USER COOPERATION STRATEGIES AND THE INNOVATION OUTPUT

ABSTRACT

At the present time the use of external sources of information for innovation has become a fundamental part of the innovation process. Among the wide variety of agents with whom cooperation can take place, cooperation with users, compared to that which occurs with other agents such as universities or suppliers, has received less attention in the literature. In this study an analysis is made of the effects exerted by relationships with users on firms' innovation *output* by taking into account the type of innovation developed in accordance with a double duality: 1) product innovations *versus* process innovations and, 2) innovations with low degree of novelty *versus* innovations with high degree of novelty. As well as analysing how the decision as to cooperate with users or not affects the probability of those four types of innovation being developed, the effects of the intensity/continuity of this relationship has also been studied. The results obtained have implications for the designing of innovation and cooperation strategies in accordance with the specific aims pursued by each firm.

Keywords: Cooperation with users, innovation output, product and process innovation, degree of novelty, intensity/continuity of cooperation.

1. INTRODUCTION

Any firm's R&D department provides an important source for change, but nowadays it cannot be regarded as the sole source of innovation activities. In this respect there are several studies, which have shown that developing innovations is a phenomenon under the influence of various actors either inside or outside the firm (Kaufmann and Tödtling, 2001; Pérez Pérez and Sánchez, 2002; Romijn and Albu, 2002). In a general sense, but particularly in the case of complex and radical innovations, having relationships with a diverse group of agents is beneficial for being able to integrate knowledge and ideas stemming from different sources (Pittaway *et. al.*, 2004).

External sources are a large and diverse number of agents who can be grouped in three categories (von Hippel, 1988; OCDE, 1997): 1) market sources (such as: competitors, purchase of incorporated or disembodied technology, users, consultants and equipment, materials, components and software suppliers; 2) teaching or research centres (including public and private research institutes and universities) and; 3) information generally available (for example: published patents, conferences, professional meetings and journals, fairs and exhibitions, etc.).

The motives leading firms to make use of such sources differ widely. Among the most important one should stress those related to technological complexity, efforts to share risk, obtaining public funds, efficiency, accessing to knowledge and adapting to the environment (Hagedoorn, 1993; Sakakibara, 1997a, b; Child and Faulkner, 1998; Cassiman and Veugelers, 2002; Bayona *et. al.,* 2003). However, these motives vary according to the type of partner

(Fritsch and Lukas, 2001; Tether, 2002; Bayona *et. al*., 2002, 2003; Cassiman and Veugelers, 2002; Miotti and Sachwald, 2003, Belderbos *et. al*., 2004; Santamaría and Rialp, 2007), with this information being highly valuable for a better understanding of the phenomenon of collaboration (Bayona *et. al.*, 2001). Indeed choosing a partner is very important and needs to be consistent with the firm's aims and strategies (Hagedoorn, 1990; Gemünden *et. al*., 1992; Sorensen and Reve, 1998; Miotti and Sachwald, 2003).

Some authors have grouped these motivations into two categories; those which are technology-related -such as technological complexity in industry or reducing R&D expenditures- and others which are market-linked -such as creating and being introduced into new markets, launching new products, or internationalization- (Bayona *et. al.* 2001). It is precisely this latter group of motivations, which serves to justify cooperation with users, which is the subject of the present work, because users are normally favourites when a firm is pursuing commercial aims (Hagedoorn, 1993; Bayona *et. al.* 2001; Santamaría and Rialp, 2007).

The present study analyses the effects of cooperation on firms' innovation activity. This analysis can be made both from the *input* and *output* viewpoint. However, in this case it has been decided to adopt the second viewpoint for two reasons. Firstly, the effects of this cooperation are particularly visible in the outputs or results of the innovation process. This is because the user's experience in handling products and technologies is of great help both in making improvements in existing designs, and coming up with new ideas or applications. Secondly, given that the ultimate aim of innovation activity is precisely to obtain different types of innovations, when the effects of cooperation on outputs are analysed, one is taking into account whether this type of relationships has any effect on effective innovation creation or not, regardless of the level of effort used (inputs).

Therefore, the aim of this research will be to help in determining whether the fact of collaboration with users impinges on the result of innovation activity in terms of the category of innovation obtained. With that aim in mind, an analysis has been made of the effects produced by cooperation with users on the development of different types of innovations, and a distinction has been made between: 1) product *versus* process innovations and, 2) innovations depending on its degree of novelty (low *versus* high degree). This double duality approach is due, on the one hand, to the literature tending to point out that cooperation with these agents is particularly geared to achieving product innovations, and there are few studies, which have considered the possibility of these agents also being able to make important contributions to the development of process innovations. On the other hand, there is a scarcity of previous works analysing the effects of this cooperation on the degree of novelty of the innovation output and, therefore, research in this area may turn up interesting findings for firm managers. Additionally, this study takes into account the effects of the intensity/continuity of the relationship between the manufacturing firm and the user on the likelihood of developing these four types of innovations. In this manner, a step further has been taken in this paper in providing proposals for the design of innovation strategies in accordance with the type of innovation planned by the firm.

The structure of the work is as follows. The second section provides a short review of the literature on innovation output and collaboration with users and the hypotheses to be tested are presented. The third section gives a description of the characteristics of the sample used, the methodology and the measurements of the variables. The study's empirical findings are presented and discussed in the fourth section. Finally, the last section records the main conclusions along with the study's most significant contributions, its limitations and future lines of research.

2. LITERATURE REVIEW

2.1. Innovation output

Innovation activities are not always easy to distinguish from other types of activities, and this in turn creates considerable difficulty in identifying their results. There are two very common errors of perception. Firstly, considering as technological innovation only those that can be clearly seen as such, when in fact, most technological progress is the result of small incremental changes, both in products and processes (Kline and Rosenberg, 1986). The fact is that any important breakthrough is usually followed by a period of incremental technological changes and during this time subsequent improvements may become of greater importance than the invention in its original form (Kline and Rosenberg, 1986; Anderson and Tushman, 1990). Likewise, it must be considered that an important part of innovation activity is not visible because it takes place inside the firm and is not reflected in statistics.

The second error occurs when innovation is treated as though it were something homogeneous and well-defined and its origin can be accurately pinpointed at a specific moment in time (Kline and Rosenberg, 1986), when in fact it is a process taking place over a number of years and not the result of a specific activity (Jensen and Webster, 2005). Moreover, any innovation involves a certain degree of novelty and as each one is unique it is impossible to quantify all of them.

Along with these two questions there are other difficulties. Kline and Rosenberg (1986) pointed out that the effects of an innovation on a particular sector are quickly spread to their suppliers, giving rise to an increased demand in other industries supplying components or materials. Jensen and Webster (2005) also pointed to the fact that the innovation process differs for each industry or even for each firm or that the profits generated by an innovation may be extended to industries having little to do with the one where it was originated.

All of these questions show clearly how difficult it is to accurately identify the result of the innovation process. Nonetheless, despite these difficulties, at the present time there are different ways of measuring the outputs of innovation activity. Among some of the most commonly used indicators such as: sales of imitation or innovative products, bibliometric and technometric analyses, advertising of new products, etc., it has been proven that the counting of patents is, without a doubt, the most frequently used. Nevertheless, in this study patents have not been considered because in the case of innovations produced by users a phenomenon known as *free revealing* is likely to occur[1], and this means that very few of the results of their innovation activity are patented. Consequently, as an alternative to the use of patents as an indicator of the innovation output it has been considered more appropriate to use another measure: the resulting type of innovation. Furthermore, very few previous studies have looked into the effects of collaborating with users on this measurement of the result, so the analysis carried out may provide interesting conclusions in this aspect.

In this sense, among the diverse categories of innovative results that can be considered, in this work four types of innovations have been taken into account, considering two dichotomies: 1) product innovations *versu*s process innovations (Pine *et. al.* 1993; OCDE, 1997, 2002; Khanna, 1995; Lambe and Spekman, 1997; Karlsson, 1997; Tether, 2003, Rosenkranz, 2003) and, 2) innovations with low degree of novelty *versus* innovations with high degree of novelty (Freeman, 1982; Nelson and Winter, 1982; Saviotti *et. al*., 1982; Damanpour, 1991; Gatignon *et. al.* 2002; Tether, 2003).

Regarding the first two, both the Oslo Manual (OCDE, 1997) and the Frascatti one (OCDE, 2002) distinguish between technological innovation in product and process. The former refers to the development of products (goods and services), which are markedly different from present ones, through the set of completely new technologies or a combination of existing ones albeit in a new way. It might even be possible to distinguish between a product, which is technologically new and one, which is technologically improved (OCDE, 1997; Tether, 2001).

Furthermore, although the definition of process innovation given by the OECD (1997:32) is broader, it is sufficient to state that it involves putting production techniques or methods into practice, which are either radically new or significantly improved ones, and this also includes distribution techniques. These methods may involve changes in equipment, production organization or both. In any case, they inevitably require new knowledge.

However, it must be borne in mind that these definitions have certain limitations. As can be observed, in both, terms such as “significantly improved” or similar are included, which produces a highly subjective interpretation (Tether, 2001). There is the possibility that, even within the same firm, two people may differ as to the meaning of “significantly improved”. This could to a great extent determine whether the firm is considered innovative or not. Another

[1] *Free revealing* consists of “someone” (normally the user) revealing information on the innovation he/she has developed. This can be taken advantage of by other users or manufacturers in designing and developing commercial products. The vast majority of innovative users give free details of their innovations.

important limitation attributed to these definitions is their emphasis on the technological aspect of innovation (Djellal and Gallouj, 1999; Tether, 2001), when in fact there is no need for the existence of an expressly embedded technology for it to be considered as innovation.

The other approach to the type of innovation result is based on the degree of novelty of these outputs, something that normally leads to a distinction being made between radical and incremental innovations (Gatignon *et. al*., 2002). There is considerable confusion when a differentiation is made between these two types of innovations. In this sense, a radical innovation has been defined as one going beyond the technological boundaries of existing technologies (Freeman, 1982), or as the appearance of a new technical characteristic[2] (Saviotti *et. al.*, 1982). What is more, an incremental innovation may be understood as a succession of changes of a quantitative nature in known parameters, or as the incorporation, in a particular product, of technical characteristics already being used in similar products (Saviotti *et. al.* 1982). Moreover, bearing in mind that any product may be studied as an integrated system with several subsystems, change will be perceived as incremental or radical depending upon the hierarchical level, which is taken as a reference within that technological system[3] (Gatignon *et. al.* 2002; Tether, 2003). As a result of the above, in this study we preferred to use the terminology "high degree of novelty" and "low degree of novelty" of the innovation instead of using the expressions "radical" and "incremental".

Bearing this double classification in mind, this research aims to help to determine whether the fact of collaborating with users has any influence on the results of the innovation activity with regard to the category of innovation obtained. Although previous studies on cooperation have analysed the effect of this type of relationship on the likelihood of developing different types of innovations (von Hippel, 1988; Kline and Rosenberg, 1986; Miotti and Sachwald, 2003; Tether, 2003; Amara and Landry, 2005; Nieto and Santamaría, 2007), the results are not yet conclusive. Thus, in a general fashion, the first hypothesis we aim to test is the following:

Hypothesis 1: *Collaboration with users in developing the innovation process impinges on the resulting type of innovation.*

Nonetheless, bearing these two classifications in mind, there is a need to delve more deeply into the effects of collaborating with users on the innovation output, an idea that is developed in the following sections.

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[2] Dahlin and Behrens (2005) have provided a definition regarding what should be understood by radical innovation and they consider that in order to claim this denomination the new design must meet three conditions: 1) to be new, 2) to be unique and, 3) to have an effect on future technologies.

[3] For example, a new turbine, which could solve a particular problem, may be deemed a radical innovation at that level, but the same change would be of an incremental nature if it were viewed from the standpoint of an airplane as a whole.

2.2. Product innovations *versus* process innovations

Regarding this dual nature, evidence shows that within the portfolio of innovation projects, which firms handle, some are more geared to obtaining product innovations, compared to those who make a greater effort to obtain process innovations. This, however, does not necessarily imply that firms specialize in a particular type of innovation (Pine *et. al.* 1993). Such ideas are clearly reflected, for example, when Japanese and Western firms are compared. The former are more committed to achieving process innovations whereas the latter invest more in product innovations (Mansfield, 1988; Albach, 1994).

Other studies have also detected that the makeup of that portfolio varies over time (Utterback and Abernathy, 1975; Abernathy and Utterback, 1982; Keppler, 1996), or that firm size is another of the variables influencing this decision (Scherer, 1991; Klepper, 1996; Cohen and Klepper, 1996; Yin and Zuscovitch, 1998; Fritsch and Meschede, 2001). What is more, it appears that when the user has a strong desire to pay to obtain a product, or if the market indicates a clear preference for differentiated products, then this will increase the firm's interest in developing product innovations compared to process innovations (Abernathy and Utterback, 1982; D`Aspremont and Jacquemin, 1988; Rosenkranz, 2003).

Similarly, there is evidence that inter-firm collaboration affects firms' strategic orientation in innovation (Khanna, 1995; Lambe and Spekman, 1997; Karlsson, 1997, Rosenkranz, 2003). Rosenkranz (2003) compared firms' strategic orientation in two different contexts: a competitive environment *versus* one of collaboration. From his results it can be observed that firms taking part in Joint Ventures invest more in product innovations.

Though user participation in the innovation process begins in the industrial field (Enos, 1962; Freeman, 1968; von Hippel, 1976, 1977a, b; Shaw, 1985; VanderWerf, 1990; Riggs and von Hippel, 1994), it quickly spreads to consumer goods areas (Herstatt and von Hippel, 1992; Shah, 2000; Franke and Shah, 2003; Lüthje, 2004; Lüthje *et. al.*, 2005). This fact leads to the thought that, at the present time, these agents are providing important contributions in the form of both product and process innovations, an idea which has been corroborated by other studies (von Hippel, 1976, 1988; Kline and Rosenberg, 1986; Miotti and Sachwald, 2003).

Likewise, it has also been pointed out that developing innovations requires two types of knowledge, which on some occasions may be costly to acquire, transfer and use (von Hippel, 1994). On the one hand, this is the case of knowledge concerning market needs and the use of innovations and, on the other hand, knowledge regarding possible solutions and their production process. Users normally have the former, whereas manufacturing firms are dominant in the latter case (von Hippel, 1994, 2005; Prügl and Schreier, 2006). Thus, the existence of these information asymmetries provides a significant advantage for those manufacturers with access to external information sources, since they find themselves better placed to identify and exploit innovation opportunities which others may not be aware of (Venkataraman, 1997).

Nonetheless, it is worth pointing out that in order to develop process innovations the manufacturing firm is dominant both in process technology and its use and, as a consequence, the information provided by users may be expected to be of lesser importance, albeit it is also the case that information regarding the users' need reveals data in many cases on the solution they are looking for or the process by which a solution can be reached (von Hippel, 1977c).

On the basis of that empirical evidence the following hypothesis is formulated:

Hypothesis 2: *Collaboration with users in carrying out the innovation process favours the attaining of product and process innovations.*

2.3. Innovations with low degree of novelty *versus* innovations with high degree of novelty

As far as the second duality is concerned, the literature argues that most innovations are minor or incremental (Knight, 1963; Hollander, 1965), regardless of their source, and, consequently, innovations thought up by users can be expected to obey this rule. Moreover, although the current growth rates force firms to be constantly investigating different mechanisms and strategies to enable them to develop innovations with high degree of novelty (Green *et. al.,* 1995; Danneels and Kleinschmidt, 2001), it is very difficult to achieve important advances over long periods of time. Firstly, because firms, rather than thinking ahead long term, need to take care of their day-to-day survival. This obliges them to concentrate on incremental improvements enabling sales and customers to be maintained, even at the cost of improving their market position in the future. Secondly, there are no effective systems to help researchers develop brand new innovations, so normally these individuals find themselves at a loss.

To tackle such problems a good alternative could be that of seeking knowledge and resources outside the boundaries of the firm. The fact is that at the present time the development of innovations is without any doubt more and more the result of joint work among different agents and not the work of a single firm (Fischer and Varga, 2002; Drejer and JØrgensen, 2005). Thus, in many cases it has been seen that when a highly novel innovation is sought, the firm places its trust in external agents to access required knowledge and what is not available inside the firm (Romijn and Albu, 2002; Tether, 2002; Amara and Landry, 2005). Furthermore, various studies have shown that having a diverse group of partners is another significant variable to achieve innovations (Chesbrough, 2003; Becker and Dietz, 2004; Laursen and Salter, 2006) and, even that the diversity of knowledge sources makes a noticeable contribution to the generation of new ideas (Cohen and Levinthal, 1990; Nieto and Santamaría, 2007). Nonetheless, it must also be taken into account that the type of partner that is chosen may determine, to a great extent, the kind of innovation obtained (Whitley, 2002). Therefore, it is worth bearing this in mind when deciding the agent one wishes to collaborate with.

Information provided by users allows the firm to have access to highly valuable resources, such as tacit complementary knowledge, information about new technologies and improvements in processes, accurate information on market needs and how they are evolving, etc. (Rothwell, 1994; Whitley, 2002). Their active participation in developing innovations helps to ensure that the new products are more successful (Atuahene-Gima, 1995; Souder *et. al.,* 1997), improve market share and strengthen the credibility of the firm's products (Jorde and Teece, 1992; Tidd and Trewhella, 1997; Tether, 2002) and contribute to the culmination of the innovation process with greater levels of efficiency compared to the use of other external sources (Gemünden *et. al.,* 1992; Jorde and Teece, 1992; Mason and Wagner, 1999; Tether, 2002; Bayona *et. al*., 2003; Santamaría and Rialp, 2007). Therefore, due to all the contributions that users can provide as a source of information, it is worthwhile promoting collaboration between users and manufacturers when the desired innovation has a high degree of novelty.

Few empirical studies have previously dealt with the effect of collaboration with users upon the degree of novelty of the resulting innovation (Amara and Landry, 2005; Nieto and Santamaría, 2007). In the work of Amara and Landry (2005) the descriptive analysis they carry out suggests that information from users is used more often to introduce innovations which are brand new at national and world level, but less often when the innovation is merely new to the firm. In parallel fashion, the authors indicate that market information sources make obtaining novel innovations on a world scale less likely, albeit this does not mean they do not impinge on the likelihood of innovate. Likewise, Nieto and Santamaría (2007), by using data on Spain, found that market-based information (suppliers and users) has a positive, significant effect on achieving both types of innovation output.

Other lines of research have shown that when the manufacturing firm innovates by itself the result can only mean incremental improvements on the existing product lines (Anderson and Thusman, 1990; von Hippel, 2005), whereas collaboration with users give rise to ideas for new product lines -radical innovations- (Enos, 1962; Freeman, 1968; von Hippel, 1988; Shah, 2000; Lettl *et. al*., 2006) and innovations of an incremental type (Knight, 1963; Hollander, 1965). In accordance with this approach, the user will have to be more or less deeply involved depending on what type of innovation is needed (Veryzer, 1998; Lüthje and Herstatt, 2004). If an incremental innovation is required, just slight collaboration with the user will be enough, for example, using interviews or questionnaires, but if a more novel innovation is the target this will inescapably require a deeper involvement of the user in the innovation process.

With the aim of determining whether collaboration with these agents really has an effect on the degree of novelty of the innovation output, the proposed hypothesis is the following:

Hypothesis 3: *Collaborating with users in the development of innovation process favours the attaining of innovations with low and high degree of novelty.*

3. SAMPLE, METHODOLOGY AND VARIABLES

3.1. Sample

The research was carried out on the basis of data obtained from the Spanish Business Strategies Survey (*SBSS*). It has been prepared every year since 1990 by the Public Enterprise Foundation (Fundación Empresa Pública *–FUNEP-),* which takes charge of the survey design, supervises its annual development and maintains the database. The part devoted to quantifying firms' innovative activities provides information about technological activities and R&D expenditures from a live sample of Spanish firms, the number of which is about 1,800 annual observations. One of their main advantages is offering information at firm level, which enables it to be the sample unit of this study.

The sample is representative of the population of Spanish manufacturing firms; it is random and stratified according to firm size (in terms of the number of employees) and industry sector. From 1998 onwards, the variables referring to technological cooperation with several partners, among them customers, were introduced.

Following on from Fritch and Lucas (2001) and Motti and Sachwald (2003), firms have been included which replied to the survey with no distinction being made between those who have innovated and those who have not. This distinction could lead to biased results, as has been recognised in previous studies on innovative behaviour in innovating firms (Bayona *et. al.* 2001, 2003; Cassiman and Veugelers, 2002; Tether, 2002; Nieto and Santamaría, 2006).

Given that not all the firms have provided complete information during all those years and that in each period not all of the participating firms were exactly the same (due to incorporations of new firms, takeover processes, excision processes, etc), this study was carried out using an incomplete panel from 1998 to 2005, made up by 1,685 firms adding up to a total of 11,881 observations[4]. Moreover, because of the large number of firms that provide information it has been judged convenient to establish a minimum of four years of participation in the survey, half of the period considered, in order to ensure certain constancy in the follow up of the firm as well as to avoid disparate patterns of permanence.

3.2. Methodology

The dependent variables in the two estimated models are dichotomous (product innovations *versus* process innovations and innovations with low degree of novelty *versus* innovations with high degree of novelty). This enables Probit models to be used to test the hypothesis. However, it is to be expected that the error terms of these models considered two by two be correlated, which makes it more convenient to use an extended Probit model, known as Bivariate Probit

[4] The sample of chosen firms is representative of the whole of the population of firms.

(Greene, 2000). This will at the same time make it possible to consider the existence of non-observable factors influencing each of these two pairs of decisions.

Other authors in the field of innovation have previously applied this econometric model and more specifically in studying the relationship between collaboration and different aspects of innovation activity, such as how regularly internal R&D is carried out (Becker and Dietz, 2004), the degree of novelty of the resulting innovation (Nieto and Santamaría, 2007) or the participation in national or international innovation programs (Busom and Fernández-Ribas, 2008).

In specifying this model two equations are considered (Breen, 1996):

$$y_1^* = \beta_1^{'} x_1 + \varepsilon_1 ; \quad y_1 = 1 \text{ si } \; y_1^* > 0, \quad y_1 = 0 \text{ si } \; y_1^* \leq 0 \tag{1}$$

$$y_2^* = \beta_2^{'} x_2 + \varepsilon_2 ; \quad y_2 = 1 \text{ si } \; y_2^* > 0, \quad y_2 = 0 \text{ si } \; y_2^* \leq 0$$

$$(\varepsilon_1, \varepsilon_2) \sim BVN\,(0, 0, 1, 1, \rho)$$

where y_1^* and y_2^* are latent variables whilst y_1 and y_2 represent dummy variables referring to obtaining product and process innovations respectively in the first case and, innovations with low and high degree of novelty respectively in the second case, β_1 and β_2 are the estimated coefficients of each of the two equations, x_1 and x_2 are the set of independent variables of each model and ε_1 and ε_2 the error terms which follow a distribution function of a normal bivariate the correlation of which is determined by ρ.

With the aim of estimating by maximum verisimilitude, the distribution function of the vector (ε_1, ε_1) will be denoted by $\Phi(0, 0; \rho)$, so that, the probability function can be expressed in the following way:

$$P_{00} = \Pr ob(y_{1i} = 0, y_{2i} = 0) = \Phi(-x_{1i}\beta_{1,-x_{2i}}\beta_2; \rho) \tag{2}$$

$$P_{10} = \Pr ob(y_{1i} = 1, y_{2i} = 0) = \Phi(-x_{1i}\beta_{1,-x_{2i}}\beta_2; -\rho) \tag{3}$$

$$P_{01} = \Pr ob(y_{1i} = 0, y_{2i} = 1) = \Phi(-x_{1i}\beta_{1,-x_{2i}}\beta_2; -\rho) \tag{4}$$

$$P_{11} = \Pr ob(y_{1i} = 1, y_{2i} = 1) = \Phi(-x_{1i}\beta_{1,-x_{2i}}\beta_2; \rho) \tag{5}$$

in such a way that, bearing in mind these probabilities, the verisimilitude function will remain in the following way:

$$L(\beta_1, \beta_2; \rho) = P_{11}^{y_1 y_2} P_{10}^{y_1(1-y_2)} P_{01}^{(1-y_1)y_2} P_{00}^{(1-y_1)(1-y_2)} \tag{6}$$

Thus, the model is constructed from two independent Probit equations, which can be estimated separately. However, in order to ascertain whether it is convenient to apply the Bivariate Probit the correlation between the error terms must be analysed to see whether the latter is statistically significant. In the event of this correlation not being significant, it would be more appropriate to make an individual estimation of each of the equations by means of four separate Probit models, since in these cases the Bivariate Probit would be less efficient (Greene, 2000). The simplest contrast that can be used in these cases is the contrast of Lagrange multiplicator, which operates under the null hypothesis that ρ equals zero.

Finally it must be mentioned that in a complementary manner this model has also been applied in a cross section in 2005 to analyse the effect of intensity/continuity of collaboration on those four types of innovation output.

3.3. Variables

a) Dependent variables

- Product Innovation. It has been directly measured by means of a dichotomous variable which takes value 1 if firm *i* claims to have obtained product innovations in period *t* and 0 in the opposite case[5].
- Process Innovation[6]. It is also a dichotomous variable, which takes value 1 if firm *i* claims to have obtained process innovations in period *t*, and 0 in the opposite case.
- Degree of novelty of the innovation[7]. Measuring this variable is rather complex and may be tackled in very different ways (Dahlin and Behrens, 2005; Lakemond and Berggren, 2006). In this case the choice was made to determine the degree of novelty only in the case of product innovations, given that in the case of process innovations there is not sufficient information to enable their degree of novelty to be calculated. In this way the characteristics of the resulting product innovation have been taken into consideration as a criterion to decide if it is an innovation with a high or low degree of novelty (Liker *et. al.*, 1999; Nieto and Santamaría, 2007). From this point two dummies have been designed with the following characteristics:
    - *Innovation with low degree of novelty*: the variable will adopt value 1 when the innovation obtained by the firm *i* in period *t* involves changes in the makeup of the product, its design or presentation, and 0 in the opposite case.
    - *Innovation with high degree of novelty:* it takes value 1 if firm *i* claims to have introduced some modification in the product's functions in period *t*, and value 0 in the opposite case.

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[5] Another alternative method could have been the number of product innovations obtained by firm *i* in period *t*. Nevertheless, although this information is available, the same is not true in the case of process innovations, so it was decided to use the same measure for both types of innovation.

6 Process innovation refers both to the introduction of new machinery and also new methods of organizing production or both strategies together.

[7] Regarding what type of data are available, it has been deemed more appropriate to talk of innovations with low or high degree of novelty instead of using the terms "incremental" and "radical", since the use of this latter classification requires having more exhaustive information available than that provided by the SBSS in this respect.

b) Explanatory variables

- *Collaboration with users*. Empirical literature has in many cases used the number of agreements (in absolute terms) as a *proxy* variable of the firm's propensity to collaborate (Colombo and Garrone, 1996). Berg *et. al.* (1982) used as a *proxy* variable the average number of agreements in *cross-industry* models, as did Arora and Gambardella (1990, 1994). Propensity to collaborate may also be measured as the coefficient between the number of agreements on R&D costs or on firm's sales (Colombo and Garrone, 1996). In this case the dependent variable which is being studied is dichotomous and takes value 1 when firm *i* claims that there has been technological collaboration with users in period *t*, and 0 if there has not been any collaboration (Miotti and Sachwald, 2003; Nieto and Santamaría, 2007).

- *Intensity/continuity of collaboration with users*. A discrete quantitative variable has been designed. It registers how many times the firm *i* has had technological collaboration with users throughout the period under consideration, 1998-2005, so that this variable will take values ranging from 0 to 8.

c) Control variables

The measures used for the control variables are recorded in the following table:

Table 1. Measures of control variables

Variable	Medida	Descripción
Size*	Small	1 if the firm has 50 workers or fewer 0 in the opposite case
	Medium	1 if the firm has between 51 and 250 workers 0 in the opposite case
	Large	1 if the firm has more than 250 workers 0 in the opposite case
Technological intensity of the sector	Low-tech intensity	1 if the firm belongs to a sector of low technological intensity 0 in the opposite case
	Medium-low-tech intensity	1 if the firm belongs to a sector of medium-low technological intensity 0 in the opposite case
	High-tech and medium-high-tech intensity	1 if the firm belongs to a sector of high or medium-high technological intensity 0 in the opposite case
Export propensity	Export propensity	(Volume of exports/total sales) by a hundred
Ownership structure	Foreign capital	1 if the firm has foreign capital shares 0 in the opposite case

***This classification by size has been made taking into account the recommendation of the European Commission: "Recommendation of the Commission, May 6, 2003", regarding the definition of micro, small and medium-sized firms" (notified in document number C(2003)1422.

Table 1. Measures of control variables (cont.)

Variable	Medida	Descripción
Public funding	Public funding	Value of all public funds obtained from the Central Administration, the Autonomous Communities and other public organisations (millions of Euros)
Innovation capacity	Total R&D intensity$_{(t-1)}$	(Total R&D expenditures/total sales) by one hundred (lagged one period)
Mergers and takeovers	Takeover	1 if firm has taken another firm over in period *t* 0 in the contrary case
	Excision	1 if firm has suffered a breakup in period *t* 0 in the contrary case
	Excised	1 if firm has jointed the sample in period *t* as a result of a breakup 0 in the opposite case
Economic cycle	Year 1998, …, 2005	1 if the observation has been recorded in 1998,…, 2005 0 in the opposite case

4. RESULTS AND DISCUSSION

4.1. Cooperation with users and type of innovation

The results of the two Bivariate Probit models which have been applied to analyse the effects of the decision as to whether to cooperate with users or not on the four types of innovation output are presented in tables 2 and 3. The *collaboration with users* and *R&D intensity* variables have been lagged one period, since normally the development of an innovation, regardless of its type, requires a more or less lengthy period of time so that it is to be expected that the effects, both of collaboration with users and efforts devoted to innovation, on the innovation output will need to be observed after a certain period of time[8].

Firstly, it should be noted that, looking at the marginal effects, in the four models presented the *collaboration with users* variable is the one exerting the greatest influence on the probability of obtaining the four types of innovations, compared to the remaining variables. These effects are commented on below.

The first analysis compares the effects of technological collaboration with users on the likelihood of obtaining product innovations *versus* process innovations (Table 2). The Wald test shows that the chosen set of variables is significant for both models. Moreover, the result produced by the LR test on the *rho* parameter indicates that the correlation existing between the error terms of the two equations is statistically significant, so the Bivariate Probit model can be said to be the correct specification.

[8] Bearing in mind that the first year in which the SBSS recorded information on collaboration with external agents is 1998, in this analysis the observations for that year were lost, so a seven-time-period has been used, 1999-2005.

Table 2: Bivariate Probit to analyse the effects of collaboration with users on the innovation output (product innovations *versus* process innovations)

Variables			Model 1		Model 2	
			Coef.	dy/dx	Coef.	dy/dx
Constant			-1.084*** (0.056)		-0.622*** (0.052)	
Cooperation with users$_{(t-1)}$			0.641*** (0.038)	0.211*** (0.014)	0.507*** (0.037)	0.187*** (0.014)
Size	Large		0.251*** (0.039)	0.076*** (0.012)	0.297*** (0.038)	0.106*** (0.014)
	Small		-0.379*** (0.039)	-0.109*** (0.011)	-0.350*** (0.036)	-0.120*** (0.012)
Sector	High and medium-high-tech intensity		0.276*** (0.039)	0.084*** (0.012)	-0.001 (0.037)	-0.0004 (0.013)
	Low-tech intensity		0.210*** (0.037)	0.062*** (0.011)	-0.098** (0.034)	-0.033** (0.012)
Export propensity			0.003*** (0.001)	0.001*** (0.000)	0.001** (0.001)	4.08e-04** (0.000)
Fereign captial			-0.148*** (0.039)	-0.041*** (0.010)	-0.122*** (0.037)	-0.041*** (0.012)
Public funding			-1.77e-08 (0.000)	-5.13e-09 (0.000)	1.07e-08 (0.000)	3.70e-09 (0.000)
Total R&D intensity$_{(t-1)}$			0.030*** (0.004)	0.009*** (0.001)	0.014*** (0.005)	0.005*** (0.002)
Takeover			0.070 (0.117)	0.021 (0.036)	0.225** (0.113)	0.082* (0.043)
Excision			0.163 (0.226)	0.050 (0.073)	0.305 (0.217)	0.113 (0.084)
Economic cycle		Year 99	0.262*** (0.054)	0.081*** (0.018)	0.286*** (0.051)	0.103*** (0.019)
		Year 00	0.240*** (0.054)	0.074*** (0.018)	0.296*** (0.051)	0.107*** (0.019)
		Year 01	0.058 (0.056)	0.017 (0.016)	0.206*** (0.052)	0.074*** (0.019)
		Year 02	0.087 (0.055)	0.026 (0.017)	0.096* (0.051)	0.034* (0.018)
		Year 03	-0.079 (0.057)	-0.022 (0.016)	-0.088 (0.054)	-0.030* (0.018)
		Year 05	-0.092 (0.058)	-0.026 (0.016)	-0.054 (0.054)	-0.018 (0.018)
Wald test χ^2 (34) = 1784.390*** Log likelihood = -9996.664 N = 9889 LR test on rho=0: Value χ^2 (1) = 720.679 (0.000)						

*p<0.1 **p< 0.05 ***p<0.01
Note: Model 1 refers to obtaining product innovations and Model 2 to obtaining process innovations.
Reference variables: *medium-low-tech sector*, *medium size* and *Year98*.
The variables *Excised* and *Year 04* have been eliminated due to co-linearity problems
dx/dy estimates the discrete change in a dichotomous variable from 0 to 1.
Standard errors in brackets.

These findings enable hypotheses H_1 and H_2 to be confirmed, since it is corroborated that collaborative relationships with users impinge upon the innovation output and specifically, upon obtaining product and process innovations. Firms cooperating with users increase their probability of developing both types of innovations of 21.1 and 18.7 percentage points, respectively, compared to firms not cooperating with these agents. The greater effect in the case of product innovations can be explained taking into account that the information and knowledge that the user may possess come directly from his/her experience in using and handling products (Urban and von Hippel, 1988; Schreier *et. al.* 2007), and not so much from the techniques and procedures necessary to produce them. For this reason, the information and knowledge that this agent may provide will be more useful for the design of new products than new processes. Nevertheless, the positive, significant influence that this collaboration has been shown to have on obtaining process innovations highlights the fact that, on occasions, information referring to their needs also provides important data for finding the technical solution the firm is looking for or improving the process needed to achieve it (von Hippel, 1977c). Therefore, this type of collaboration is also highly useful for developing process innovations and acquiring knowledge on new technologies (Lettl *et. al.* 2006).

Table 3 presents the results of the second analysis comparing the effects of technological collaboration with users upon the degree of novelty of product innovations, distinguishing between: low and high degree of novelty. As in the previous case, the Wald test indicates that, for both models, the variables chosen as a whole are highly significant. To ascertain whether the model chosen is more suitable than the independent Probits, all that needs to be done is to analyse the results of the LR test on the *rho* parameter. These results indicate that this parameter is significantly different from zero (value equal to 1939.7 with p-value<0.01). So the existing correlation between the error terms of the two equations means that the correct specification is the Bivariate Probit.

The most important result is that referring to the effect of the variable representing technological cooperation with users. Whether the β coefficients are taken or the marginal effects are considered, it can be detected that this variable has a positive, significant influence in both cases. These causality relationships that have been found are consistent with those observed in other studies, such as those of Hollander (1965) or Knight (1963) in the case of incremental innovations and those of von Hippel (1988), Shah (2000), Amara and Landry (2005) or Lettl *et. al.* (2006), among others, in the case of highly original innovations

It is possible to explain these results when the type of information handled by the user is taken into account. If we look at their knowledge and experience when providing ideas, they are limited to what they know because they do not always have the ability to dream up new applications. The fact that the information is shared with the user in the innovation process extends their knowledge base, and gives them the chance to generate more original ideas or even discover unfilled needs that hitherto they were unaware of (Leonard and Rayport, 1997; von Hippel and Katz, 2002). This could lead to totally novel products.

Table 3. Bivariate Probit for analysing the effects of collaboration with users on the innovation output (innovations with low *versus* high degree of novelty)

Variables			Model 1		Model 2	
			Coef.	dy/dx	Coef.	dy/dx
Constant			-1.281*** (0.060)		-1.590*** (0.071)	
Cooperation with users$_{(t-1)}$			0.564*** (0.038)	0.177*** (0.013)	0.630*** (0.041)	0.129*** (0.010)
Size	Large		0.247*** (0.039)	0.071*** (0.012)	0.245*** (0.044)	0.042*** (0.008)
	Small		-0.360*** (0.039)	-0.099*** (0.011)	-0.425*** (0.047)	-0.067*** (0.007)
Sector	High and medium-high-tech intensity		0.281*** (0.039)	0.081*** (0.012)	0.235*** (0.045)	0.040*** (0.008)
	Low-tech intensity		0.231*** (0.038)	0.064*** (0.011)	0.021 (0.045)	0.003 (0.007)
Export propensity			0.003*** (0.001)	0.001*** (0.000)	0.001 (0.001)	0.000 (0.000)
Foreign capital			-0.147*** (0.038)	-0.039*** (0.010)	-0.103** (0.043)	-0.016** (0.006)
Public funding			-1.07e-08 (0.000)	-2.96e-09 (0.000)	-7.27e-09 (0.000)	-1.16e-09 (0.000)
Total R&D intensity$_{(t-1)}$			0.028*** (0.004)	0.008*** (0.001)	0.032*** (0.004)	0.005*** (0.001)
Takeover			0.127 (0.109)	0.037 (0.033)	0.139 (0.117)	0.024 (0.022)
Excision			0.106 (0.201)	0.030 (0.060)	0.111 (0.219)	0.019 (0.040)
Economic cycle		Year 99	0.391*** (0.058)	0.120*** (0.019)	0.222*** (0.069)	0.039*** (0.013)
		Year 00	0.377*** (0.057)	0.115*** (0.019)	0.278*** (0.068)	0.050*** (0.014)
		Year 01	0.201*** (0.058)	0.059*** (0.018)	0.183*** (0.068)	0.032** (0.013)
		Year 02	0.209*** (0.058)	0.061*** (0.018)	0.189*** (0.068)	0.033** (0.013)
		Year 03	0.052 (0.061)	0.014 (0.017)	0.075 (0.072)	0.013 (0.012)
		Year 04	0.131** (0.060)	0.037** (0.018)	0.132* (0.071)	0.022* (0.013)
Wald test χ^2 (34) = 1388.940*** Log likelihood = -6915.990 N = 10099 LR test on rho=0: Value χ^2 (1) = 1939.700 (0.000)						

*p<0.1 **p< 0.05 ***p<0.01

Note: Model 1 refers to obtaining innovations with low degree of novelty and Model 2 to obtaining innovations with high degree of novelty.
The variables *Excised* and *Year 05* have been eliminated due to co-linearity problems
dx/dy estimates the discrete change in a dichotomous variable from 0 to 1.
Standard errors in brackets.

These results confirm hypotheses H_1 and H_3 and clearly show that even though the general idea is that the market information provided by these agents is more useful when dealing with innovations with low degree of novelty, it has been shown that this type of relationship is also totally suitable when the aim is to discover highly novel innovations (Meyers and Athide, 1991; Tether, 2002; Amara and Landry, 2005; Lettl *et. al.,* 2006). So, it is worthwhile to promote the idea that having users for developing the innovative process is highly positive for achieving both small, incremental changes and much more radical innovations (Veryzer, 1998; Lüthje and Herstatt, 2004; Lettl *et. al.,* 2006; Nieto and Santamaría, 2007). In many cases, sophisticated users, as *lead users*, have far greater experience than the manufacturer in the field in which the desired innovation will be developed, because the manufacturer is simply the one devoted to selling products (Schreier and Prügl, 2008). Therefore, collaboration with these agents can be transformed into much more original and attractive innovations (Lettl *et. al.* 2006). Indeed, to achieve this type of innovations, it has been shown by several studies that a good alternative is to take advantage of users who are familiar with analogous markets, that is, they do not belong to the same sector for which the development of the innovation is planned, but they may have to deal with similar needs or trends (von Hippel *et. al.* 1999; Lilien *et. al.,* 2002, von Hippel, 2005, Hienerth *et. al.* 2007).

Regarding the remaining variables of the models (Tables 2 and 3), some of the most important results are briefly presented below. For the four types of innovations *size* is observed to have a significant, positive influence on the whole group of Spanish manufacturing firms, as can be deduced from the fact that in all cases the *large* size variable has turned out positive and significant whereas the *small* size is significant albeit negative.

As for the *technological intensity of the sector,* if the value of the β coefficients is taken into account as well as those of marginal effects, it is detected for the first two models (Table 2) that the relationship is not a linear one. In the case of product innovations, belonging to sectors of both high and high-medium-tech as well as low-tech intensity has a positive, significant effect, whereas only belonging to a low-tech intensity sector has turned out to have a significant effect on obtaining process innovations, albeit a negative one. However, the sign presented by the high and high-medium-tech intensity sector in this second model is also negative, although not significant. The relative importance of the sector's technological intensity is greater in the case of product innovations compared to process innovations (0.084 and 0.062 are the values of the marginal effects in the first case and -0.033 in the second), but the direction of the effect is not clear for any of them.

This effect is still not clear whilst considering the degree of novelty of the resulting innovation (Table 3). Thus, it is difficult to draw conclusions in this respect. But it can be affirmed that in the case of innovations with low degree of novelty, being part of high and high-medium-tech as well as a low-tech intensity sector has a positive, significant influence compared to sectors of medium-low-tech intensity, and that the greater the intensity the higher this effect will be (marginal effect 0.081 compared to 0.064). On the other hand, it is clearly seen that the development of highly novel innovations is significantly favoured if the firm belongs to a high-tech sector. This is logical if we bear in mind that in order to achieve this kind of innovations it is essential to have previous experience and a good knowledge base which will only have been acquired if the firm operates in a sector which forces it to be highly active and dynamic in innovation.

With regard to the firm's *export propensity,* this significantly favours the obtaining of product, process and innovations with low degree of novelty. In this sense, it would appear logical to think that when the firm faces international markets, there will be an increase in the level of competitiveness, which in many cases makes it necessary to improve the functions of the products and/or the manufacturing processes. In any case, it is necessary to point out that this effect is greater in the case of obtaining product innovations than it is in process ones (Table 2). Moreover, Spanish manufacturing firms seem to lack motivation in making an effort to obtain more novel innovations when they face the challenge of entering foreign markets. This fact could be explained if it is taken account that the technological level of the Spanish productive sector is relatively much lower than that of many other countries, whether Europeans, for example, Germany and France, or non-Europeans, United States or Japan. Thus, Spanish firms are at a clear disadvantage when competing on innovation, so that our firms could have opted for doing it in segments where innovations are less radical.

The presence of *foreign capital* also impinges in a significant but negative way on the four types of innovations. This finding is explained by bearing in mind that if the firm is a subsidiary of a multinational, the new product and process designs, regardless of how novel they are, will be developed by the parent company and therefore the subsidiaries will not have to make any effort in this respect compared to firms which are wholly Spanish-owned, who will have to achieve any type of innovation on their own (Blind and Jungmittag, 2004; Pini and Santagelo, 2005).

In none of the models is *public funding* shown to influence the development of any type of innovation, which leads one to surmise that the public programs operating at this moment in Spain, both of national origin, and from the European Union, are not stimulating innovation development. In the face of this, *R&D intensity,* as was expected, acts as a stimulus for obtaining the four types of innovations, so that an increase in any unit of this intensity, *ceteris paribus,* would produce an increase of 0.9 and 0.5 percentage points in the likelihood of obtaining product and process innovations, respectively, and 0.8 and 0.5 percentage points in that of innovations with a low and a high degree of novelty, respectively. And the fact is that the greater the innovative capacity developed by the firm in the past, the more likely it is to have the resources and knowledge base to obtain any type of innovation.

Finally, it just remains to point out that the taking over of another firm in the period impinges positively on the likelihood of obtaining process innovations and the macroeconomic conditions that have occurred in some years have favoured the obtaining of different types of innovation output. However, it would be interesting to be able to analyse these findings deeper to be able to find a justification for their effect.

4.2. Intensity/continuity of collaboration with users and type of innovation

In complementary fashion to the previous analyses, two Bivariate Probit models have been set up to measure the effect of the intensity/continuity of collaboration with users on the innovation output. In these the dependent variables are still obtaining product innovations *versus* process innovations in the former, and innovations with low *versus* high degree of novelty, in the latter. As intensity/continuity of collaboration stands for the number of years the firm claims to have maintained technological collaboration with these agents during the period 1998-2005, the data from the dependent variables as well as the rest of the independent variables corresponds to the final period, 2005[9]. Therefore, when it is a cross section, the last two groups of control variables are not included.

The findings of these two models along with their marginal effects are recorded in Tables 4 and 5. In both cases the Wald test (χ^2 (34) =192.34), p-value = 0.000 and χ^2 (34) = 177.32, p-value =0.000; respectively) indicates that the variables selected are highly significant as a whole. Likewise, it has been proved that the use of Bivariate Probits is more suitable than the estimation of four independent Probit models since the LR test on the *rho* parameter indicates the presence of correlation between the error terms of those two-by-two models, because in both cases they are significantly different from zero.

According to the results obtained it can be seen that, unlike the two models in the previous section, when the intensity/continuity of the relationship with users is considered instead of simply the decision to collaborate with them or not, the effects on the innovation output show a slight difference. In this case, the effect of the collaboration continues being positive and significant on the four types of innovation results. However, taking into account the marginal effects, it is observed that the intensity/continuity has a greater positive effect in the case of innovations in process compared to those for products and in the case of innovations with high degree of novelty compared to the least original. That is, when the duration of the relationship increases by one period, *ceteris paribus,* the likelihood of obtaining a product innovation rises by 2.9 percentage points, whereas the process one increases by 4 percentage points. Likewise, if the duration is prolonged by one year, *ceteris paribus*, the likelihood of achieving innovations with low degree of novelty increases by 2.5 percentage points and the highly novel ones by 4 percentage points.

[9] Except in the case of R&D intensity, which has been lagged one period.

Table 4: Bivariate Probit for analysing the effects of intensity/continuity of collaboration with users on the obtaining product innovations *versus* process innovations

Variables		Model 1		Model 2	
		Coef.	dy/dx	Coef.	dy/dx
Constant		-1.307*** (0.122)		-0.762*** (0.108)	
Intensity/continuity of cooperation		0.113*** (0.018)	0.029*** (0.005)	0.127*** (0.018)	0.040*** (0.006)
Size	Large	0.209* (0.113)	0.057* (0.032)	0.221** (0.107)	0.072** (0.036)
	Small	-0.246** (0.112)	-0.063** (0.028)	-0.337*** (0.103)	-0.105*** (0.032)
Sector	High and medium-high-tech intensity	0.285** (0.113)	0.078** (0.032)	0.054 (0.105)	0.017 (0.034)
	Low-tech intensity	0.374*** (0.108)	0.100*** (0.029)	0.107 (0.098)	0.034 (0.031)
Export propensity		0.004** (0.002)	0.001** (0.000)	-0.002 (0.002)	-0.001 (0.001)
Foreign capital		-0.217* (0.114)	-0.053** (0.026)	-0.159 (0.108)	-0.049 (0.032)
Public funding		-3.11e-08 (0.000)	-8.07e-09 (0.000)	4.63e-08 (0.000)	1.46e-08 (0.000)
Total R&D intensity$_{(t-1)}$		0.006 (0.007)	0.001 (0.002)	-0.002 (0.009)	-0.001 (0.003)
Wald test χ^2 (34) = 192.34*** Log likelihood = -1202.993 N = 1285 LR test on rho=0: Value χ^2 (1) = 103.267 (0.000)					

*p<0.1 **p< 0.05 ***p<0.01
Note: Model 1 refers to obtaining product innovations and Model 2 to obtaining process innovations.
Reference variables: *medium-low-tech sector* and *medium size*.
dx/dy estimates the discrete change in a dichotomous variable from 0 to 1.
Standard errors in brackets.

On the basis of these findings it is possible to deduce certain interesting conclusions. Thus, the fact of collaborating with users has been seen to have a more marked positive effect in the case of product and innovations with low degree of novelty compared to process and innovations with high degree of novelty. Nonetheless, if the intensity/continuity of the relationship is considered, it is clearly shown that the knowledge base that users would need to be able to make useful contributions in the two latter types of innovations will be probably only achievable after a long period of contacts with the manufacturing firm and its design and implementation processes of innovations. In this way, as well as the knowledge the user already has from using and handling the products, all of which may be highly valuable in providing ideas on new products or incremental improvements in the present ones, he/she will acquire certain technical knowledge (Lüthje *et.al.,* 2005; Hienerth *et. al.,* 2007), which he/she usually lacks, and which may produce new ideas on process innovations (von Hippel, 1977c) or much more original innovations (Lynn *et. al.*, 1996; Veryzer, 1998; Lüthje and Herstatt, 2004).

Table 5. Bivariate Probit for analysing the effects of intensity/continuity of collaboration with users on the degree of novelty of the innovation obtained

Variables		Model 1		Model 2	
		Coef.	dy/dx	Coef.	dy/dx
Constant		-1.343*** (0.124)		-0.762*** (0.108)	
Intensity/continuity of cooperation		0.101*** (0.018)	0.025*** (0.004)	0.127*** (0.018)	0.040*** (0.006)
Size	Large	0.211* (0.114)	0.054* (0.031)	0.218** (0.107)	0.071** (0.036)
	Small	-0.244** (0.113)	-0.059** (0.027)	-0.338** (0.103)	-0.106*** (0.032)
Sector	High and medium-high-tech intensity	0.259** (0.116)	0.067** (0.031)	0.053 (0.105)	0.017 (0.034)
	Low-tech intensity	0.398*** (0.110)	0.101*** (0.028)	0.108 (0.098)	0.034 (0.031)
Export propensity		0.004** (0.002)	0.001** (0.000)	-0.002 (0.002)	-0.001 (0.001)
Foreign capital		-0.228** (0.116)	-0.052** (0.025)	-0.159 (0.108)	-0.048 (0.032)
Public funding		-2.21e-08 (0.000)	-5.40e-09 (0.000)	4.61e-08 (0.000)	1.45e-08 (0.000)
Total R&D intensity$_{(t-1)}$		0.004 (0.007)	0.001 (0.002)	-0.003 (0.009)	-0.001 (0.003)
Wald test χ^2 (34) = 177.32*** Log likelihood = -1189.004 N = 1285 LR test on rho=0: Value χ^2 (1) = 88.975 (0.000)					

*p<0.1 **p< 0.05 ***p<0.01

Note: Model 1 refers to obtaining innovations with low degree of novelty and Model 2 to obtaining innovations with high degree of novelty.

Reference variables: *medium-low-tech sector* and *medium size*.

dx/dy estimates the discrete change in a dichotomous variable from 0 to 1.

Standard errors in brackets.

These findings therefore reinforce hypotheses H_1, H_2 and H_3 but, moreover, provide certain additional information which may be very useful for firms when planning their strategies for innovation and/or collaboration, given that when these cause-effect relationships are known the firm can better adjust that decision on the basis of what type of innovation it wants to develop.

Furthermore, it is just worth mentioning that large *size* still favours obtaining all types of innovations compared to small size and that, with regard to the *sector's technological intensity,* a non-linear, U-shaped relationship is observed, both in the case of product innovations and in the innovations with low degree of novelty, whereas this variable ceases to be significant in the case of process innovations and highly original ones. The same occurs with *export propensity* and the presence of *foreign capital,* which have a significant influence, albeit respectively positive and negative on the models 1 in each table, but they lose significance in both models 2. Finally, we wish to mention that both *public funding* and *R&D intensity* have no effect on the innovation result in either of the models.

5. CONCLUSIONS

The main purpose of this study has been to make a contribution to knowledge on cooperation with users in innovation and more specifically, to analyse the effects that this collaboration has on the firm's innovation outputs, to determine whether the innovative result of those maintaining this type of relationship differs from those who do not, and in what way. To achieve this aim a double viewpoint has been adopted. On the one hand, the impact of obtaining product innovations *versus* process innovations has been considered and on the other, the possible effect on the degree of novelty of the resulting innovation, making a differentiation between innovations with high and low degree of novelty. Moreover, the study has been completed with the analysis of the effects of the intensity/continuity of collaboration on these types of innovative output.

This paper contributes to previous literature, which usually analyses whether collaboration with these agents favours innovation or not, analysing the impact of this type of cooperation on obtaining different types of innovations. In this sense, it has been shown that the decision to collaborate with users favours obtaining all types of innovations. What is more, the analyses carried out clearly reveal that, compared to other characteristics of the firm and the sector, this variable is the most influential in the four types of innovations proposed, which denotes how important it is to be taken into account when designing the innovation strategy. However, the point must be made that the size of the effect is greater in the case of product innovations compared to process ones and in the least novel compared to the most, although these findings are the opposite when that relationship is maintained in a continuous form over time.

These findings have important implications for firms regarding the design of their innovation strategy, given that if the influence exerted by this type of collaboration on obtaining different types of innovation is known beforehand**,** it will be easier to define a strategy exactly matching the desired innovative result. In this sense, it has been seen that simple collaboration with users would be of particular interest when the firm's aims consist of achieving product innovations or not very novel innovations. However, when the firm proposes developing process innovations or those with a high degree of novelty, it is advisable to avoid sporadic contact with users. Instead, stable collaborations continued over time should be fostered. This fact is justified by bearing in mind that, basically, the knowledge that a user possesses stems from his experience in using and handling products, so the contributions he/she offers can be of great use in developing product innovations and innovations with low degree of novelty. On the other hand, if he/she is allowed to take part in a continuous way in the innovation process, he/she will be able to develop more technical skills, thus extending his/her knowledge base and the possibilities of also contributing to the design of new processes and more original innovations.

Taking into account the results obtained in this study we recommend that, apart from the desired innovation, the closer the relationship with users and the longer it is continued over time, the more valuable the contributions of these agents for any innovation intended to be developed will be. Nonetheless, it is also worthwhile bearing in mind that process innovations and highly novel innovations may provide the key to establishing a competitive advantage which is sustainable in the long term, given that the knowledge required to put them into practice has a high tacit component (innovations with a high degree of novelty) and it is usually idiosyncratic to the firm (process innovations). These characteristics make the possibility of imitations more difficult and, as a consequence, they may establish the bases for a successful differentiation strategy, which will make the firm more competitive.

Thus, whereas the simple cooperation with users leads to firms being more competitive when they need to produce a practical, rapid response to the market (product and not very novel innovations), maintaining a continuous relationship over time is more geared to attaining long-term economic results and an improvement in their competitive position in the market (process innovations and innovations with a high degree of novelty). In this way, the manager, in addition to bearing in mind the type of innovation he/she intends to develop, must also consider the time horizon for the results of the innovation process to become economic results. If the objective were short-term sales, cooperating with users at specific times would be a good way to provide a quick answer for market demands. However, if the aim were to create value and achieve a solid position in the market, it would be worthwhile for collaboration with users to be a permanent strategy of the firm.

The findings and conclusions to be drawn from this research have to be interpreted while taking into consideration a series of limitations, many of which derive from the data source we used, but which can also lead to future research work. The first limitation is related to the measurement of the degree of novelty of the innovation obtained. The fact that the SBSS only provides information in this respect for the case of product innovations obliges one to treat the results obtained with caution, since it would be convenient to see what would happen in the event of our having this type of information available in the case of process innovations. Similarly, it would be very useful to have information or extra measures of the degree of novelty of the resulting innovation in order to obtain more accurate results and be able to use the terms “incremental” and “radical” more rigorously, when referring to this aspect. It would even be of interest in future research to assess the effect of collaboration with users, not only on the probability of achieving innovations, but also on how successful such innovations are in the market.

Along this same line, collaboration with users, measured as a dichotomous variable or via the duration of the relationship, has served as the basis for this study, although, undoubtedly, having some type of additional information on how these relationships have been run or how close to each other the two parties were, would enable us to go more deeply into knowledge of this phenomenon, and also develop more suitable competitive strategies for specific cases.

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