knowledge with a clear market orientation. In accordance with the above, the following hypothesis is formulated:

HYPOTHESIS 1: *Cooperation with users influences how firms distribute their R&D expenditures on basic research, applied research and technological development.*

2.2 *Outputs* and cooperation with users

The literature has also analysed the effect that collaboration with users has on innovation *output.* In this way it is being considered whether this type of relationship influences the effective generation of innovations or not. Different indicators are normally used. However, when talking of cooperation with users it is logical to think that their contributions will be of particular usefulness in developing product innovations rather than process innovations. The fact is that because of experience in product handling (Schreier *et. al.* 2007), users are the ones who know best what they want and need, thus cooperation with them will focus especially on product innovations (Tether, 2002).

One of the characteristic dimensions of innovation activity but one hardly dealt with in the literature on cooperation with users is just how novel the innovation developed is (Tether, 2003). Depending upon the degree of novelty, usually a distinction is made between incremental and radical innovations (Gatignon *et. al.* 2002). The sustained idea in the literature is that the vast majority of innovations are minor or incremental ones (Knight, 1963; Hollander, 1965), regardless of their source. Consequently, it is to be expected that the innovations dreamt up by users will also adjust to meet this rule.

A priori, the user's knowledge and experience are particularly linked to the use of the existing products, and, normally when providing ideas they limit themselves to what they know, because they do not have the capacity to think up new applications. Nonetheless, the fact of becoming a participant in the innovation process extends their base of know-how, and offers them the opportunity of generating new ideas or even discovering unmet needs which hitherto he/she was unaware of (von Hippel and Katz, 2002).

Thus, users may provide the firm with highly valuable resources as complementary knowledge of a tacit nature, information on new technologies, markets and improvements in processes and accurate information on market requirements and how they are evolving (Rothwell, 1994; Whitley, 2002). All these contributions have made collaboration with these agents very convenient, not just for developing incremental innovations, but also when the intended innovation has a high degree of

novelty (Meyers and Athaide, 1991; Veryzer, 1998; Lüthje and Herstatt, 2004; Amara and Landry, 2005; Lettl *et. al.*, 2006; Nieto and Santamaría, 2007).

There are few empirical studies which have analysed the effect of collaboration with users on the degree of novelty in the resulting innovation (Amara and Landry, 2005; Nieto and Santamaría, 2007). In the study of Amara and Landry (2005), the descriptive analysis of their data suggests that information provided by users is used more frequently by firms introducing innovations which are new on a national and worldwide level but less by those choosing innovations that are only new for the firm. Simultaneously, the authors mention that sources of market information reduce the likelihood of obtaining unknown innovations on a worldwide level, although it does not mean that they have no influence on the likelihood of innovating. In the same way, Nieto and Santamaría (2007) using data on Spain, found that information provided by the market (users and suppliers) has a positive, significant effect on both types of innovation *outputs.*

Other lines of research have indicated that when the manufacturing firm innovates by itself the result can only be incremental improvements in existing product lines (Anderson and Thusman, 1990; von Hippel, 2005) whereas cooperation with users gives rise to ideas on new product lines - radical innovations- (von Hippel, 1988; Shah, 2000; Lettl *et. al*., 2006) and incremental innovations (Knight, 1963; Hollander, 1965). According to this approach, whether the user will participate in a more or less intensive way depends upon what type of innovation is wanted (Veryzer, 1998; Lüthje and Herstatt, 2004). If incremental innovation is the target, all that is required is slight collaboration of the user (e.g. interviews or questionnaires), but if the aim is a more novel innovation, then inevitably the user will be much more deeply involved in the innovation process. In accordance with the above, the hypothesis formulated is:

HYPOTHESIS 2: *Cooperation with users influences the degree of novelty of innovations.*

2.3 Location and cooperation with users

As has been indicated previously, in this study for the first time an *input-output* approach is adopted to compare these two hypotheses. Also, it has been deemed of interest to explore the effects of user's location in studying these relationships in order to determine the influence of proximity on how large the effect of cooperation is. Abundant literature makes the point that the proximity of firms, agents, institutions and resources is a key factor in developing the innovation process (Storper, 1997; Asheim et. al. 2003; Asheim and Gertler, 2005). Likewise, factors identified by the theory as

relevant for technological change to occur, such as the nature of the relationship between agents or the capacity for learning, are significantly different among regions (Oughton *et. al*. 2002). Recent studies show, on the one hand, that the level and success of the innovation activity can be changed by the amount of technological knowledge accumulated in a region (Fritsch, 2000), and in a similar way, accumulation of technology and proximity increase knowledge spillovers, which contribute to create new technological opportunities (Acs and Armington 2006; Kirchhoff *et. al*. 2007).

There exists abundant literature that demonstrates the importance of geographical proximity for innovation and the vast majority of those studies refer to successful knowledge-sharing clusters, as for example, Silicon Valley. Clusters can be considered as geographically co-located firms in a value chain that collaborate in some fashion with the aim of gaining a measure of collective efficiency (Rabellotti and Schemitz, 1999; Davenport, 2005). Geographical proximity is important for innovative activity as it facilitates inter-organizational transmission of tacit knowledge (Powell et. al. 1996), generates economic externalities (Audrestsch and Feldman, 1994; Feldman, 1994) or makes collective learning more efficient (Belussi, 1999).

It is also important to consider that the relationship between cooperation, innovation and location varies from one industry to another and those differences are due to several factors. Among those factors we can enumerate the use of the ICT technologies (Zaheer and Manrakhan, 2001), the spatial location of production (Audestrsch and Feldman, 1994), the role of foreign firms and multinationals (Kearns and Görg, 2002) or the different approaches to innovation and the growth stage of the industry (Davenport, 2005). In addition, studies are not conclusive about the effect of geographical proximity on innovation. Whilst some authors point out that it increases innovative activity (Baptista and Swann, 1998) others have shown that this proximity reduces firms' commitment to R&D (Beal and Gimeno, 2001) or that it does not necessary lead to R&D cooperation and innovation (Hassink and Wood, 1998).

Davenport (2005) explored the role of geographical proximity in SME knowledge-acquisition in New Zealand. One of the most outstanding results of this work is that interfaces with international customers have been demonstrated to be the most important source of knowledge for firms and also the major driving factor for innovation. This is particularly true when the firm follows an innovation strategy based upon high levels of customization because this implies a deep understanding of customers' needs and context. When high levels of customization are required, firms seek collaboration with international customers instead of local sources of

knowledge to find a solution that exactly suits customers' requirements. On the contrary, geographical proximity is favoured in contexts of low levels of customization. In similar fashion, collaboration with local public research sources is more common in the early phases of firms' growth, whilst international customers become one of the most relevant sources of knowledge as soon as international resources are accessible.

The study of Monjon and Waelbroeck (2003) analyses the effects of collaboration with domestic and international partners on the degree of novelty of the resulting innovation. Though the coefficients of the variables representing cooperation with suppliers are not very significant, among its findings the outstanding point is that cooperation with domestic and foreign universities (EU) has a positive effect upon the innovation's degree of novelty, whereas cooperation with foreign suppliers (EU) of equipment and software has a negative effect. The results of the study suggest that the partner's proximity in cooperation moderates the relationship between cooperation and innovation activity.

For all of these reasons and with an exploratory character, the final hypothesis posited in this paper is:

HYPOTHESIS 3: *The location of the user affects the effect exerted by cooperation on inputs and outputs of the innovation process.*

3. METHODOLOGY

In this study a *matching estimator* (*ME*) was applied to analyse the effect of cooperation with users on firms' innovation activity. This method estimates the causal effect of cooperation in R&D by comparing firms who cooperate with those which do not cooperate and which form part of a control group.

The construction of this control group is not easy, since the decision to cooperate in R&D is not random. The literature shows that the profile of cooperating firms differs from those that are not. This causes a problem known in econometric studies as "sample selection bias". The *ME* reduces this bias by means of a matching method which compares firms that cooperate with those that do not, but which are similar in terms of their observable characteristics X_i. Because the matching between firms with an *n*-dimensional vector of many characteristics *n*, in general, is not viable, the method reduces the characteristics of each firm to a scalar variable or *propensity score* [$p(X_i)$] to make the matching more feasible (Rosenbaum and Rubin 1983). The $p(X_i)$ is defined as the conditional probability of cooperating in R&D with users, given a group of X_i characteristics of firms. In this way, the *ME* compares firms which cooperate with firms which do not, but which have the same propensity to do so. In this study a Probit model was used to estimate $p(X_i)$, since it is the most used in

literature. The estimations of this Probit model are also used to analyse which X_i variables influence the propensity to cooperate with users.

Because of the low probability of finding two firms with the same value of $p(X_i)$, there are different matching processes to choose the firms of the control group on the basis of a proximity criterion. The most common method is the *Nearest Neighbour Matching* (*NNM*). This method selects for each cooperating firm another firm which is not cooperating but which has the closest $p(X_i)$ value. In this study the bias-corrected nearest neighbour proposed by Abadie and Imbens (2006) was used. This has the property of correcting the bias when the matching between firms is not exact.

Once the control group is formed, if Y_i represents firms' innovation activity, C_i takes the value of 1 when the firm cooperates with users and 0 in the opposite case and $P(X_i)$ represents the *propensity score*, the effect of cooperation (τ) can be estimated as the difference between innovation activity of cooperating firms and the innovation activity of non-cooperating firms, thus:

$$\tau = E\{E\{Y_{1i} \mid C_i = 1, p(X_i)\} - E\{Y_{0i} \mid C_i = 0, p(X_i)\} \mid C_i = 1\} \quad [1]$$

Dwhejia and Wahba (2002) carried out a painstaking revision of this methodology. What is more, Abadie and Imbens (2006) give a detailed explanation of the bias-corrected matching estimator.

It is also important to mention that in study at firm level the analysis of the relationship between innovative effort and collaboration is not easy due to a problem of endogeny between the two variables. An important body of empirical evidence has found that innovative effort influences the decision to collaborate in developing innovations (Colombo and Garrone, 1996; Fritsch and Lukas, 2001; Tether, 2002; Belderbos *et. al.* 2004; Bönte and Keilbach, 2005) and a limited group of studies has analysed the inverse causality, that is, the influence of collaboration on innovative effort (D´Aspremont and Jacquemin, 1988, 1990; Colombo and Garrone, 1996; Kaiser, 2002). This last group has been motivated by comparing the hypothesis that collaboration increases a firm's innovative effort.

4. SAMPLE AND VARIABLES

4.1 Sample

The data used to carry out the research come from the Technological Innovation Panel (PITEC). This panel was created with data coming from the Technological and R&D Innovation Survey drawn up by the Instituto Nacional de Estadística of Spain (INE). The panel was created with the aim of providing a database for analysing the innovative behaviour of Spanish firms and their evolution. Since 2003, the panel has been registering information from more than 7,200 firms belonging to two sub-populations.

The first correspond to firms with over 200 employees and the second to firms declaring that they have in-house R&D. The representativity of the first sub-population is 73% of Spanish firms and 60% in the second case.

The data used in the present paper covers the period between 2003 and 2005. Specifically, the effect of cooperation is analysed for the years 2004 and 2005. The variable which indicates whether the firm cooperates with users or not is determined by lagged explanatory variables, that is, their values in 2003. This allows us to reduce the problem of endogeneity and improve the quality of the matching.

The final sample used in the study is of 4,713 firms which replied to the survey in the period 2003-2005. Of these firms, 656 collaborated with users[1], 401 of whom collaborated only with users from the same country (Spain) and 74 of them cooperated only with international users located in "other countries". In the comparative study based on the location of the partner, 181 firms (27% of the total) who cooperated simultaneously with domestic and international users have been excluded in order to obtain more accurate results on the influence of the user's location. In this way, the hypotheses were compared in a general model and in two sub-samples by user location (domestic *versus* international users).

4.2 Variables

The vector of covariables X_i used to estimate the *propensity score* $p(X_i)$ or the propensity to cooperate with users, includes variables which, in accordance with the literature, influence this propensity (Kaiser, 2002; Santamaría *et. al*. 2002; Tether, 2002; Bayona *et. al*. 2003; Belderbos *et. al*. 2004; Bönte and Keilbach, 2005; Heijs *et. al*. 2005; Santamaría and Rialp, 2007a, b). In the first place, we have included representative variables of the firm's structural characteristics such as: size (logarithm of the number of employees), age (dummy variable indicating whether the firm has been recently created or not), ownership structure (dummy variable indicating whether the firm is a domestic one or not) and export propensity (ratio between exports and sales). Next, we also included dummy variables as indicators of firms' innovation activity, for example: whether the firm belongs to a high or medium-tech manufacturing or service sector and whether the firm has invested in R&D in the past. Finally, a dummy variable was considered which indicates whether the firm received public funding for R&D activities in the past.

Trying to measure innovation has always been difficult for researchers. In this study, indicators of *inputs* and *outputs* of the innovation process have

[1] The final sample contains firms that have only collaborated with users. Those firms that cooperated simultaneously with other external agents as suppliers, universities, etc., have been dropped from the sample.

been combined to estimate the effect of cooperation on innovative activity Y_i.

Just as was indicated in the review of the literature, the most approximate indicator of innovation *inputs* is the so called "innovative effort or "innovation intensity". This effort is normally measured by means of R&D expenditures as a percentage of the firm's total sales figures (Colombo and Garrone, 1996; Heijs *et. al*. 2005; Motohasi, 2005; Santamaría and Rialp, 2007a) or the number of people involved in R&D activities as a percentage of the firm's total number of employees (Fritsch and Lukas, 2001; Belderbos *et. al*. 2004; Busom and Fernández-Ribas, 2008).

In the present study, innovation *input* has been measured by means of private R&D effort, calculated as the ratio between private R&D expenditure (excluding other sources of financing) and firm's sales, multiplied by hundred. One of the contributions of this paper is the analysis of the effects of cooperation with users on how firms distribute their private R&D expenditures among: 1) basic research, 2) applied research and 3) technological development, to find out how cooperation with users affects decisions on knowledge generation in the early stages of the innovation process. In the study these variables have been defined as a percentage of the total in-house R&D expenditures, multiplied by hundred.

As for innovation *output*, it is worth pointing out that the indicators used in the literature are very diverse. Maybe the most widespread is the count of cited patents. However, in our analysis patents have not been considered because innovations developed by users are usually characterised by a phenomenon called *free revealing*[2], which means that very few results from innovation activity are going to be patented. Thus, a more appropriate indicator of innovation *output* was considered: the type of innovation developed.

More specifically, the degree of novelty of new products has been taken into account. There are few previous studies concerning the analysis of this characteristic of the innovation *output* and each of them has dealt with it in a different way (Lakemond and Berggren, 2006). As with other authors (Nieto and Santamaría, 2007), two variables that reflect the degree of novelty of innovations have been used and they are similar to those used by Amara and Landry (2005): a) percentage of sales of products new for the market, by the hundred (high novelty) and b) percentage of sales of products new for the firm, by the hundred (low novelty). This way it will

[2] *Free revealing* consists of "someone" (normally a user) revealing information on his innovations that could be used by other users or manufacturers to generate commercial products. The vast majority of innovative users freely reveal details of their innovations.

be possible to determine the effects of cooperation on the degree of novelty of innovations.

5. RESULTS

5.1 Likelihood of cooperating with users

In Table 1 a summary is given of the results of the probit model used to estimate the propensity to cooperate with users (*propensity score*). In the three models the dependent variable took the value of 1 if the firm cooperated with users (users in general, domestic users or international users, respectively) and 0 in the opposite case.

Table 1: Estimation results of the probit model and marginal effects

	General		Domestic		International	
Variables†	Coef.	M.E.	Coef.	M.E.	Coef.	M.E.
Size	0.04**	0.01**	0.01		0.07**	0.00**
Age	0.15		0.04		0.53**	0.03*
Domestic firm	-0.21***	-0.05***	-0.12		-0.16	
Export propensity	0.00		-0.01***	-0.00***	0.01***	0.00***
High tech manufacturing sector	0.12		0.08		-0.09	
Med tech manufacturing sector	0.08		0.02		0.18*	0.01*
High tech service sector	0.68***	0.19***	0.39***	0.07***	0.18	
R&D expenditures	0.00*	0.00*	0.00		0.00	
Public funding	0.52***	0.12***	0.44***	0.07***	0.31***	0.01**
N	4713		4532		4532	
Nº cooperating firms	656		401		74	
Log Likelihood	-1759.62		-1297.81		-341.64	
Pseudo-R^2	0.06		0.05		0.10	
Correctly classified	86.51%		91.49%		98.43%	

† All variables are lagged one year
M.E.= Marginal Effects
***p<0.01; **p<0.05; *p<0.10

In the general model, the results show that firm size, belonging to a high-tech service sector, previous R&D experience and public funding have a significant, positive influence on cooperation with users. Nevertheless, export propensity reduces the likelihood of cooperation with users. An estimation of the marginal effects shows that belonging to a high-tech service sector and obtaining public funding are the variables which most influence this propensity and what is more, they increase it markedly, *ceteris paribus*, by 19 and 12 points, respectively.

Although the literature does not offer any consensus regarding the effect of size on cooperation, the results of our general sample and the international one are in line with those that argue that size favours the setting up of relationships of this type (among others: Fritsch and Lukas, 2001; Miotti and Sachwald, 2003; Belderbos *et. al*. 2004; Bönte and Keilbach, 2005). In the Spanish context, our results are consistent with those obtained by Santamaría and Surroca (2004) and Heijs *et. al*. (2005) in the case of vertical cooperation and those of Santamaría and Rialp (2007a, b) in the case of specific cooperation with users. It must be taken into account that Spanish firms, particularly small-sized ones, have been mainly focused on traditional sectors, which limits the chances of finding foreign partners to cooperate with (Bayona *et. al*. 2001).

As has been shown in other previous studies, both in Spain (Santamaría and Surroca, 2004; Santamaría and Rialp, 2007a, b) and at international level (Fritsch and Lukas, 2001; Tether, 2002; Bönte and Keilbach, 2005) having previous experience in R&D does not substitute for the use of external sources of information, rather the opposite, it spurs firms to establish cooperative relationships with external agents, in this case, with users. This result demonstrates that it is advisable to strengthen the firm's absorptive capacity (Cohen and Levinthal, 1990), because in this manner, it is possible to achieve better results from collaboration with external partners (Veugelers, 1997).

Belderbos *et. al.* (2004) and Santamaría and Rialp (2007a) when analysing the determining factors of cooperation with users and Santamaría and Surroca (2004) in the case of vertical cooperation, also found that public funding is a factor of positive influence. On the other hand, other studies point to the fact that, in Spain, funds from Public Agencies do not appear to have any effect on vertical cooperation (Bayona *et. al.* 2003; Heijs *et. al.* 2005). Even though achieving this type of funding is not one of the main reasons for cooperating with users in developing innovations, the results of this study demonstrate that it can be used to stir firms' interest in collaborating with this kind of agents.

A comparative analysis between firms cooperating with domestic users and firms cooperating with international ones shows there are significant differences in the profile of these two groups of firms. The firms most likely to cooperate with domestic users are those in the high-tech service sector, receiving public funding and having a lower tendency towards internationalisation. As in the general model, an estimation of the marginal effects reveals that the most important variables are those of belonging to a high-tech service sector and obtaining public finding for R&D.

Other findings indicate that the propensity to cooperate with international users is significantly increased by: size, age, export propensity and

obtaining public funding. Also belonging to a medium-tech manufacturing sector increases this propensity. According to the estimated marginal effects, a change in these variables never implies an increase of more than 3 percentage points in firms' propensity to cooperate, as occurs when mention is made of cooperation with domestic users.

Therefore, from our analysis it can be seen that there are clearly two differentiating elements in the profile of these two groups of firms. On the one hand, in the case of domestic cooperation, firms belong to high-tech service sectors and in the case of international cooperation, to medium-tech manufacturing sectors. On the other hand, a difference has been observed in the firm's level of internationalisation. Export propensity reduces the likelihood of cooperating with domestic users whereas it increases the likelihood of cooperation with international users.

5.2 Effects of R&D cooperation with users and its location on innovation *inputs*

Estimating the causal effect of cooperation on R&D in accordance with equation (1) requires comparing the innovation activity of cooperating firms with the innovation activity of the control group where firms do not cooperate. To carry out this matching there has been a condition imposed, namely, that each cooperating firm will be matched with a similar firm (that is, with the nearest *propensity score*) in its same sector of activity. The matching has been exact in 100% of the cases. This procedure has been repeated in estimating the effect of cooperation on each representative variable of the *inputs* and *outputs* of the innovation process.

Table 2. Mean comparison of firms' propensity score before and after the matching

	General		Domestic		International	
	C_i=1	C_i=0	C_i=1	C_i=0	C_i=1	C_i=0
	Mean	Mean	Mean	Mean	Mean	Mean
Before the matching						
Propensity Score	0.18	**0.13 *****	0.11	**0.08*****	0.04	**0.02*****
N	656	4070	401	4312	74	4639
After the matching						
Propensity Score	0.18	0,18	0.11	0.11	0.04	0.04
N	656	2624	401	1604	74	296

Note 1: Significances (***p<0.01; **p<0.05; *p<0.10) indicate that the means compared differ according to the two tailed t-test.

Note 2: C_i takes the value of 1 when the firm cooperates with users and 0 in the opposite case

In addition, table 2 provides evidence of the matching quality by showing the findings of the test applied to the means of the *propensity score* before and after the matching. As can be observed before the matching there are

significant differences in the propensity scores. After the matching these differences between the firms that cooperated and the firms belonging to the control group disappear[3].

Table 3 shows the results of the effect of cooperation with users in general and in accordance with the location of the agent. Though previous studies, which have analysed the effect of cooperation with users seem to indicate that this type of cooperation reduces time and costs related to the innovation process (Herstatt and von Hippel, 1992; Thomke and Nimgade, 1998; Jeppesen, 2002, 2005; Henkel and von Hippel, 2005; von Hippel, 2005; Lettl *et. al*. 2006), our findings are in line with those that point out that collaboration increases firm's innovative effort (D´Aspremont and Jacquemin, 1988, 1990; Colombo and Garone, 1996; Kaiser, 2002). In this fashion, collaboration with users may become a source of competitive advantage, by strengthening the development of in-house R&D efforts. As has already been indicated, in order to be able to make use of information provided by external agents, it is necessary to have a certain absorptive capacity (Cohen and Levinthal, 1990), and this can only be developed in-house. Consequently, if the firm wants to gain the maximum advantage from collaborative relationships with users it will have to raise the intensity of its private R&D activity.

Table 3. Average effect of cooperation with on firms' innovation activity

	General		**Domestic**		**International**	
	2004	**2005**	**2004**	**2005**	**2004**	**2005**
	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.
Inputs						
Basic research	**-2,84****	0,21	**-3,99*****	-0,59	1,66	-0,51
Applied research	**3,54****	2,12	0,89	0,16	0,94	-4,97
Technological development	2,90	**4,76****	**7,31*****	**7,98*****	-3,56	**11,38****
Outputs						
% Sales of products new for the firm	1,35	-0,13	-0,91	-1,66	**10,16*****	2,19
% Sales of products new for the market	**4,66*****	0,80	**4,44*****	**3,05****	1,64	-1,71
Percentage of exact matching (sector)	100	100	100	100	100	100
Potential control group (number of firms)	3936		1604		296	
Firms cooperating (number of firms)	656		401		74	

***significant at 1 percent; ** significant at 5 percent; * significant at 10 percent

[3] To analyze the robustness of our results, we use the 4 nearest-neighbour observations for each treated according to González and Pazó (2008).

Bearing in mind the location of the partner, domestic cooperation was seen to have a positive, significant effect on private R&D effort, whereas international cooperation does not give rise to it. This indicates that proximity to the user is a determining factor in stimulating the firm's commitment to innovation activities.

On the other hand, the effects of cooperation with users on the way firms distribute their private R&D expenditures among: 1) basic research, 2) applied research and 3) technological development have not been previously explored in the literature. These activities have a different strategic value for firms and give rise to different types of knowledge, all of them being valuable for the innovation process.

The study shows that cooperation with users reduces firms' investment in basic research in the year of cooperation, compared to firms that do not cooperate. This reduction is significant in the case of cooperation in general and domestic cooperation. The results also point out that cooperation with users in general leads to a significant 3.54 percentage point growth in investment on applied research by firms who cooperate, compared to those who do not. In addition, technological development activities are focused on transforming technological knowledge into products and services (Beesly, 2003). The findings show that firms cooperating with users significantly increased their investments in technological development in comparison with those who did not. In the same way, in the general sample and in the international sample these investments are observed throughout the year after cooperation had taken place, whilst domestic cooperation stimulated these investments throughout both years.

Finally, in comparing the coefficients of these three types of activities it can be noticed that firms cooperating with users give greater emphasis to investments in technological development, which shows that they might be more interested in providing immediate solutions for the market rather than acquiring knowledge. As a consequence, investments in technological development would lead these firms to be more focused on *advancing core technologies* and to invest less in technologies which are outside their field (*core domain*) (Santoro and Chaakrabarti, 2002).

All these results confirm the first hypothesis of this study because it has been demonstrated that cooperation with users influences on the distribution of R&D expenditures.

5.3 Effects of R&D cooperation with users and its location on innovation *outputs*

Studies which have analysed the effects of cooperation with users on innovation *output* from the viewpoint of the degree of novelty are scarce (Amara and Landry, 2005; Nieto and Santamaría, 2007) and, to our

knowledge, there are no previous studies which have at the same time taken into account the location of the user.

The findings summarised in Table 3 shows that cooperation with users has positive effects upon *outputs* of the innovation process and in its degree of novelty, so the second hypothesis proposed is true. Firms cooperating with users increased their sales of products new to the market by 4.66 percentage points, compared to firms that did not cooperate. According to the literature, this effect can be understood as an increase in the production of radical innovations. These innovations are obtained by firms which are strongly oriented toward technology (Ettlie *et. al*. 1984) and its development requires a firm to renew and extend its knowledge base by creating competences that it did not have previously (Herrmann *et. al*. 2006). The study's findings confirm these statements. The profile analysis shows that firms who cooperate with users who have prior experience in R&D belong to a high-tech service sector and receive public R&D funding.

The causal relationships found show that cooperation with users has a positive and significant influence on both the development of innovations new for the market -high degree of novelty- (general and domestic model) and on the development of innovations new for the firm -low degree of novelty- (international model). These findings are consistent with other previous studies since, albeit in a generalised way, it has been thought that information provided by users is more useful for the development of incremental innovations.

Additionally, this study clearly shows that the location of the partner has a significant influence on the novelty of innovations. Although the information provided by domestic and international users stimulates investments in technological development, the proximity of the user increases the sales of radical innovations whereas distance increases the sales of incremental innovations. Firms cooperating with domestic users had a significant increase in the sales of products that are new for the market throughout the year of cooperation and the following year (4.44 and 3.05 percentage points, respectively). Firms which cooperated with international users significantly increased the sales of products that are new for the firm, throughout the year in which cooperation took place, by 10.16 percentage points against firms which did not cooperate.

Thus, when the user's location is not taken into account, cooperation with these agents is not used to improve existing products or imitate the existing ones (new for the firm). These findings are similar to those obtained by Aschhoff and Schmidt (2008) at the level of cooperation in general. The fact is that the necessary knowledge to develop this type of innovation can be obtained by other means. Conversely, if the user's location is taken into consideration, it is observed that cooperation with international users is

indeed a useful strategy for copying products or incorporating minor improvements into already existing ones. So, the location of the user enables the type of strategy used by the firm to be distinguished. In the case of domestic users, differentiation is sought via highly novel products to be able to compete in the national market, whilst cooperation with international users is based on imitation.

In an *input-output* analysis the study reveals that firms cooperating with users who increased their private R&D effort achieved radical innovations. The benefit of cooperation with users on firm's competitiveness will be only visible if the firm increases its commitment to innovation activities and invests in R&D activities that generate technological knowledge with a clear application to the market (applied research and technological development). In addition, throughout this section, an influence of the user's location on innovation *inputs* and *outputs* has been indicated, thus the third hypothesis has been also confirmed.

6. CONCLUSIONS AND MANAGERIAL IMPLICATIONS

In this paper analyses have been made of the profile of innovating firms involved in cooperation relationships with users and the effects of this cooperation on firms' innovation activity. In this sense, and unlike other previous studies, an *input-output* approach has been adopted to analyse the effect of this cooperation on the early stages of the innovation process (*inputs*) and in obtaining innovation results (*outputs*). Also, the study has been carried out taking into account the location of the user –domestic users (Spain) *versus* international users (other countries)- to find out the effect of the agent's proximity on innovation.

One of the conclusion is that the size of the firm, its belonging to a high-tech service sector, previous R&D experience and obtaining public funding lead to a significant increase in their propensity to cooperate with users. This profile demonstrates that firms cooperating with these agents are strongly oriented towards innovation. The study also shows that the location of the user influences firms' profile and, that the sector of activity and export propensity were the differentiating variables. On the one hand, in cooperation with domestic users a positive influence was exerted when the firm belonged to a high-tech service sector and in international cooperation belonged to a medium-tech manufacturing sector. On the other hand, firms cooperating with international users are more prone to internationalisation than those cooperating with domestic users.

To explain the first of these results it must be borne in mind that in international cooperation partners are sought on the basis of the country's technological strength (Veugelers, 1997; Archibugi and Coco, 2004; Arranz and Fdez. de Arroyabe, 2008). Thus, in the Spanish case, medium-

tech and high-tech manufacturing sectors are less developed than in other countries, so firms operating in these sectors will be more likely to seek international partners. Compared to this, Spanish service sectors in general are in a much better position than the manufacturing ones, so these firms will not need so urgently to look for international partners in order to find valuable resources.

Regarding the second difference, the challenge of satisfying foreign markets forces firms to seek the best way of adapting their products to local needs and tastes, and this reinforces collaboration with users in these local markets, as has been shown by other studies at the Spanish level (Santamaría and Surroca, 2004; Heijs *et. al.* 2005; Santamaría and Rialp, 2007b) and also at international level (Tether, 2002). It can be expected that the firm will know the needs of its domestic market well enough. On the other hand, if it aims to be present in foreign markets it will need to devote great efforts to identifying and meeting the needs of these users. This fact will have a positive effect on cooperation with international users and a negative one on cooperation with domestic ones.

Concerning the effect of cooperation on innovation *inputs*, the findings show that cooperation with users only has a positive influence on firms' innovative effort in the general sample and in the sub-sample of domestic users. Unlike other studies, in this one for the first time an analysis was made of the influence of cooperation with these agents on the way firms distribute their private expenditures on R&D, distinguishing among activities of: 1) basic research, 2) applied research and 3) technological development. The results suggest that cooperation with users reduces investments in basic research in the general sample and in that of domestic users. Investments in basic research are carried out without a specific aim and serves as a way of being in touch with the latest technological advances in a particular field. It permits access to knowledge which later on may be very useful in developing other types of R&D activities (Beesly, 2003). When choosing a partner, the value of the resources each type of partner can provide must be borne in mind. In vertical cooperation (users and suppliers) normally the objective is to acquire complementary knowledge (Arranz and Fdez. de Arroyabe, 2008), especially of commercial nature. Firms cooperating with users will probably reduce their investments in basic research because the knowledge provided by these agents may be highly useful to undertake activities close to the market. Contact with users may be an exploratory method for obtaining information about market requirements and it turns out to be particularly useful for the subsequent development of technologies and complex products (Tether, 2002). So, this cooperation does not replace the firm's own efforts but it may help to reduce them.

In contrast, this cooperation is a spur to applied research when the user's location is not taken into account. Applied research generates knowledge with a specific practical objective. Technological knowledge of this activity is nearer to firms' technological domain (Roper *et. al*. 2004). It must be taken into account that the type of information owned by the user comes from his/her experience in the use and handling of products, whereas the manufacturer is the person who has the necessary knowledge to think up and physically make the products that meet the expressed needs (von Hippel, 1994, 1998). Thus, when cooperating with users, the firm becomes aware of the needs of the market and on that basis applies its knowledge to designing products to meet its needs (applied research).

The study also shows that technological development activities are promoted by cooperation with users in all cases. The underlying idea in this case is the same one as that for applied research. Firms cooperating with users take advantage of knowledge generated through technological development to act quickly in the market and make profits. Taking into account the location of the users, the results show that proximity to the market has an effect on continuity in R&D investments.

All these findings indicate that information provided by users encourages investments in activities providing solutions to concrete problems and they affect central business areas (applied investment and technological development). On the other hand, it reduces investments in activities geared to increasing firms' stock of technological knowledge (basic research).

From the *output* side, the findings demonstrate that cooperation with users has a positive influence on the sales of innovative products and in their degree of novelty. The analysis of the general sample shows that the information provided by users makes it easier for firms to compete with products which are new for the market, thus increasing their competitive advantage. Our findings suggest that these relationships are quite advisable for the development of innovations with a high degree of novelty (von Hippel, 1988; Meyers and Athaide, 1991; Shah, 2000; Tether, 2002; Amara and Landry, 2005; Lettl. *et. al*. 2006). Consequently, it is worth promoting the idea that cooperation with users is very positive for achieving both incremental improvements and more radical innovations (Veryzer, 1998; Lüthje and Herstatt, 2004; Lettl *et. al*. 2006; Nieto and Santamaría, 2007).

Moreover, it is observed that the location of the user has an influence on how novel the innovations are. Firms cooperating with domestic users increase the sales of products new for the market compared to those who cooperated with international users, who only increase the sales of products new for the firm. This indicates that the geographical proximity of the user makes it easier to transfer technological knowledge, particularly tacit

knowledge which can be the base for radical new ideas, as has been suggested by other authors (Davenport, 2005). This knowledge will be materialized into economic results and increase the competitiveness of the firm.

From this *input-output* analysis, important managerial implications can be drawn. In this sense, cooperation with users has been demonstrated to be a source of valuable information for the firm because it influences both R&D effort (*input*) and the degree of novelty of the innovation developed (*output*). It was seen that to obtain innovations with a high degree of novelty (new for the market) firms cooperating with users must increase their effort in R&D activities; otherwise, the firm would only manage to develop incremental innovations. Therefore, firms are advised that when deciding whether to cooperate with users or not, they should bear in mind that the effects are produced simultaneously on *inputs* and *outputs* of the innovative process. Additionally, the study proves that firms, which cooperate with users, strengthen their activities in applied research and, particularly in technological development, with the aim of obtaining economic returns from their innovations in a short period of time. That is, cooperation has been shown to increase firms' investments in those activities that extend their base of knowledge in the firm's technological domain. The final result is that firms can create a technological distance with their competitors in the short-term.

Furthermore, the study shows that the role of user's proximity is a key factor for the innovation strategy of the firm. It has been observed that if the objective is to obtain innovations with a high degree of novelty, managers should stimulate relationships with domestic users. In these circumstances, firms should implement mechanisms (practices) for a continuous cooperation with users[4]. Innovations with a high degree of

[4] Examples of some possible methodologies in this sense are: the Lead User approach, user toolkits and user communities. The first one was initially developed by von Hippel (1986) and it has been empirically validated by a vast number of studies (Urban and von Hippel, 1988; Lilien *et. al.* 2002; Thomke and von Hippel, 2002; von Hippel and Katz, 2002). The key idea of this methodology is to involve in the innovation process, users that present two characteristics: (1) they expect attractive innovation-related benefits from a solution to their needs and so are motivated to innovate, and (2) they experience needs for a given innovation earlier than the majority of the target market. This methodology helps firms to be at the cutting edge of the market as they are the first to identify future customer's needs. The use of toolkits, enabled by new information and communication technologies, has been demonstrated to be a relevant way of integrating customers during the early phases of the innovation process. They make it easier for the customer to contribute with his/her technological knowledge based on the use of the product. This methodology is especially useful in business-to-business areas (von Hippel, 1986; von Hippel *et. al.* 1999; von Hippel and Katz, 2002). When talking about user communities, we refer to a group of users that physically or virtually (online)

novelty are developed by firms with a strong technological and innovative orientation, because these innovations present an unpredictable and larger life cycle as well as being more dependent on the context. Radical innovations require a renewing and extending of the firm's base of knowledge in order to create competences that the firm did not have. Thus, cooperation with domestic users adds value to the firm. On the contrary, cooperation with international users allows firms to compete by using an imitation strategy (low degree of novelty) in international markets. It must be borne in mind that incremental innovations are built on the basis of existing capabilities and knowledge, which are usually more extensive in the case of large firms with international orientation. Cooperation with international users does not add value to the firm, but it improves its economic performance in the short and medium term.

In general terms, Spanish firms must see cooperation with domestic and foreign partners in a different light. When they cooperate with domestic partners the aims are related with growth, gaining market power or reducing costs and risks. On the other hand, in cooperation with international partners they seek to take advantage of synergies from cooperation to tackle the lack of a market and overcome technological obstacles.

Before concluding it is also a good idea to enumerate some limitations of this paper. In the study only firms carrying out R&D activities have been analysed. Thus, considering firms developing other types of activities would enrich the findings. In similar fashion, it would be recommendable to analyse the effect of cooperation with users also on process innovations. Finally, extending the period of the analysis would make it possible to improve the conclusions on the dynamic effect of this type of cooperation.

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interact in order to share ideas and solutions to concrete problems. Firms can use that information in order to improve their existing products or design new ones (von Hippel, 2001; Fanke and Shah, 2003; Jeppesen and Molin, 2003; Chan and Lee, 2004; Jeppesen and Frederiksen, 2006; Dahlander and Wallin, 2006). This is also a good way of testing products before their launch onto the market, reducing the risks of commercialization.

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