

**EXTERNAL SOURCES OF INFORMATION FOR INNOVATION DEVELOPMENT:
A COMPREHENSIVE ANALYSIS OF THE EUROPEAN AND SPANISH EVIDENCE**

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ABSTRACT

The ever-greater complexity and dynamism innovation entails have forced firms to complement their internal knowledge basis cooperating with different stakeholders. Between several existing alternatives, the cooperation with customers is one of the most important sources of innovative ideas. Thus, the current paper attempts to explore different sources of information that European and Spanish firms use to innovate and it highlights the importance of customer cooperation. This analysis is completed with an empirical study of cooperation influence on innovation activity intensity. The data refers to twenty Spanish productive sectors and four types of cooperation (cooperation with customers, suppliers, universities and experts/consultants). In conclusion the paper shows that collaboration with customers significantly increases the firm's innovation intensity and consequently, this variable can be used as a reliable indicator of the effort that the firm is devoting to innovation activities.

KEYWORDS: external innovation sources, client/customer cooperation.

CÓDIGO JEL: O32

1. INTRODUCTION

Technological innovation is one of the most powerful drivers in the enhancement of economic growth. Still, since the eighties and due to the ever-greater complexity, uncertainty, costs and risks that innovation entails (Nootboom, 1999; Hagedoorn, 2002), the cooperation in R&D between firms and their stakeholders has increased significantly. Analysts have discovered that in many cases firms are unable to possess on their own all required knowledge to carry out innovation activities. This fact leads to a special interest for the R&D cooperation phenomenon.

Since then, it has been generally admitted that the R&D department is not the only source of innovative ideas. In consequence, it is feasible to divide innovation sources into two types: internal versus external (von Hippel, 1988; OECD, 1997). The former, the internal information sources, is constituted by all innovation activities carried out inside the organisation, particularly those related to R&D, production and marketing departments. The second type, the external information sources, compiled miscellaneous agents like suppliers, competitors or customers (market sources); universities or research institutions (institutional sources) or conferences, meetings, professional journals, exhibitions and fairs (generally available information like).

R&D cooperation with final customers has been used by many firms, some of which world-wide known as for instance Kellogg, Hilti, Johnson & Johnson, Phillips, Nestlé, IBM, Technicon Corporation, making them participating in the generation and development of new products. This way, the customers themselves bring ideas and suggestions, contributing to the improvement of the final result and/or to a higher efficiency of the innovation process, by for instance decreasing innovation costs (Herstatt y von Hippel, 1992; Jeppesen, 2002, 2005; Chan y Lee, 2004; Henkel y von Hippel, 2004; von Hippel, 2005).

In spite of the growing interest in these external information sources, the number of academic papers about cooperation with customers in industry and service sectors is not large enough and most of these studies have been focussed on only one specially selected firm or activity sector. Thus, the current paper will bring us a much larger and objective vision of the reality of this phenomenon.

This study aims a double objective. On the one hand, it realizes an exhaustive review of the previous literature about cooperation between firms and customers. On the other hand, it empirically compares customer cooperation to three other external innovation sources (suppliers, experts and consultants, universities) in order to determine whether some of them has got a significant influence on the innovation activity.

The paper is organised as follows: Section 2 presents a review of the topic, emphasizing on the reasons why firms have been lead to cooperate with their customers. Section 3 describes the empirical evidence of the cooperation phenomenon in Spanish and European firms. In Section 4 an empirical study is carried out on twenty Spanish manufacturing industries, analysing the effects of these four external innovation sources on the intensity of innovation activity in three different models, in order to determine whether some of them has got a significant influence that would justify taking them into account in strategic decisions. Finally, Section 5 synthesises the findings and offers the main conclusions.

2. AN OVERVIEW OF COOPERATION WITH CUSTOMERS FOR INNOVATION ACTIVITIES.

Traditionally, when economists studied innovation, they always laid down as a basic principle that the manufacturers have been the only trigger for the innovation process. Recent studies about technological and organizational changes showed that this assumption strongly shortens the reality of the innovation process (von Hippel, 1988).

Since then, the importance of external information and knowledge sources for innovation activities was recognized. The origin of this information can be miscellaneous, for instance customers, suppliers of equipment, components and software or other agents implicate in the innovation process (von Hippel, 1998). From then, it has been acknowledged that firm's productivity strongly depends on its ability to find, acquire and manage efficiently this kind of sources (Cohen y Levinthal, 1990).

When achieving information to develop innovations, firms have been following two kinds of strategies: generate the knowledge internally or obtain it from the outside, i.e. *make* or *buy*, according to Veugelers and Cassiman (1999).

Nevertheless, recently analysts have been observing another, hybrid, way to get the needed knowledge: cooperation with external agents in innovation activities (Navarro, 2002), clients and customers among others.

The now largely accepted idea about the importance of complementing firm's internal knowledge basis with external information was actually proposed by Alfred Marshall in 1925. He showed how important is for the economic growth that firms develop positive externalities through a market-based organisation (Marshall, 1925:335).

From a theoretical point of view, the Resource Based View (RBV) was established on the latter idea (Penrose, 1959; Rumelt, 1984; Teece, 1984; Wernerfelt, 1984; Barney, 1991 and Peteraf, 1993). RBV is a strategic management theory that explains, among others, the phenomenon of cooperation with customers. It is shown that partnerships with external agents are an important resource in the current competitive environment, particularly in the development of new products and processes. Thus, the different endowment and use of these resources could explain the observed disparity in the performance of firms competing in the same industrial sector (Barney, 1986a, 1986b, 1991, 2001; Wernerfelt, 1984; Peteraf, 1993).

Taking into account the great diversity of resources available for a firm, tangible and intangible, the intangible resources enclose the biggest potential to become a source of sustained competitive advantage (Teece, Pisano and Shuen, 1997; Ray, Barney and Muhanna, 2004). They can be accumulated inside the firm and they can come from partnerships with external innovative agents. The high tacit component and the social complexity of such relations (Dierickx and Cool, 1989; Peteraf, 1993) make them hardly identifiable and/or reproducible resources for competitors, and thereby turn them into a potential source of a competitive advantage¹.

Clearly, this is the case when firms make use of customer knowledge as a information source for innovation activities. For example, it's quite easy to obtain information about explicit customer needs related to current products, using surveys or other traditional marketing research methods, also available to any competitor. Consequently, this information cannot be a source of competitive advantage. Nevertheless, if the firm allows its customers to collaborate in innovation process and new products development, it will be able to discover needs that the own customers in many cases weren't even aware to have. Competitors will find very difficult to imitate this kind of relationships, so this valuable information can be used as a basis for designing a successful competitive strategy.

The importance of these "other" sources of ideas in the generation and development of innovations has also been established by empirical evidence. In the specific case of users, this fact can be observed in many cases, some of which are described in Table 1.

¹ The RBV considers that to become a source of sustained competitive advantage, a resource must possess four characteristics: valuable, rare, inimitable and non-substitutable (Barney, 1995:56).

TABLE 1: Participation percentages of different innovation sources in industrial products

<i>Autor</i>	<i>Study</i>	Innovation Source			
		User	Manufacturer	Others	Total innovations
<i>Enos (1962)</i>	Major innovations in petroleum refining	43%	14%	43%	7
<i>Freeman (1968)</i>	Chemical processes and process equipment	70%	30%	--	810
<i>von Hippel (1976)</i>	Scientific instrument innovation process:				
	- initial comercial practice	100%	0%	--	4
	- mayor improvement in functional utility	82%	18%	--	44
	- minor improvement in functional utility	70%	30%	--	63
<i>Lionetta (1977)</i>	Innovation within the pultrusion industry	85%	15%	--	13
<i>Von Hippel (1977)</i>	Semiconductor and Electronic Subassembly Process Innovation:				
	- initial comercial practice	100%	0%	--	7
	- major improvement in functional utility	63%	21%	16%	22
	- minor improvement in functional utility	59%	29%	12%	20
<i>Shaw (1985)</i>	Medical equipment	53%	47%	--	--*
<i>Riggs & von Hippel (1994)</i>	Scientific instrument	44%	56%	--	64

(*) There is not data about the number of analysed cases.

Without forgetting the importance of the supply or other sources as powerful drivers of the process, several studies about “innovation activity user dominated” (Rosenberg, 1976; von Hippel, 1976, 1977a, 1986; Lundvall, 1988; Herstatt and von Hippel, 1992; Shah, 2000; Franke and Shah, 2003; Lüthje, 2004; Lüthje *et. al.*, 2005, among others) have recently been appearing inn contrast to the so-called “innovation activity manufacturer dominated” (von Hippel, 1977). All of them analyze thoroughly the participation of users in the development and implementation of innovations and recognize the important role that users play in innovation activities, at least in some industrial sectors.

The origins of this kind of empirical economic literature are located in the mid-seventies and it focused on industrial markets. The current studies are extending these theories to consumer markets. During that decade, it has been shown that “sophisticated users” increased the speed of technological progress in the machine tool industry (Rosenberg, 1976). Almost at the same

time, other evidences showed that users were responsible for the progress in scientific instrument innovations (von Hippel, 1976) and in the development of semiconductor and electronic subassembly manufacturing equipment (von Hippel, 1977). By then was emitted for the first time the idea to use “lead users²” as generators of ideas for new products (von Hippel, 1986). Some years later, interactions between users and manufacturers were recognized as an important contribution to the innovation progress in complex industries (Lundvall, 1988).

Table 2 compiles some representative examples of this topic, showing the percentages of innovating users among a given (representative) user population. The percentage of users who improve prototypes or develop completely new solutions is not insignificant. The numbers range from 19% to 45% in most cases. Furthermore, it must be noticed that this tendency do not only occurs in industrial markets, but also in consumer markets, as formerly was outlined.

Nevertheless it is probably even more important to justify this reality than to establish its existence. The explanation can be found analyzing the reasons why firms search cooperation with this kind of agents as well as the incentives leading customers to develop innovation activities.

The motives why firms choose cooperation with external agents can be classified into two major categories following the classification made by Bayona *et. al.* (2000): the first is related to technology (i.e. technological complexity in industry or R&D cost reduction) and the second is linked to the market (i.e. creation and introduction in new markets or launching new products).

² “Lead Users” are users that: 1) have needs that foreshadow general demand in the marketplace and 2) expect to obtain high benefit from a solution to their needs (von Hippel, 1986, 1988).

TABLE 2: Percentages of users that have innovated in different categories of industrial and consumer products

Source	Industrial Products	Percentage developing and building product for own use	Number of users sampled
<i>Urban & von Hippel (1988)</i>	Printed circuit CAD software	24.3%	136
<i>Herstatt & von Hippel (1992)</i>	Piper hanger hardware	36%	74
<i>Franke & von Hippel (2003)</i>	Apache OS server software security features	19.1%	131
<i>Lüthje (2003)</i>	Surgical equipment	22%	261
Source	Consumer Products	Percentage developing and building product for own use	Number of users sampled
<i>Shah (2000)</i>	Skateboarding, snowboarding, and windsurfing equipment	58%	57
<i>Morrison et. al. (2000)</i>	Library information systems (OPAC)	26%	102
<i>Franke & Shah (2003)</i>	“Extrem” sporting equipment	37.8%	197
<i>Henkel & Thies (2003)</i>	Simulation software	35%	2713
<i>Jeppesen & Federiksen (2004)</i>	Computer controlled music instruments	8%	395
<i>Tietz et. al. (2004)</i>	Kitesurfing equipment	45%	157
<i>Lüthje (2004)</i>	Outdoor consumer products	9.8%	153
<i>Lüthje, Herstatt & von Hippel (2005)</i>	Mountain bike equipment	19.2%	291

Due to the recently appeared forms of cooperation with innovative users³ it is now possible to go beyond the improvements of the known attributes of a product or a service, by even identifying needs that, in many cases, the customer himself wasn't aware of them yet (Leonard and Rayport, 1997). This allows the current firms to rapidly face the changes of market's tastes in our modern societies (von Hippel and Katz, 2002).

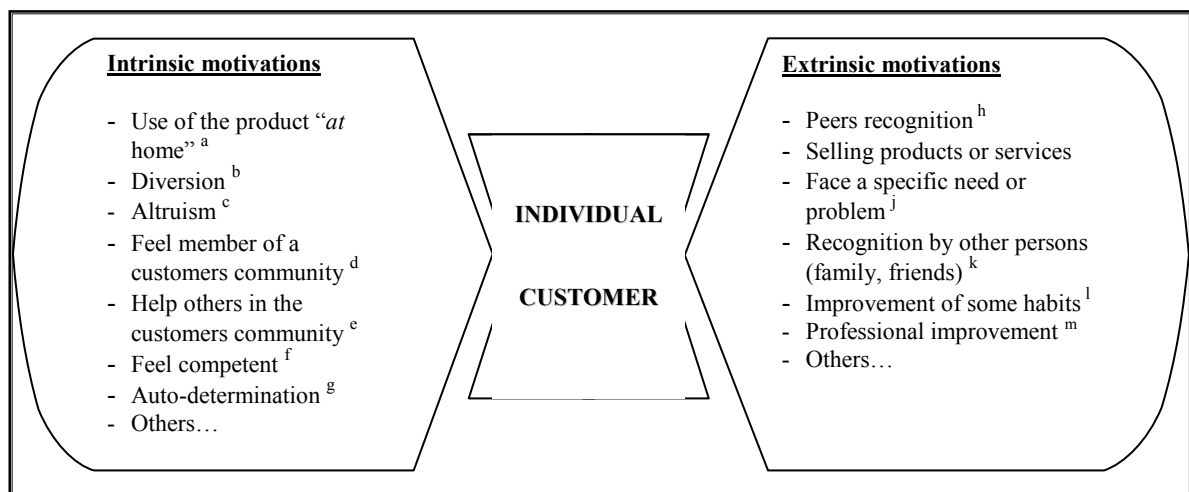
Besides the improvement of product designs, these cooperation methods provide other advantages like a better guidance of the innovation process, spending less time, lower costs, etc. (Jeppesen, 2002).

³ Among others can be noted especially: the *Lead User* method, the tools designed for innovating customers (*toolkits*) and the virtual communities of innovating customers.

Still, in terms of developing innovations together with users, the motivations of these agents must also be taken into account. Indeed, when participating in an innovation process, users rarely obtain an economic benefit from their work, in compassion with manufacturers. To take advantage of the situation, the user should make use of some kind of property protection methods (patents, copyright, etc.), that usually don't offer enough protection or are out of the economic capabilities of most customers.

Several factors incite customers to develop innovations. These factors can be divided into intrinsic and extrinsic motivations (Figure 1). The first are originated from the innate human need to feel competent and trustful to face the environment. The second arise from the search for social recognition and improvement of the professional situation.

FIGURE 1: Motivations of individual customers to participate in innovation activities⁴



⁴ Reviewed studies: 1. *Intrinsic motivations*: (a): von Hippel, 2002; Lüthje, 2003, 2004; Franke and von Hippel, 2003; Henkel and Thies, 2003; (b): Lakhani and von Hippel, 2003; Henkel and Thies, 2003; Jeppesen and Molin, 2003; Hertel, *et. al.*, 2003; Jeppesen and Frederiksen, 2004, (c): Lakhani and von Hippel, 2003; Hars and Ou, 2001, (d) and (e): Hars and Ou, 2001; Lakhani and von Hippel 2003; Hertel, *et. al.*, 2003, (f) and (g): Hars and Ou, 2001. 2. *Extrinsic motivations*: (h): Riggs and von Hippel, 1994; Hars and Ou, 2001; Lerner and Tirole, 2002; Lakhani and von Hippel, 2003; Jeppesen and Molin, 2003, Jeppesen and Frederiksen, 2004, (i): Hars and Ou, 2001, (j): Lakhani and von Hippel, 2003; Lerner and Tirole, 2002 (k): Hertel, *et. al.*, 2003, (l): Hars and Ou, 2001; Henkel and Thies, 2003; Jeppesen and Frederiksen, 2004, (m): Hars and Ou, 2001; Lerner and Tirole, 2002; Hertel *et. al.*, 2003.

Firms interested in cooperation with its customers must know the underlying reasons that make these agents participate in the process. This way, the firm could design appropriate strategies to promote and reinforce that cooperation.

2. EUROPEAN AND SPANISH EMPIRICAL EVIDENCES: A comprehensive description

Considering the potential of the demand, some countries in the European Union have implemented strategies to increase its pressure on innovation activity, in order to benefit from its effects. So for instance the French government has invested in the expansion of cellular phone networks in rural areas in order to increase the use of this technology. Like other member countries, Germany has introduced technological subjects in its scholar program with the aim to accelerate the application of new information and communication technologies. In the English case, White Book of Competitiveness from 1998 recognized that consumers taking decisions in competitive markets and having good information can promote the development of high valuable innovations.

This section lights up the current situation of innovation cooperation in Europe and in Spain, emphasizing the importance and notoriety of relationships with clients and consumers.

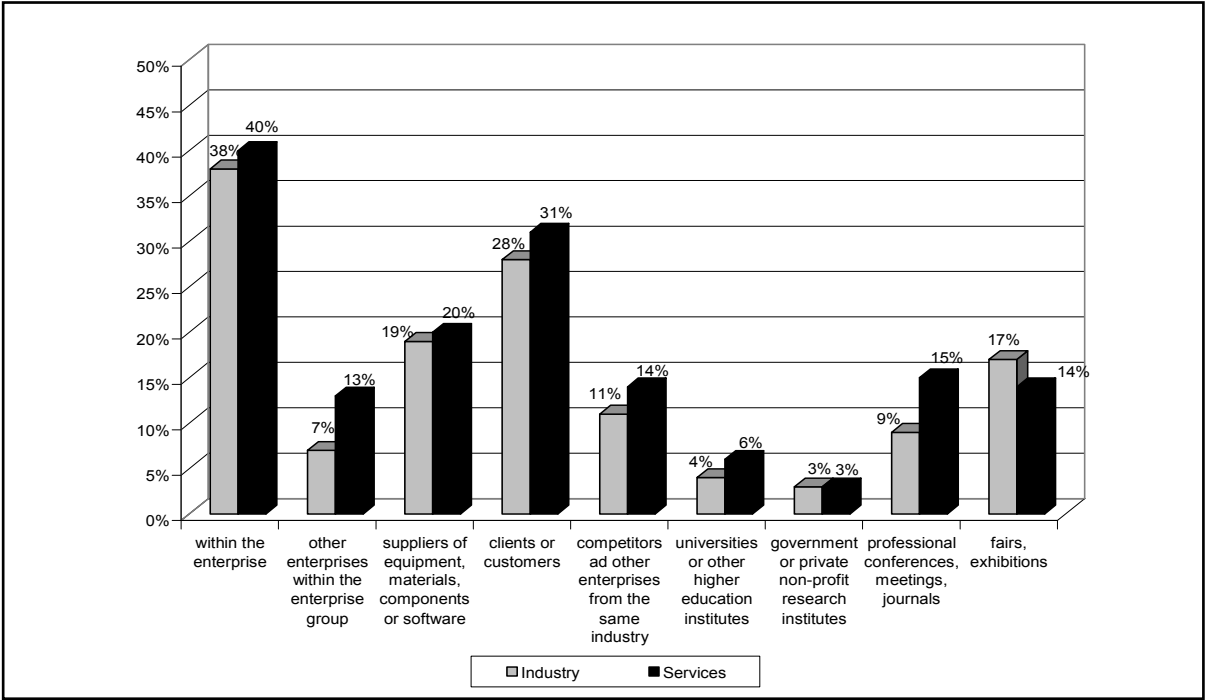
The magnitude of cooperation with different innovative agents in Europe can be obtained analysing the data gathered by the Third Community Innovation Survey (CIS3) from 1998 to 2000. It was carried out by the European Community in collaboration with Eurostat (2004). It offers an overall view of the cooperation influence on new products and processes development in industrial and service sectors.

This survey gathers data about different aspects of the innovation process and uses a sample of 458.000 firms from all over the European Union, Island and Norway. Among these firms, approximately 44% (i.e. 201.000), had carried out some kind of innovation activity during the

considered period. They had worked with different categories of information sources for innovation, considering who generates the original idea that implements a profitable project.

On the one hand, Figure 2 illustrates the kind of sources firms consider as most important for their innovation projects. Logically, in industrial sectors, the firm itself is cited as the most valuable source of information for innovation, i.e. 38% of the interviewees considered internal knowledge as very important. Still, when analysing only external sources, cooperation with clients and consumers appeared in the first place (28%), quite far ahead of different kinds of suppliers (19%). In service sectors, the industrial sector's ranking is conserved (firstly the internal source, secondly clients and thirdly suppliers), although the percentages are slightly different (respectively 40%, 31% and 20%). These data evidence clearly the importance that European enterprises give to their customers as a source of information to new idea generation and innovation projects development.

FIGURE 2: Enterprises with innovation activity: proportion citing specified sources of information as highly important for innovation, EU, 1998-2000 (%)



Source: Eurostat, NewCronos, CIS3.

(*) Multiple answers are allowed.

On the other hand, the firm size also is a determining factor in innovation cooperation; although it doesn't necessarily affect the type of partner the relationship is established with. Indeed, even if it could be thought that the SMEs (small and middle sized enterprises) would have a major tendency to cooperate in order to compensate their lack of internal resources, the study shows that large companies are the most inclined to collaborate (57%), then the middle-sized firms (24%) and finally, the small ones (14%) (European Commission and Eurostat, 2004). This tendency has been observed in industry as well as in service sectors.

As table 3 shows the majority of firms, large ones as well as small ones, considered themselves as the main source of innovative ideas, although this fact is particularly true in the case of large companies (70% of them have confirmed this idea). Again, firms of different sizes admitted that among the external sources, the most important information is that coming from agents they have business with, i.e. clients and suppliers.

TABLE 3: Enterprises with innovation activity: proportion citing specified sources of information as highly important for innovation, by size, EU, 1998-2000 (%)

	Within the enterprise	Other enterprises within the enterprise group	Suppliers	Clients	Competitors / other enterprises from the same industry	Universities / other higher education institutes	Government / private non-profit research institutes	Professional conferences, meetings, journals	Fairs / Exhibit.
Total	38	9	20	28	12	5	3	11	16
Small	34	6	19	26	11	4	2	11	16
Medium	41	14	18	30	13	5	3	10	15
Large	70	31	29	47	21	10	6	16	17

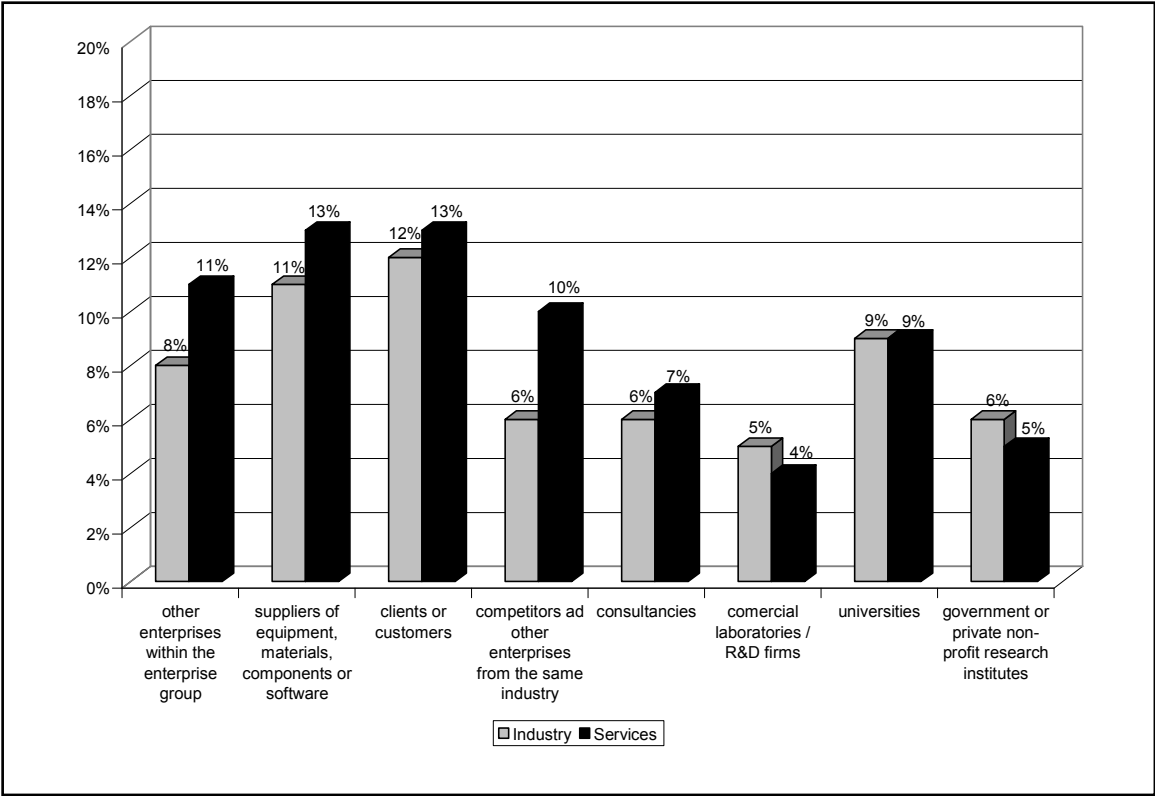
Source: Eurostat, NewCronos, CIS3.

Besides the way the firms assess these different information sources, it can be even more interesting to analyse data about the exact kind of agents they have had contacts with (Figure 3).

This figure shows that, in industrial sectors as well as in service sectors, the relationship with customers has been the principal source of information for innovative activities, although tightly followed by suppliers of equipment, materials, components or software. Respective cooperation percentages are situated between 13% and 11%. It is also noticeable the

cooperation level with other enterprises within the enterprise group (8%-11%) and universities and other higher education institutes (9%). The most important element about this figure is the fact that clients are actually an important information source for innovation projects.

FIGURE 3: Proportion of enterprises with innovation activity involved in innovation co-operation, by partner, EU, 1998-2000 (%)



Source: Eurostat, NewCronos, CIS3.

Still based on the data from the CIS3, analysis can be made of the concrete case of Spanish firms (Table 4). Again the firm itself is considered as the most important information source (in 33% of industrial enterprises and 39% of services). This time it is followed by suppliers and then by clients and customers: 24% and 19% respectively in the industrial sector and 27% and 20% respectively in the service sector. In this way, Spanish firms are slightly different from the rest of Europe as they consider their suppliers a more important source of information than their clients. In any case, these agents appeared to be the second external source of information for innovative projects.

TABLE 4: Proportion of Spanish enterprises with innovation activity citing specified sources of information as highly important for innovation, 2000 (%)

	Total	Industry	Services
Internal Sources			
- Within the enterprise	35	33	39
- Other enterprises within the enterprise group	11	9	16
Market Sources			
- Suppliers of equipment, materials, components or software	25	24	27
- Clients or customers	20	19	20
- Competitor and other enterprises from the same industry	11	10	15
Institutional Sources			
- Universities or other higher education institutes	3	3	3
- Government or private non-profit research institutes	5	5	4
Other Sources			
- Professional conferences, meetings, journals	10	10	11
- Fairs, exhibitions	18	19	15

Source: Own elaboration using the CIS3.

Analysing the link between cooperation and firm size, Spanish firms consider their own firm as the most important information source for innovation just like the rest of European companies, without differences due to size. However, the proportion of large firms considering their internal sources as principal is higher than in the case of SMEs. Obviously, large firms were also according more importance to cooperation with other enterprises within the enterprise group than smaller ones.

Again, suppliers and clients were considered an important innovation source for Spanish firms of different sizes. Still, in the case of small firms, the latter sources only got a third place in the ranking due to the increase of fairs and exhibitions' importance (Table 5).

TABLE 5: Proportion of Spanish large, medium and small enterprises with innovation activity citing specified sources of information as highly important for innovation, 2000 (%)

	Within the enterprise	Other enterprises within the enterprise group	Suppliers	Clients	Competitors / other enterprises from the same industry	Universities / other higher education institutes	Government / private non-profit research institutes	Professional conferences, meetings, journals	Fairs / Exhibit.
Small	30	8	24	19	11	2	4	10	20
Medium	47	18	25	20	10	5	6	9	14
Large	56	28	28	27	13	7	8	12	11

Source: Own elaboration using the CIS3.

3. AN EMPIRICAL ANALYSIS OF THE SPANISH CASE:

4.1. Sample

This paper has been carried out using a sample of twenty productive sectors which include the whole of Spanish manufacturing and service firms –nearly 150.000 enterprises- (see Appendix 1 and 2). The data have been gathered by the Firms Technology Innovation Survey compiled by the Statistics National Institute (Instituto Nacional de Estadística -*INE*) from 2001 to 2003. This survey has been designed in order to provide information about the structure of the innovation process (R&D and other innovation activities). Analysing it, focus can be made on the link between the innovation process and the technological strategy, factors influencing firm's ability to innovate and the economical performance of the companies.

4.2. Results

The aim of this section is to analyze quantitatively the effect of four types of cooperation on the intensity of R&D activities in the Spanish productive sector. The objective is to identify which type of cooperation has a significant influence on the intensity of R&D activity, and in which direction. Four external sources have been selected: 1) customers, 2) suppliers, 3) experts and consultants and 4) universities. Obviously, the first type has been chosen because it corresponds to the kind of agents studied in this paper. The rest because of being the three most frequent interlocutors of the Spanish firms in terms of cooperation according to the Firms Technology Innovation Survey⁵ (INE, 2003), (see Table 6).

⁵ In the previous section the data about Spanish and European firms were entirely obtained from the CIS3 (1998-2000). They considered the percentages of European firms which have actually cooperated with different kinds of agents. In this section, the data source is different and it refers exclusively to Spanish productive sectors, Firms Technology Innovation Survey, realized by INE during 2001-2003. Observed differences can thus be justified by the use of two different data sources in two different periods of time.

Three multivariate regression models have been carried out based on these data. In the first one, the dependent variable is formed by the total innovation activity intensity⁶. The second dependent variable is the intramural R&D intensity (Model 2) and the last one is the extramural R&D intensity (Model 3). In all the three models, independent variables were the four mentioned cooperation agents (customers, suppliers, experts/consultants and universities).

TABLE 6: Innovation cooperation by type of partner, 2001-2003

	Total	%
EIN enterprises with innovation cooperation with:	5.710	100
- Other enterprises within the enterprise group	835	14,6
- Clients	733	12,8
- Suppliers	2.283	40,0
- Competitors and other enterprises in from the same industry	668	11,7
- Experts and consultants	1.095	19,2
- Commercial laboratories and R&D firms	454	8,0
- Universities	1.534	26,9
- Public R&D institutions	673	11,8
- Technological centres	900	15,8

Source: INE, 2003.

* The same enterprise can cooperate with several agents.

The dependent variables were measured using the following criteria. In Model 1, the variable “total innovation activity intensity” was quantified as: (innovation activity expenditures/Turnover) x 100. In Model 2, the dependent variable “intramural R&D intensity” was measured by: (intramural R&D expenditures/Turnover) x100. And at last, in Model 3, the dependent variable “extramural R&D intensity” was quantified as: (extramural R&D expenditures/Turnover) x 100. The results are presented in Table 7.

The models were proved to be valid in the three cases and their results are presented in Table 2. In Model 1, the coefficient of determination (R^2) equals 0,55. This means that a little more than half of the variation of the total innovation activity intensity of the productive sector is

⁶ The term “total innovation activity intensity” is used because it not only considers intramural and extramural R&D activities, but also the effort made on other activities like formation, acquisition of other external knowledge, acquisition of machinery and equipment, market introduction of innovations, design and other preparations for production/deliveries, etc. (INE, 2003). Nevertheless, as the internal and external R&D form the major part of the innovation expenditures (65% of the total expenditures in innovation activities), these are the most interesting data to achieve an individual analysis

explained by technological cooperation. In the same way, the four variables representing the different cooperation types explain the 75,5% of the variation of innovation activity intensity realized through in-house R&D (Model 2) and the 47,2% of the variation of innovation activity intensity realized through external R&D (Model 3).

TABLE 7: Results of multivariate regression models

Type of cooperation	MODEL 1 Total innovation activity intensity	MODEL 2 Intramural R&D intensity	MODEL 3 Extramural R&D intensity
- (Constants)	0,577	0,157	0,016
- Customers cooperation	0,891***	0,443***	0,179**
- Experts and consultants cooperation	-0,143	0,026	-0,002
- Suppliers cooperation	0,076	-0,054	0,016
- Universities cooperation	-0,113	-0,004	-0,008
R²	0,550	0,755	0,472

*, **, *** coefficient statistically significant at a 90%, 95% or 99% level.

These results show that the three models are convenient to explain the effect of different kinds of cooperation on the R&D intensity of the whole Spanish economy, even if it is to be noted that other variables, in addition to cooperation, can also influence on these intensities.

When analyzing the different types of cooperation, it is observed that the only variable with a significant influence on the three models is the relationship with customers. As the standard coefficients are positive in the three cases, the effect of this type of partnership increases the intensity of innovation. This way, it is shown that the higher the percentage of firms cooperating with their customers (in comparison to the total number of firms), the higher the intensity on innovation activities, in general terms as well as in intramural and extramural terms.

5. CONCLUDING DISCUSSION

This paper is about one of the most outstanding subjects in terms of innovation: the sources of idea-generation, and particularly the cooperation with customers. It offers empirical evidence of its importance in the case of Europe and Spain. Up to now, the previous studies have investigated the innovation cooperation with customers in specifically selected firms or

sectors. In contrast, here we have used a wide sample of enterprises which obviously offers a much more representative and objective vision of this phenomenon.

From the descriptive analysis, two major conclusions may be taken. Firstly, the information sources considered important by firms can be clearly classified. On the one hand, it can be concluded that at European as well as at Spanish level the information provided by clients or customers is considered to be one of the most valuable sources for innovative ideas, independently of the size of the firm. On the other hand, when we analyze deeper the various types of agents the firms have had relations with, the clients and customers are shown to be particularly worthy partners, together with suppliers, in industrial sectors as well as in service sectors.

Secondly, the influence of these information sources on innovation activity is shown in the Spanish case. Indeed, only cooperation with customers has proved to have significant influence on R&D intensity according with the regression analyses. It means that the more the firm cooperates with customers, the more intense will be the internal and external efforts to reach the planned objectives. This is indicated by the significantly positive coefficient related to customer cooperation in the three models. Thus, cooperation with customers must be considered as a significant indicator of the weight devoted to innovation activities.

These results get particularly interesting when we consider the literature about this subject. Indeed, previous studies show that the cooperation with clients during the innovation process reduces innovation costs (Herstatt and von Hippel, 1992; Jeppesen, 2002, 2005; Chan and Lee, 2004; Henkel and von Hippel, 2004; von Hippel, 2005). This way, the indicator found in this study could be considered as counter-intuitive because it reflects more R&D investments when the firm collaborates with those stakeholders.

The rationale explanation to this situation is that cooperation with customers can reduce some innovation costs, like for instance prototyping costs or costs related with the identification of client's needs, but not necessarily reduce the global innovation costs. Actually, it would be more correct to speak about a redistribution of expenditures among different activities of the innovation process.

Another reason why client collaboration does not always reduce R&D costs is that customers don't necessarily know the manufacturing processes characteristics and how they operate. This means that their ideas could force to important changes in order to adapt processes to the new design. For this reason, it is important to provide the client with certain training and innovation toolkits in order to let him or her offers valuable, still feasible, ideas for new product generation and design. This technical training obviously also implies costs, and may be part of the explanation of the money redistribution among R&D activities.

Nonetheless, these results are in line with other studies, i.e. companies that have cooperation relationships with external agents also invest more in R&D activities (Colombo and Garrone, 1996; Lillien *et. al.*, 2002; Pérez and Sánchez, 2002; Becker and Dietz, 2004; Pittaway *et. al.*, 2004). It can also be noted that the cooperation with customers can reduce cost related to acquiring market information (Jeppesen, 2005) or the chance to make the wrong bets when companies are investing heavily in new technologies (Tether, 2002). However, if the firm transfers some tasks to customers, it would need to allocate more support to those agents and this implies necessarily more costs (Jeppesen, 2005).

Besides, when firms have effective networks with stakeholders, they require an appropriate infrastructure in which to frame collaborative behaviour and this involves more resources in research and development, hence more R&D intensity (Pérez and Sánchez, 2002; Pittaway *et. al.*, 2004).

As a conclusion, the results of this paper clearly show that firms interested in collaboration agreements with their customers are also those with major interest in innovation activities, and the ones ready to make major efforts to aim their projects.

The empirical analysis also points out that even if the other three agents (suppliers, experts/consultants and universities) are the favourite partners in Spanish productive sectors (INE, 2003), they do not have a significant influence on any of the three studied models. They do thus not have any affect on innovation intensity.

All these results lead to the conclusion that cooperation with customers as a source of information for innovation is a researching area with a lot of potential, permitting a better comprehension of the innovation process and its determining factors.

Some managerial implications can also be derived from this study. Considering the results, Spanish firms should boost cooperation with external agents, and particularly with their customers, for instance by designing special strategies for innovation activities, as virtual communities of users (Franke and Shah, 2002) or contacts with lead users (von Hippel, 1986).

This study is the departure point for a future research agenda. An issue that deserves further attention is whether (and how) those types of collaboration affect the performance and effectiveness of the resulting innovations. It could also be interesting to undertake an empirical analysis with a major number of external innovation sources (competitors, fairs and exhibitions, technological institutions, and so on) and/or consider a long-term period in order to make an in-depth study about the evolution of different cooperation types, and their effects on the transformation of the Spanish productive sectors. A detailed analysis of such collaboration implications should be interesting too.

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APPENDIX 1: Measures of intensities and expenditures in total innovation activities, intramural R&D activities and extramural R&D activities by sectors from 2001 to 2003.

SECTOR	Turnover	Total R&D expenditures	Total innovation activity intensity (%)	Intramural R&D expenditures	Intramural R&D intensity (%)	Extramural R&D expenditures	Extramural R&D intensity (%)
Industrial Sectors							
1. Extractive and petroleum industries	29863,56	176,20	0,59	70,07	0,23	28,21	0,09
2. Food, drinks and tobacco products	71448,98	421,55	0,59	125,12	0,18	36,55	0,05
3. Textile, clothing, leather and leather products	19528,28	466,73	2,39	69,87	0,36	15,68	0,08
4. Lumber and wood products, paper, printing and graphic arts	33787,43	236,51	0,70	54,78	0,16	17,12	0,05
5. Chemical products	42892,07	995,10	2,32	652,68	1,52	202,40	0,47
6. Rubber and miscellaneous plastic products	14520,73	158,28	1,09	72,63	0,50	14,93	0,10
7. Miscellaneous mineral non metal products	26321,75	150,03	0,57	51,60	0,20	23,74	0,09
8. Metallurgy	19878,66	133,19	0,67	47,11	0,24	15,14	0,08
9. Metal industries	26964,30	345,14	1,28	116,07	0,43	18,05	0,07
10. Industrial and commercial machinery and transportation equipment	119713,44	2956,92	2,47	1107,07	0,92	1064,49	0,89
11. Miscellaneous manufacturing industries	11900,00	78,54	0,66	32,94	0,28	10,06	0,08
12. Recycling industries	961,46	8,56	0,89	5,31	0,55	0,72	0,08
13. Energy and water industries	24513,71	85,80	0,35	55,58	0,23	16,22	0,07
14. Construction industries	131492,78	236,69	0,18	72,02	0,05	83,74	0,06
Service Sectors							
15. Trade and hotel trade	359308,06	1113,86	0,31	107,93	0,03	711,09	0,20
16. Transportation and storage	75060,82	547,94	0,73	56,66	0,08	20,55	0,03
17. Communication	39461,93	430,14	1,09	121,21	0,31	108,35	0,27
18. Financial intermediation	131930,00	395,79	0,30	144,27	0,11	67,32	0,05
19. Estate agents` and firm services	112455,06	2001,70	1,78	1412,80	1,26	323,07	0,29
20. Public, social and collective services	34192,11	259,86	0,76	58,96	0,17	17,90	0,05

Millions of euros.

APPENDIX 2: Innovation cooperation from 2001 to 2003 by type of partner and economic sector.

SECTOR	Total enterprises	Enterprises involved in innovation cooperation (%)	Cooperation partner (%)			
			Clients	Suppliers	Experts and consultants	Universities
1. Extractive and petroleum industries	820	2,80	0,12	0,61	0,61	1,34
2. Food, drinks and tobacco products	5881	5,46	0,39	1,92	1,02	1,87
3. Textile, clothing, leather and leather products	6373	3,15	0,24	1,88	0,55	0,27
4. Lumber and wood products, paper, printing and graphic arts	5783	3,34	0,10	1,71	0,35	0,50
5. Chemical products	2171	18,56	3,27	3,04	3,36	8,38
6. Rubber and miscellaneous plastic products	1503	9,05	1,66	1,86	1,26	2,20
7. Miscellaneous mineral non metal products	3703	5,13	0,19	1,76	0,54	1,19
8. Metallurgy	743	11,97	1,08	4,04	1,35	3,50
9. Metal industries	7655	5,28	1,02	2,73	1,18	0,86
10. Industrial and comercial machinery and transportation equipment	7056	10,96	1,98	3,57	2,24	4,28
11. Miscellaneous manufacturing industries	3628	3,75	0,30	0,80	1,21	0,69
12. Recycling industries	120	11,66	6,66	3,33
13. Energy and water industries	358	8,94	0,56	2,79	1,68	6,71
14. Construction industries	35108	0,79	0,01	0,18	0,29	0,27
15. Trade and hotel trade	41189	2,04	0,11	1,20	0,37	0,19
16. Transportation and storage	8482	2,72	0,52	0,93	0,53	0,18
17. Communication	966	6,73	0,83	4,76	1,55	2,28
18. Financial intermediation	1142	10,60	0,26	4,99	3,15	2,63
19. Estate agents` and firm services	20212	4,71	1,15	1,62	0,93	1,85
20. Public, social and collective services	10889	2,80	0,06	1,78	0,06	0,45

* It is possible the cooperation with several agents.