Public funds and internal innovation goals as drivers of open innovation practices: A European regional comparison

Abstract.

Open innovation (OI) has demonstrated to be crucial in increasing firms' innovation and economic performance, but there is still limited understanding about the drivers of inbound OI. Our main goal is to shed light in this direction by simultaneously analysing the firms' internal and external drivers of formal and informal OI practices. In order enrich the analysis and to obtain more robust results we test our hypotheses on samples from two European regions, Navarre (Spain), classified an innovator follower, and Noord Brabant (Netherlands), an innovator leader. Results indicate that, for the internal drivers, product-related motives to innovate and in-house R&D intensity are strong drivers for both formal and informal OI engagement, while process- and environmental-related motives are context dependent. As for the external drivers we observed that public policy influences the formal and informal OI adoption but effects vary across regions depending on origin of funds

Fondos públicos y objetivos internos de innovación como determinantes de las prácticas de innovación abierta: una comparación regional europea

Resumen:

La innovación abierta (IA) ha demostrado ser crucial para aumentar la innovación y el desempeño económico de las empresas. Sin embargo todavía existe una comprensión limitada de los factores que impulsan realizar esta IA. Nuestro objetivo principal es arrojar luz en esta dirección al analizar simultáneamente los determinantes internos y externos que llevan a las empresas a realizar prácticas formales e informales de IA. Para enriquecer el análisis y obtener resultados más robustos contrastamos nuestras hipótesis con muestras de dos regiones europeas, Navarra (España), calificada como región seguidora en innovación, y Noord Brabant (Países Bajos), líder innovador. Los resultados indican que, para los determinantes internos, los motivos relacionados con la búsqueda de innovaciones en producto y la intensidad interna de I + D son fuertes impulsores para todas las prácticas de IA, mientras que la importancia de los motivos relacionados con la obtención de innovaciones en proceso y medioambientales dependen del contexto regional. En cuanto a los factores externos, observamos que la política pública influye en la adopción de IA tanto formal como informal, pero estos resultados varían entre las regiones dependiendo del origen de los fondos.

Palabras clave: Determinantes de innovación abierta, motivos para innovar, fondos públicas y comparación regional

Fundos públicos e objectivos internos de inovação como determinantes das práticas abertas de inovação: uma comparação regional europeia

Resumo:

A inovação aberta (IA) provou ser crucial para aumentar a inovação e o desempenho económico das empresas. No entanto, ainda há uma compreensão limitada dos fatores que conduzem essa IA. Nosso principal objetivo é lançar luz nessa direção, analisando simultaneamente os determinantes internos e externos que levam as empresas a realizar práticas de IA formais e informais. Para enriquecer a análise e fortalecer os resultados, contrastamos nossas hipóteses com amostras de duas regiões européias, Navarra (Espanha), classificada como seguidor de inovação, e Noord Brabant (Holanda), líder inovador. Os resultados indicam que, para os determinantes internos, os motivos relacionados à busca de inovações no produto e na intensidade interna de P & D são fortes impulsionadores para todas as práticas de IA, enquanto a importância dos motivos relacionados à obtenção Inovações em processo e ambientes dependem do contexto regional. Em relação aos fatores externos, observamos que a política pública influencia a adoção de IA formal e informal, mas esses resultados variam de acordo com as origens dos fundos.

Palavras-chave: Determinantes da inovação aberta, razões de inovação, fundos públicos e comparação regional

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1. Introduction

Traditionally, firms have innovated by looking inside the firm for new ideas, technologies, products and processes that could give them a sustainable competitive advantage. The limitation of these exclusively internal activities is that firms might miss out on ideas, knowledge and technology that are located beyond their boundaries. Some firms are aware of these limitations and have changed from a closed innovation strategy to an open innovation strategy (OI, hereafter).

The concept of open innovation has been split up into two main types of activities (Chesbrough and Crowther, 2006), inbound and outbound open innovation. Outbound activities are defined as the flow of knowledge which goes from inside to outside the firm, for example patents, licenses, and start-up companies creation (Huizingh, 2011).

Inbound open innovation comprises exploring knowledge through integration of ideas, the acquisition of patents and other technologies and joint development of innovation processes through alliances and partnerships (Gassmann and Enkel, 2004) such as customers, suppliers, competitors, and research institutes. The interactions with these partners include actions such as innovation co-creation through alliances and collaborations (formal OI) and knowledge exploration through sourcing ideas and expertise (informal OI) (Faems et al., 2010; Bianchi et al., 2011). Although some authors indicate that these two mechanisms are essential to understand and measure OI practices (Dahlander and Gann, 2010), the literature has not systematically investigated whether the drivers of OI adoption vary depending on whether the interaction with external agents is formal or informal.

On the other hand, although the literature has studied the different external and internal drivers (van de Vrande et al., 2009; Schroll and Mild, 2011; Gassmann and Enkel, 2004, Eberberger et al., 2011 among others), a main drawback of previous studies is that they have

analysed one single industry (e.g. Howells et al., 2008), a specific type of firm (e.g. Mortara and Minshall, 2011) or a single region (e.g. Van de Vrande et al., 2009). As Keupp and Gassman, (2009) argue, studies comparing OI behaviours in different geographical locations are need.

In this context, the goal of this research is to shed light in understanding the drivers of formal and informal OI by simultaneously analysing the firms' internal and external drivers. Furthermore we consider that the adoption of OI can be context dependent (Ebersberger et al., 2011) because great differences exist due to cultural heterogeneity (Muruveca and Prodan, 2009) and the different industrial conditions, public funding policies, and national innovation systems (Reinstaller and Unterlass, 2011; Kafouros and Forsans, 2012). For this we conducted the study in two European regions, Navarre (Spain), classified an innovator follower, and Noord Brabant (Netherlands), an innovator leader (Hollanders et al. 2012). We consider that a regional study suits better since OI is boosted by the existence of networks that are stronger at regional levels rather than national ones (Crescenzi and Rodriguez-Pose, 2011).

Definitely, technological and market opportunities depend on the region and country state of development. In this regard, firms from more innovative countries and regions could be more open as they might have more potential technology/knowledge partners and benefit from geographical proximity due lower costs of accessing information locally (Romer 1987; Krugman 1991). On the other hand, firms from less innovative countries and regions will need to open to foreign markets to be able to acquire the needed technology and knowledge to successfully compete.

Therefore, our study presents significant implications for the body of knowledge on inbound OI. First, while most of the literature has focussed on one single type of OI practice, we distinguish between formal and informal inbound OI practices. Moreover, we will analyse the

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internal and external inbound OI drivers simultaneously, by focusing on reasons like achieving product innovation or process innovation motives for innovation activities, internal R&D intensity and size, and analysing the role that different sources of public funding and sector have as a determinant of formal and informal OI adoption. Second, we will test our hypothesis on two samples coming from two different European Regions, This allows us to observe whether the adoption motives of the OI practices are robust independently from the firms' location or if they vary across regions due to context dependence. We perform our research by means of the Community Innovation Survey (CIS) 2008 for manufacturing and service firms based in the above-mentioned regions.

The paper is structured as follows. In the second section, we present the theoretical framework and propose the hypotheses. A comparison between the two regions analysed is presented in the third section. The fourth section presents the methods used while the results and discussion are shown in the fifth section. Conclusions are reserved for the sixth section.

2. Theoretical Framework

Inbound OI has proven to be an effective strategy to increase firm performance. Tomlinson (2010) found that inter-firm collaboration with suppliers, buyers and competitors fosters the realisation of product and process innovations. Laursen and Salter (2006) also observed a positive effect of OI on firm innovative performance, although too much OI has a negative effect. But, why do some firms decide to go open, while others prefer to stay closed?

2.1 Internal drivers

Offensive motives

The resource-based view (RBV) stresses that firms might be willing to open their boundaries in order to fill gaps in their knowledge, and look for complementary resources, (Cruz-Cázares et al., 2013), reduce risks (Bayona et al., 2001; Keupp and Gassmann, 2009) or as a response

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to innovation impediments, such as lack of capabilities or information access (Mortara and Minshall, 2011). Other studies argue other type of reason for engaging OI related with the goals of innovation activities, denominated *offensive motives*. In this set of reasons were found achieving product innovation (Chiaroni, et al., 2009; Bigliardi and Galati, 2013) or process innovation (Gassmann and Enkel, 2004), keeping up with current market developments (Van de Vrande et al., 2009), obtaining complementary resources to commercialise innovations (Bayona et al., 2001), developing breakthrough technology and creating a new company image (Mortara and Minshall, 2011).

Achieving product innovation or process innovations can be one of reasons to the implementation of informal OI practices. As Gómez et al. (2016) found that external sources of knowledge play an important role in producing product or process innovations. Firms know they may benefit from their customers and suppliers' ideas and innovations by proactive market research, providing tools to experiment with and/or develop products similar to the ones that are currently offered, or by producing products based on the designs of customers and evaluating what may be learned from general product development (Van de Vrande et al., 2009). Even informal ties of employees with employees of other organizations are crucial to understand why products are created and commercialized (e.g. Chesbrough and Crowther, 2006). Therefore, firms seeking product or process innovations rely on informal OI practices.

Furthermore, due to the circular or interactive nature of the innovation process it is increasingly necessary for firms to work formally with other organisations in order to carry through their research and development initiatives, formal OI. Literature has indicated that in mature sectors establishing a new range of products, or substituting the existent ones, can motive establishing cooperation agreements (Hagedoorn, 1993, Bayona et al., 2001). Formal OI (i.e. cooperation agreements) also gives companies access to larger domestic and foreign

markets, thereby improving their expectations of recovering their investment. Besides, reasons linked to processes innovations (i.e. standardization, production flexibility, increase in quality, reduce their production costs, etc.) can also encourage cooperation agreements (Bayona et al., 2001), As a result we believe that firms' motivations to innovate both influence formal and informal OI practices.

H1. Offensive motives to innovate are positively associated with formal and informal inbound open innovation practices

In-house R&D intensity

It is important to highlight the fact that the OI approach does not lead firms to rely exclusively on external knowledge, but rather to combine it with their own. Several authors (Chesbrough, 2003; Berchicci, 2013) describe OI as engagement with, not total reliance on, external sources of knowledge. Firms that depend entirely on external sources and partners may lack internal R&D activities of their own and, thus, the ability to fully capture and assimilate external knowledge would be diminished.

Absorptive capacity stresses the complementarity between the open and closed strategies (Cohen and Levinthal, 1990). Abecassis-Moedas and Mahmoud-Jouini (2008) define absorptive capacity as the firm's ability to recognise the value of external knowledge and to assimilate and apply it to commercial ends. Although some studies hold that external knowledge can be acquired easily (Arrow, 1962), other authors (i.e. Cohen and Levinthal, 1990) propose that knowledge spillovers come at a cost to the recipient. That is, firms must invest resources to absorb knowledge spillovers (Lim, 2009). It is through in-house R&D activities that firms enhance their opportunities to scan and integrate external knowledge (Arora and Gambardella, 1990; Laursen and Salter, 2006) In this sense Kim et al. (2016) state that technological search and knowledge sourcing have internal aspects: Units may scan the

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internal environment for potentially useful knowledge. These sources of knowledge can be both external sources for new ideas (*informal open innovation*) and cooperation agreements (*formal open* innovation) with suppliers, customers and other external actors.

Barge-Gil (2010) states that internal R&D is a variable that explains OI engagement and that owing to the fact that internal R&D enhances absorptive capacity, those firms that perform internal R&D are able to reduce the cost of both formal and informal OI practices. Keupp and Gassmann (2009) found positive and significant effects of R&D intensity on informal OI, and Laursen and Salter (2014) found a positive relationship between R&D intensity and informal and formal OI practices.

From these points of view, internal effort in R&D increases the propensity to adopt OI practices.

H2. In-house R&D intensity is positively associated with formal and informal inbound open innovation practices

Firm Size

Some authors as Spithoven et al. (2013) argue that formal and informal OI practices are highly relevant for SMEs. Owing to their limited technological resources, they have a strong incentive to adopt OI practices and search for ideas and alternative options to innovate, generate economies of scale, reduce risk, and market their products. External search or informal practices can be seen as a form of soft openness, involving activities without the necessity of enter into legally binding agreements (Laursen and Salter, 2014) and then being an accessible practices for SMEs. However, formal OI practices come with significant pitfalls and costs, which are even more significant for SMEs. Formal OI requires the firm and their external partners to adhere to an agreed structure for the exchange, it can be described as a hard form of openness and it is more problematic for managers (Laursen and Salter, 2014). Firms sometimes fall into searching for external knowledge too much, which can result in an

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excess of ideas eventually leading to time and management problems affecting innovative performance (Laursen and Salter, 2006). When the number of partners is high and the complexity of an alliance portfolio increases, the firm will have to use more resources to manage this alliance (Hoffmann, 2005). As noted by Faems et al. (2010) the adoption of a diverse technology alliance portfolio requires a wide variety of alliance management skills that SMEs often do not possess e.g. hiring dedicated alliance managers.

On the other hand empirical studies confirm that most of inbound open innovation adopters are large firms (Keupp and Gassman, 2009; Van the Vrande, 2009; Bianchi et al., 2011) and some of them have found that firm size influences firms in engaging in formal OI practices (Bayona et al., 2001; Fritsch and Lukas, 2001; Tether, 2002). Increasing firm size is associated with an increasing number of external knowledge receptors and the diversity of internal competences which can be allocated in cooperation agreements (Ebersberger et al., 2011).

From these perspectives, we consider that firm size increases the propensity to adopt formal OI practices.

H3. Firm size is positively associated with inbound, formal open innovation practices

2.2 External drivers

Next to the internal factors shaping the innovative behaviour and innovative strategy there are external factors too. Damanpour and Schneider (2009) argue that a firm's innovation strategy is shaped by pressure from environmental factors such as competition, deregulation, scarcity of resources and customer demand. Most of these factors will be controlled in our study because we study two different regions, as reflected in section three.

In this section we centred our arguments on two external drivers: public funds and sector..

Public funds for innovation

When firms are not able to appropriate the returns of innovations due to market constraints, private investment is hindered; that is, the market fails (Arrow, 1962). This condition provides a rationale for government intervention aiming to raise innovation activities. There are different but complementary categories of policy instruments (Ebersberger et al., 2011) affecting OI practices. Some instruments predominantly involve measures to increase intramural R&D efforts enhancing the stock of basic knowledge that is available in the innovation system while other instruments are focussed to establish linkages between a given economy, other economies and international innovation networks more broadly (Ebersberger et al., 2011), namely formal OI practices. Therefore, public policy plays a critical and direct role in the adoption and effectiveness of formal OI. The policy incentives will facilitate the knowledge transfer through networking, collaboration and IP management (De Jong et al., 2010).

Public funding is among the most used policies to incentivise innovation behaviour, and some empirical evidence exists about the role of public funding on formal OI adoption. For example, some surveyed firms participating in public programmes strengthened their networks and collaboration with other firms (Georghiou and Clarysee, 2006). Some researches (Ebersberger et al., 2011; Bayona-Sáez et al., 2013) found that public funding for R&D is not only a factor influencing firms' decisions to undertake R&D activities but it is also a factor that determines firms' choice of R&D strategy.

Regarding formal OI practices, some differences are observed depending on funding origin. While state funding programmes have several goals including promotion of cooperation, a feature that distinguishes European funds like the Framework Programme or Eureka Programme is promoting only cooperative innovation, finally the range of regional government programmes is very wide and very difficult to generalise (Bayona-Sáez et al. 2013).

Ebersberger et al. (2011) with a European countries sample observed that national funding increases domestic vertical and science system collaboration at the country level, but positive and negative effects are detected at industry level. These authors also found that national public funding predominately broadens the formal OI of medium and large firms, and the positive impact of EU funding on collaboration in general is demonstrated throughout all firm size groups.

Consequently, and based on the previous theoretical arguments and empirical evidence, we expect public funding to be positively related to formal OI activities.

H4: Public funding (regional, national or European) is positively associated with formal inbound open innovation practices

Sector

Another external key driver of the adoption of OI is the industry to which the firm belongs. In this sense, Gassmann (2006) argues that industries characterised by high levels of globalisation, technology intensity, technology fusion, new business models, and knowledge leveraging are better suited to the adoption OI practices.

Studies in manufacturing firms are more frequent. OI adoption is associated with high-tech manufacturing firms as they are struggling with high technological changes and high product complexity. Therefore, they are not able to do everything in-house and require external sources of technology and knowledge. Cruz-Cázares et al. (2013) showed that firms in high-tech manufacturing are more prone to combine internal and external R&D than merely to do in-house R&D. However, Chesbrough and Crowther (2006) argued that OI is a strategy used beyond high-tech manufacturing firms and has spread to more traditional and mature industries. Mortara and Minshall (2011) observed that low-tech manufacturing firms focus primarily on inbound OI. Additionally, manufacturing firms with high product modularity

where explicit knowledge is required tend to adopt OI practices, independently of the technological intensity (Gassmann and Enkel, 2004).

Despite the research performed on OI, the cooperation practices and external information sources of service firms remain under-investigated (Tether and Tajar, 2008). Prior research indicates that service firms innovate in different ways and to different extents than manufacturing firms do (Evangelista, 2006). Chesbrough (2011) argues that differences are present in the OI framework since the client plays a different role in service firms than he does in manufacturing ones. Due to the intangible nature of the service, the client needs to have a co-creation role in the service provided, leading to a close participation in the innovation process. Service firms rely heavily on information and communication technologies and non-R&D expenditures and seem to use more external knowledge sources than manufacturing (Tether and Tajar, 2008). As Mina et al. (2014) explain the intangible nature of services does not favour highly contractual solutions and their interactive nature promotes relational solutions favouring informal over formal arrangements.

As a result of the above argued, we formulate the following hypothesis.

H5. Manufacturing sector is positively associated with formal inbound open innovation practices

3. A regional comparison between Navarre and Noord-Brabant

The geographical context shows Navarre as a small autonomous region located in the north east of Spain, sharing a border with the south of France. It is a small region with a population of 620,000 people, but with a dynamic economy and an estimated GDP per capita of €28,000, which makes Navarre one of the wealthiest regions in Spain and the 38th EU region in terms of income per capita. In the decentralised system of the Spanish state, Navarre has the most

progressive and wide-ranging powers of all the Spanish regions when it comes to the design and implementation of public policies on a variety of fields, including innovation policy. Navarre's Regional Innovation Strategy 2008-2011, the overall goals of which are consistent with the Lisbon Agenda, mainly focuses on two specific priorities: support for collaborative policies in the fields of research, technology development, and innovation, and the internationalisation of the regional innovation system. In this regard, the Navarre RIS clearly fits with the concepts and actions stressed in the OI approach.

The Noord-Brabant region covers the south east of the Dutch province Noord-Brabant and is also called Brainport Region Noord-Brabant. It has about 740,000 inhabitants. With the city Noord-Brabant as its core, the Noord-Brabant region is the hub of a network stretching out across the South-East Netherlands and the Dutch borders. The region has a GDP per capita of €35,500 (2010) and is number one in Europe for patenting. According to the Intelligent Community Forum (ICF) it was the world's smartest region in 2011. The Noord-Brabant region is a breeding ground for innovation and the home base of world-class businesses, knowledge institutes and research institutions. It focuses on areas such as high tech systems and materials, automotive, and design. Although the region has its own innovation agenda, it is strongly embedded in the national system of innovation. Together with the Amsterdam and Rotterdam regions, Noord-Brabant region is an important pillar of the Dutch economy.

The Regional Innovation Scoreboard 2012 (Hollanders et al., 2012) provides a comparative assessment of innovation performance across regions of the European Union with the objective of informing policy priorities and monitoring trends. Twelve indicators are considered in the study, which range from 0 to 1, where 1 represents the highest performance. Based on a cluster analysis the authors have identified four archetypes of regions classified as leaders, followers, moderate and modest. The Noord-Brabant region is classified as innovator leader while the Navarre region is perceived as an innovator follower.

In order to have a profound understanding of these regional differences, we present in Figure 1 the values of ten items analysed in the Regional Innovation Scoreboard. As has been noted, the greatest difference between them is on EPO Patents, where Noord-Brabant has the maximum value. It is also in a considerably better position than that of Navarre in terms of technological and non-technological innovations, SMEs innovating in-house, and in R&D and non-R&D expenditures. It also seems to be more open than Navarre, since the values for private-public publications and SME collaboration are higher. On the other hand, Navarre presents firms with larger percentage of sales due to innovative products, and the government intervenes more in terms of R&D expenditure although the differences are small in relation to Noord-Brahan. In summary according to Figure 1, Noord-Brahan presents a more open and innovative profile than Navarre

(Insert Figure 1 over here)

Based on Figure 1 and following the arguments of Romer (1987) and Krugman (1991), we could expect that Noord-Brabant firms would be more open, since they are more innovative and have more potential collaborators. However, Navarre firms could be prompted to open since they require access to other markets in order to acquire the technology required.

4. Methods

As argued in the theoretical framework, the explanatory variables of informal (breadth) and formal (cooperation breadth) inbound OI practices are innovation motives (i.e product-, process- environmental-related motives), internal R&D, firm size, public funding, and industry. In order to observe whether geographical context affect the drivers of OI practices we estimate separate models for each of the regions in our sample.

The estimates have been carried out by means of a negative binomial regression. As shown below, the dependent variables (outcome OI) are count variables. Count data have traditionally been estimated using the Poisson regression, which assumes that the variance equals the mean of the dependent variable. In the absence of overdispersion, when the variance exceeds the mean, the Poisson model fits well, but if overdispersion exists, estimates may be biased. The negative binomial regression is an alternative, since it follows a Poisson distribution but assumes that unobservable heterogeneity exists (Arocena and Núñez, 2009).

4.1 Sample selection

The data analysed has its origins in Community Innovation Surveys (CIS), which are produced in 27 Member States of the European Union. In order to ensure comparability across countries, Eurostat, in close cooperation with the EU Member States, developed a standard core questionnaire for the CIS 3, with an accompanying set of definitions and methodological recommendations. The CIS 3 is based on the Oslo Manual, which gives methodological guidelines and defines the concept of innovation. In the Netherlands the Statistics Netherlands (CBS) and in Spain, the National Institute of Statistics (INE) provided the data for this study.

The sample selected includes manufacturing and service firms that completed the CIS for the year 2008. Although Eurostat gives guidance and recommendations on methodological issues and a standard core questionnaire, each National Statistical Office has the autonomy to introduce modifications to the CIS. The main difference between Noord-Brabant and Navarre regions is that the former considers less innovation information sources and partners for cooperation.

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In order to avoid any bias in the sample selection we included all firms in the analysis, both innovative and non-innovative firms, and no discrimination was made for large or small firms, or for firms belonging to a certain industry (Fritsch and Lukas, 2001). The final Navarre sample consisted of 1,288 observations, and the Noord-Brabant sample consisted of 623 observations.

4.2 Variables

Dependent variables

As argued before, the aim of this paper is to understand firms' internal motivations to engage in formal and informal inbound OI practices. To measure informal OI relationships, we use the breadth of information sources for innovation (Laursen and Salter, 2006). Breadth accounts for the number of external information sources on which the firm relies in its innovative activities. In order to measure formal OI practices, we use the breadth of the cooperation agreements, which represents the number of external agents with whom the firm cooperates.

Based on the CIS survey, we identify nine different agents that serve as information sources: suppliers, clients, competitors, consultants or R&D private institutes, universities, public research centres, conferences, scientific journals, and industry associations[1]. Therefore, by adding up the number of sources used, the Breadth variable ranges from 0, where no source is used (totally closed), to 9 when all sources of information are used (totally open).

The survey asks also whether the firm has carried out innovation projects in collaboration with other agents, and, if so, what type of partner was involved. To emphasise the mutually interactive nature of cooperative innovation, the questionnaire explicitly describes it as

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[1] For Navarre the CIS provided ten different external information sources. These are the same as for Noord-Brabant, but consultants and private R&D institutes are considered independently. Therefore, in order to ensure comparability in the model estimation, we previously merge these two variables into one and ended up with nine information sources.

"active participation with other enterprises or non-commercial institutions in innovation activities". This excludes mere contracting-out of work with no active cooperation. Potential partners include firms within the group, suppliers, customers, competitors, research institutes, universities, and governmental institutions. The methodology for creating the formal Cooperation Breadth variable is similar to that of informal breadth. The range of cooperation breadth is from 0 to 7^2. A firm cooperating with the seven different partners is assigned a score of seven while a firm with no cooperation agreements for innovation would be marked as zero.

Independent variables

As mentioned earlier, inbound OI adoption depends on firm internal circumstances and external drivers. In this regard, we include in our model both internal and external variables.

Internal drivers

As already stressed, we have special interest in analysing the effect of the offensive motives that stimulate firms to open their boundaries. In addition to motives related to product and process innovations the CIS includes information on issues related to the environmental innovations. Therefore, three variables account for offensive motives: product-, process-, and environment-related motives. The variables are composite, owing to the adding of a set of variables together[3]. The items used to create our offensive motive variables concern CIS questions about the reasons that drive the engagement in innovation activities[4]. For the two

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[2] Similar to the information sources, the CIS for Navarre, considered 8 cooperation partners, the same as Noord-Brabant plus consultants. In order to ensure comparability we merge this partner with research institutes.

[3] We perform the analysis using composite variables instead of the original set of items for two reasons. First, each item within a set of items is highly correlated with the others and this would cause severe multicollinearity problems in the model estimation. Second, composite variables allow us to compare the innovation motives equivalently for both Noord-Brabant and Navarre.

[4] Navarre included more items but were not included in order to ensure comparability results against Noord-Brabant.

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samples the Cronbach's alpha statistic[5] are presented in Table 1. This table also shows how the composite variables relate to the original items.

(Insert Table 1 over here)

As for the in-house R&D intensity variable, we include a measure for the percentage of total innovation expenditure allocated to in-house R&D activities, which includes current and capital costs. Finally, firm size is the last internal variable used, and is measured as the natural logarithm of the number of employees.

External drivers

We use the following question included in the CIS in Noord-Brabant and Navarre to measure public funding: "*During the three years 2006 to 2008, did your enterprise receive any public financial support for innovation activities from the following levels of government? a) Regional, b) National, c) other, such as EU.* As a result, we encompass three dummy variables (1, when the firm received the funds, 0 otherwise) accounting for the three possible sources of public funds.

Finally we include the variable manufacturing that takes the value of 1 if a firm belongs to this type of activity and 0 otherwise.

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[5] Statistics are available in Appendix A. As observed, the lowest is 0.691 (product-related motives for Eindhoven) while the largest is 0.942 (environmental-related objectives for Navarre). The rule of thumb is the desirable reliabilities should be larger or equal than 0.7. In our case, the lowest value is too close to this cutoff. Further, Churchill et al. (1984) suggested that a value lower than 0.6 is undesirable.

5. Results & Discussion

5.1 Descriptive results

Table 2 presents the percentage of innovative firms – those achieving product and/or process innovations – according to sector and firm size. In our samples Navarre firms are more innovative than their counterparts (47% vs. 38%)[6]. The common innovation behaviour is observed in both samples, where manufacturing and large firms are more innovative than their peers.

(Insert Table 2 over here)

Table 3 shows the descriptive results of the variables used in our model. As observed, Navarre seems to be more open in terms of informal activities, that is, breadth of the external sources of innovations. In Navarre, firms use more than two sources of information (2.596) on average.

Noord-Brabant firms are more engaged in terms of formal OI practices, because they have cooperation agreements with 0.542 partners, while Navarre firms have on average 0.366 partners. The percentage of open firms is considerably lower, but is pretty similar across regions when we look at formal OI: only 15.67 percent and 16.05 percent of Navarre and Noord-Brabant firms are open, respectively[7]. This suggests that in both regions, the general tendency is toward external informal sources of knowledge instead of formal cooperation agreements.

With regard to the offensive motives for innovation, it can be noted that Navarre firms have larger values for these variables, indicating a more offensive strategy. As for public funding,

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[6] The apparent different patter observed in the percentage of innovative companies depicted in Figure 1 could be due to the fact of the size of the sample in each study and the mechanisms used to select each sample.

[7] Additional description is available upon request to the authors.

Table 3 shows very different figures for the two regions. European funding has been granted to 3.7 percent of the firms in the Noord-Brabant sample and to 1.8 percent of the firms in the Navarre sample, half of the Noord-Brabant figures. Regional funding presents an opposite tendency; the proportion of firms benefitting from this funding is seven times higher for Navarre than it is in Noord-Brabant (20.5% vs. 2.9%, respectively). The percentage of firms receiving national funding is very similar, around 12-13 percent.

(Insert Table 3 over here)

Finally, with respect to Internal R&D, Noord-Brabant shows an important effort in internal investment, five times greater than Navarre.

5.2 Drivers of formal and informal OI adoption

Table 4 shows the estimates of the models proposed for identifying the drivers of formal and informal inbound OI practices. All models present satisfactory indicators of goodness of fit, as they present highly significant Wald tests, and pseudo R^2's range from 0.1723 to 0.2233.

As regards the first hypothesis of offensive motives as drivers for engaging in OI practices, for Navarre it is corroborated for both formal and informal OI. That is, the greater the importance given to the innovation objectives, the greater the probability of opening their innovation boundaries. In the case of Noord-Brabant the product-related motive is the only one affecting both formal and informal OI, partially corroborating hypothesis 1. Nevertheless, we can support Van de Vrande's et al. (2009) argument that market-oriented motives are the main driver for OI engagement.

With respect to process-related innovation only, it is a driver of Breadth in Noord-Brabant ($\beta=0.2897$), while it is a strong driver for both formal and informal OI activities in Navarre. The results for formal OI in Noord-Brabant agree with the results from Vega-Jurado et al.

(2009). According these authors process innovation is largely driven by the acquisition of knowledge embodied in machinery and equipment and the cooperation with external agents has no significant effect. Because of that, firms seeking process innovations don't carry out formal OI practices. Interestingly, environmental objectives for innovation do not drive either the engagement in formal or in informal OI practices for Noord-Brabant firms. This might indicate that Noord-Brabant firms mainly rely on their internal knowledge to achieve this innovation type.

The commitment to internal R&D clearly increases the propensity to adopt OI practices, both formal and informal, and this effect is produced in both regions, therefore hypothesis 2 is corroborated. Our results are in line with those of Keupp and Gassmann (2009), Barge-Gil (2010), Ebersberger et al. (2011) and Laursen and Salter (2014) where it is found that internal R&D enhances the absorptive capacity, which in turn facilitates firms' ability to recognise, assimilate, and integrate external knowledge. In other words, OI practices require the active combination of internal and external knowledge (Chesbrough, 2003).

Firm size, the last internal driver, seems not to be a clear determinant of the inbound OI enrollment in Noord-Brabant as it is Navarre for formal OI; partially corroborating hypothesis 3. In line with previous results (Bayona et al., 2001), large firms in Navarre are more likely to establish formal OI practices ― collaboration breadth ― with a larger amount of partners.

Paying attention now to the external drivers, hypothesis 4 is partially supported in Noord-Brabant and totally supported in Navarre. One important difference between Noord-Brabant and Navarre is that the former is not influenced by regional funding when companies decide to open, while the latter increases the degree of breadth and cooperation breadth when firms receive this type of funding. Certainly, this difference could be explained based on the amount of firms granted with regional funding in each region, as described in Figure 1. Furthermore, as indicated in Table 2 the proportion of firms benefitting from regional funding is seven

times higher for Navarre than it is in Noord-Brabant indicating the strong commitment of the regional government with the innovation in Navarre. Differently, national funding has a positive influence in formal OI in both regions, supporting H4. European funds are not significant drivers of engagement for formal OI activities in Noord-Brabant but in Navarre European funding is slightly significant for formal OI, supporting H4.

For Noord-Brabant, it is not clear whether government intervention for enhancing (open) innovation is having the expected direct effects in facilitating knowledge transfer through networking – informal – and collaboration – formal (De Jong et al., 2010). However, the way the data is collected in the CIS, public funding is counted in the intramural R&D expenditure, but we cannot identify the percentage that it represents. According to Ebersberger et al. (2011), one policy instrument is to increase intramural R&D, which as a consequence might increase the absorptive capacity and could incentive the engagement in OI, as our results show. Therefore, the possibility exists that government intervention is having an indirect effect on our sample analysis.

Finally, according to our results, industry effect is not among the most important determinants of OI adoption and the hypothesis 5 is not supported. The industry effect is not relevant for any of the OI practices either Noord-Brabant nor in Navarre. With this hypothesis we expected that due to intangible nature of the service and the interaction existent with the client, to achieve cooperative agreement is more complex than in manufacturing firms. However this theory is not corroborated and the hypothesis is rejected, this result is in line with Segarra-Blanco and Arauzo-Carod (2008) who find the existence of important relations for technological cooperation between service firms and public institutions, like universities and public research centres over collaboration with other firms like customer or suppliers

(Insert Table 4 over here)

As observed, the two regions where our model was tested show different patterns in their open innovation behavior. We could find some theoretical explanations of these differences in spatial innovation theory. This approach sustains the existence of a close relationship between space factors and innovation behavior, and suggests that the accumulation of skills and knowledge takes place in the spatially bounded context, which creates a favorable atmosphere for generating and diffusing new ideas (Pred, 1977; Malecki, 1983). Empirical literature that has emerged over recent decades confirms that space-specific factors strongly influence both a firm's innovative performance, and regional patterns of specialisation (Iammarino, 2005).

Spatial closeness might facilitate the cognitive, organizational and institutional proximities which in turn facilitate the learning process through the mechanism of knowledge spillovers, through networks among people, and the shared values arising from those networks (De Dominicis et al., 2007; Boschma, 2005). Spatial theory argues that these networks will work better within regional systems than they do in national ones. Codified knowledge can be transferred over large distances, but closer proximity and common socio-institutional infrastructure and networks will endorse the uncodified knowledge transfer within a region, since face-to-face contacts are maximized within relatively small territories (Crescenzi and Rodriguez-Pose, 2011). This is corroborated in our study since we observed that Navarre tends to be more open and informal, than Noord-Brabant, and this might be because the former is much smaller than the latter when comparing the number of inhabitants (740,000 vs.2,482,000), and firms (36,738 vs. 57,480).

However, when it comes to formal OI a different pattern emerges. We find that Noord-Brabant is more open in cooperation agreements than Navarre. This could be explained based on Gassmann and Enkel (2004) who argue that firms shift from a closed to an open innovation strategy due to the access to external knowledge and, based on spatial theory, there is more knowledge in Noord-Brabant than in Navarre in terms of patents (Figure 1).

6. Conclusions and Implications

Inbound OI has demonstrated itself to be crucial to increasing firms' innovation and economic performance, but there is still a demand in the literature to reach a better understanding of the drivers of inbound OI adoption. We have extended previous studies by considering both formal and informal inbound OI practices, and observing differences in the drivers of each type of OI activity while most of the literature has neglected this issue. In particular we have examined internal firm motives, such as offensive innovation actions, internal R&D and firm size, as determinants of formal and informal OI adoption. We have also considered some external drivers, such as public funding and sector. Finally, this paper seeks to add to knowledge in this field, while simultaneously contributing to the existing literature by observing differences across two regions located in two different countries with cultural and market dissimilarities.

Based on previous literature, we formulated five hypotheses and tested them on samples from Noord-Brabant and Navarre. Interesting results emerged that add to knowledge of drivers of inbound OI adoption.

First, internal drivers of OI adoption have been analysed in previous studies, yet there is still a gap in evaluating the role that the offensive innovation motives play in the adoption of inbound OI practices. We observe that firms decide to open or not open, and to select between formal and informal OI activities, depending on the type of innovation goals. Product-related motives such as increasing the range of products, new market entrance, or replacing outdated products are crucial drivers for establishing collaboration agreements and finding ideas from external agents in both regions. Noord-Brabant firms seem to be more self-sufficient (closed innovators) when pursuing process- or environment- related objectives because they do not open their boundaries, either formal or informal, for these offensive motives. Navarre firms, on the contrary, seem to be more dependent on informal and formal external relationships

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when looking for process-related innovations (i.e. increase production flexibility and/or capacity, reduce cost per unit) and when looking for environment-related innovations (e.g. lower environmental impact, increased health and safety). Therefore, only product-related motives as drivers of inbound OI are not context dependent and are equally important for firms located in both regions Therefore, policy makers should facilitate the establishment of information and cooperation networks regardless of geographic context to help achieve such goal. However if the objective of firm is to obtain process and environmental innovations, the open innovation option depend on firm's region. In this case, the availability of these networks will be important only in some geographical contexts and this fact should be taken into account by policy makers.

Second, in-house R&D is a key factor determining the OI engagement either in formal – collaboration agreements – or informal – source ideas from external partners – for firms located in both regions. This clearly shows that, as other authors have commented, in-house R&D is necessary for searching and absorbing the technological knowledge of external partners and, as result, it will boost the firms' openness. Consequently managers should carry out internal R&D if they want to take advantage of open innovation practices. Further, as product-related innovations, the effect of internal R&D on formal and informal OI activities goes beyond location effects and is not context dependent.

Third, specific contextual factors such as public funding for R&D also determine inbound OI adoption, but the effect is also context dependent. For example, in Navarre, regional funding seems to be the most important source stimulating firms to open up both formally and informally. By contrast, the same source of funding does not stimulate Noord-Brabant firms to open up, either formally or informally. This might be due to the strong regional commitment (intervention) to innovation activities by the Navarre government. In general, Navarre seems to be a region that is more dependent on public funding when embracing OI

practices than Noord-Brabant is. This in line with Ebersberger et al. (2011) who observed that public funding fosters higher levels of collaboration in technology user countries than in technology leader countries. Further, our results extend Bayona et al.'s (2013) arguments that public funding exerts an influence on the innovation strategy and that its effects are not equal in all regions. Therefore, although government funding for R&D activities incentivises to look for external sources of information to innovate and to establish formal cooperation agreement, policy makers should pay special attention to the specific contextual conditions when developing public policies to encourage inbound OI practices. Thus, regions classified as innovator followers should promote public policy based on public funding if the objective is embracing OI practice while innovator leader regions do not depend so much on public aid to stimulating firms to open up both formally and informally.

Fourth, other circumstances such firm size or sector do not seem determinate the engagement on inbound OI practices. Only firm size determines formal OI in Navarre.

Fifth, results indicate that drivers of OI vary across the regions analysed, except for product-related motives, in-house R&D and sector. This means that the drivers of the OI strategy are context dependent so regional decisions to encourage open innovation should not be taken by policy makers without regard these context factors. This result supports Damanpour and Schneider's (2009) finding that firms' innovation strategy is shaped by contextual factors such as competition, deregulation, and customer demand. In our case, as observed in the descriptive variables, the region with a better innovative performance, Noord-Brabant, is less open in terms of informal relationships, but more open in formal activities than Navarre, a region characterised by a modest innovative performance and a larger dependence on imported technology.

This work is not free of limitations, but these could be solved with future research in this field. First, the data used for the analysis is cross-sectional, and it is difficult to observe causal

effects besides CIS survey was not designed with the specific aim of studying Open Innovation therefore the variables used in some cases are weak although wide used in the literature. Second, due to a limitation of the data, we cannot control for whether the cooperation agreements are done exclusively for inbound or if there is also a component of outbound activities. Third, we are not able, also due to data constraints, to distinguish between the different types of activities sourced, because they could differ in scale. Finally, it is beyond the scope of this paper to examine the adequate balance of formal and informal OI practices in order to maximise innovation performance, which would create additional insight.

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Figure 1. Innovation performance of Navarre and Noord-Brabant in 2007
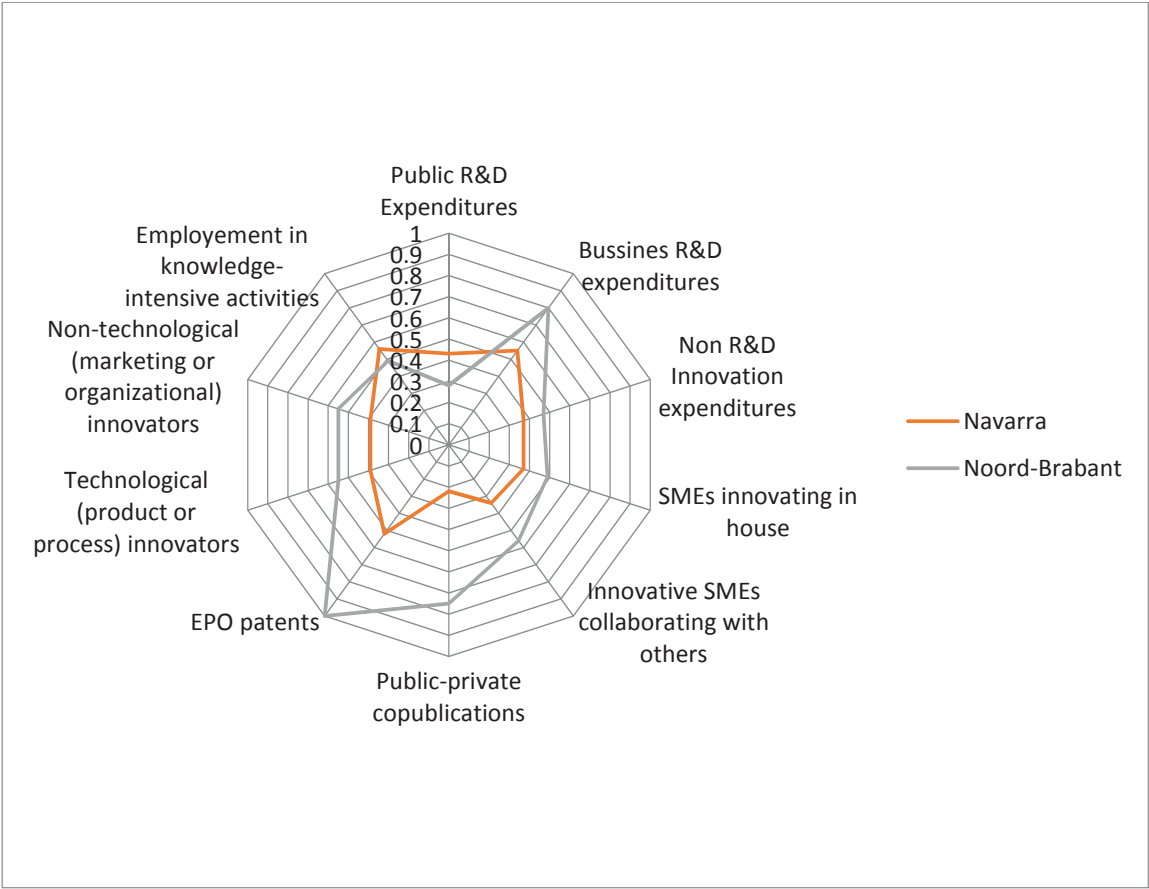
Source: Hollanders et al. (2012).

Table 1. Composite variables of offensive motives and Cronbach's alpha

Composite Variables	Original variables form the CIS	Cronbach's alpha for Noord-Brabant sample	Cronbach's alpha for Navarre sample
Product-related motives	Increase range of products/ services; replace out-dated products; new market entrance; increase market share; increase quality in products/ services.	0.6908	0.9345
Process-related motives	Increase production flexibility; increase production capacity; reduce labour cost per unit output;	0.7122	0.9425
Environment-related motives	Increase health and safety; comply with environmental law.	0.7423	0.9169

Table 2. Percentage of innovative firms

	Noord-Brabant	Navarre
% Innovative firms	38.52%	47.59 %
Manufacturing firms	56.6%	63.9%
Service firms	26.0%	40.1%
Small firms	28.3%	46.8%
Medium firms	46.9%	57.9%
Large firms	59.6%	84.7%

Table 3. Variables descriptive

Variable	Noord-Brabant		Navarre		Values
	Mean	Std. Dev.	Mean	Std. Dev.	
Breadth	2.284	3.285	2.596	3.353	0-9
Coop breadth	0.542	1.427	0.366	1.043	0-7
Product motives	0.675	0.981	0.844	1.058	0-3
Process motives	0.557	0.895	0.735	0.942	0-3
Environmental motives	0.450	0.819	0.654	1.022	0-3
Regional funding	0.029	0.168	0.205	0.404	0-1
National funding	0.124	0.329	0.136	0.343	0-1
European funding	0.037	0.189	0.018	0.132	0-1
Manufacturing	0.407	0.491	0.516	0.500	0-1
Firm size*	133.49	442.85	119.40	881.75	Continuous
In-house R&D intensity	0.183	0.343	0.035	0.011	Continuous (0-1)

* This variable is presented in absolute numbers in order to facilitate understanding but in the model estimation it was introduced as the natural logarithm of the number of employees.

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Table 4. Estimates for the drivers of informal and formal OI adoption for Navarre and Noord-Brabant regions				
	Informal OI/ Breadth		**Formal OI/ Cooperation breadth**	
Drivers / OI archetype	**Noord-Brabant**	**Navarre**	**Noord-Brabant**	**Navarre**
Product objective	0.9583***	0,5721***	1.0226***	0.2913**
	(0.0927)	(0.0479)	(0.2089)	(0.1219)
Process objective	0.2897***	0.4374***	-0.0019	0.2889***
	(0.0874)	(0.0437)	(0.2105)	(0.1063)
Environmental objective	-0.0315	0.2034***	-0.0169	0.2943***
	(0.0837)	(0.0365)	(0.178)	(0.0869)
Internal R&D	1.2703***	0.5630***	1.241***	0.7155***
	(0.1643)	(0.0009)	(0.3434)	(0.0023)
Firm size	0.0247	-0.0184	0.1343	0.1764***
	(0.1643)	(0.026)	(1.54393)	(0.0603)
Regional funding	-0.1618	0.2143***	0.1607	0.6409***
	(0.2473)	(0.0792)	(0.456)	(0.1818)
National funding	0.3041**	0.1131	1.0335***	0.7247***
	(0.152)	(0.0901)	(0.4146)	(0.1975)
European funding	-0.0723	0.2091	-0.114	0.6736*
	(0.2155)	(0.1978)	(0.4146)	(0.4066)
Manufacturing	-0,0604	0,0169	0.1048	-0.2602
	(0.1168)	(0.0682)	(0.2517)	(0.1718)
Constant	-1.2748***	-0.9073***	-3.4756***	-3.5169***
	(0.1817)	(0.1087)	(0.3997)	(0.2562)
Wald chi-square (9)	494.87***	1070.19***	194.11***	313.19***
Pseudo R2	0.2233	0.2043	0.1963	0.1723
X^2 (test of rho = 0)	184.22***	487.90***	163.86***	254.10***

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| Log likelihood | -860.65235 | -2084.4094 | -397.4227 | -752.4942 |

Standard errors in parentheses; * p<0.01, ** p<0.05, *** p<0.001