

Cooperation vs. Firm-Based Innovation: A Sectoral Comparison in Portugal

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Abstract: In today's knowledge-intensive economies, the enterprises can have a strong economic and social influence as "market protagonists". Facing today's economic instability they ought to provide a constant stream of innovations to clients. Researchers suggest that firms can reshape the market through their innovations, for which can contribute some external expert knowledge. The process of developing an innovation may imply three types of approach: make; buy or cooperate with other agents to acquire specific competences or knowledge. This last occurs when the firms' internal knowledge or skill-base is not sufficient or effective and is conveniently complemented with external sources. Firms' cooperation, among them or with clients or other stakeholders, and its potential for innovation is not new. In this paper, our aim is to identify the sectors more willing to engage in cooperation initiatives in order to accomplish innovation. Thus, this paper is structured as follows: Introduction; 1. Literature Review (Innovation and its assets; Disclosing the process of innovation; Open innovation; Cooperation for innovation); 2. Research Design (The CIS instrument; Sampling); 3. Results (The nature of the innovation process by sector: cooperation-based vs. firm-based; The scale and scope of cooperation); Concluding Remarks. Using descriptive statistics, the first step will be to identify the sectors more willing to engage in cooperation initiatives in order to accomplish innovation. Secondly, for those sectors a more detailed analysis on the scale and scope of cooperation is developed. For this study a secondary dataset was used from the CIS-2012 (DGEEC, 2014). The CIS, operation acronym in the Eurostat for Community Innovation Survey, is the main statistical survey (mandatory for EU member states) on innovation in companies. The universe contemplates Portuguese companies with 10 or more employees belonging to the NACE codes. The INITIAL sample consisted of 9423 companies. 6840 valid answers were considered.

Keywords: process of innovation, open innovation, cooperation for innovation

1. Introduction

The process of developing an innovation may imply three types of approach: make; buy; or cooperate with other agents to acquire specific competences or knowledge. This last occurs when the firms' internal knowledge or skill-base is not sufficient or effective and is conveniently complemented with external sources. Several studies on innovation support that firm's boundaries require porosity in order to absorb knowledge and capabilities from the external environment. This can provide an extensive variety of ideas, opportunities, sharing of costs and resources. In this paper, our aim is to identify the sectors more willing to engage in cooperation initiatives in order to accomplish innovation. In Portugal, due to the crisis and other factors such as a weak institutional supporting structure ('InnoStruct' - Filippetti and Archibugi, 2011), it is more difficult for enterprises to maintain a competitive advantage only through internal R&D. Given the dynamism and complexity of the environment, enterprises need to complement their internal resources and capabilities with ideas from outside interacting with a wide range of actors. This contribution to internal R&D can give enterprises access to complementary assets, needed to turn an invention into a successful product or service (Teece, 1986). Thus, many firms seek external expert knowledge in order to compete in a dynamic and fast changing market and achieve business success. Regarding these initiatives, it is interesting to analyse if Portuguese firms complement their internal R&D with external sources, and which ones, according to their sector of activity. Thus, this paper is structured as follows: Introduction; 1. Literature Review (Innovation and its assets; Disclosing the process of innovation; Open innovation; Cooperation for innovation); 2. Research Design (The CIS instrument; Sampling); 3. Results (The nature of the innovation process by sector: cooperation-based vs. firm-based; The scale and scope of cooperation); Concluding Remarks.

2. Literature review

2.1 Innovation and its assets

Innovation and its external vs. internal assets are the main subject of this research (cooperation vs. firm-based innovation and sectoral patterns). Innovation is a theme of interest for researchers in different business and

management disciplines such as strategy, information technology, marketing, operations management, entrepreneurship or even engineering and product design. A definition of innovation common to all of these areas is not easy. As Damanpour and Schneider (2006) state, “innovation is studied in many disciplines and has been defined from different perspectives” (p. 216). Addressing this ambiguity, due to a high number and diversity of innovation definitions, Baregheh et al. (2009) proposed both a diagrammatic model and a simple textual definition which mutually acts as a foundation for summarizing the meaning of innovation: “Innovation is the multi-stage process whereby organizations transform ideas into new/ improved products, services or processes, in order to advance, compete and differentiate themselves successfully in their marketplace” (p. 1334). It is important to mention that it can only be considered an innovation when the enterprise develops an invention that is introduced in the market and is commercialized bringing economic return to the firm (Kuznets, 1962).

2.2 Cooperation for innovation

In the process of developing new products/services it becomes essential to perceive the significance wielded by external agents as a source for innovation projects. Nowadays, firms cannot rely solely on their R&D departments as they need to balance internal resources and capabilities with ideas from beyond their boundaries, and interact with a large choice of players within the innovation system. This concept is the main support of the “open innovation” model (Chesbrough, 2003a,b). Open innovation is defined as: “...the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the market for external use of innovation, respectively” (Chesbrough et al., 2006: 2).

The process of developing an innovation normally implies two types of strategy: generate knowledge in-house (make) or purchase it (buy) (Veugelers and Cassiman, 1999), nevertheless, in recent times theorists have detected a third strategy for acquiring knowledge – Cooperation in innovation with other agents (Navarro, 2002).

Strategy authors have demonstrated that agents from outside the enterprise constitute a significant resource in actual competitive framework, especially in the development of new products and processes (Penrose, 1959; Teece, 1984; Barney, 1991; Peteraf, 1993). The enterprise’s intention to cooperate with other agents in innovation activities is impelled by the fact that it is an efficient way to improve the chances of success on the development of differential products or services (Becker and Dietz, 2004; Abramovsky et al., 2005, Sampson, 2007). Besides, enterprises that are highly internally focused, not opening themselves up to external networks and relationships may miss a lot of opportunities (Chesbrough, 2003a; Laursen and Salter, 2006). Hence, in the development of innovations the decision to cooperate with other agents is important (Mowery and Rosenberg, 1989) since it will enhance the enterprise’s learning capabilities. However, literature states that the enterprises performance depends on their ability to locate, absorb and exploit these sources in a productive way (Cohen and Levinthal, 1990). Several factors support the firm’s decision to cooperate considering that it allows to share expenses and uncertainty, exploit synergies, scope or recognize economies of scale, as well as to benefit from government support (Veugelers and Cassiman, 1999; Becker and Dietz, 2004). Given these advantages of cooperation, if the concept of innovation among firms has been introduced in an industry, non-participation will be acknowledged as a competitive disadvantage (Enkel et al., 2009).

The innovation process may involve external sources from different origins, ranging from clients, suppliers, universities, to competitors as well as other agents (von Hippel, 1988, 2005; Powell et al., 1996). Essentially, innovation sources are divided in two types: internal and external. Table 1 shows a more detailed picture of these sources. The internal type comprises the innovation activities carried out within the enterprise: R&D, marketing and production departments. The external are related to: (1) market sources such as customers and users, suppliers (materials, equipment, software, etc.) competitors, consultants and experts, other sources such as commercial laboratories or technological parks, (2) educational and research sources (universities and research institutes) and (3) public available information (conferences, fairs/exhibitions, journal and magazines and patents).

Table 1: Sources of innovation

Internal	External
R&D Department	(1)Market Customers and users Suppliers

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Internal	External
	Competitors Consultants and experts Others
Marketing Department	(2) Educational/Research Universities Research institutes
Production Department	(3) Public available information Conferences Fairs /Exhibitions Journals, Magazines Patents

Source: Own elaboration

It is clear that enterprises have at their disposal a wide range of agents to cooperate in their innovatory effort, yet, decide which one(s) to cooperate with, depend on the ability to identify the type of agent that can better satisfy their internal needs and improve their competitive advantage.

2.2.1 Customers

Customers can be the cooperation agent with greatest impact on the intensity of innovation activities, somewhat because, just like the suppliers, it is vertical or non-competitive cooperation.

The success of product innovations in public sector institutions is also highly related to cooperation with customers (Freel and Harrison, 2006). This external partner is an important source of knowledge because its inputs help firms to identify new ideas about products and solutions (Urban and Von Hippel, 1988), comprehend customers' needs, and identify new market trends in advance (Li and Calantone, 1998). For example high-tech industries benefit from customers contribution particularly to learn about technological trends and develop superior products. (Atuahene-Gima and Ko, 2001; Brettel and Cleven, 2011). Some firms invite customers to participate in the innovation process, most frequently in the design of the next new product, for example, the online Lego DesignbyMe tool (von Hippel, 2005). Regarding complex technologies and / or products this external source provides particularly valuable information (Tether, 2002). The similar principle applies when the product presents a high level of novelty (Amara and Landry, 2005).

2.2.2 Suppliers

The relationship between suppliers is normally considered as vertical or non-competitive cooperation. It is a fact that enterprises have increased their relationships with their suppliers from the eighties onwards mainly because of Japanese car and electronics success relationship in the innovation development (Bidault et al., 1998). According to Håkansson and Eriksson (1993), suppliers are base factors of business. These players can be a source of innovative ideas and critical technologies considering that suppliers have specific knowledge and competencies not to mention that they are always interested in improving relationships with their clients.

In countries like the United Kingdom and the United States, large enterprises that choose to downsize and concentrate on core competences, have increased their collaboration with these agents to guarantee a supply of quality inputs. The high degree of efficiency attained is one of the main reasons for cooperating with suppliers in terms of innovation in new products or processes (Tether 2002; Santamaría and Rialp 2007). Suppliers are also the partners of choice when the enterprise's objectives have a commercial nature, such as entering new markets or internationalization (Santamaría and Rialp, 2007). These agents, just like customers, assist not only the development of products and processes, quality improvement and market adaptation, but also productivity and flexibility (Chung and Kim 2003). Reduction of production cost is another reason to cooperate with suppliers (Atallah 2002), likewise costs and risks involved in new product development (Chung and Kim 2003).

2.2.3 Competitors

Establishing a relationship with competitors is normally referred horizontal cooperation which is not an unusual type of cooperation. Competitors are an external source that can be involved in the innovation process (von

Hippel, 1988, 2005). The knowledge generated by these agents can easily be accessed and exploited by firms that do not hold a high level of internal technological competence (Cohen and Levinthal, 1990).

This type of relationship is quite appealing, considering that it contributes to intensify international competitiveness in enterprises, industries and countries and to solve issues associated to market failures and its technological deficiencies (Harabi, 2002). Relationships with competitors involve, on the one hand a reduction in investment risk and market uncertainty, and on the other, sharing of costs when enterprises initiate their R&D activities (Harabi, 2002). According to Von Hippel, enterprises copy and improve products and processes by learning from their competitors, and through know-how exchange as well (Von Hippel, 1988).

2.2.4 Consultants and experts

Enterprises tend to seek alternative sources of knowledge and information when the development of innovations is affected, in particular when it is not going as fast as needed or does not correspond to the enterprise expectations. In this context, consultants and experts are a suitable solution (Tether, 2002). These agents are a source of specialized knowledge and skills that provide a wide range of valuable inputs for innovation development.

Consultants and experts render possible experience sharing, concerning the definition and articulation of specific innovation needs, offer ideas on new needs and solutions, or even idea transfer among enterprises (Bessant and Rush, 1995). Besides, these agents can bring to the enterprise different points of view, as they are not familiar to the enterprises products and processes, since the enterprise staff can sometimes be an obstacle to new ideas. Thus, the contributions brought by these types of agents encourage a growth in the number of effective innovative ideas (Bruce and Morris, 1998).

2.2.5 Universities and research institutes

The most common form of partnership is cooperation with scientific agents particularly in science-based firms (Castro and Fernández, 2006). Universities and research institutes have a main role in the development of technological innovations contributing to new scientific and technological knowledge (Drejer and Jørgensen, 2005). This type of collaboration does not bring any type of commercial risk, unlike cooperation with competitors, inasmuch as these agents are focused in generating R&D knowledge of a basic or generic nature, and not introducing it in the market (Miotti and Sachwald, 2003). Cooperation with Universities is a way of sharing costs and exploit knowledge which is available to public (Veugelers and Cassiman, 2005).

Universities as well as their research institutes are constantly creating and developing scientific knowledge, thus, as research in firms intensifies and becomes very expensive, specialized academic knowledge is brought to balance and complement the firm's R&D in order to gain access to rising technologies (Tidd and Trewhella, 2002) and achieve technological discovers that lead to viable commercial products (Spencer, 2003).

Probably, one of the reasons why enterprises chose this source may be to benefit from public funds destined to research (Davenport et al., 1999; Cassiman and Veugelers, 2002; Miotti and Sachwald, 2003; Fontana et al., 2006). It is quite usual for policy-makers the encouragement of the relationship between enterprises and research institutes as a mandatory requisite to subsidize projects with public funds.

Although cooperation with these agents is very important, enterprises must have an important in-house R&D capability in order to absorb scientific knowledge generated (Cohen and Levinthal, 1990).

3. Research design

3.1 The CIS instrument and sampling

For this study a secondary dataset was used from the CIS-2012 (DGEEC, 2014). The CIS, operation acronym in the Eurostat for Community Innovation Survey, is the main statistical survey (mandatory for EU member states) on innovation in companies. European Union employs this main statistical instrument to monitor Europe's progress in the area of innovation, which is conducted by national statistical offices. In Portugal, following the methodological recommendations of Eurostat, the CIS aims to directly collect information on innovation (product, process, marketing, and organizational) in companies based in Portugal. Data collection,

corresponding to the period of 2010-2012, was performed between June 3 and March 14, 2014 through an online electronic platform. The universe contemplates Portuguese companies with 10 or more employees belonging to the NACE codes (economic activities, see Table 2). The sample consisted of 9423 companies, based on census combination (for companies with 250 or more persons employed) and random sampling for other companies. Of the 7995 companies of the corrected sample, 6840 valid answers were considered, corresponding to a response rate of 86%.

The CIS instrument provides useful information on how firms interrelated with its surrounding external environment in order to access information considered important for the development of new innovation projects or the completion of existing ones. Firms may use external agents as information sources or engage in more formal cooperation activities, meaning their active participation with other enterprises or institutions on innovation accomplishments.

Table 2 gives the sample distribution by sector in CIS 2012 instrument.

Table 2: Sample distribution by sector

NACE REV3	Description	Number of firms	Percentage
7 – 9	Mining and quarrying	73	1,1
10 – 12	Food, beverages, tobacco	323	4,7
13 – 18	Textiles, wearing, leather, wood, paper, printing	889	13,0
19 – 25	Coke, chemicals, non-metal, metal products	1436	21,0
26 – 27	Computer, electrical equipment, optical product	144	2,1
28 – 33	Machinery, transport equip, furniture	808	11,8
35 – 39	Electricity, gas, water supply, sewerage, waste	284	4,2
42 – 43	Construction	36	,5
46 – 53	Wholesale, retail trade, transportation, storage	1642	24,0
58 – 63	Information, communication	376	5,5
64 – 75	Financial, insurance, legal, accounting, others	735	10,7
86	Health	94	1,4
	Total	6840	100,0

Source: Own elaboration based on CIS 2012 data

3.2 Conceptualisation and research questions

3.2.1 Product (good or service) innovation

The CIS instrument considers that product innovation occurs when a firm introduces to the market a new or significantly improved good or service with respect to its capabilities, technical specifications user friendliness, components or sub-systems. Improved good or service does not need to be new to the market; however it must be new to the firm and it should not matter if it was originally developed by the firm or by other external partners.

It is considered that product innovation occurs if the firm answered positively to one of those two questions in Table 3. In consequence these two variables were transformed into a single variable named product/service innovation (INOV_PRD_SRV) with a 0="No";1="Yes" codification.

Table 3: Variables for product/service innovation

Product/Service Innovation Survey Questions		
Variable	Description	Codification
INPDGD	During the reference period, did your firm introduce new or significantly improved goods?	0 = "No";1 = "Yes";
INPDSV	During the reference period, did your firm introduce new or significantly improved services?	0 = "No";1 = "Yes";

Source: Own elaboration based on CIS 2012 data

3.2.2 Process innovation

Process innovation occurs when a firm implements a new or significantly improved production process, or new and significantly improved methods of supplying services, or supporting activity (in Table 4). Purely organizational or managerial changes are excluded. This innovation does not need to be new to market; however, it must be new to the firm not mattering if it was originally developed by the firm or by other external partners.

Table 4: Variables for process innovation

Process Innovation Survey Questions		
Variable	Description	Codification
INPCME	Did the firm introduce new or significantly improve methods of manufacturing or producing goods or services?	0 = "No";1 = "Yes";
INPCLG	Did the firm introduce new or significantly improve logistics, delivery or distribution methods for your inputs, goods or services?	0 = "No";1 = "Yes";
INPCSU	Did the firm introduce new or significantly improve supporting activities for your processes, such as maintenance systems or operations for purchasing, accounting, or computing?	0 = "No";1 = "Yes";

Source: Own elaboration based on CIS 2012 data

It was considered that the firm really implemented a process innovation if it answered positively to one of those three questions. Therefore, these three variables were transformed into a single variable named process innovation (INOV_PROC) with a 0="No";1="Yes" codification. Innovation rates are given by the ratio between the number of innovative firms (the ones implementing a product or process innovation) and the total number of sample firms.

3.3 The nature of the innovation process

Firms were asked about the way product and process innovations have been developed. To the question: "Who developed the innovation", four possible answers were available: (1) The firm; (2) The firm in cooperation with other firms or institutions; (3) The firm adopting or modifying goods or services originally developed by other firms or institutions; (4) Other firms or institutions. In this paper, our aim is to identify the sectors more willing to engage in cooperation initiatives in order to accomplish innovation, so we distinguish between "Cooperation-based innovators" (firms responding 2) and "Firm-based innovators" (firms responding 1 or 3). Table 5 gives the frequencies for these variables (with a 0="No"; 1="Yes" codification). The percentages indicate the proportion of firms with positive answers.

Table 5: Who developed the innovation?

Who developed the innovation:	Product Innovation		Process Innovation
	Goods	Services	
(1) The firm	19.4%	14.3%	26.0%
(2) The firm in cooperation with other firms or institutions	10.3%	9.2%	18.7%
(3) The firm adopting or modifying goods or services originally developed by other firms or institutions	5.3%	5.2%	6.7%
(4) Other firms or institutions	3.2%	3.5%	6.5%

Source: Own elaboration based CIS 2012 data

Table 6: Cooperation-based vs firm-based innovation

	Innovation rate	Coop-based innovation	Firm-based innovation
Product Innovation	33%	16%	28%
Process Innovation	40%	19%	29%

Source: Own elaboration based on CIS 2012 data

In relative terms, we note a slight tendency for process innovation rely more on cooperation (but the association is not significant according to the chi square test).

The review of the literature suggests the importance of external linkages, recognizing that small firms are frequently fragments of extended networks with different possible partners and geographic scales. By accessing other markets, assets and economic agents, firms not only release themselves from the limits of local and internal competences, but are also aware of new and more demanding market conditions that constitute a stimulus to innovation. In the scope of the present paper, a sample of Portuguese firms from CIS 2012 was used. Firms' cooperation dynamics were assessed by observing their behaviour regarding the use of partners of cooperation for the development of innovative activities. According to these considerations, the following research questions were addressed in this paper:

RQ1: Which sectors are more willing to engage in cooperation initiatives in order to accomplish innovation?

RQ2: Which is the scale and scope of the cooperation developed?

4. Results: A synopsis

4.1 The nature of the innovation process by sector: cooperation-based vs. firm-based

Based on the previous conceptual framework, the following figures provide a visual diagnosis on the nature of the innovation process, by sector. Besides identifying the sectors more willing to engage in cooperation initiatives in order to innovate, these graphics also allow to compare the nature of the innovation process (firm-based or cooperation-based) by sector and the nature of innovation (product or process).

Regarding product innovation (Figure 1) the results show a slightly inferior incidence of cooperation-based innovation when compared to firm-based innovation, regardless the sector. Firms tend to be more cautious and reluctant to cooperate when it concerns the exposure of potentially profitable new products (Tether, 2002).

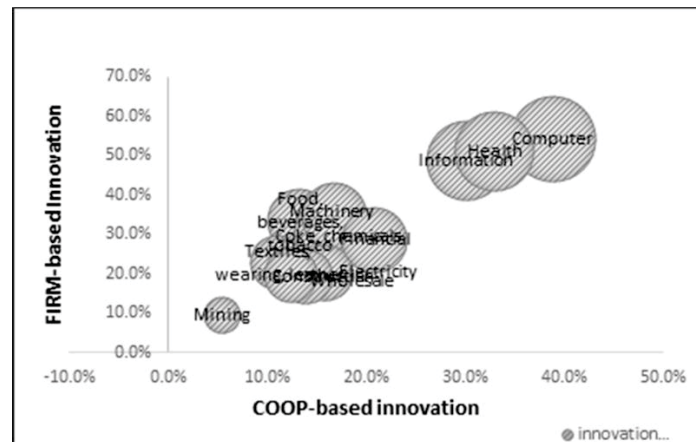


Figure 1: Product innovation: cooperation vs. firm-based innovation by sector

Bubble size based on product innovation rate

Source: Own elaboration based on CIS 2012 data

A slightly different sectoral behavior is observed when considering process innovation (Figure 2). The health sector is, in this case, the one with a higher incidence of cooperation-based innovation, but contrarily to what happens with product innovation, in the case of process innovation this sector presents slightly more innovative initiatives based on cooperation than firm-based ones. This pattern applies, in minor degree, to construction industry. Firms tend to be more open to collaborate with others when there is no new product involved (Tether, 2002; Cassiman and Veugelers, 2002).

4.2 The scale and scope of cooperation

A higher sectoral desegregation level allows us a better understanding of different sectoral behaviours across the sample. The results show that computer, civil engineering, retail trade, insurance, R&D and human health stand out as the sectors more willing to cooperate when innovating (Table 7). According to the design of CIS, firms may cooperate with different partners: Other firms from the group; Suppliers; Customers; Competitors; Consultants; Universities and R&D Labs. Also, the geographical scale of cooperation may vary, as cooperation can be developed with Portuguese partners, European partners, USA, China/India or others.

In general, these selected sectors cooperate especially with universities, R & D Labs, private suppliers and customers. We must, however, refer to the primacy given by “Computer, electrical equipment, optical products” sector to R & D Labs, the “Civil Engineering” sector to Universities, the “Retail” sector to other group companies, the “Insurance” sector to competitors (possibly within business associations). The R&D sector shows a pattern very similar to the Computer sector. The “Health” sector is a supplier dominated sector, with an inherent opening to the public sector as well as a higher propensity to academic collaboration.

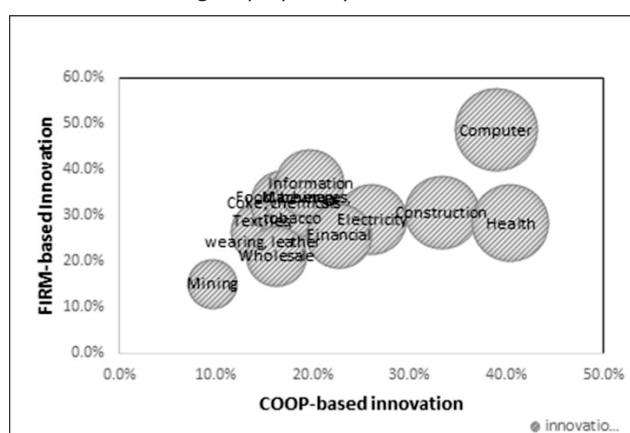


Figure 2: Process innovation: cooperation vs. firm-based innovation by sector

Bubble size based on process innovation rate

Source: Own elaboration based on CIS 2012 data

Table 7: Cooperation-based vs. firm-based innovation by sector

NACE code	Sector	Product Innov	Process Innov	Prod Innov - Coop based	Proc Innov - Coop based	Prod Innov - Firm based	Proc Innov - Firm based
26	Computer manufacturing, electronic and optical products	73,6%	67,9%	45,3%	41,5%	62,3%	50,9%
42	Civil engineering	24,0%	56,0%	12,0%	40,0%	16,0%	32,0%
47	Retail trade, except motor vehicles and motorcycles	46,7%	73,3%	46,7%	46,7%	40,0%	60,0%
65	Insurance, reinsurance and pension funding, except compulsory social security	72,7%	67,3%	50,9%	47,3%	58,2%	49,1%
72	Scientific research and development	63,3%	56,7%	40,0%	30,0%	56,7%	46,7%
86	Human health activities	53,2%	54,3%	33,0%	40,4%	51,1%	38,3%
62	Consultancy, computer programming and related activities	64,6%	52,2%	30,4%	21,1%	63,4%	48,4%

Source: Own elaboration based on CIS 2012 data

5. Brief review of findings

The first research question was to identify the sectors more willing to engage in cooperation initiatives in order to accomplish innovation. Regarding product innovation the data reveal an inferior incidence of cooperation-based innovation (when compared to firm-based), regardless the sector. Firms tend to be more cautious and reluctant when it concerns the exposure of core ideas and projects (Tether, 2002). In process innovation, the health sector has higher incidence of cooperation-based innovation, followed by construction. Often, process innovation is confused with incremental innovation, a reason why these firms tend to be more open to share or interact with external partners.

The second research question referred to the scale and scope of that cooperation. The R&D, Computer and more scientific sectors cooperate with universities and labs. The Retail sector with other firm group, and the Insurance with competitors. And the Health sector is a supplier dominated sector. We acknowledge a traditional set of cooperation partners according the major sector's dependences for core activities. Some innovation trends are emerging from combinatory innovations, among which are the inter-sectoral creations. Portugal is less mature on this kind of innovation, thus its cooperation patterns are more inner-sectoral.

6. Concluding remarks

The theoretical framework of this paper clarified the current and future importance of cooperation for innovation, implemented at the level of customers, suppliers, competitors, consultants and experts, universities and research institutions.

The brief presentation of some results for the Portuguese economy served primarily to show the interest of this type of analysis, namely, in establishing a diagnosis that may support innovation public policies.

An introduction of analytical data analysis methods (like factor analysis, structural equations and CHAID analysis) to assess the influence of the external environment (information sources and cooperation agents) on the two different types of innovation (product/service and process), will help disclosing further economic, financial, managerial and organisational distinctive innovation aspects. That is the purpose of the current and upcoming work.

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