PROFITING FROM COLLABORATIVE AND ORGANIZATIONAL INNOVATION PRACTICES: A RESEARCH THROUGH CASE STUDIES AND QUANTITATIVE ANALYSIS

Ph. D. Thesis

Paula Anzola Román

Supervisors:
Cristina Bayona Sáez
Teresa García Marco

Universidad Pública de Navarra
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A mi hermana, que ha hecho la proofreading *de los capítulos de esta tesis en menos de una semana.*

Al equipo cunicular, el soneto prometido:

Apenas unos pasos a la espalda,
estrenaba aventura y equipaje.
Ante el primer desvío, eché el anclaje:
¡qué reunión feérica inesperada!

Y me adentré en el claro, deslumbrada.
Pacté conmigo misma este chantaje,
jugando a desencontrarme en el viaje.
"Como todo en tu vida", dijo un hada.

Por tierras abruptas y en suelo llano,
el cónclave me azuza, ¿me acompaña?
Me habla de los pasos, pero en arcano.

Un poco yo misma, y un poco extraña;
a punto de llegar, sobre mi mano,
se deshace el hielo que la luz baña.

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He leído muchas veces en publicaciones de obras de otras personas la fórmula, un tanto *commonplace*, de "*esta novela/tesis/obra/biografía/… no existiría sin la inestimable ayuda de…*". En mi caso, el tópico deviene verdad absoluta. Conocí a Cristina y Teresa cuando entré a formar parte del equipo para el proyecto europeo que mencionaba al principio. Fueron ellas las que me animaron a llevar la investigación adelante como un trabajo de tesis. Y han sido ellas las que han estado a cada paso del camino, hasta este momento que muchas veces parecía inalcanzable. En el trayecto, ha sido mucho y muy valioso lo que he aprendido de ellas, profesionales excelentes siempre dispuestas a compartir conmigo su instinto, su experiencia y su tiempo. Y todo ello con una paciencia infinita a prueba de espíritus dispersos como el mío. Y con muchísimo cariño. No me cansaré de decir lo afortunada que he sido de llevar a cabo este proyecto con ellas como directoras, y lo mucho que me han demostrado que les importan esta tesis, mi carrera, y yo.

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ABSTRACT

This research covers a wide range of innovation practices, and intends to advance the understanding of how to better profit from their implementation, taking into account contextual factors and the potential effects of their joint adoption. In particular, the studies presented here delve into the implementation and effects of in-house R&D&I practices, collaborative R&D&I activities developed with the participation of external agents, and organizational innovation practices. In order to do so, the thesis adopts a comprehensive approach that encompasses the complexity of these innovative processes and the diverse range of contingencies affecting them. Therefore, the research is conducted through both qualitative and quantitative methods. Indeed, the case study methodology applied in the first stage of the investigation helps to define and formulate the research questions for the second stage, whose analysis is conducted through the estimation of causal models, and implies an interpretation of the results by means of calculating average marginal effects. The conclusions from the first qualitative study highlight the relevance of the implementation of organizational innovation practices for value generation in firms, suggesting that organizational innovations allow for better exploitation of the results of technological innovation practices. The third study tests these conclusions through a quantitative analysis, providing evidence of the complementary effect of technological (be it internal or collaborative) and organizational innovation practices when pursuing the generation of complex technological innovations (both product and process innovations). The multiple case study presented in chapter two results in the proposal of a theoretical framework on how organizational context factors influence the profiting of collaborative innovation practices along the stages of the process. Also with purposes of better understanding how firms may profit from collaborative innovation practices, taking into account the potential influence of strategic decisions and internal context contingencies, the study described in chapter four presents a quantitative analysis on the causal effects on innovative performance of technological proximity and the intensity of collaboration in different stages of the process. The evidence found here suggests that firms should try to collaborate intensely with technologically proximate partners, and pay attention to proper protection mechanisms, especially when collaborating in the later stages of the innovation process.

RESUMEN

Esta investigación abarca una amplia variedad de prácticas de innovación, y pretende avanzar en la comprensión sobre el aprovechamiento de las mismas, teniendo en cuenta factores contextuales y los potenciales efectos de su adopción conjunta. En concreto, los estudios que conforman esta tesis profundizan en la implementación y los efectos de prácticas internas de I+D+i, actividades de I+D+i desarrolladas en colaboración con agentes externos y prácticas de innovación organizativa. A tal efecto, la tesis adopta una perspectiva holística que abarca la complejidad de estos procesos de innovación y la naturaleza diversa de las contingencias que pueden afectarlos. De esta forma, la investigación se ha desarrollado a través de métodos cualitativos y cuantitativos. Así, el estudio de casos llevado a cabo en una primera etapa contribuye a la formulación de las preguntas de investigación de la segunda fase, cuyo análisis se desarrolla a través de la estimación de modelos causales y basa la interpretación de los resultados en el cálculo de efectos marginales. Las conclusiones del primer estudio cualitativo subrayan la importancia de la innovación organizativa para la generación de valor en las empresas, y sugieren que ésta favorece la explotación de los resultados de las prácticas de innovación tecnológica. El tercer estudio testea estas conclusiones a través de un análisis cuantitativo, y presenta evidencia de la existencia de efectos complementarios entre la adopción de prácticas de innovación tecnológica (tanto internas como en colaboración) y de innovación organizativa con respecto a la generación de innovaciones complejas (de producto y proceso conjuntamente). El estudio múltiple de casos presentado en el capítulo dos concluye con la propuesta de un marco teórico sobre el efecto de factores contextuales organizativos en el aprovechamiento de prácticas de innovación en colaboración a lo largo del proceso innovador. Con similares objetivos de avanzar en la comprensión del aprovechamiento de este tipo de prácticas, teniendo en cuenta la influencia de decisiones estratégicas y de contingencias internas, el último estudio presenta un análisis cuantitativo sobre los efectos causales en el desempeño innovador de la proximidad tecnológica y de la intensidad de la colaboración en las distintas etapas del proceso. La evidencia hallada sugiere que las empresas deberían intentar colaborar intensamente con socios tecnológicamente próximos, y prestar atención a los mecanismos de protección, especialmente cuando se colabora en las fases tardías del proceso innovador.

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THESIS OVERVIEW

Research focus

The research presented here as a thesis dissertation focuses on innovation practices adopted by firms and the effect that said adoption may have on performance. The innovation practices of interest for this study transcend the traditional conception of in-house, technologically intensive R&D activities. Although these kind of practices have benefited from a solid body of literature confirming their positive influence on performance and economic growth (e.g., Grossman y Helpman, 1994; Fagerberg, 1994), it is nevertheless true that this strict view on the innovation phenomenon has been put in jeopardy for a long time now. Indeed, this narrow perspective disregards the fact that most innovative practices are not carried out as institutionalized activities in internal R&D departments, but take place through the participation of firm in networks, implying agents of diverse backgrounds (Som et al., 2012). This has been widely acknowledged, and currently there is a strong consensus regarding the consideration of innovation practices beyond technology and internal activities (e.g., Fagerberg, 2005; Chesbrough, 2007) and the need to adopt the appropriate approach to take in a comprehensive view of the innovative efforts firms engage in across all economic sectors, which the aforementioned strict conception fails to provide (Schmidt and Rammer, 2007).

This change in the paradigm reveals the complexity of the innovation processes and the existence of new challenges for scholars in the study of the innovation phenomenon, its determinants and its effects, as well as in terms of taking decisions regarding the implementation of said practices by firms. A systematic and holistic view should thus take into account the complex nature of the innovative processes carried out by firms, taking explicit consideration of the activities that trespass organizational boundaries and of those revolving around non-technological objectives.

Accordingly, this research adopts an inclusive perspective on the innovation concept and pays special attention to collaborative innovation practices and organizational innovation activities.

With respect to first concept, the focus of the study lies on those practices carried out in order to enrich the focal firm's knowledge base through the integration of knowledge, resources, and expertise

from external partners such as customers, suppliers, competitors and research institutes (Dahlander and Gann, 2010). The study of this kind of innovation activities has been developing for several decades now (e.g., Lundvall, 1992; Dyer y Singh, 1998; Nooteboom, 1999), and thus it constitutes one of the most significant contributions to the literature on innovation management. In this sense, it is worth noting Chesbrough's systematization of the inter-organizational innovation practices under the term of 'open innovation' (Chesbrough, 2003), which accounts for all those R&D&I activities for which the development and/or marketing of new technologies are carried out with the participation of an external actor (Enkel et al., 2009). The coining of this term and the subsequent contributions devoted to refine the concept and its implications implied a significant trend for academic research. All in all, there is a vast body of literature dealing with the influence of inter-organizational R&D&I activities on performance, providing evidence of the positive effects derived from their implementation on the generation of technological innovations (e.g., Un et al., 2010; Plunket et al., 2001; Becker and Dietz, 2004; Bayona-Sáez et al., 2017).

This thesis intends to delve further into the understanding of that relationship between collaborative innovation practices and innovative performance, because extant research on the subject, extensive as it is, still leaves room to considerations regarding the optimization of these practices. Furthermore, the aforementioned evidence of the positive influence of collaborative R&D&I activities on innovation outcomes has been confronted by studies highlighting their drawbacks, such as the risks of opportunist behavior, technology leakages or appropriability problems (Kang and Kang, 2009; Mazzola et al., 2012), and their limits (Belderbos et al., 2010).

Therefore, there is still much to learn on how firms may take full profit of collaborative innovation practices, about their limits and potential moderators or determining success factors (Huizingh, 2011; West and Bogers, 2014), taking into account aspects such as the role of context (Foss et al., 2011; Lazzarotti et al., 2016) or the intersection of these practices with other types of innovation activities.

Regarding this last aspect, particularly with respect to the joint effects of inter-firm R&D&I practices and the implementation of non-technological innovations, it remains to day an under

researched subject. Some contributions have ventured into the study of the potential complementarities of these activities (e.g., Foss et al., 2011; Hollen et al., 2013; Hecker and Ganter, 2016), but more research is needed in order to fully comprehend the intricate nature of this kind of processes.

In line with the holistic aspiration of this thesis, and as mentioned above, non-technological innovation practices take a prominent position in the research. As with inter-firm innovation, scholars have been also making a strong point for broadening the scope of the innovation conceptualization towards non-technological aspects for a few decades (e.g., Nelson and Winter, 1982; Boer and During, 2001; Baranano, 2003), and currently the field devoted to the study of these practices is growing steadily (e.g., Hervás-Oliver and Sempere-Ripoll, 2015)

The particular interest of this research lies on organizational innovation activities, a concept that has received a wide variety of approaches (Lam, 2006; Armbruster et al., 2008). An interesting effort towards its definition is reflected in the third edition of the Oslo Manual (OECD and Eurostat, 2005), which introduced a typology including the concepts of organizational and marketing innovations alongside the more traditional ones of product and process innovations. The importance of organizational innovation in terms of competitivity is nowadays widely recognized. Studies point to positive effects on general performance, such as improvements in quality, flexibility, productivity and rapidness (e.g., Schmidt y Rammer, 2007; Kirner et al., 2009), as well as on innovative performance, i.e., the generation of product and process innovations (e.g., Mothe and Nguyen-Thi, 2010; Gunday et al., 2011). There are also studies offering conclusions regarding the combinative effect between organizational innovation and technological innovation outputs on measures of firm performance, such as sales of novelties and cost reduction (e.g., Schmidt and Rammer, 2007; Sapprasert and Clausen, 2012; Sempere-Ripoll and Hervás-Oliver, 2014). The understanding of this complementarity, nevertheless, calls for further research in order to provide more consolidated evidence and determine its intensity (Schmidt y Rammer, 2007; Battisti y Stoneman, 2010). Furthermore, the combination of organizational innovation and R&D&I practices, considered both as input of the process, and their potential joint effect on innovation outputs is yet to be examined, not only in the case of collaborative

R&D&I practices, as it has been noted above, but also with regards of in-house technological innovation activities.

Summing up, the research objectives of this thesis cover a wide range of innovation practices (i.e., technological and non-technological, in-house and inter-firm), and they consist on advancing the understanding of how to better profit from their implementation, taking into account contextual factors and the potential effects of their joint adoption.

In order to do so, it is necessary to adopt a comprehensive approach that encompasses the complexity of these innovative processes and the diverse range of contingencies affecting them. Therefore, the research has been conducted through both qualitative and quantitative methods. Indeed, the case studies methodology applied in the first stage of the investigation helped to define and formulate the research questions for the second stage, whose analysis was conducted through the more traditional estimation of causal effects.

Overview of the chapters

The first two chapters originated from the qualitative research. In both of the studies, a case study methodology was employed, which has been signaled as appropriate to address analysis questions like 'how?' and 'why?' (Yin, 2003), particularly when a holistic perspective is required to advance the understanding of complex phenomena (Gummesson, 2000). The selection of cases, based on the concept of theoretical sampling (Eisenhardt and Graebner, 2007), resulted in three firms operating in the Spanish region of Navarre representing different relevant industries in the territory, different sizes and different ownership structures.

The study described in the first chapter originated from a single case study on one of the aforementioned firms. Particularly, the firm of interest in this study had undergone a profound process of organizational renewal. In this sense, the first chapter offers the analysis of said process and illustrates how and to what extent it contributed to value generation, addressing both direct effects as well as the combined effect derived from the technological and organizational innovations activities carried out by

the firm. The main findings of the study are presented as conclusions in the form of theoretical propositions regarding how organizational innovation practices contribute to value creation in firms.

The second chapter presents a multiple case study analysis, conducted in order to understand how organizational contextual factors affect the way firms profit from collaborative innovation practices. The analysis was performed by means of applying an analytical framework that structures the collaborative innovation process in three areas of relevance (i.e., development, integration and commercialization of the innovation). The results inform the proposal of a theoretical framework that identifies the factors that determine the success or failure of collaborative innovation practices in each of the stages of the process.

The theoretical propositions derived from the qualitative analysis informed the direction for the second part of the research presented in this thesis. Indeed, the study described in the third chapter was designed with purposes of testing the main conclusions presented in the first chapter (i.e., the direct and joint effect of technological and organizational innovation practices), while the research presented in chapter four intends to provide an empirical quantitative analysis for the casuistic treated in chapter two (i.e., the profiting of collaborative innovation practices depending on contingencies).

Each of the quantitative studies employs a different dataset. The first one relies on Spanish PITEC panel database, which has its origins in the Community Innovation Survey (CIS), produced at a supra-national level, and collects data on a wide range of aspects related to firms' innovation activities and performances. The dataset employed comprises 51,289 observations pertaining to 9,586 Spanish firms from 2008 to 2013. On the other hand, the analysis presented in chapter four uses data obtained from an international survey designed by researches from several European universities and collected during 2012 and 2013, covering aspects related to collaborative innovation practices and performance. The total number of observations in the dataset amounts to 467 firms, from Italy, Sweden, Finland and the UK.

The main purpose of the quantitative research is to test for direct and, particularly, joint or moderating effects. With this purpose, the analysis relies not only on the traditional interpretation of the

estimated coefficients of the covariates of causal models, but also on the estimation and interpretation of the average marginal effects of said covariates.

Scholars generally recognize that the analysis of the results yielded by non linear models demands special attention (Hoetker, 2007), because the estimated coefficients of the covariates do not communicate the unconditional average effects. Moreover, the coefficients of the interaction terms cannot be interpreted as meaningful with regard to the magnitude nor the sign. Thus, reporting on the significance and level of non linear model coefficients, especially when it comes to multiplicative variable, does not provide useful information for the analysis. This awareness should arise also in the case of linear interaction regressions including multiplicative terms (Leeper, 2017), because neither in this case the estimated regression coefficients can be read as the predicted change in the dependent variable due to a unit change in the covariate of interest. The use of the indicators such as the average marginal effects allows for better interpretation of the estimated effects, as they provide relevant and accurate information on the causal relationships (Brambor et al., 2006).

While relying, thus, on the same methodological instruments to perform the analysis, chapter three presents a study based on panel data methodology and the research from chapter four relies on a cross section analysis. In particular, the first of the quantitative studies focuses on determining whether organizational innovation moderates the effect of internal and externally sourced innovation practices on the probability of obtaining product and process innovations. The results present evidence supporting the positive effect of internal and externally sourced technological innovation practices, and of organizational innovation; and also point to a complementary effect of technological and organizational innovation practices when pursuing the generation of complex technological innovations (both product and process innovations).

Finally, chapter four presents a study on collaborative innovation practices that analyses the direct and joint effect on innovative performance of technological proximity and the intensity of collaboration in the early and late phases of the process. The findings suggest that there is a positive unconditional relationship between the aforementioned aspects and innovative performance, and that the joint effects diverge depending on the stage of the process; i.e., while in the early phase,

collaborating intensely with close partners seems to be advisable, this circumstance proves to be problematic in the late phase of the innovation process.

A compendium of the conclusions reached through the research overviewed here is presented in a section at the end of this thesis.

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CHAPTER I:
VALUE GENERATION THROUGH ORGANIZATIONAL INNOVATION: DIRECT AND MODERATING EFFECTS[Ω]

1. INTRODUCTION

Over the last few decades, research on innovation management has focused mainly on technological innovation as a driver for company performance and economic growth (Fagerberg, 1994; Grossman and Helpman, 1994). However, the academic community has identified a need to broaden this perspective given that the positive impact of innovation is not limited solely to practices involving high technology or large investments in internal R+D activities (Chesbrough, 2007; Marsili and Salter, 2006).

This expanded perspective on the innovation concept is reflected in the third edition of the Oslo Manual, which adopts a Schumpeterian view (Som et al., 2012) and includes in the typology of innovations the concepts of marketing and organizational innovation, adding these to the traditional notions of product and process innovation.

In view of this inclusive vision of the concept of innovation, this study focuses on those practices which the Oslo Manual defines as organizational innovations and also analyzes the joint implementation of organizational and technological innovations. Furthermore, the permeable nature of firms' borders is also taken into account when it comes to analyzing the impact that these innovation practices might entail in terms of performance. Some studies in the field of organizational innovations do in fact take into account the systemic nature of business and innovation processes (Armbruster et al., 2007, Hervás-Oliver et al., 2014; Hollen et al., 2013).

Despite the fact that research on organizational innovation is less developed than that on technological innovation (Battisti and Iona, 2009; Mol and Birkinshaw, 2009), and although it has been noted that there is still much work to do to understand the effects derived from it (Damanpour et al., 2009, Sapprasert and Clausen, 2012*), a series of studies have highlighted the benefits that companies can obtain from the implementation of organizational innovation practices, both as a result*

[Ω] This study, coauthored by my thesis supervisors and myself, was published in 2015 in Universia Business Review under the title '*La generación de valor a partir de innovaciones organizativas: efectos directos y moderadores*'.

of the direct impact of these practices on performance and as a consequence of their joint adoption with R&D&I practices (e.g. Schmidt and Rammer, 2007; Sapprasert and Clausen, 2012*).*

In order to identify and understand these positive effects on performance, this study applies the theoretical construct of the business model; particularly, the canvas proposed by Osterwalder and Pigneur (2010), which allows for adopting a holistic perspective and reflects the logic of the processes through which firms generate value. In this sense, the use of the business model as an analytical framework is appropriate for exploring the following question: How do companies generate value based on the implementation of organizational innovation practices?

This study will delve into this question through the analysis of a case study, with purposes of unveiling how organizational innovation practices can become a prominent factor for value generation, both due to their adoption considered in an isolated fashion and because of the potential effects derived from implementing them in conjunction with technological innovations. The exploratory study culminates with the laying out of several propositions related to the identification of the positive effects of organizational innovations and the explanation of the logic behind these effects. The selected firm is a medium-sized company dedicated to the design and manufacturing of brake systems which underwent a deep organizational innovation process starting from the year 2000.

The contribution of this study complements the literature on the innovation management, as it helps to further understand the complex processes through which organizational innovation practices generate value. Furthermore, firms' innovation managers can benefit from the description of good practices that the analysis of the case study presents.

Finally, the understanding of the characteristics and effects of the innovation practices analyzed in this work might be valuable and bring clarity for the design of public policies to promote innovation.

2. THEORETICAL FRAMEWORK

2.1. Organizational innovation

There is a wide range of approaches to the concept of organizational innovation (Armbruster et al., 2008)[1], but third edition of the Oslo Manual (OECD and Eurostat, 2005:51) offers the most widely used definition in empirical research, thus allowing comparability across European studies (Som et al., 2012). According to this definition, organizational innovation consists in the '*implementation of a new organisational method in the firm's business practices, workplace organisation or external relations*'. Furthermore, the Manual *(OECD and Eurostat, 2005:51) specifies that in order for an organizational change to be considered an innovation, it must involve the introduction of an organizational method 'that has not been used before in the firm and is the result of strategic decisions taken by management'.*

Several studies have echoed the benefits that firms can obtain from implementing organizational innovation practices. In particular, *Armbruster et al., (2007) concluded about the relevance of organizational innovations pointing out to the following reasons: (1) they facilitate technological innovations; (2) they are an immediate source of competitive advantage and (3) they are a pre-requisite for the advancement of knowledge in firms. If we take into account these reasons, it can be stated that the literature refers mainly to two types of effects derived from the implementation of organizational innovations: (1) direct effects on performance, and (2) moderating effects on the influence of technological innovation practices on performance or effects derived from the joint implementation of these two* types *of innovation practices.*

Regarding the direct effects, some studies have highlighted that changes in the organization of productive processes and changes in the workplace can contribute to the improvement of firms' competitiveness and success (Tidd and Bessant, 2005). Schmidt and Rammer (2007) identified as direct effects of organizational innovation the improvement of service quality and the reduction of reaction times in the face of customers' need. Sapprasert and Clausen (2012) proved that organizational innovations are strongly related to the improvement of performance, constructed as a measure derived

[1] See Hervas-Oliver and Sempere-Ripoll, 2014 for a review of the conceptualization of this term.

from a factor analysis on six aspects: shorter time of response to customers' needs, improvement of goods and services quality, lower unit costs, improvement of staff satisfaction, improvement of capacity and higher productivity. Laforet (2013) carried out a study on the effects of organizational innovations in SMEs and concluded that these practices contribute to improve productivity, margins, market leadership and work environments. Evangelista and Vezzani (2010), on their part, found that adopting organizational innovations has a positive effect on sales.

Furthermore, academic literature highlights the importance of adopting organizational and technological innovation practices jointly when it comes to achieving firms' objectives. This phenomenon has been referred to by different terms, such as synchronic innovation (Ettlie, 1988) and organizational integration (Ettlie and Reza, 1992). In this regard, some authors also note that the complementary adoption of organizational innovations optimizes the effect of technological innovation on performance (e.g. Hervás-Oliver et al. 2014; Hollen et al., 2013; Sempere-Ripoll and Hervás-Oliver, 2014). Sapprasert and Clausen (2012) concluded that the combination of organizational and technological innovation practices has a significant positive effect on performance. The study by Sempere-Ripoll and Hervas-Oliver (2014) shows that the organizational innovation practices carried out by SMEs drive up the positive aspects of technological innovation in aspects such as quality and range of goods and services, market quota, flexibility and efficiency. Schmidt and Rammer (2007) analyzed the relationship between technological and non-technological innovations and its effects on company performance. The results revealed that companies which combine both practices obtain better performance in terms of sales of novel products and cost reduction when compared to those which focus solely on technological innovations. The joint adoption of product innovation practices and organizational innovation was also shown to have a positive effect on profit margins.

2.2. Value generation based on organizational innovations

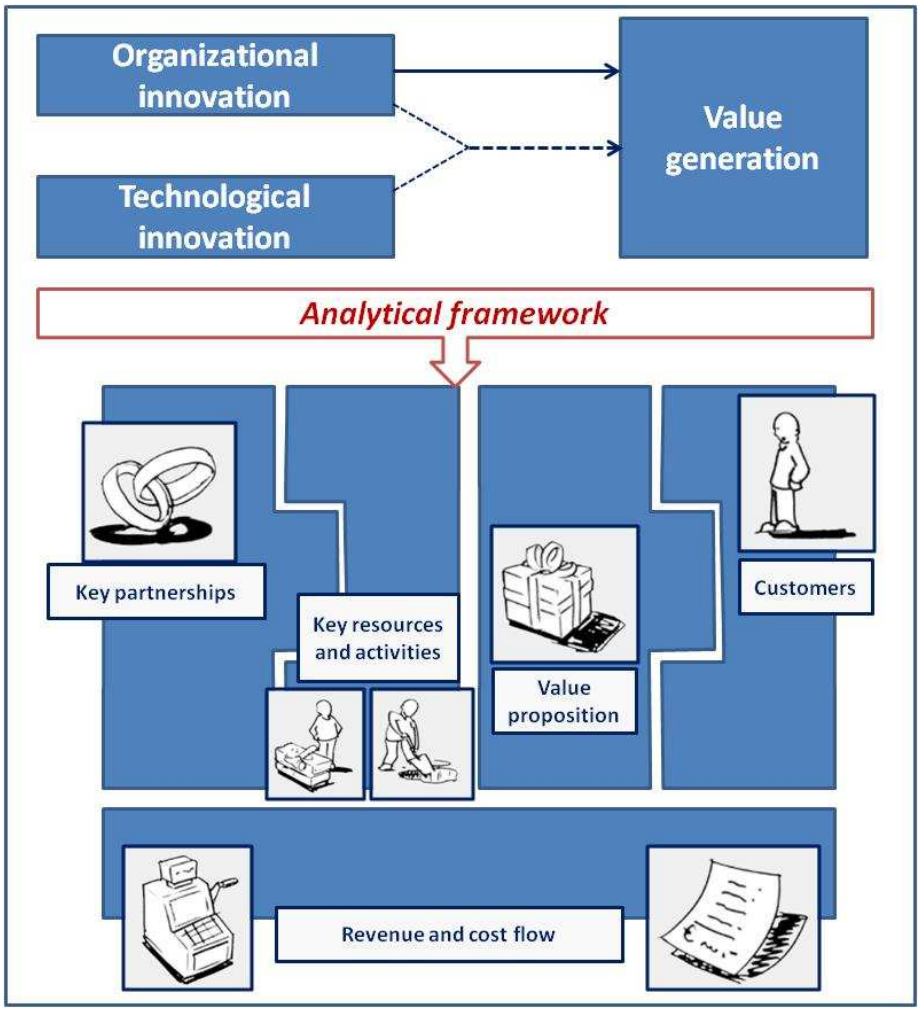
Crossan and Apaydin (2010) point out the need to understand how results from organizational innovation lead to the improvement of performance in order to determine whether these practices generate value for firms and if so, how it is achieved. Further to that, it is worth noting that the setting up of an empirical relationship between organizational innovation and performance will be affected by

the intrinsic characteristics of this type of practices (complex and invasive) and by methodological aspects such as measurement difficulties, which imply a high level of uncertainty in relation to the derived impact of these practices (Tidd, 2001). Moreover, it is necessary to bear in mind that organizational innovation has specific features in each individual company; thus, research methods need to cover potential contingencies in order to understand how organizational innovation processes are initiated, implemented, carried out and assessed (Som et al., 2012). Therefore, this study applies an analytical framework that allows for delving deeply into the particular aspects of the organizational innovations carried out by a given firm and identifies performance as value generation. In this sense, this work develops an exploratory study consisting in a case scenario analyzed through the lens of the business model canvas proposed by Osterwalder and Pigneur (2010).

All approaches to the theoretical concept of the business model–developed by different authors– share an emphasis on the idea of value generation and on the adoption of a holistic perspective (Zott et al., 2011). Thus, the business model can be understood as a system of articulated and interdependent components whose functioning reflects the way in which a firm generates value (Demil and Lecocq, 2010). Therefore, applying a conceptual model based on the business model allows for comprehending the logic underlying the complex process of value generation. The business model canvas proposed by Osterwalder and Pigneur (2010) –one of the best known contributions– includes nine components or blocks which can be grouped along the following five dimensions: customers, value proposition, key resources and activities, revenue and expenses flow and key collaborations.

The case study proposed here is based on the description of each block in the business model in order to identify the main implications derived from the organizational innovation process undertaken by the selected firm. The qualitative nature of the study and the conceptual framework applied allow for analyzing the complex innovation processes implemented, focusing on the way organizational innovation activities contribute to value generation, both directly and in conjunction with technological innovation practices (see Figure 1).

Figure 1: Theoretical framework



Business model canvas adapted from Osterwalder and Pigneur, 2010

3. METHODOLOGY

Through the application of the analytical framework previously described, this article presents an exploratory case study on the mechanisms that lead to value generation related to implementing and developing organizational innovation practices. Although it is important not to overlook the limitations of this method –especially with regard to the possibility of making generalizations from its results–, it still remains a very useful tool for understanding the 'how' and 'why' of complex phenomena in their natural contexts (Yin, 2003), for carrying out exploratory studies (Benbasat et al., 1987; Voss et al., 2002; Yin, 2003) and as a basis for suggesting good practices (Huston and Sakkab, 2006).

The firm under analysis here is Frenos Iruña, SAL (henceforth Fisal), a business established in 1958 specialized in the design, development and production of brake systems for automobiles, other

vehicles and wind turbines, which underwent a significant organizational innovation process starting from 2001.

Prior to the field work, an action protocol to apply to the interviews was designed. It consisted of a questionnaire including all the aspects intended to be covered in the case analysis under the prism the business model conceptual framework. With regard data collection and processing, the principle of triangulation was respected (Jick, 1979) through the use of multiple sources, in order to strengthen the credibility of the collected data (Yin, 2003). Thus, several in depth interviews were carried out with a series of agents, including both the firm's Managing Director and other executive staff as well as relevant external agents with purposes of mitigating possible distortions and subjective interpretations. The interviews were all carried out by two researchers in order to enhance the understanding of all aspects involved, to complement the questioning of items of interests and also to reduce potential observation biases (Eisenhardt, 1989). All interviews were recorded and transcribed for further analysis. The data from the interviews was supplemented with financial statements, strategic plans, presentations, industry reports and press articles.

4. CASE STUDY: FRENOS IRUÑA, SAL (FISAL)

This section presents the in-depth case study on the firm Fisal. With the objective of systemizing the information gathered and carrying out the desired analysis, the business model framework was used as a methodological tool. As mentioned above, this framework sets up five interdependent blocks which unveil the logic of value generation in firms. The construct serves to describe, for each of these components, the changes carried out by the firm.

A brief description of the firm and its organizational innovation process is presented below, followed by the case analysis, structured according to the five blocks in the analytical framework.

4.1. Fisal and the organizational innovation process

Fisal is a firm located in Pamplona, in the region of Navarre (Spain). It was founded in 1958, then acquired by its workers in 1980, become later a Sociedad Anónima Laboral [labor limited company]. Fisal has traditionally specialized in the automotive sector. Today, it designs, develops and manufactures

brake systems both for automobiles and industrial vehicles and for wind turbines. In 2013 it had a turnover of 9.5 million Euro and a workforce of 80 employees.

By the end of 1990, Fisal had consolidated a significant business re-direction, shifting from the automotive sector to the off highway vehicles. It then started to make a series of strategic decisions deriving in the implementation of different organizational innovations with purposes of adapting to the environment, improving technical efficiency and competitiveness, diversifying its business and expanding its international outreach.

In 2001, the firm embarked on a process of organizational innovation starting with the introduction of the Unidades de Generación de Valor[2] (Value Generation Units, henceforth UGVs) given the wide range of models and manufacturing processes and aiming to organize production through flexible manufacturing and assembling cells. Each UGV integrates all the processes per product line and includes a manager, a technical team and a manufacturing team. This organizational re-design implied the breaking down of the firm's departmental structure and the design of a flatter organization. Traditional departments (i.e., administration, commercial, human resources) became the support for the UGVs, around which the whole organization now pivoted. The UGVs improved the design and manufacturing processes, increased technical efficiency and facilitated a good coordination of different activities[3]. In terms of the requirements set out in the Oslo Manual (OECD and Eurostat, 2005:52), the implementation of the UGVs is an organizational innovation in the workplace: this type of innovation occurs when new methods of allocation of responsibilities and decision-making power between employees and the division of labor are implemented, as well as new structural concepts such as the integration of different activities.

[2] This article maintains the expression used by the company to refer to the production system introduced, which matches the characteristics of what is commonly called cell production, a management practice considered to be an essential aspect of lean manufacturing (Shah and Ward, 2003).

[3] This organizational system was awarded 'Premio Nacional de Mejores Prácticas Empresariales' [National Award for Best Business Practices] in 2002 by the Club de Gestión de Calidad [Quality Management Club], representative in Spain of the EFQM (The European Foundation for Quality Management).

In 2008 Fisal absorbed one of its suppliers –Fundiciones Greyco – specialized in casting processes, a highly relevant input in the manufacturing of brake systems. This vertical integration was driven both by a will to control such a significant supply function and by an intention to reduce costs and time of production through adding casting design processes to the value chain. Therefore, this strategic decision implied the implementation of '*new methods of integrating providers*' (OECD and Eurostat, 2005:52), which makes it an innovation in the organization of the firm's external relations.

In 2009, the firm's Strategic Plan introduced the Business Lines into the organizational model, which structured the firm according to the different customer segments: automotive, off-highway, wind power, aftermarket and foundry[4]. The objective was to ensure the development of all the markets targeted by Fisal, consolidate the firm's traditional business and strengthen its new ventures. Through this new structure, the commercial side of the business was emphasized, the focus drawn on capturing clients and building their loyalty, and ensuring that resources were assigned suitably to achieve each Line's objectives. By that time the customer portfolio had undergone considerable growth and diversification and thus there was a need to adapt the organizational structure to this new reality. Furthermore, the Business Lines were articulated with the UGVs (all the UGVs can interconnect with each Line) to optimize the technology and advances acquired with the development of each new product and thus ensure a constant transfer of knowledge so that improvement in any given product could feed to the others. Similarly to the UGVs, these Business Lines implied an organizational innovation in the workplace, in accordance to the Oslo Manual (OECD and Eurostat, 2005:52).

4.2. Analysis of the implications of organizational innovations in value generation

a) Customers

By the end of 1990 Fisal provided for two main customer segments: automotive, particularly one specific niche within this sector (i.e., manufacturers of small series vehicles, the usual production figure being around 20,000 units per year); and off-highway, whose customers are manufacturers of vehicles

[4] Out of Fisal's five Business Lines this study focuses on the three most relevant (Automotive, Off-road and Wind Power), in terms of their representativeness and their intrinsic interest for the study.

related to public works and agriculture. The firm was focused mainly on the latter sector, which represented 60% - 70% of the business.

Departing from this on this situation, Fisal committed to business diversification and started looking for new geographical and industrial markets (i.e., in 2008 the company started offering brake systems to wind turbines manufacturers), which resulted in a clear segmentation of Fisal's customers base.

Reflecting this new reality, in 2009 the firm implemented the Business Lines organizational model. In the words of the manager of one of the UGVs, Fisal is dedicated to *'all the products involving brake systems; an automobile, an off-highway vehicle or wind turbines (…); the purpose of the Lines is (…) for leaders to be capable of mobilizing resources to (…) provide for all markets'*.

Indeed, the Business Lines system highlights a perspective focused on customers; it makes the organization of work and the allocation of the resources pivot around the goal of acquiring and keeping customers, and drives the efforts towards the improvement of speed and efficiency in assessing and satisfying customers' needs and in reacting to contingencies. Therefore, the introduction of this organizational innovation in the workplace contributes to value generation through the improvement of quality of customer service, in line with the results of a number of studies (Sapprasert and Clausen, 2012; Schmidt and Rammer, 2007).

b) Value proposition

Fisal's value proposition relies in its specialization in short series, the quality of the firm's own design and the possibility of serving customers throughout the whole process, from the initial phase of the project, through the design and validation of the prototype, to the serial manufacturing of a successful product. Vehicle manufacturers working with short series have more difficulties in accessing high quality components by comparison to those producing long series. Fisal orientates its staff and production management towards short production runs and can be competitive at levels as low as 5,000 units (though in general it works with around 20,000 units a year). Thus, producing well designed, quality niche products is an important differentiation on which to build a competitive advantage.

Although the focus on short series and in-house design is the general rule, the customer segmentation previously described involves offering specific products for each Business Line as well as differentiated treatment and approaches. Thus, while specialization in short series still prevails in the Automotive Line and it is essential to offer customers quality design in Off-Highway, price competitiveness is the main concern in Wind Power given that wind turbine manufacturers are undergoing a sharp reduction in profit margins. Therefore, the Business Lines model facilitates the assessment of the essential value proposition characteristics for each customer segment and thus allows for advancing on the most relevant aspects for each division and therefrom building a meaningful competitive advantage.

Business Lines contribute to assess relevant aspects and customers' needs, and the UGVs enable the offering of products which comply with these requirements and the shortening of waiting times –an aspect also observed by Sapprasert and Clausen (2012) and Schmidt and Rammer (2007)–, given that they improve the design and manufacturing processes and increase technical efficiency.

Furthermore, the vertical integration of the foundry allows for the offering of products at competitive prices. As mentioned before and stated by the manager of one of the UGVs: '*In the wind power sector, design is also important, but price issues are highly relevant. (…) We are very competitive here, because we have the foundry*'.

c) Key resources and key activities

Design, development and validation of prototypes are key activities in the firm. They ensure Fisal's capability to complete the whole process, from the reception of the initial request to the delivery of products specifically adapted to each customer's needs. In this regard, all efforts made in terms of knowledge and technological advances are particularly relevant. The firm has its own product development team of 15 designers, it assigns 10% of its turnover to R&D&I projects, and over the last decade it has taken part in different projects subsidized by the CDTI [Centre for the Development of Industrial Technology, Public Business Entity], many of them in partnership with other entities.

The implementation of the UGVs and Business Lines implies a significant improvement regarding the profiting from technological innovation results –consistently with studies highlighting the

moderating effect of organizational innovation on the performance of technological innovations (e.g., Sempere-Ripoll and Hervás-Oliver, 2014)–, given that it favors the development of synergies and the continuous transfer of knowledge across the different product families.

'*We can take technological features originally from off-highway products and apply them to short series automotive products, and the other way around (…): technology we brought from from other automotive companies and apply it to off-road products. The same happens with wind power (…) we bring in current wind power technology, and we are able to improve thanks to the knowledge we have acquired working in the off-road and automotive sectors. The relevant thing here is that synergies are being created among all the products and that we are always innovating.*' (Manager of one of the UGVs in Fisal)

Furthermore, the implementation of the UGVs had a positive impact on employees' motivation, an effect of organizational innovations observed by Sapprasert and Clausen (2012) and Laforet (2013). In the words of the General Manager of Fisal: '*we decided that workers should have the autonomy required to take part in decisions, feel useful and be satisfied (…). The organization system [based on UGVs] implies that employees can now visualize the whole process so it makes sense for everybody; thanks to it, they can assess the results through customer' and internal indicators; [the system also] promotes collective learning and proposals of ideas for improvement*'.

d) Income and cost flow

Revenues come mainly from product sales. Although in 1999 Fisal's net revenue experienced a decrease of 7% in relation to the previous year, the company then started a pattern of growth with the introduction of the UGV organizational system. This patter intensified in 2004, when the firm reached growth rate of 28% and continued growing up to 2007. Fisal's General Manager refers to the effect of the economic crisis in the following way: '*In 2008 turnover started to go down. In 2010, we took relevant measures and it gradually recovered and 2011 was better. (…) But this was the result of these organizational changes and the shift to the Business Lines system*'. Therefore, the Business Lines reduced the negative effects of the crisis on the firms's revenue. In this regard, Evangelista and Vezzani (2010) also highlighted the positive effect of organizational innovations on net revenues.

Regarding Fisal's costs structure, those related to design and manufacturing are worth noting in contrast to bigger companies in the automotive sector, whose strategy is based on the acquisition of manufactured material for assembling. However, the cost of materials is relevant for Fisal's Wind Power Line given that brake systems for wind turbines require expensive raw materials. Therefore, raw material cost control is an essential strategy in this Business Line, an issue which notably contributed to the vertical integration of the foundry in 2008. In this sense, cost reduction as a derived effect of organizational innovations has been pointed by scholars (e.g., Sapprasert and Clausen, 2012).

e) Key partnerships

This block in the analytical framework allows for adopting a systemic and open perspective in the study of the effect of organizational innovations, by taking into account the permeable nature of the firm's borders its relationship with external agents.

The main partnerships with external agents are related to R&D&I. Joint participations in product design and collaborations in technological innovation are common practice in Fisal and have evolved over many years. In the 1990s, when the firm specialized mainly in the off-highway sector, the most significant partnerships were with other brake manufacturers, thanks to which Fisal added new technologies for product development. Furthermore, the firm has relied on cooperation with its customers for product design and development for years.

Starting with the growth and diversification strategy launched in the first decade of 2000, the number and intensity of partnerships in technology development experienced an increase and Fisal began working with a diverse range of external agents.

'*Here we have ongoing partnerships with technological institutes and universities, an aspect which has always made us strong (…); we also work together with our competitors or with partners specialized in brake systems*', notes the manager of the UGVs. Regarding customers, she adds: '*we work together in each product design (…); customers require more and more design services from Frenos Iruña, because we have ever increasing responsibility in the design of their machinery'*.

This joint work provides Fisal with continuous improvement in product design and manufacturing, which is at times essential for prototype development. Such was the case when they

entered the wind power sector. In order to be able to provide brake systems to wind turbines manufacturers, Fisal did intensive work with two technological centers (one specialized in metallurgical research and one focused on technology for the automobile industry) so as to acquire the necessary skills for manufacturing the new prototypes and to set up suitable testing facilities for them.

As from 2009, collaborations with external agents were promoted and systematized following the logic of the Business Lines. While suppliers and customers are the key partners in the Automotive Line (where cooperation between Fisal and a car manufacturer to produce the brake system for an electric car prototype is worth highlighting), when it comes to the Off-Highway Line, joint work with universities is particularly relevant for the development of innovations and design and manufacturing of these products. As for the Wind Power Line, the aforementioned partnership with technological centers for new product development and testing facilities is worth noting. Ultimately, the market-focused perspective introduced by this organizational innovation drives the decisions related to collaborative technological innovations, thus allowing the knowledge provided by external sources to be translated into value generation, given that these partnerships are in line with the firm's commercial strategy.

Figure 2 and table 1 illustrate and summarize the implications of the organizational innovations carried out by Fisal.

Figure 2: Fisal's business model before and after the organizational innovation process.

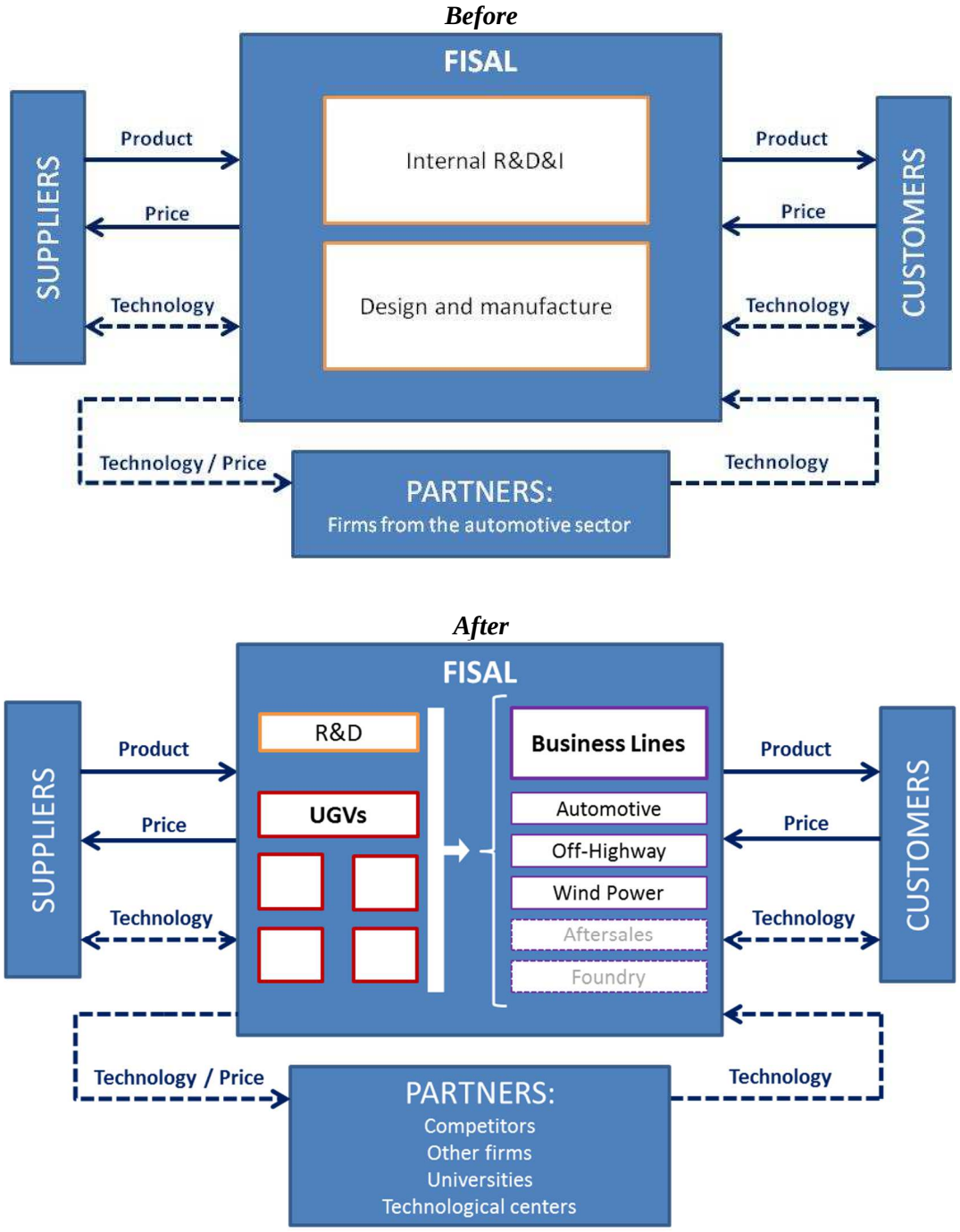


Table 1: Implications of the organizational innovations in Fisal

BUSINESS MODEL BLOCKS	BEFORE THE ORGANIZATIONAL INNOVATION PROCESS	AFTER THE ORGANIZATIONAL INNOVATION PROCESS	RELEVANT ORGANIZATIONAL INNOVATION / IMPLICATIONS FOR VALUE GENERATION
Customers	Focus on the off-highway segment.	Diversification of customer portfolio (new customers, new businesses and new geographical markets). Organization of activities and resources around the Business Lines: Automotive, Off-Highway and Wind Power.	**Business Lines**: Consolidation of customer perspective: efforts on customer acquisition, loyalty and satisfaction.
Value Proposition	Building competitive advantage based on specialization on short series and on design (indistinctly for each customer segment).	Building competitive advantage based on the differential aspects of each customer segment: • **Automotive**: short series (quality for small customers) • **Off- Highway**: design • **Wind Power**: price competitiveness	**UGVs:** Improvement of processes and waiting times. **Vertical Integration:** Competitive prices (especially relevant for the wind power division). **Business Lines:** Identification of the most relevant aspects for each customer segment.
Key Resources and activities	Design, development and validation work. Internal R&D&I.	Same key resources and activities.	**UGVs**: Improvement of staff motivation. **UGVs + Business Lines**: Transfer of knowledge and technology across the different product families.
Revenue and cost flow	Sales revenue. Main costs: product development and manufacturing.	No relevant variations in the revenue and cost structure.	**UGVs and Business Lines**: Positive effect on turnover. **Vertical Integration**: Control and reduction of raw material costs.
Key alliances	Other brake manufacturers: incorporation of their brake technology in Fisal. Customers and suppliers.	Extension of the range of external partners. Relevance according to different businesses: • **Automotive**: customers and suppliers • **Off-Road**: universities • **Wind Power**: technology centers	**Business Lines**: Systematization of partnerships according to the needs for developing the different markets.

5. CONCLUSIONS

The analytical framework of the business model applied to the case study has allowed for covering the complexity of the practices and processes of organizational innovation implemented and has shed light on the analysis of the way these practices contribute to value generation. The results derived from this analysis are presented below in the form of propositions. Following that, the limitations and contributions of this study will be outlined.

5.1. Propositions

Regarding the effect of the introduction of the UGVs and the Business Lines organizational models, the analysis revealed that these organizational innovations have a positive impact on the coordination of activities; they facilitate the identification of competitive advantages in each area and drive a re-direction of efforts towards expanding and maintaining a growing customer portfolio. These effects in turn result in the improvement of the relationship with customers and of the services provided. In this regard, empirical evidence has highlighted as direct effects of organizational innovation aspects such as improvement of goods and service quality, reduction of waiting times (Sapprasert and Clausen, 2012; Schmidt and Rammer, 2007) and an increase of sales turnover (Evangelista and Vezzani, 2010), an aspect also observed in the analysis of this case . In view of this, the following proposition is established:

Proposition 1: The introduction of organizational innovations in the workplace contributes to an increase of sales turnover thanks to the improvement of a series of aspects of the service provided to customers, such as fast and effective needs assessment, coordination of production processes and reduction of delivery times.

Furthermore, and in line with other studies (Sapprasert and Clausen, 2012; Laforet, 2013), the case study has shown the enhanced autonomy of UGV work teams, thus contributing to the improvement of staff motivation, an aspect included in the following proposition.

Proposition 2: Organizational innovations in the workplace contribute to improving the working atmosphere and to boosting staff motivation by assigning them responsibilities and autonomous decision making power.

Cost reduction as an effect of implementing organizational innovations has also been pointed out in the literature (Sapprasert and Clausen, 2012). In the case analyzed here, the vertical integration of the foundry enhanced competitive advantage, especially in the wind power business, as it allowed cost control of supplies, highly relevant in this business given that customers also value downward adjustments in prices. Therefore, the following proposition is laid out:

Proposition 3: Introducing organizational innovations in a firm's external relations aiming at integrating supply functions has positive effects on cost control and consequently on the building of competitive advantages based on competitive prices.

The analysis of key resources and activities is relevant for understanding the harnessing of joint implementation of organizational and technological innovation practices. In this regard, the literature has noted that the complementary adoption of organizational innovations optimizes the performance of technological innovations (Sempere-Ripoll and Hervás-Oliver, 2014; Hervás-Oliver et al. 2014; Hollen et al., 2013; Sapprasert and Clausen, 2012; Schmidt and Rammer, 2007). The case study reveals that the organizational system based on the UGVs and the Business Lines structures the necessary dynamics so that the knowledge acquired and the technological innovations applied to any given product family can flow towards other areas, which leads to the following proposition.

Proposition 4: Organizational innovations in the workplace allow for better exploitation of the results of technological innovations by facilitating a fluid transfer of technological advances and knowledge across the different areas of design and manufacturing.

The collaborative practices described in the block of key collaborations result in the integration of knowledge and technological advances, which are translated into the design and

manufacturing of the firm's products. The R&D&I system implemented by the firm, with permeable borders so as to integrate technology from external sources, was systematized and strengthened with the introduction of the Business Lines, which ensure that Fisal works from a market perspective. Thus, decisions in matters of collaborative technological innovations are taken consistently with the firm's commercial strategy, which facilitates that the knowledge and technological advances derived from external sources is translated into value generation. These results lead to the following proposition:

Proposition 5: Organizational innovations in the workplace allow for better exploitation of collaborative technological innovations through the systematization of these partnerships and their alignment with the firm's commercial strategy.

5.2. Limitations and contributions

The main limitation of this study lies in the qualitative nature of the analytical method applied, especially the fact that it is based on a single case study, which compromises the generalization of the results of the analysis. However, this methodology has been reported to be suitable for carrying out exploratory studies such as the one dealt with here in order to advance in the understanding of complex phenomena (Yin, 2003) and to suggest good practices (Huston and Sakkab, 2006).

In terms of contributions, this study delves into the research of the effects derived from organizational innovation practices, thus strengthening the body of literature in this field and contributing to addressing the weakness observed when it comes to understanding these effects *(Damanpour et al., 2009,* Sapprasert and Clausen, 2012*). The propositions laid out collect the results derived from the analysis of the case study and refer both to the positive impact of organizational innovation practices and to the logic underlying these effects. These propositions can be taken as a basis for carrying out future empirical studies.*

Furthermore, the results may be highly useful for business practice given that they not only help to better understand the impact of organizational innovation practices but they also

illustrate a set of good practices which can be a model, inspiration and reflection for agents in charge of innovation management within companies.

Finally, this study intends to provide support for those responsible of designing public policies. In this regard, it is worth noting that there is still not enough evidence to assess the exact and specific extent to which non-technological innovations contribute to economic growth and development. Moreover, this type of innovation practices have been claimed to be typically low-risk and low-cost (Som et al., 2012). Therefore, the legitimacy of public policies to support to this type of practices is still a matter of debate. Advances in knowledge of the effects of non-technological innovations are thus essential to resolve this ambiguity.

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CHAPTER II:
PROFITING FROM COLLABORATIVE INNOVATION PRACTICES: IDENTIFYING ORGANIZATIONAL SUCCESS FACTORS ALONG THE PROCESS

1. INTRODUCTION

Previous research has shown that the outcomes of collaborative innovation practices are positive, such as growth and higher innovation performance, but also that they lead to negative effects, such as the risk of the partner's opportunist behavior, technology leakages or appropriability problems (e.g., Kang and Kang, 2009). In this sense, firms' internal context has been recognized as crucial for explaining the effects of these practices on performance (e.g., Foss et al., 2011).

Therefore, this paper adopts a qualitative case study approach in order to identify the critical organizational context factors that might influence the success or failure of collaborative innovation practices. This particular research methodology is appropriate to advance the understanding of complex phenomena, to address analysis questions like 'how?' and 'why?' and to conduct research of inductive nature (Eisendhardt, 1989; Yin, 2003). The discussion of the three cases selected is conducted using as an analytical tool a conceptual construct that follows closely West and Bogers' proposal (2014) and covers the stages of the collaborative innovation process: development, integration and commercialization of the innovation.

Ultimately, this paper poses the following question: how do organizational factors affect the way companies profit from collaborative innovation practices?

In addressing this question and performing the analysis leading to its response, the objective pursued is the concretion of a theoretical framework that adopts a comprehensive view of the whole collaborative innovation process and unveils the critical organizational factors influencing the capitalization of collaborative innovation practices in each of the stages of the process.

This paper contributes to the literature and managerial practice, first, by making a theoretical contribution to innovation management research by considering organizational contextual factors as potential moderators on the success or failure of collaborative innovation

practices (Huizingh, 2011; West and Bogers, 2014). Secondly, it adopts a comprehensive view of the whole collaborative innovation process when examining the capitalization of said practices (West and Bogers, 2014). It thus aims to bring together the factor approach and the process approach that has characterised the research on innovation at the organizational level (Pichlak, 2016).

The rest of the paper is structured as follows: the next section addresses the antecedents in literature regarding the capitalization of collaborative innovation practices. Later, the methodology is explained, with special emphasis on the construction of the framework used for the analysis of the case studies. The next section is devoted to the discussion of the case analysis results and the presentation of the theoretical framework for the identification of the critical aspects determining the success of the collaborative innovation practices in each of the stages of the innovations process. Finally, a last section for the general conclusions is presented.

2. ANTECEDENTS

The systemic nature of innovation processes has been highlighted by various researchers (e.g., Dyer and Singh, 1998; Bayona et al., 2001), who note that companies typically innovate in collaboration and interdependence with various agents (other businesses, customers, suppliers, governments, universities, etc.).

In this sense, several studies have focused on the effect of R&D inter-organizational collaborations on firm performance (e.g., Faems et al., 2010; García-Martínez et al., 2016). Positive effects derived from the implementation of this kind of practices include growth, increased knowledge bases, customer satisfaction, revenues and profitability, higher innovation performance and the sharing of financial and organizational risk with collaboration partners (Kang and Kang, 2009; Dahlander and Gann, 2010; Tomlinson, 2010; Huizingh, 2011). However, the findings of positive effects on financial and innovation outcomes derived from R&D collaborative practices have been counterbalanced by studies showing that they also introduce certain disadvantages leading to negative effects on performance that might not be compensated by the potential benefits (Dahlander and Gann, 2010; Faems et al., 2010), such as the risk of the

partner's opportunist behavior, technology leakages or appropriability problems (Kang and Kang, 2009; Mazzola et al., 2012). Also, a study by Belderbos et al. (2010) presents evidence of the existence of limits to the benefits that might derive from the use of external sources of innovation, thus positioning their findings in the line of those obtained by Laursen and Salter (2006), who had already found a curvilinear relationship (in the form of an inverted U) between the use of said sources of innovation and the improvement of firm performance.

Regarding these findings, West and Bogers (2014) pointed to limits and potential moderators in the process of profiting from externally sourced innovations that are yet to be addressed and analysed, and Huizingh (2011) highlighted the need to provide further evidence on how firms may take full profit of these practices, taking into account the role of contextual aspects, which might play as determining success or failure factors. When addressing the internal context, the author categorizes them as demographic (including aspects such as size and age) and strategic, which imply purposeful acts that shape the characteristics of firms, such as strategic orientation and organizational culture.

This work focuses on this latest spectrum of the internal context, related to organizational factors derived from the strategic configurations of firms. Positing that the set of organizational context factors characterises and affects the effectiveness of collaborative innovation practices is aligned with the assumptions of the contingency theory and also implies the adoption of the resource-based view, which emphasises the role of internal attributes and resources in configuring the business strategy and ultimately in determining the effectiveness of performance (Vega-Jurado et al., 2008).

Thus, the internal context of the form has been recognized as crucial for the consolidation of innovation capabilities and for explaining their effect on innovative performance (Vega-Jurado et al., 2008; Urgal et al., 2011). Some studies have specifically addressed its importance when it comes to profiting from collaborative innovation practices (Foss et al., 2011; Segarra-Ciprés et al., 2014; Lazzarotti et al., 2016). Despite this recognition, it has been posited that organizational context stands to date as a fairly under researched aspect; Lazzarotti et al. (2016) highlight that most contributions on this matter usually focus on analysing internal context as a pre-condition

affecting the propensity to engage in R&D collaborations. Thus, a deep analysis of the role of these organizational factors on the capitalization of these practices is still lacking.

This is precisely the gap that this work aims to address, with the purpose of advancing an understanding of which specific organizational aspects might act as critical success factors influencing the outcomes of collaborative innovation practices. Previous literature has offered various categorizations of internal context aspects affecting the innovation process behaviour. For instance, Urgal et al. (2011) state a firms' internal climate prone to innovation is defined by the high management commitment and the participation of the members of the firm. Galende et al. (2003) mentions organizational resources among the internal determinants of innovative behaviour, including as such inter-functional synergies, intra-firm communication capabilities, knowledge management through teamwork, organizational excellence and the fostering of learning for external sources. Vega-Jurado et al. (2008) also posit organizational competences among the basic firm characteristics acting as determinants of innovation, which are related to administrative styles, the formalization of internal communication systems, and the interdependence of work teams.

More specifically, among the studies dealing with the role of the organizational context in collaborative innovation processes, Foss et al. (2011) links internal organization with structure, communication channels and reward systems; and Lazzarotti et al. (2016) define the internal context as capabilities facilitating an internal climate which favors knowledge sharing.

In line with this stream of research, this paper seeks to systemize the critical organizational factors affecting the capitalization of R&D collaborative practices through the different stages of the collaborative innovation process, thus contributing to the study of the potential moderators of the success of these practices, and adopting a comprehensive view of the whole process (West and Bogers, 2014; Pichlak, 2016).

3. METHODOLOGY

3.1. Research approach

This work adopts a qualitative case study approach; in particular, a multiple case study methodology will be used, conducting the analysis of the cases through the lens of an analytical framework based on the collaborative innovation process with the purpose of focusing, structuring and homogenising the description of the cases.

While it is important not to lose sight of the limitations of qualitative research based on case studies, particularly regarding the generalizing of its results, several authors have pointed out that this methodology is appropriate to advance the understanding of complex phenomena, to address analysis questions like 'how?' and 'why?' and to conduct research of inductive nature (Eisendhardt, 1989; Yin, 2003). Also, case studies are specially appropriate when a holistic perspective is needed to study a complex phenomenon (Gummesson, 2000), which is precisely what is intended to do here, as this work aims to take into consideration the whole process related to collaborative innovation practices carried out by a focal firm.

Three case studies were selected and analyzed; thus, a multi-case study is used, a method that aids triangulation and improves the generality of findings (Yin, 2003), making the research more robust overall (Herriot and Firestone, 1983).

3.2. Case studies selection

The selection of case studies relies on the concept of theoretical sampling (Eisenhardt and Graebner, 2007). As a basic criterion, all the cases should be established firms operating in the Spanish region of Navarre and engaged in collaborative innovation processes. In addition, the firms should represent different relevant industries in the territory, different sizes and different ownership structures.

The first case relates to Ingeteam, a company with over 1,500 employees and a turnover exceeding 200 million euros, part of a business group specialized in the development of electrical engineering. The second company, Fisal, is owned by its 75 employees, has an annual turnover of around 11 million euros and specializes in the design, development and production of brake

systems for cars, other vehicles and wind turbines. Finally, the third firm, Bodegas Ochoa, is a winery and one of the oldest producers of wine in its region, which has an annual turnover of 2 million euros and 18 employees. Thus, with regard to size, the cases refer to a large, medium and small firm, respectively. Each of them is dedicated to a different industry (electrical systems for wind turbines, brake systems for motor vehicles and gastronomic products), and presents different ownership structures (one is a corporation, another is owned by its workers and the third is a family business,). As stated, all these three factors were selection criteria. In addition, the study of the cases revealed singularities in the type of partnership carried out by each firm in order to develop technological innovations: the first firm partnered with a university, the second engaged in an alliance with a technological centre and the third collaborated with a supplier.

Table 1 provides an outline of relevant information of each of the cases.

Table 1. Cases outline

	CASE 1	**CASE 2**	**CASE 3**
Firm	Ingeteam Power Technology, SA (Ingeteam)	Frenos Iruña SAL (Fisal)	Bodegas Ochoa
Base	Zamudio,Vizcay, Spain	Pamplona, Navarre, Spain	Olite, Navarre, Spain
Origins	A merger dating back to 1990	Founded in 1956	Dates back more than six centuries
Ownership	Part of a corporation	Acquired by its employees in 1980	A family business
Size	The corporation in 2016 employed 3,800 workers and achieved a turnover of 483 million € (of which 1,570 workers and 211 million € correspond to the company studied).	In 2016, the firm's sales reached 11 million € and it employed 75 workers.	In 2016, the firm's sales were around 2 million €, and it employed 18 people.
Industry	Design, development and manufacture of electrical and electronic systems for wind turbines (within the energy division of the corporation).	Design, development and manufacture of brake systems for cars, industrial vehicles and wind turbines.	Manufacture of wine and gastronomic products.
Collaborative innovation practice	Collaboration between Ingeteam and a university for the purpose of developing new products with the technical characteristics necessary to expand the firm's customer portfolio.	Collaboration between Fisal and of a technology center to undertake the necessary adaptation of its product for the diversification into the wind sector.	Collaboration between the winery and a tree nursery with the purpose of developing the necessary knowledge to begin olive tree cultivation and thus expand its product offering.

The multiple nature of these case studies and the differences in the firms' size, the industries in which they operate, their legal form, structure of ownership and the type of partners with whom they engaged, help to strengthen the validity of the research (Eisenhardt, 1989) and enhance the generality of the results (Yin, 2003).

3.3. Data collection

The principle of triangulation (Jick, 1979) was respected by using multiple sources, strengthening the credibility of the information collected (Yin, 2003). Several in-depth interviews were conducted, both with internal agents, such as CEOs and other senior staff, and with significant external agents. The information derived from these interviews was complemented with financial statements, strategic plans, company presentations, industry reports and press releases (see table 2 for a relation of the data sources).

As for the most important source of information (i.e., the interviews), an initial protocol for a semi-structured interview was designed, consisting of a questionnaire covering all aspects relevant to the case analysis. However, this protocol did not imply a rigid framework for the content of the conversations, as the interviewees and interviewers were given room to deviate from the guidelines in order to focus on the most interesting aspects for the research. All the interviews were conducted by two interviewers, in order to complement the understanding of the phenomena treated and the proposal of focuses of interest, as well as to avoid potential observer bias (Eisenhardt, 1989). In addition, as stated before, more than one informant from each firm was interviewed (Kumar et al., 1993), and even external agents were contacted, in order to mitigate risk of informant bias and to control for the subjective judgement of individuals, thus increasing the construct validity (Jick, 1979; Gibbert et al., 2008).

Table 2. Data sources

	CASE 1	**CASE 2**	**CASE 3**
# of interviews	5	4	2
Interviewees	Manager of the Wind Power Division (2) Responsible of New Clients Area of the Wind Power Division (1)	CEO (2) Responsible of the Off-Highway Business Line (1) Technical Manager of the technological center (1)	Production, R&D and Quality Manager (1) Marketing Manager (1)

	Head of the research group from the University (1) Researcher from the University (1)		
Other data sources	- Annual reports - Website - Company brochures - Press coverage - Industry reports	- Annual reports - Website - Company brochures - Press coverage - Industry reports	- Annual reports - Website - Press coverage

Regarding the processing of the information, all the interviews were taped and transcribed verbatim to enhance subsequent analysis. Content obtained from the interviews was refined and extended through informal follow-up based on telephone calls and e-mails. Based on the information gathered thereby and from all the other sources, individual case reports for each firm were written and within-case analysis was performed (Eisenhardt, 1989; Yin, 2003). These case reports provided an overview on how each firm carried out its own collaborative innovation process and profited from it. Whenever missing data was revealed at this stage, the case material was complemented through additional data. Lastly, the firms were given access to these reports, to test their accuracy.

The individual case reports constituted the basis for performing the case analysis under the analytical framework proposed in this work.

3.4. Data analysis: the analytical framework

An analytical framework based on the collaborative innovation process is used in order to analyse the information gathered and processed from the three case studies. Said framework relies on previous literature on the logic of the innovation process carried out in collaboration with external agents. Several studies have focused on analyzing how firms profit from collaborative innovation practices through the application of theoretical models (e.g., Zahra and George, 2002; Dewangan and Godse, 2014; West and Bogers, 2014) following the traditional models of development, processing and commercialization of technology (Freeman, 1982; Teece, 1986). Following closely West and Bogers' proposal (2014), this work establishes an analytical framework

covering three stages: (1) development of the innovation with the collaborator, (2) integration and (3) commercialization of the innovation.

For purposes of structuring the analysis of each of the three cases, main items related to the challenges when profiting of collaborative innovation practices will be identified for each of the stages of the framework.

3.4.1. Development of the innovation in collaboration with the external agent

It has been frequently stated that selecting the right partner when intending to develop joint R&D activities might be the key to the success of the project (Kang and Kang, 2010). According to Gassmann and Enkel (2004), such success depends on the company being able to find a partner who provides the skills and knowledge necessary to gain a competitive advantage. In this sense, the diversity of the backgrounds of the partners has been considered a source of creativity and a success factor for innovation projects (Nooteboom, 2003). However, this diversity might also be a source of communication difficulties leading to conflicts and project failures (Tidd et al., 2001). The type of partner, thus, is a critical aspect to be taking into account when anticipating the existence of complementarities and, on the other hand, potential conflicts that might arise during the development of the innovation (Kang and Kang, 2010; García-Martínez et al., 2016).

In this regard, collaborations with competitors imply some specific problems, as they tend to be less stable (Dussauge et al., 2000) and can lead to opportunistic attitudes (Quintana-García and Benavides-Velasco, 2004). Obviously, much of the casuistry related to this type of conflict disappears when the partnership is carried out with companies from different sectors. Relationships with customers and suppliers are characterized by high levels of trust between partners (Langfield-Smith and Greenwood, 1998). On the other hand, partnerships held by private companies with universities and research centres tend to present their own set of recurring conflicts: for one thing, the latter parties have an interest in publishing the results of the investigation, revealing them to the general public, something that may harm the interests of firms; in addition, companies normally want to carry out projects more quickly than universities, to commercialize the application of research as soon as possible; finally, management practices

in public organizations differ markedly from those in firms (Bayona et al., 2004; Montoro-Sánchez and Mora-Valentín, 2006; Lazzaroti et al., 2016).

Also, the likelihood of conflicts arising in the course of the collaboration decreases in the face of a of strategic fit, that is, if the objectives of all partners are aligned (Mora-Valentín et al., 2004) and if the partners have already engaged in previous successful cooperative agreements (Park and Ungson, 1997), which reduces the risks of cultural incompatibility or of strategic objective collision and of opportunistic attitudes (Mora-Valentín et al., 2004; Teegen, 1998).

In any case, the conflicts arising during collaborative relationships may be resolved if the participants have the relational capacity to handle the relationship properly (Gassmann and Enkel, 2004).

Taking all this into account, the items of analysis for the first stage of the framework are listed as follows: (a) type of partner, (b) characteristics of the relationship with the partner (duration, previous experience), (c) objectives of the partners and (d) conflict management.

3.4.2. Integration of the innovation

According to the absorptive capacity theory, coined by Cohen and Levinthal (1990), for collaborative innovation practices to result in marketable technological innovations, the firm must have a sufficiently developed technological base (Cohen and Levinthal, 1990; Kim, 1997, 2001), which in turn depends on the efforts made by the focal firm in terms of internal R&D (Schoenmakers and Duysters, 2006). Therefore, internal R&D intensity or expense is normally considered a proxy for a firm's absorption capacity (West and Bogers, 2014). In general, studies confirm the postulates of Cohen and Levinthal (1990), as they show that firms with higher absorptive capacity are more likely to transform the knowledge and expertise of external partners into technological innovations, either because it accelerates the assimilation and commercialization of knowledge (Fabrizio, 2009), or because it enhances the benefits derived from the external source in terms of innovative capacity and financial results (Rothaermel and Alexandre, 2009).

Empirical evidence is more contradictory with regard to the relationship between internal R&D intensity and the propensity to engage in collaborative innovation activities. Indeed, while several authors find that firms' R&D capacity is positively related to their participation in collaborative agreements (Arora and Gambardella, 1994; Bayona et al., 2001; De Faria et al., 2010), Barge-Gil (2010) suggests that firms with a solid base of internal R&D are less interested in using external sources of innovation. This points to the existence of a substitution effect, which could be supported by the resources and capabilities theory: it seems logical that firms with a sufficient technological base do not need to reach for outside sources for the development of research projects. This reasoning may explain why managers might be reluctant to invest in both types of innovation sources, as they could perceive that to be a zero-sum game (Witzeman et al., 2006).

The analysis of the stage will thus address the following items: (a) the internal R&D base of the focal firm and (b) the complementarity between internally and externally sourced knowledge.

3.4.3. Commercialization of the innovation

The value created by the development and integration of technological innovation materializes through its delivery to customers, that is, when that innovation is commercialized.

Thus, it can be stated that the inherent value of a technology remains latent until it is commercialized, the extent to which its value is realized being contingent upon the manner in which that commercialization takes place (Chesbrough and Rosenbloom, 2002). On this point, Teece (2010) states that technological creativity that is not matched by business resourcefulness and creativity may not yield any value to the inventor at all.

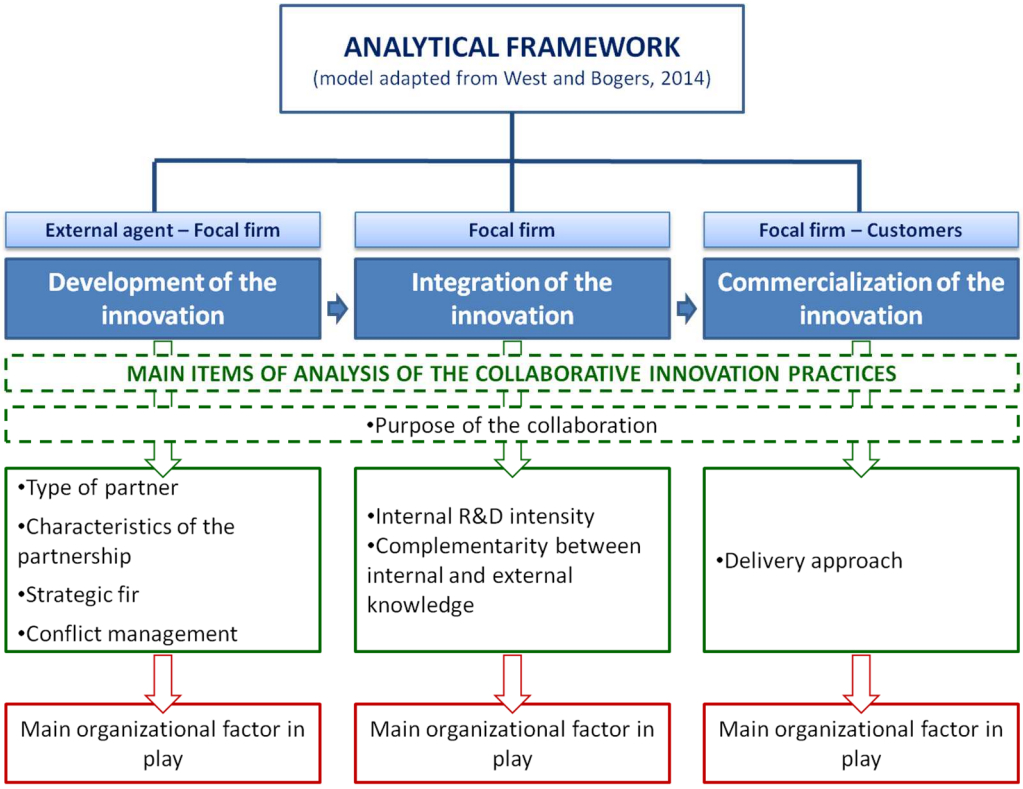
Summing up, the item of analysis derived for this stage of the framework is (a) the approach of the firm when delivering the innovation to the client.

The framework for the analysis of the case studies thus encompasses a list of items regarding each of the stages of the collaborative innovation process. Each of said items will be addressed with

the purpose of identifying the internal context factors that have influenced the failure or success of the development, integration and commercialization of the collaborative innovation.

Figure 1 shows the analytical framework described above.

Figure 1. Analytical framework



4. CASE STUDIES

This section provides the analysis of the collaborative innovation practices carried out by the firms from the perspective of the analytical framework described above. At the end of the section, table 3 offers a summary of the analysis, highlighting the particularities of each case regarding the main items of analysis, as well as the organizational context factors influencing the success of the development, integration and commercialization of the collaborative technological innovations.

4.1. Development of the innovation

The cases show singularities regarding the partnerships in which each of the firms engaged in order to pursue the development of innovations.

Ingeteam and the Public University of the region in which it operates joined forces in 2007 to develop the technology needed to adapt Ingeteam's offering to the technical requirements of a mature market that demanded concrete specifications for the equipment to be incorporated into wind turbines. However, this was not the first time the two organizations had engaged in a partnership; they had been already working together since 1996 and had built a solid tradition of collaboration in R&D.

As for Fisal, the firm worked intensively with a technological centre specializing in technology development for the automotive industry. The firm had decided to diversify towards the wind power sector, and thus needed to develop brake systems intended for wind turbines. In order to validate the new prototypes, Fisal turned to the technological centre to access the technical expertise required. The terms of the collaboration involved the technological centre in developing a test bench with the necessary capacity to test the new brake designs for wind turbines.

The relationship between Fisal and the technological centre predates the firm's diversification into the wind power market, as the partners had been collaborating in the context of the automotive sector.

Finally, to enter the olive oil business, Bodegas Ochoa relied on a collaboration with one of their suppliers, a tree nursery dedicated to the propagation of woodland plants. This relationship had previously developed thanks to the joint work carried out for the vineyard. It was due to this previous work and to the firm's decision to begin an olive tree plantation that the tree nursery suggested collaboration in order to test a new olive variety. In 2004, the two firms started the development of a joint project to optimize super-intensive cultivation of olive trees of the Aberquina variety.

Regarding the goal pursued by the partners, the collaboration between Ingeteam and the University benefits the partners in several aspects. Through this partnership, Ingeteam receives

R&D services from the University, which in turn receives monetary incentives and the opportunity to test the results of their basic research. In addition, the joint projects developed do not only result in technology acquisition by Ingeteam; on the contrary, they involve bidirectional flows of knowledge. Participating in collaborative projects with the firm provides a great opportunity for the University to define and guide its research into areas of interest, aligning them with the real problems arising during the implementation of the advances obtained in the laboratory.

'*This helps us to determine the lines on which we must continue. In many cases, the research lines we follow have been the result of problems detected in the equipment they [Ingeteam] have.*' (Head of the research group from the University)

As for the second case, the collaboration between Fisal and the technological centre to develop the test bench was an important opportunity for both companies. Thanks to working on the development of the test bench for the firm, the centre was able to provide other customers of the wind power sector with the acquired knowledge and technology. Thus, the collaboration with Fisal allowed the technological centre to initiate its own diversification process.

'*The centre had a great opportunity there, because it was starting to get stuck in the automotive sector. (…) Then we thought that we could diversify. And there we started. (...) Both parties have benefited: they [Fisal] have managed to move forward within their business and the centre got new customers.*' (Technical Manager of the technological centre)

Lastly, the research project carried out by Bodegas Ochoa and the tree nursery provided an opportunity for both firms to undertake the testing and development of new business. Planting crops in the grounds of the winery allowed the tree nursery to test both a new variety of plant and an innovative cultivation technique. For its part, Bodegas Ochoa entered a new sector with these products and innovative techniques thanks to knowledge developed through collaboration because, as the R&D Manager of the winery admits, '*they taught us how to work with the trees*'.

When analyzing the conflicts that could endanger the projects and the way the firms address and manage them, Bodegas Ochoa would be expected to be the least affected by conflicts derived from collision of goals and lack of trust, taking into account that the partnership in charge

of developing the olive trees was formed by the focal firm and one of its traditional providers. It's true that the partners have different backgrounds regarding their businesses and the specific markets they serve, but the complementarities between both firms are very high; in the end, both are framed within the same industry (production of wine).

On the other hand, Ingeteam and Fisal both engaged in collaborations with a public institution (a university and a technological center, respectively), and the potential for organizational and strategic differences between the partners to pose a risk for the project is therefore higher.

The partnership between Ingeteam and the University could be threatened, in principle, by differences in the way of organizing the work and managing time and administrative tasks and, specially, by the potential conflicts regarding the divulgation of the results derived from their joint projects. However, the partners expressed their deep satisfaction with the work carried out together, the results of their joint research activities not only contributing to the firm's technological development but also usually ending up being published in scientific journals.

'*They have always understood that we are a university, (...) and that we have certain needs, including publishing. They have always been open to this. We have published many of the projects (...) carried out with them, which have been profusely referenced.*' (Head of the research group at the University)

These partners have a long tradition of intensive cooperation in many fields maintained over the years. Ingeteam participates in activities with the University that go beyond the development of joint R&D projects, such as conferences, training courses and mentoring students' projects. Furthermore, it is important that the University is a source of human resources for Ingeteam (the firms' engineers working in joint projects with the University staff are usually ex-alumni) and that the partners share the same facilities (usually, at the University) in the course of the development of R&D projects.

For its part, and given the nature of the firm's collaborator, Fisal had to face the possibility that a competitor would hire the services of the technological centre for the validation of its own prototypes for the wind sector. In other words, part of the knowledge generated in collaboration

would necessarily be disseminated to other companies, including competitors. Fisal clearly understood the conditions of the collaboration and thus committed to the project, the partnership between the firm and the technological centre being a close and long-lived one strengthened over the years that promotes the communication and understanding between the workers of both organizations.

Both Ingeteam and Fisal made a point to state their team perspective. Ingeteam began its trajectory in the wind power sector developing extensive technological projects for its three clients, and prioritized the building of cohesive teams of members of both its organization and its clients' over protecting their know-how against them. As the Manager of the Wind Power Division explained: '*we set the standards [to run the electric system], and if they want a basic programming, we give it to them (…); we give them our know-how*'. Also, Ingeteam participates in a wide range of activities with the University, such as conferences, training courses and mentoring students' projects, in several occasions jointly with other firms, which also servers to illustrate the firm's willingness and capacity to coordinate team work. As for a Fisal, it is worth noting that the propriety of the firm belongs to its workforce, which is highly committed to the organization and very used to coordinate their efforts towards common goals.

'*When an initiative is to be fostered, a single group of four or five people can't pull the forces towards the change, even if they hold high directive positions; the changes and the decisions are driven by a team of fifteen, followed by thirty or so of the workers that have a very clear idea of the firm's strategy.*' (CEO at Fisal)

In conclusion, teamworking was found to be very valuable in both cases to leverage the benefits of working with partners of different backgrounds and at the same time mitigating the disadvantages of doing so.

4.2. Integration of the innovation

Ingeteam's continuous effort to develop its own technology is a key factor for its success. At the corporation level, R&D expenditure in 2013 was 27 million euros, and nearly 400 workers out of 2,800 were R&D staff. The Manager of the Wind Power Division of the company emphasizes the

importance of the firm's commitment to R&D even in times of recession: '*There is a high commitment to R&D (...). Since 2007 (...) the crisis has hit us, and yet, despite this, the R&D staff has been increasing.*' The consolidation of its own technological base has significantly contributed to the firm's ability to integrate effectively the results of the research carried out with the University.

As for the second case, the design, development and validation activities guarantee Fisal's capability to conduct the whole process from taking the client's order to the delivery of a product specifically tailored to the customer's needs. Fisal points out to this capability as one of the key factors in the success of its business. In this regard, efforts devoted to the development of knowledge and technology are particularly relevant. The firm has an internal team for product development, which employs about 15 designers, allocates 10% of its turnover to R&D and over the last 15 years has taken part in several State-funded R&D projects, many in collaboration with other entities. Fisal has established an organizational culture based on the innovative spirit, which encompasses both technical and organizational aspects. The joint design of a suitable test bench with the technological centre and the subsequent success of the project were possible thanks to the firm's technological capability and the knowledge acquired and consolidated along its trajectory of commitment to R&D.

Bodegas Ochoa's commitment to innovation is accomplished through ongoing research activities (1% of the budget is allocated for this purpose). This innovative spirit is manifested in many R&D projects undertaken by the firm. In this regard, it is noteworthy that it was the first Spanish winery to undertake a CDTI (Spanish public institution) project in 1994. Since then, it has continued to carry out projects funded by this institution, some in collaboration with other agents. '*We always have R&D projects in progress (...) and the change is constant*', said the R&D Manager. The absorption of the knowledge resulting from the joint research project with the tree nursery is guaranteed thanks to the involvement of the firm in the entire process and its technological capacity.

Also, the three firms proved to have a very permeable attitude towards their environment and the external agents with whom they might engage in order to obtain mutual benefits.

Ingeteam maintains an open attitude towards knowledge sharing with different partners. From the beginning of its activities in the wind power sector, the firm has driven its business relying on joint work with the manufacturers of wind turbines, so that the electrical equipment was designed in close collaboration between supplier and customer. Universities and technology centres have also been regular partners in order to develop the technology used by Ingeteam.

Joint participation in the design of products with customers, suppliers, competitors and other agents is common practice for Fisal. The collaborative philosophy is not limited to the development of materials and technology but also extends to commercial alliances: the company has embarked on a variety of initiatives (such as joint ventures and consortia) to enter new sectors and geographical markets. '*It's always good to share experiences with other firms that have undertaken similar challenges*', the Responsible of the Off-Highway Business Line of the firm said.

Collaboration with external agents is also an essential aspect for Bodegas Ochoa. '*In virtually all R&D projects we undertake, we have a collaboration with the University for the vineyard. (...) We can always learn more about our vineyard*', the Production, R&D and Quality Manager of the firm stated.

In this sense, the relationship between the internally and externally sourced innovations carried out by these three firms can be stated to be complementary, the culture of openness towards external agents cultivated by these firms contributing to their propensity to engage with both types of sources and to their taking profit from them.

4.3. Commercialization of the innovation

In 2007, Ingeteam considered diversifying its customer portfolio because of the mature state of the wind power industry: turbine manufacturers had become key players and the sector had accumulated the experience needed to determine the technical specifications for wind turbine components and thus demand standardized products from their suppliers. Until then, the business Ingeteam had developed was based on the design and manufacture of highly customized electrical equipment for a small group of customers. Changing the rules of the market led to the need to

develop new products that could meet the customers' requirements, for whose sake Ingeteam worked in close cooperation with the University.

'*Somehow, especially when it's a time of crisis, we realize that we had passed from a situation in 2008, when we still had just three customers (...), to see that there are many manufacturers of wind turbines. Commercially, we must make a major effort, and we need to address that.*' (Manager of the Wind Power Division of Ingeteam)

Also, Ingeteam states finding it of utmost importance that the clients consider them as more than a mere provider and trust them as if they were partners. That's where the firm focuses its added value, in offering their clients the assistance of high skilled technicians to solve their problems and thus differentiate themselves from their competitors, who are mostly big sized firms unable to provide those kind of human resources as a regular contact for their clients.

'*When we attend fairs and visit clients, a technical specialist is always working hand in hand with the marketing representatives, and thus we are able to offer a comprehensive description of our services and to solve any doubts the potential clients might pose*.' (Manager of the Wind Power Division of Ingeteam)

When Fisal approached the technology centre with the proposal for the test bench development, it had already decided to diversify its offer to the wind power market. This decision bore fruit following the participation of the company, in 2008, in a program to promote intersectoral cooperation for regional innovation, which gave them the opportunity to make their first contacts in the sector. Also, in 2009, the firm implemented an organizational restructuration, the Business Lines, according to the different market segments addressed by the firm, in order to guarantee the development of all said markets, consolidating the traditional business while fostering the new ventures. This new organizational structure emphasizes the commercial approach, prioritizing the customers' capture and fidelization activities of each of the Lines.

'*We took this decision because we saw the need to go to the market. The purpose was to foster the commercial part, but with people who clearly understood the history of Fisal, our values, our product.*' (CEO at Fisal)

As for the third case, the winery has a clear commitment towards the continuous development of new products that meet the demands of the market. Thus, the main idea behind the decision of Bodegas Ochoa to produce olive oil was to include a gastronomic element in its offer in order to give greater value to their direct customers (distributors) and have more resources to reach final consumers. After the first olive harvest in 2006, the company began commercializing its new product: extra virgin olive oil, which since then has complemented and strengthened its product range.

'*Our customers value that we offer a complementary product of the Mediterranean diet, without being forced to buy in bulk. If you have a very wide range, in which case, you include the oil, you have more chances with potential customers.*' (Marketing Manager at Bodegas Ochoa)

Bodegas Ochoa also stresses the importance of maintaining a direct relationship with all the agents that take part in the distribution of their products, as each of them may be '*ambassadors of the Bodegas Ochoa brand*', as the Marketing Manger states. Also, the firm takes into high consideration the opinions and recommendations offered by their clients, distributors and final consumers when developing their products. In the words of the R&D and Quality Manager, '*a good product is the result of a tight collaboration between the provider and the consumers*'.

It is clear, thus, that all three firms had a very focused view of the market potentialities of the innovations they intended to develop, and that this view played a major part in the monetarization of the innovations in each case.

Table 3. Summary of the analysis

	Development	Integration	Commercialization
	CASE STUDIES ANALYSIS OUTLINE		
Ingeteam	**Purpose of cooperation**: Adapting the supply of electrical systems for wind turbines to the specifications of a mature market.		
	Partner: University. **Relationship**: Dates back a long time. Has covered different fields (R&D, teaching, knowledge dissemination). Strong ties among the staff of both organizations. **Strategic fit**: Firm gets staff and technology; university gets validation of research results, guidelines to focus its research, and publication opportunities. **Conflict management**: Potential conflicts (secrecy vs publication interests) overcome thanks to fluid communication and mutual understanding of the partner's needs.	**Internal R&D base**: Great effort in internally sourced R&D and development of own design, even in times of economic recession. Strong technology base ensures proper assimilation of the knowledge developed with the University and its transformation into the new product offering technology. **Complementarities of internally and externally sourced knowledge**: Permeable attitude towards knowledge exchange (intensive joint work with traditional customers to develop their electrical systems; traditional collaboration with several universities and research centers for the development of research projects).	**Approach to the delivery to clients**: Innovation framed within diversification strategy (from joint development of electrical systems with few clients to providing standardized products to a wider market). Firms focuses its added value in providing their customers with high skilled technicians as a permanent contact.
Fisal	**Purpose of cooperation**: Developing a test bench for validation of new brake prototypes for wind power sector.		
	Partner: Technological center. **Relationship**: Dates back a long time. Has covered R&D collaborations for automotive sector. Strong ties among the staff of both organizations. **Strategic fit**: Alignment of strategic objectives (diversification into the wind power industry). Firm gets prototype validation to launch new products onto a new market. Technological center gets opportunity to start its own diversification process. **Conflict management**: Potential conflicts (spread of the jointly generated knowledge to firm's competitors) overcome thanks to fluid communication and mutual understanding of the partner's needs.	**Internal R&D base**: Strong commitment to internal R&D and design. Innovative culture also extends to organizational aspects. Strong R&D base allows the detection of a technology gap to develop the new initiative and ensures that the firm is able to provide knowledge for the development of the test bench, and thus exploit the results of the collaboration. **Complementarities of internally and externally sourced knowledge**: Permeable attitude towards knowledge exchange (firm has spent years consolidating a culture of collaboration, both for technological and commercial purposes).	**Approach to the delivery to clients**: Innovation framed within diversification strategy (from automotive industry to wind power sector). Firm restructured its organizational model according to the different Business Lines (market segments) addressed.

Bodegas Ochoa	**Purpose of cooperation**: Developing olive cultivation with certain technical characteristics in order to embark on the production of olive oil.		
	Partner: Tree nursery; supplier. **Relationship**: Dates back a long time. Has covered collaborations for the vineyard. **Strategic fit**: Alignment of strategic objectives. Testing of an olive tree variety and an innovative cultivation technique, involving great business opportunities for both partners. **Conflict management**: No important potential conflicts detected. Client-supplier type partnership.	**Internal R&D base**: Strong commitment to internal R&D (numerous R&D projects; first winery to be funded to develop an R&D project). Firm's R&D and knowledge base allowed it to assimilate the expertise developed in collaboration with the tree nursery. **Complementarities of internally and externally sourced knowledge**: Permeable attitude towards knowledge exchange (many of the R&D projects are carried out in collaboration with external agents).	**Approach to the delivery to clients**: Innovation framed within product range expansion strategy (complementing wine with olive oil). Firm stresses the importance of maintaining a direct relationship clients, distributors and final consumers and taking into consideration their recommendations when developing their products.
	MAIN ORGANIZATIONAL CONTEXT FACTORS IN PLAY		
	Teamworking	**Openness and permeability**	**Customer orientation**

5. DISCUSSION AND THEORETICAL MODEL

The discussion of the results derived from the analysis of the case studies is structured, as the previous section, following the stages of the collaborative innovation process. At the end of this section, the theoretical framework and its corresponding propositions materializing the results of the research are presented.

5.1. Development of the innovation

Literature has extensively settled that the type of partner with whom a focal firm collaborates in order to develop an innovation has a crucial importance regarding the complementarities and competitive advantages that said partner might bring into the project (Gassmann and Enkel, 2004), but may also pose a serious risk of conflict if the partners' backgrounds are very diverse (Tidd et al., 2001).

The analysis of the cases showed that the collaboration between Bodegas Ochoa and the tree nursery, one of the winery's suppliers, proved to be driven conflict-free, in line with extant literature stating that relationships with customers and suppliers are characterized by high levels of trust between partners (Langfield-Smith and Greenwood, 1998).

On the other hand, Ingeteam and Fisal engaged in innovation projects with public institutions whose objectives and management practices didn't specifically align with their partners', a circumstance that is also consistent with the traditional set of recurring conflicts between private companies and universities or technological centres pointed out by the literature (i.e, Montoro-Sánchez and Mora-Valentín, 2006). Therefore, the relational capacity (Gassmann and Enkel, 2004) to handle the potential conflicts that could arise from the diversity of the partners' backgrounds became paramount for the success of the collaborations held by Ingeteam and Fisal.

Overcoming the potential difficulties with their partners required both Ingeteam and Fisal to be willing to share the benefits derived from the joint projects to an extent that could pose certain threats to them, which implied a predisposition towards collectivism. Also, the ability to coordinate complex tasks with a partner that presents substantial differences in the way to organize work and that serves in a different industry is necessary. Thus, the internal context factor that contributed to the success of the joint development of the innovation with the external partner was teamworking.

5.2. Integration of the innovation

In all three cases, the consolidation of their own technological base has significantly contributed to the firms' ability to integrate effectively the results of the research carried out with their partners, in line with the absorptive capacity theory (Cohen and Levinthal, 1990).

However, a perspective based on the resources and capabilities theory could suggest the existence of a substitution effect between internally and externally sourced innovations, as in explaining that those firms with high internal R&D resources are less interested in using external sources of innovation (Barge-Gil, 2010). The fact remains, thus, that investing in internal R&D

resources seems to be indispensable to profit from collaborative innovation practices while it might also hinder the propensity to engage in such practices.

The three cases show that all the firms studied, which have a successful tradition of internal innovation, have nevertheless overcome constructs distinctive of 'closed' innovators, such as the 'not invented here' syndrome (Katz and Allen, 1982). Indeed, all of them have developed an organizational culture that relies on openness towards their environment and external agents.

Thus, openness and permeability is identified as the organizational factor that explains the propensity to collaborate with external parties for R&D purposes, even though the firms have a strong internal technological base, thus pointing to the existence of a complementary rather than a substitution effect between internally and externally sourced innovation practices.

5.3. Commercialization of the innovation

The case analysis shows that all three firms decided to resort to their respective collaborations motivated by the desire to enter new markets (in the case of Ingeteam and Fisal) or to enlarge their product range to better serve their customers (in the case of Bodegas Ochoa). That is, in all three cases the decision to develop a technological innovation jointly with an external agent obeyed to a strategic direction taken beforehand in alignment with the particular needs and evolution detected in their respective markets.

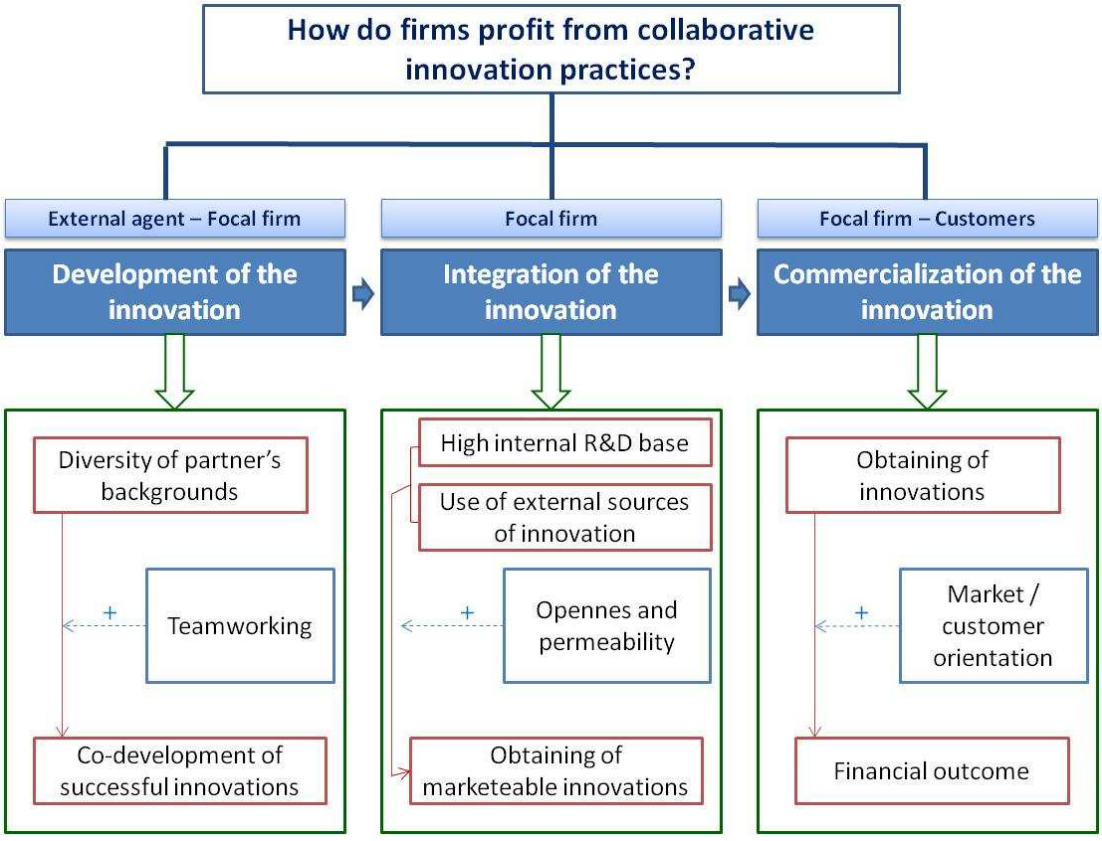
As stated in literature, to fully benefit from technological innovations resulting from the joint effort in collaboration with external agents, the focal company must transform them into a deliverable customer offering (Chesbrough and Rosenbloom, 2002), with features such as to enable a corresponding increase in price, and thus capture some of the value generated.

Accordingly, the three firms had taken into account both the particularities arising from the technological innovation and the characteristics of the market in which it would be commercialized. Also, all of the firms emphasized the importance of focusing on their clients and devoting their resources to their capture and fidelization.

Therefore, a customer orientation perspective is the organizational factor positively affecting the relationship between the generation of a technological innovation and the realization of its value.

The resulting framework regarding the profiting of collaborative innovation practices and the effect of internal context is shown below in figure 2:

Figure 2. Theoretical framework for the capitalization of collaborative innovation practices, addressing the organizational context factors influencing the success of each stage.



6. CONCLUSIONS

When studying the effects performance of collaborative innovation, literature has addressed the existence of certain disadvantages that might not be compensated by the potential benefits (Dahlander and Gann, 2010; Faems et al., 2010). In this sense, some authors have stated the need to provide further evidence on the potential influence of

moderating contextual factors in the process of profiting from externally sourced innovations (West and Bogers, 2014; Huizingh, 2011).

Therefore, the ultimate purpose of this work was to determine whether internal context factors affect the way in which companies profit from collaborative innovation practices, and to materialize the findings in the proposal of a theoretical framework to inform the effects of organizational factors on the capitalization of said practices in each of the stages of the collaborative innovation process.

The results derived from the analysis of the case studies and incorporated into the theoretical framework could be summarized as follows.

In the phase for the joint development of the innovation, the organizational factor influencing the success of the stage is teamworking, which has a positive effect on the relationship between the partners' background diversity and the successful development of collaborative innovations.

As for the integration stage, an open and permeable organizational culture favours a complementary effect between the use of both internal and external sources of innovation, thus presenting a positive effect between the joint development of internal and collaborative innovation practices and the obtaining of marketable innovations.

Finally, in the commercialization phase, a market approach positively affects the relationship between the obtaining of marketable collaborative innovations and the financial outcome of the firm.

The relevance of this study lies in the attention paid to the problems that the literature has identified as worthy of investigation, such as the study of organizational contextual factors as potential moderators on the capitalization of collaborative innovation practices and adopting a comprehensive view of the whole process (West and Bogers, 2014). Moreover, the results can be useful for business practice, because they contribute to a better understanding of the impact of innovative activities, and the thick descriptions of the cases illustrate a set of best practices that

can serve as models, inspiration and reflection for the agents in charge of innovation management in firms.

Regarding the limitations of this research, the generalization of the theoretical implications is challenging due to the methodology used, for they have been derived from the analysis of three case studies. However, as explained above, measures to guarantee the validity of the qualitative analysis have been taken. In any case, it would be convenient to test the theoretical framework proposed here by means of quantitative methods such as the estimation of direct and moderating causal effects of the aspects identified on performance measures for each of the stages of the collaborative innovation process, which constitutes an interesting opportunity for further research.

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CHAPTER III:
ORGANIZATIONAL INNOVATION AND TECHNOLOGICAL INNOVATIVE PERFORMANCE: DIRECT AND MODERATING EFFECTS ON INTERNALLY AND EXTERNALLY SOURCED INNOVATION PRACTICES

1. INTRODUCTION

The purpose of this paper is to determine whether organizational innovation affects innovative performance (that is, the generation of product and process innovations), be it directly or through a moderating effect on internal R&D and externally sourced innovation practices. For a long time, research on innovation management focused mainly on technological innovation as a fostering aspect for firm performance and economic growth (Fagerberg, 1994; Grossman and Helpman, 1994). As Schmidt and Rammer (2005) pointed out, this technological approach to the innovation phenomenon has been criticized, among other reasons, because it fails to provide a comprehensive picture of the innovative efforts firms engage in across all economic sectors. Also, scholars have pointed out the need to broaden the scope on the concept, signaling that the positive impact of innovation is not limited to the practices that imply high technology or high investment on internal R&D activities (e.g., Marsili and Salter, 2006). A systematic and holistic view on the innovation phenomenon should thus take into account the fact that firms engage in innovative activities that transcend the boundaries of their organizations and explicitly include the consideration of non-technological activities that may also constitute a source of innovation.

As for overcoming the strict internal view on innovation, it is worth noting the contribution embodied in vast literature dealing with the innovation practices carried out in collaboration with external agents (Dyer and Singh, 1998; Nooteboom, 1999). Particularly, the current study focuses on innovation practices encompassing all those activities aiming to integrate knowledge, resources and expertise from external agents, via cooperation agreements or less formalized procedures, such as the external sourcing of knowledge and ideas.

Also, the importance of broadening the scope of the innovation conceptualization towards non-technological aspects dates back a few decades; indeed, the seminal work by Nelson and Winter (1982) emphasized the relevance of firm organization as a variable for analysis in its own

right and stated that an evolutionary theory should consider organizational innovation just as it treats technical innovation. In line with these postulates, more recent research has recognized that innovation is not just about developing and applying new technologies but also about adopting and re-organizing business routines, internal organization, external relations and marketing (see Boer and During, 2001; Baranano, 2003). Accordingly, interest in the field is growing steadily, and this has been reflected in the ever-growing body of works devoted to the study of non-technological innovations (e.g., Hervás-Oliver and Sempere-Ripoll, 2015).

In line with this trend, the present study addresses the effects that the introduction of organizational innovations may have on the probability of obtaining successful technological innovations, as well as their potential moderating effect on the influence that internal and external innovation practices have on innovative performance. It is worth pointing out that the perspective held in the current work views organizational innovation as an *input* in the innovation process, thus affecting innovative performance, understood here as the generation of technological innovations. This view is in line with a stream of literature that suggests that organizational innovation enhances flexibility and creativity, which in turn facilitates the development of technological innovations (see Mothe and Nguyen-Thi, 2010).

As previously pointed out, the relationship between technological and organizational innovations has not been sufficiently analyzed (Battisti and Stoneman, 2010). On the one hand, the effects of implementing organizational innovation on technological innovative performance are still under researched. Some studies found a positive effect of implementing organizational innovations on the generation of process innovations, while also identifying insufficient evidence to sustain the existence of an effect on the realization of product innovations (Gunday et al., 2011; Cozzarin, 2017). Mothe and Nguyen-Thi (2010 and 2012), nevertheless, have obtained results that point precisely to a positive impact of organizational innovation on the probability of developing product innovations.

On the other hand, previous research addressing the potential benefits of combining technological and non-technological innovation generally has examined whether the

implementation of organizational innovations enhances the influence of technological innovation outputs (i.e., product and process innovation) on firm performance (e.g., Schmidt and Rammer, 2007; Sapprasert and Clausen, 2012; Sempere-Ripoll and Hervás-Oliver, 2014). Other works have focused on determining the potential interactions between organizational innovations and collaborative innovation activities (Foss et al., 2011; Hecker and Ganter, 2016). However, contributions regarding the potential combinative effect of organizational innovation and R&D activities on the probability of obtaining such successful outputs is still lacking. Also, to our knowledge no empirical quantitative study has used a longitudinal approach to deal with the interactive effects of combining organizational innovation with technological innovation practices in an inter-organizational context.

To address this research gap, the objective of this paper is to adopt a comprehensive view on the innovation phenomenon and explore (i) whether the introduction of organizational innovations affects the probability of obtaining successful product and/or process innovations, and (ii) whether organizational innovation leverages the effects that internally and externally sourced innovation practices have on said technological innovative performance.

For this purpose, random-effects univariate and bivariate probit models are estimated, in order to analyze the causal effects of the set of innovation practices described above on the probability of obtaining successful technological innovations in the following scenarios: the generation of product innovations, the generation of process innovations and the generation of both types of technological innovations. The dataset employed collects information for more than 11,000 Spanish firms from 2008 to 2013.

This paper contributes to the innovation management literature by offering a refined insight on the combinations and interactions among different types of innovation practices, thus taking a comprehensive view of the innovation phenomenon, which has stepped aside from a strictly technological and isolated perspective to encompass non-technological aspects and a systemic view. In line with the resource-based view and a socio-technical perspective, this work tackles on the idea that technological and non-technological innovation activities reinforce one

another and should be jointly implemented and harmonized in order to optimize performance. In this sense, there are still few contributions that focus on the complementarity of R&D and organizational innovation practices, and these tend to consider organizational innovation as an *output* that, together with product and process innovations, have a combinative effect on other measures of performance. This work posits, notwithstanding, organizational innovation as an *input* with a causal effect on the generation of product and process innovations. There are few studies that adopt this perspective and, to our knowledge, there is no contribution to date that examines the potential complementary effect of organizational and internal R&D activities on the generation of product and process innovations, as this work does.

Also, this work relies on the estimation and analysis of average marginal effects in order to determine the existence of direct and moderating effects. Prominent scholars have been warning against the use of estimated coefficients in non linear models to draw conclusions on the causal effects of the independent variables, especially when said models include interaction terms (e.g., Hoetker, 2007; Norton et al., 2004). However, the estimation of marginal effects has been rarely used in previous studies focusing on the influences of innovation practices (see for instance the works by Ganter and Hecker from 2013 and 2015). Thus, this study aims to contribute to the consolidation of the aforementioned methodology in the field of innovation management.

Lastly, this research sheds light on the intricate nature of the relationships arising between organizational and technological (both internally and externally sourced) innovation practices and helps to better understand how firms might benefit from their joint adoption, which might be of interest for practitioners and policy makers alike. Indeed, results draw some interesting conclusions on the complementary or substitutive nature of the combination of technological and non-technological innovation activities, offering insight on how to make better profit of their joint implementation.

The remainder of the paper is structured as follows: first a literature review on the effects of organizational and technological (internally and externally oriented) innovation is presented, in order to establish the hypotheses of the study; the research design and the data used are

described in the methodology section; the results are then presented and discussed; finally, some conclusions are offered, together with the exposition of the limitations and main contributions of the study.

2. ANTECEDENTS AND HYPOTHESIS DEVELOPMENT

2.1. Baseline hypotheses

Technological competences developed internally, generally measured by R&D intensity, have been widely recognized as one of the organizational characteristics acting as a determinant affecting the realization of successful technological innovations (e.g., Love and Ropper, 1999). Many studies focusing on this particular antecedent of innovative performance adopt the resource-based view, which highlights the role played by internal attributes in a business strategy and thus consider internal innovation activities as a 'basic competence' (Leornard-Barton, 1992; Tidd, 2000) for innovative performance. As Mairesse and Mohnen (2010) stated, efforts on developing internal R&D competencies constitute the most often reported explanation of innovation output.

More recent works confirm the acknowledged effects of R&D on increasing the probability of success of technological innovations (e.g., Peters et al., 2013; Conte and Vivarelli, 2014). Finally, even research adopting an open perspective on the innovation phenomenon (i.e., studies dealing with the effects of collaborative innovation activities), hypothesizes that investments in internal R&D help firms to capitalize on external sources of innovation; in line with the theory of absorptive capacity coined by Cohen and Levinthal (1990), the results of these studies confirming the benefits derived from a strong internal R&D base (see West and Bogers, 2014).

Thus, a positive effect is expected for engaging in internal innovation practices on the probability of obtaining technological innovations (both for the case of product and process innovations).

H1: The engagement in internal R&D activities positively affects the probability of obtaining successful technological innovations.

Research on inter-organizational R&D practices constitutes one of the most significant contributions to the literature on innovation management. Indeed, the systemic nature of the innovation phenomenon was pointed out by several authors (e.g., Dyer and Singh, 1998; Nooteboom, 1999) long before Henry Chesbrough coined the term 'open innovation' in 2003[5], based on the idea that in the innovation process, the search for, development and marketing of innovations is carried out with the participation of an external actor (Enkel et al., 2009). Exploring this notion, Gassman and Enkel (2004) introduced the concept of coupled processes to refer to the joint development of knowledge and technology with external partners through inter-firm collaborations where each party commits some resources and assets. In this sense, coupled open innovation practices are essentially a cooperative pattern for R&D to obtain and give complementary know-how (Mazzola et al., 2012) and thus a clear link is drawn between the coupled innovation concept and the vast literature on R&D inter-organizational collaborations.

This study focuses on those practices that intend to enrich the firm's knowledge base through the integration of knowledge, resources, and expertise from external partners such as customers, suppliers, competitors and research institutes (Dahlander and Gann, 2010), be it through collaborative agreements or through less formalized procedures that aim for the insourcing of external knowledge and ideas. A large number of studies have shown the positive effects derived from the implementation of collaborative innovation practices on technological innovative performance. Specifically, some contributions have shown that the probability of realizing product innovations is enhanced by engaging in joint R&D activities with external partners (e.g., Vonortas, 1997; Koschatzky et al., 2001; Plunket et al., 2001; Becker and Dietz, 2004; Un et al., 2010; Nieto and Santamaría, 2007; Bayona-Sáez et al., 2017). As Un and Asakawa (2015) pointed out, most of these studies indicate that inter-organizational R&D practices are important for achieving product innovation because they provide the external

[5] See special Issues in Technovation (Volume 31, Issue 1), R&D Management (Volume 40, Issue 3) or European Journal of Innovation Management (Volume 14, Issue 4).

knowledge that firms need to obtain product innovations, and state that this stream of literature often assumes that insights from studies of product innovation can be applied to process innovation, without directly focusing on determining the effect on the latter.

Regarding the activities focused not so much on carrying out joint R&D projects but more particularly on sourcing knowledge and ideas from outside the firm, previous research has also consistently highlighted the importance of such practices in order to enhance innovative performance (e.g., Laursen and Salter, 2006; Greco et al., 2016) and, specifically, on the generation of product and process innovations (Gómez et al., 2016; Bayona-Sáez et al., 2017).

Taking into account these contributions, the following baseline hypothesis is established:

H2: The engagement in externally sourced innovation activities positively affects the probability of obtaining successful technological innovations.

2.2. Hypotheses on the direct and moderating effect of organizational innovation

There are a wide variety of approaches to the term organizational innovation (Lam, 2006; Armbruster et al., 2008)[6]. By introducing it as a type of innovation, together with the traditional concepts of product and process innovations, the third edition of the Oslo Manual (OECD and Eurostat, 2005:51) provided the widest known and used definition of organizational innovation for empirical research and allows for comparability among European studies (Som et al., 2012). According to the Manual, organizational innovation is '*the introduction of a new organizational method in the business practices, the organization of the workplace or the external relations of the firm*'.

Research on organizational innovation is still relatively scant but constitutes a steadily growing body of literature (Schmidt and Rammer, 2007; Damanpour et al., 2009; Sapprasert and Clausen, 2012), and it has been recognized as a source of competitive advantage (Battisti and

[6] A review of the conceptualization of the term can be consulted in Hervás-Olivier and Sempere-Ripoll (2015).

Iona, 2009; Mol and Birkinshaw, 2009) and a support for technological innovation in a context of increasing competition fueled by globalization (Ayerbe, 2006).

Since Schumpeter (1934), it has been widely acknowledged that there are strong complementarities between different forms of innovation. Scholars have stressed the importance of integrating product, process and organizational innovation for successfully transferring new ideas and new business opportunities into market success (see Tidd et al., 2005; Cozzarin and Perzival 2006). Thus, there is a common understanding that innovations influence each other and should be implemented jointly (Walker, 2004). Contributions pointing out specifically the close relationship between organizational and technological innovations are abundant and date back a few decades (e.g., Burns and Stalker, 1961; Kimberly and Evanisko, 1981).

While most of the works examining this relationship focus on the pathway from technological to organizational innovation, highlighting that the introduction of the first calls for the reorganization of the firm's systems, another research stream emphasizes an inverse direction in the relationship, suggesting that organizational innovation facilitates creativity and flexibility, thus leading to better technological innovative performance (Haned et al., 2004; Le Bas et al., 2015).

Damanpour and Evan (1984) based the justification of both pathways of this relationship on the socio-technical systems framework. The socio-technical perspective posits that the social and the technical systems have to pair up into a single and integrated system (Trist and Bamforth, 1951). It is thus paramount to pay close attention to both systems so that they operate jointly and in due balance. Therefore, the framework implies that changes in one system are normally followed by adequate changes in the other one, in a correlative relationship between the two. The authors explain that the balance and adequacy in this correlation are normally understood as the social system being rearranged around the technical system, changes in the social system being generally introduced out of necessity after the implementation of technical changes. They posit, nevertheless, that despite the perceptions among managers and academia that might lead firms to follow this direction, the inverse correlation is due considering, and justify that alterations in the

social system might pave the path for successful technical changes and, indeed, have a greater impact in the whole system. Drawing on Daft (1978), the authors explain that organizational (or 'administrative') innovations tend to originate from high management spheres and spread from there to the rest of the organization, while technological innovations tend to spur from the particular operative area. Considering that high management takes into account the overall performance of the firm, it is thus in an invaluable position to provide the adequate conditions for the introduction of technological innovations.

More recent contributions provide further justification of the influence of organizational innovation on the technical system. Haned et al. (2014) stated that the former has crucial influences on competitive advantages and firm innovation, in the sense that they provide input for firm innovation processes and innovation capabilities. Also, Le Bas et al. (2015) explained that firms devoting resources to new organizational forms and practices should be better suited to efficiently manage new knowledge and technologies.

Literature has also provided empirical evidence on the positive effect of organizational innovation on innovative performance. For instance, Damanpour and Evan (1984), after performing a study on 85 public libraries, found that the more organizational innovations were adopted in a given period, the more technological innovations were likely to be adopted in the subsequent period. Gunday et al. (2011) relied on a dataset of 184 manufacturing firms in Turkey and concluded that organizational innovation led to the generation of process innovations, but did not find evidence to sustain the same effect for product innovations. The study by Cozzarin (2017) drew similar conclusions. The author employed a cross-section dataset derived from a Canadian national survey, the SIBS 2009, which uses the terminology proposed by the Oslo Manual, containing information from more than 2,500 manufacturing firms. The results of the study provided little evidence on the effect of organizational innovation on product innovation, but showed that organizational innovations in business practices and in external relations have a positive effect on the number of process innovations generated.

In contrast, the causal analysis performed by Mothe and Nguyen-Thi (2010 and 2012) on a sample of 555 firms of the CIS4 for Luxembourg evidenced that organizational innovation has a positive influence on the likelihood of obtaining product innovations. Finally, Gallego et al. (2012) drawing on the CIS4 dataset for 18 countries, stated that firms undertaking organizational innovation practices are more likely to implement product or process innovations.

Based on the theoretical and empirical literature described above, a positive direct effect is thus expected for organizational innovation on the probability of generating product and process innovations:

H3: The introduction of organizational innovations positively affects the probability of obtaining successful technological innovations.

As stated before, the development of internal R&D activities has proven to be a key aspect affecting the generation of successful product and process innovations. Also, the implementation of organizational innovation is arguably another relevant aspect for innovative performance. The independent effect of these two different types of innovation practices might be accompanied by an enhancing effect derived from their joint implementation. Indeed, from a resource-based view, it can be stated that the joint adoption of technological and organizational innovation practices allows for the consolidation of an integrated system of interrelated assets and capabilities which mutually reinforce one another (Porter, 1996; Rivkin, 2000; Hervás-Oliver and Semepere-Ripoll, 2015).

Some empirical studies confirm these postulates of complementarity between technological and non-technological innovations (e.g., Schmidt and Rammer, 2007; Battisti and Stoneman, 2010; Sapprasert and Clausen, 2012; Hervás-Oliver and Sempere-Ripoll, 2015), but all of them draw conclusions on the combinative effect between organizational innovation and technological innovation *outputs* on other measures of performance, such as sales of novelties, cost reduction and competitiveness.

The focus in this work, nevertheless, considers organizational innovation as an *input* (Haned et al., 2014) whose implementation affects the likelihood of obtaining those technological innovation *outputs*. Thus, the potential complementarity of interest here implies the joint adoption of organizational and technological innovation *practices*, understanding the latter as R&D and innovation activities, not as the *output* of the process.

To our knowledge, there is no contribution to date that examines the potential complementary effect of organizational and internal R&D activities on technological innovative performance, that is, on the probability of obtaining successful product and process innovations. However, Lokshin et al. (2008) already posited that firms combining customer, technological and organizational skills, such as team cohesiveness and slack time, experience a synergetic effect and are more successful in generating technological innovations.

Coming back to the resource-based view of the firm, the combination of different types of resources has been highlighted for purposes of acquiring a sustainable competitive advantage. In this sense, the joint implementation of organizational and R&D innovation practices might lead to the configuration of a complex innovation system, enhancing technological innovation capabilities, and thus building on a unique and inimitable resource base.

Accordingly, the hypothesis presented in this work regarding the joint effect of internal R&D activities and organizational innovation on technological innovative performance states the following:

H4: The introduction of organizational innovations leverages the positive effect of the implementation of internal R&D practices on the probability of obtaining successful technological innovations.

Despite the aforementioned positive effects of externally sourced innovation practices on firm performance posited by the scientific literature, the need to provide further evidence on how firms may take full profit of these practices has been pointed out, together with the role of contextual factors on determining their success or failure (Huizingh, 2011). Among said

contextual factors, the internal context stands as a fairly under researched aspect, despite having been recognized as crucial for explaining the effects of open innovation practices on performance (Foss, Husted and Michailova, 2010) and the existence of studies stating that the organizational and social context needs to be suitable for the implementation of these practices (Lazzarotti and Manzini, 2009; Wallin and Von Krogh, 2010). Indeed, the engagement with externally sourced innovation practices brings about a range of challenges resulting from the growth in complexity, which in turn requires adequate organizational responses and mechanisms for managing resources and knowledge. Consequently, organizational innovation could play an important role, as a manifestation of the internal context of the firm that might determine the success of the implementation of externally sourced innovation practices.

There are studies that have tackled this subject from a conceptual perspective. For instance, Anzola-Román et al. (2015), using a case study methodology to unveil the logic of value creation through organizational innovation, showed that firms might indeed optimize their efforts aimed at developing technology together with external agents thanks to the implementation of organizational innovations in the workplace. More specifically, Hollen et al. (2013) used illustrations from established manufacturing firms to develop a series of propositions on how organizational innovation might affect innovative performance. In particular, the study explained how different subtypes of organizational innovations enable the success of the development phase of technological innovations when said phase is carried out in external test facilities. In other words, the authors concluded that successfully performing the development phase of technological process innovation in the inter-organizational context of an external test facility requires organizational innovation.

Hecker and Ganter (2016) provided an interesting contribution on the understanding of how externally oriented innovation activities might enhance the effect of different types of organizational innovations on technological innovative performance. Their study, drawing on cross-sectional data of German firms, found some support for the existence of positive interaction effects between the external orientation of R&D and the impact of organizational innovation.

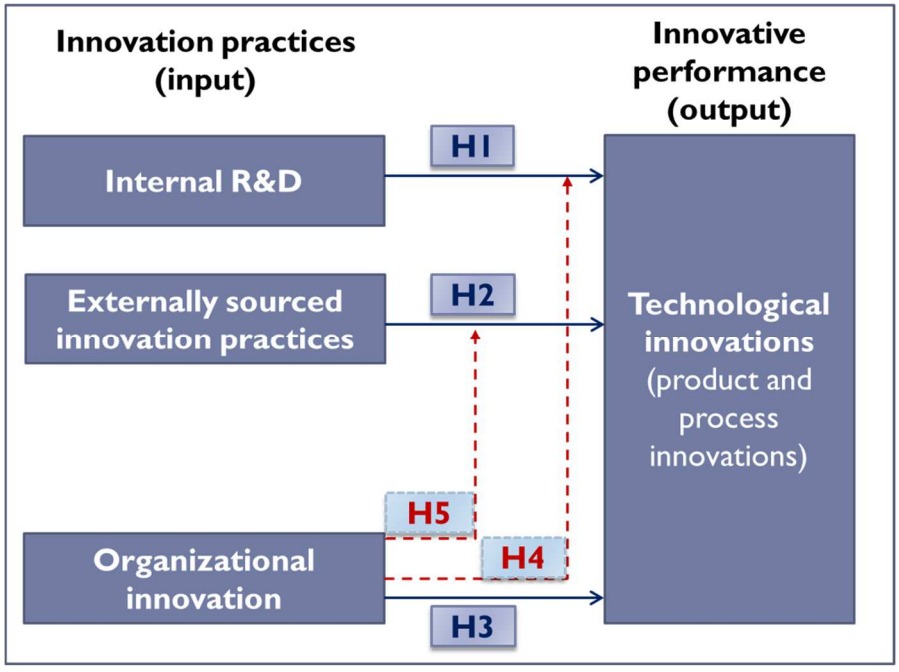
They found some evidence of complementarity between external R&D orientation and organizational innovation (in knowledge management) regarding the effect on product innovation while showing that organizational innovation (in external relations) has a more distinct positive effect for process innovations.

Taking into consideration the literature addressed, the last hypothesis of this work would read as follows:

H5: The introduction of organizational innovations leverages the positive effect of the implementation of externally sourced innovation practices on the probability of obtaining successful technological innovations.

Figure 1 offers a conceptualization of the hypothesis developed in this section.

Figure 1. Conceptual framework on the effects of different innovation practices on innovative performance



3. DATA AND METHODOLOGY

3.1. Database and mathematical formulation of the model

The study uses the information from the Spanish PITEC panel database, which collects data on a wide range of aspects related to firms' innovation activities and performances. This survey has its origins in Community Innovation Survey (CIS), produced at a supra-national level. CIS collects data on a wide range of aspects related to firms' innovation activities and performances.

The final dataset, after applying filters to remove firms with less than 10 employees or less than 4 consecutive observations, comprises 51,289 observations pertaining to 9,586 Spanish firms from 2008 to 2013.

Taking into account the longitudinal nature of the sample, the conceptualization of the theoretical model established in the previous section can be formulated as follows:

$$\begin{aligned}\mathbf{Tech\_inn_{it}} = {} & \alpha + \beta_1 * IntInn_{it-1} + \beta_2 * ExtSour_{it-1} + \beta_3 * CoopAgr_{it-1} + \beta_4 * OrgInn_{it-1} + \\ & \beta_5 * IntInnxOrgInn_{it-1} + \beta_6 * ExtSourxOrgInn_{it-1} + \beta_7 * CoopAgrxOrgInn_{it-1} + \\ & \beta_{10} * Size\_large_{it-1} + \beta_{11} * Size\_medium_{it-1} + \beta_{12} * Sector\_hightech_{it-1} + \\ & \beta_{13} * Sector\_mediumtech_{it-1} + \beta_{14} * Year2008_i + \beta_{15} * Year2009_i + \\ & \beta_{16} * Year2010_i + \beta_{17} * Year2011_i + \beta_{18} * Year2012_i + \upsilon_i + \varepsilon_{it}\end{aligned}$$

υ_i accounting for the existence of individual-specific, time-invariant effects; this assumption calls for the estimation of the model through panel data techniques (in particular, this study uses random effects models).

As observed, all the independent and control variables are lagged one period in order to avoid endogeneity, simultaneity and reverse causality problems, which are quite common when using CIS data (Mairesse and Mohnen, 2010). Lagged-variable models have been shown to possess superior predictive validity, particularly when measuring innovative outcomes (Bradley et al., 2010).

3.2. Variables

The set of dependent variables (**TechInn**) is based on the questions about having or not having obtained product or process innovations in the period in which the survey was filled out or the two preceding periods. Different econometric models are estimated, according to the disaggregation of this construct into three variables: **ProdInn**, **ProcInn** and **JointTechInn**, which account for the fact of having or not having obtained product, process and both types (both product and product) of technological innovations, respectively. The third edition of the Oslo Manual (OECD and Eurostat, 2005) defines product innovation as the introduction of a new (or significantly improved) good or service, with newness being related to the characteristics or the use of the product; and process innovation as the introduction of a new (or significantly improved) production or delivery method.

The independent variable **IntInn** (internal innovation) is constructed based on the survey questions referring to whether the firm did or did not perform internal R&D in the specific period and, if so, whether it was on a regular basis or just occasionally. Therefore, the variable takes values 0, 1 or 2, for the cases in which the firm did not innovate internally, did so occasionally or performed internal innovation at a constant pace, respectively.

As for the construct related to externally sourced innovation practices, CIS poses two different sets of questions, one regarding the importance that various external information sources had on innovation practices in the current period or the two preceding, and the other related to the existence of collaboration agreements for innovation with several outside parties for the current period or the two preceding periods. The first set of questions is used to construct the variable **ExtSour**, focusing on the fact of having or not having used these external sources in order to search for ideas for innovation, and matching the value of the variable with the number of sources used. In this way, the variable ranges from 0 to 7. The second set of questions leads to the construction of the variable **CoopAgr**, which ranges from 0 to 7, depending on the different types of external actors (i.e., suppliers, clients, competitors, consultants, universities, public research

institutes and R&D private centers) the firm has engaged with in order to carry out cooperative innovation agreements.

The definition of organizational innovations provided in the Oslo Manual 2005 serves as the basis for the questions on this matter. The Manual distinguishes between three different subtypes of organizational innovation:

- a new method in the practices for the organization of procedures and work,
- a new method in the organization of the workplace, in order to better attribute responsibilities and decision power, and/or
- a new method in the external relations of the firm.

Accordingly, in the CIS survey firms are asked whether they have or have not implemented each subtype of organizational innovation in the current period or the two preceding periods. The variable **OrgInn** (organizational innovation) in this study captures whether the firm has implemented organizational innovation, and is thus constructed as a dichotomous variable that takes a value of 1 if the firm has engaged in any of the previously categorized types of organizational innovation and 0 if it has not.

In order to capture the eventual moderating effect of organizational innovation, the model includes the **multiplicative variables** combining each of the three variables referring to technological innovation activities (i.e., IntInn, ExtInn and ColInn) with the organizational innovation indicator.

Checks for outliers and multicollinearity (via the variance inflation factor) were performed (see Table 2 in the next section). Also, dummy variables were introduced in order to control for the effect of firm size, the technology intensity of the industry sector and the years.

Table 1 sums up the variables used in the analyses and explains their construction.

Table 1. Variables

Variable	Label	Description
DEPENDENT VARIABLE		
Product innovation	ProdInn	Dichotomic variables referring to the fact of having or not obtained each kind of innovations in periods n, n-1 and n-2.
Process innovation	ProcInn	
Product and process innovation	JointTechInn	
INDEPENDENT VARIABLES		
Internal innovation	IntInn	Introduction of internal innovation in period n. Values: 0 if no innovation; 1 if occasional innovation; 2 if regular innovation.
External Sourcing of Ideas	ExtSour	Use of external information sources in periods n, n-1 and n-2. Values: 0 if no use; 1-7 according to how many external sources have been used.
Cooperative Agreements	CoopAgr	Cooperative agreements with outside parties in periods n, n-1 and n-2. Values: 0 if no agreement; 1-7 according to with how many external agents the firm has established a collaboration with.
Organizational innovation	OrgInn	Introduction of organizational innovation in periods n, n-1 and n-2. Values: 0, 1.
Internal Innovation x Organizational Innovation	IntInnxOrgInn	Multiplicative variable
External Sourcing of Ideas x Organizational innovation	ExtSourxOrgInn	Multiplicative variable
Cooperative Agreements x Organizational innovation	CoopAgrxOrgInn	Multiplicative variable
Firm sector	Sector_hightech	Dichotomic dummy
	Sector_mediumtech	Dichotomic dummy
Firm size	Size_large	Dichotomic dummy
	Size_medium	Dichotomic dummy
Years	Year:20xx	Dichotomic dummies for years 2008 to 2012

3.3. Econometric techniques for the analysis

The estimation techniques used in this study consist of **two different random effects probit models**. On the one hand, in order to determine the causal effects of the different innovation

practices on product and process innovation, the study relies on the estimation of a random effects **bivariate probit model**[7], thus taking into account the interdependencies that might exist between the two dichotomous dependent variables (i.e., product and process innovations). Bivariate probit models are a generalization of the probit model that imply two binary dependent variables and allow for correlation between the error terms of the two equations, which are assumed to follow a normal distribution with a mean of zero, while maintaining all other standard assumptions for the probit model.

$$\begin{bmatrix}\varepsilon_1\\ \varepsilon_2\end{bmatrix} \mid X \sim N\left(\begin{bmatrix}0\\ 0\end{bmatrix}, \begin{bmatrix}1 & \rho\\ \rho & 1\end{bmatrix}\right)$$

The estimation of the correlation coefficient □ between the residuals of the two equations allows for testing the pertinence of using the bivariate model as opposed to two separate univariate models: whenever the estimated □ parameter is statistically significant, the assumption that the error terms of the two separate equations are correlated cannot be ruled out, and thus the estimation should rely on a bivariate model.

In addition to the estimation of causal effects on product and process innovations independently, this study is complemented by the estimation of a **random effects univariate probit model**, in order to test for the effects on the probability of obtaining both types of technological innovations jointly (that is, using the construct JointTechInn as the dependent variable).

It is worth noting that the interpretation of the results in non linear models demands special attention (Hoetker, 2007). Basing the interpretation on the estimated coefficients might lead to misleading analysis, especially considering that the main focus of the study relies on the interpretation of interactions. The parameters of the probit model, like those of any non linear model, are not the marginal effects. Thus, reporting on the significance and level of non linear model coefficients, though methodologically correct, does not provide useful information for the

[7] The estimation of the model is conducted using the Stata command *cmp* developed by Roodman (2011).

analysis. Moreover, the coefficient of the interaction terms cannot be interpreted as meaningful with regard to the magnitude and also the sign, as there can be a significant interaction effect even if the coefficient of the multiplicative variable is not significant, and vice versa.

Therefore, this paper discusses the estimated marginal effects of the explicative variables. In the case of a probit model, the marginal effect is not constant along the whole range of values of the dependent variable, as is the case for linear models: the effect of a change in one explanatory variable depends on the value of the other variables in the model. Average marginal effects (henceforward, AMEs), also called average partial effects, as calculated in this work, account for the effects of the variable averaged across the sample: that is, the method used offers the marginal effect of a given variable setting the rest of the explanatory variables at the values obtained for each of the responses in the sample and then averaging the results. This method of calculating AMEs is the one favored by current practice (see, e.g., Wooldridge, 2002).

4. RESULTS AND DISCUSSION

The following table shows descriptive statistics and the pairwise correlation coefficients (including significance level) of the variables in the model.

Table 2. Descriptive statistics, correlations and VIFs

Variables	Obs.	Mean	St. D.	Pairwise correlations							
				1	2	3	4	5	6	7	VIF
1. ProdInn	51,289	0.48	-	1							
2. ProcInn	51,289	0.51	-	0.39 ***	1						
3. JointTechInn	51,289	0.34	-	0.76 ***	0.70 ***	1					
4. IntInn	43,721	0.84	0.94	0.54 ***	0.35 ***	0.45 ***	1				2.67
5. CoopAg	31,804	1.03	1.71	0.21 ***	0.14 ***	0.24 ***	0.33 ***	1			4.43

6. ExtSour	31,804	4.14	2.47	0.26 ***	0.13 ***	0.24 ***	0.43 ***	0.40 ***	1		2.53
7. OrgInn	43,721	0.43	-	0.31 ***	0.37 ***	0.36 ***	0.34 ***	0.22 ***	0.23 ***	1	4.45
8. IntInnxOrgInn											5.22
9. ColInnxOrgInn											5.33
10. ExtSourxOrgInn											7.39

*p <0.05; **p <0.01; ***p <0.001

Correlation values among independent variables are generally low to moderate suggesting low multicollinearity risks. The highest correlation between two pairs of explicative variables is 0.43 (independent variables), far less than the problematic level (0.75) (Tsui et al., 1995). This is confirmed by the analysis of the variance of inflation factors (VIF): the maximum VIF value is 7.39, below the rule of thumb cut-off of 10, which again indicates that there are no serious multicollinearity problems in the models (Neter et al., 1996).

4.1. Effects on the likelihood of obtaining product and/or process innovations independently

Turning now to the analysis of the causal effects, table 3 shows the estimations of the hierarchical random effects bivariate probit model. As can be seen, the Pseudo R^2 measure reflects a progressive increase of the explicative capacity of the hierarchical models, especially when introducing the variables IntInn, ColInn, ExtSour and OrgInn to the model with the control variables.

Table 3. Estimations for the random effects bivariate probit model

	Model 1.1	**Model 1.2**	**Model 1.3**
DEPENDENT VARIABLE #1			
ProdInn			
INDEPENDENT VARIALES			
IntInn		0.55***	0.53***
ExtSour		0.07***	0.07**

CoopAgr		0.14***	0.13*
ExtSour		0.07***	0.07**
OrgInn		0.32***	0.26
IntInnxOrgInn			0.04
ExtSourxOrgInn			0.00
CoopAgrxOrgInn			0.01
Size_large	0.04	0.03	0.03
Size_medium	0.23	0.03	0.03
Sector_hightech	1.74***	0.68***	0.68***
Sector_mediumtech	1.13***	0.64***	0.64***
Year dummies	Yes	Yes	Yes
Constant	-1.29***	-1.36***	-1.33***
DEPENDENT VARIABLE #2			
ProcInn			
INDEPENDENT VARIALES			
IntInn		0.14**	0.09
ExtSour		0.05**	0.03
CoopAgr		0.10***	0.10**
OrgInn		0.56***	0.32*
IntInnxOrgInn			0.11
ExtSourxOrgInn			0.04
CoopAgrxOrgInn			-0.01
Size_large	0.52**	0.67***	0.67***
Size_medium	0.45**	0.35***	0.35***
Sector_hightech	0.60**	-0.11	-0.11
Sector_mediumtech	0.33	-0.10	-0.10
Year dummies	Yes	Yes	Yes
Constant	-1.04***	-0.87***	-0.78***

□	0.45***	0.28***	0.28***
Pseudo R^2	-37,956.071	-29,141.418	-29,122.692

*p <0.05; **p <0.01; ***p <0.001

It is worth noting that the coefficient □ is significantly different from zero. This indicates that the error terms of the two different equations (for product and process innovation dependent variables) are correlated and thus confirms the validity of the bivariate probit model.

Drawing on the results of model 1.2, the estimated coefficients of the explanatory variables IntInn, ColInn, ExtSour and OrgInn are all positive and significant, thus pointing to a positive direct effect of all four variables of innovation practices. This interpretation is confirmed by the results of the estimation of the AMEs of these variables[8], and their confidence intervals[9]. As shown in Figure 2, the confidence intervals of the AMEs for all the explanatory variables IntInn, ColInn, ExtSour, and OrgInn are above zero. Internal innovation and externally sourced innovation practices have a positive impact on the probability of obtaining successful technological innovations (both for the case of obtaining product innovations and for the case of obtaining process innovations), thus confirming the baseline hypothesis of this work. This is consistent with the commonly accepted understanding of the positive direct effects of said practices on innovative performance, widely acknowledged by the literature.

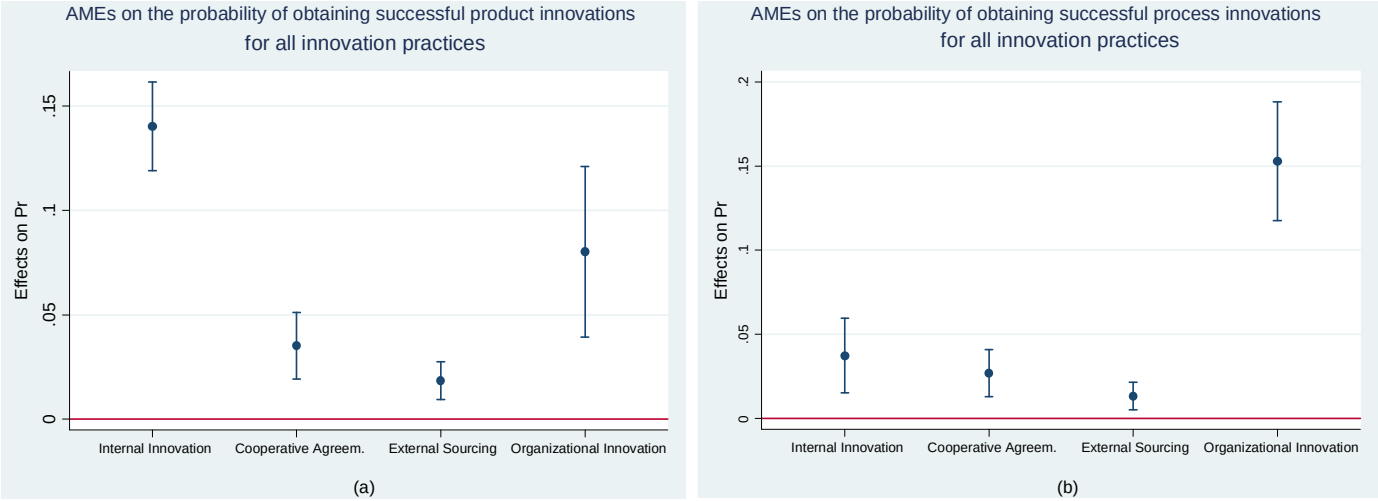
Also, the results point to a positive direct effect of organizational innovation for both cases; that is, organizational innovation increases the probability of obtaining successful product and process innovations, in line with hypothesis 3. However, observing the AMEs depicted in Figure 2, it is perceptible that in order to obtain process innovations, organizational innovations have a more relevant role than the rest of the innovation practices analyzed in this work, while the results related to the generation of product innovations show a particular prominent effect of

[8] AMEs are calculated referring to the model including the interaction terms (model 1.3).

[9] All AME intervals are calculated with a 95% confidence level.

the internal R&D activities. This finding is in line with previous literature addressing that, out of the two types of technological innovations, process innovation has been considered to present the most complementary relationship with organizational innovation (Womack et al., 1990), as organizational and technological process innovation capabilities usually reinforce each other (Hollen et al., 2013). Beyond their differences, process and organizational innovations share several common characteristics: both types of innovation are mainly oriented to increase business efficiency and effectiveness, via improvement of delivery lead-times, decrease of operational costs or increase in performance and quality of production processes (i.e., see Camisón and Villar-López, 2012 and Hervás-Oliver and Sempere-Ripoll, 2015).

Figure 2. AMEs for all innovation practices (obtained from the bivariate probit model)



Focusing now on the analysis of the potential moderating effect of organizational innovation on the influence of internally and externally sourced innovation practices on innovative performance, AMEs are calculated for IntInn, ColInn and ExtSour, contrasting the results between the presence and absence of organizational innovation. Subsequently, a traditional

Wald test is performed in order to test for the significance of the difference between the effects for presence and absence of organizational innovation[10].

Results suggest that engaging in organizational innovation does not moderate the effect of technological innovation practices on innovative performance (see Figures 3, 4 and 5). Indeed, the confidence intervals of the difference between the AMEs in the presence and absence of organizational innovation show that these differences are not statistically significant. Only in one case was this difference significant: as shown in Figure 3b, there is evidence that firms perform better in absence of organizational innovation, in terms of the effect of internal innovation on the probability of obtaining successful product innovations, particularly when engaging more frequently in these innovation activities, thus pointing to a substitutive effect between organizational innovation and internal innovation. This result suggests that, in order to obtain product innovations, the efforts made in internal R&D activities pay off better in the absence of organizational innovation practices. This could point to the existence of colliding forces drawing from the simultaneous engagement in both types of innovation activities, in the sense that the dedication of time and efforts on the implementation of organizational innovation might be draining resources away from effectively profiting from the internal innovation activities being undertaken. It is worth noting that the generation of product innovations is particularly influenced by the engagement in internal innovation activities, as mentioned previously. Frequent engagement in internal R&D activities in order to obtain product innovations could be reflecting a profile of firms highly committed to the development of in-house technology, with established procedures to carry out the innovation processes, whose workers might feel destabilized by the introduction of organizational changes. In this sense, firms with a strong focus on their internal technological innovation activities should be careful when implementing organizational innovations, so as to avoid the risk of collision of the latter with the ongoing R&D practices.

[10] Intervals for the differences between AMEs are calculated with a 95% confidence level.

Figure 3. Contrasting AMEs in presence and in absence of organizational innovation, for internal innovation (obtained from the bivariate probit model)

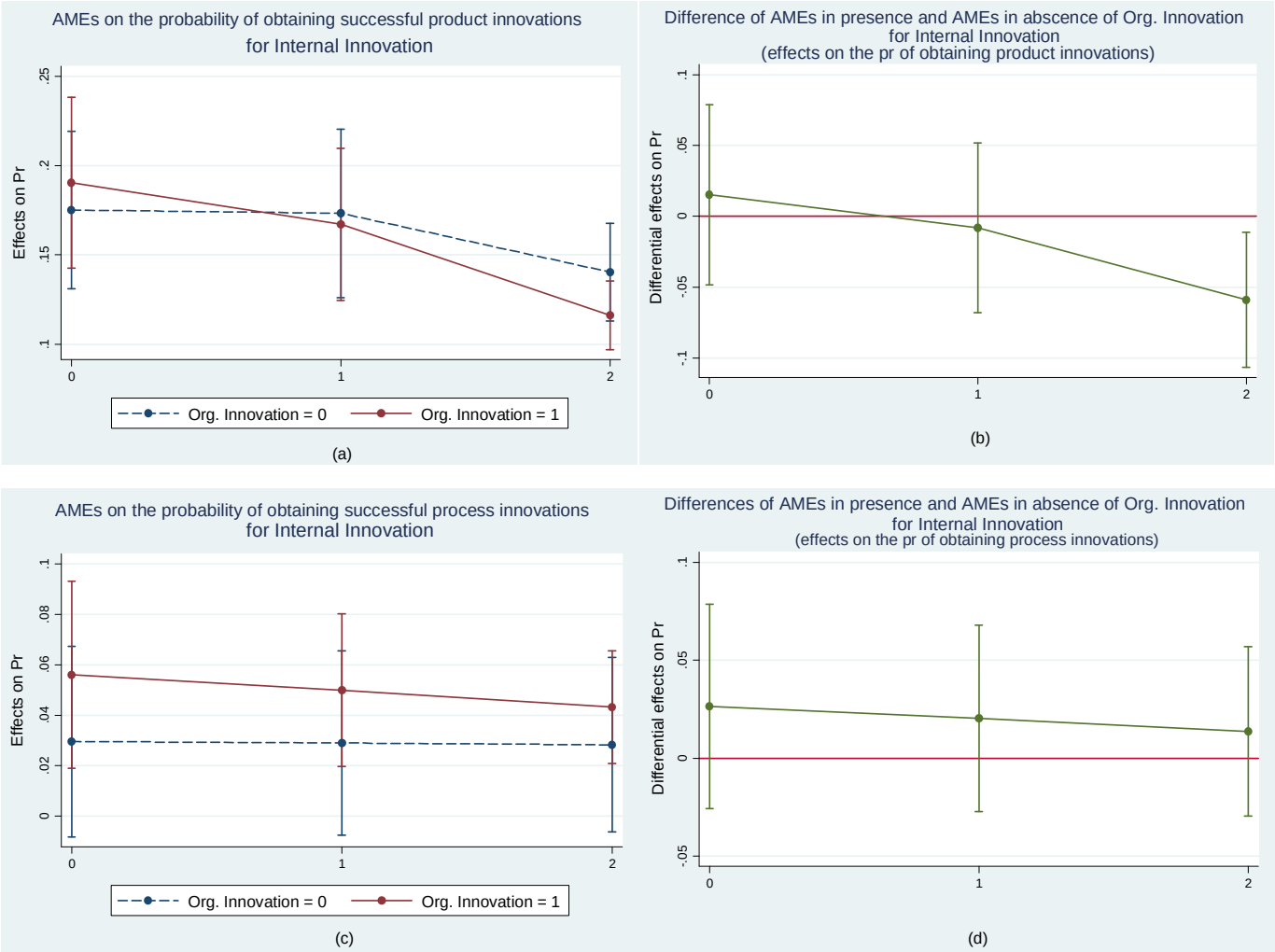
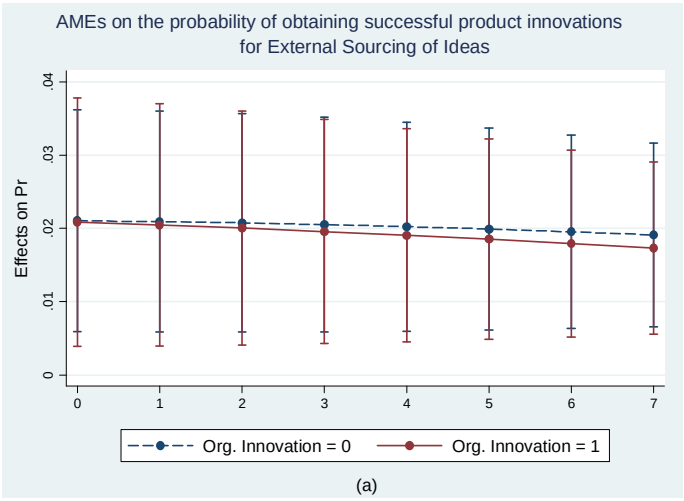
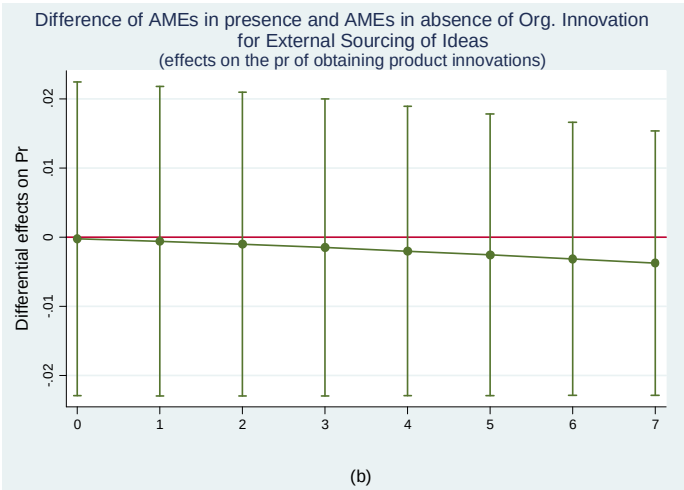


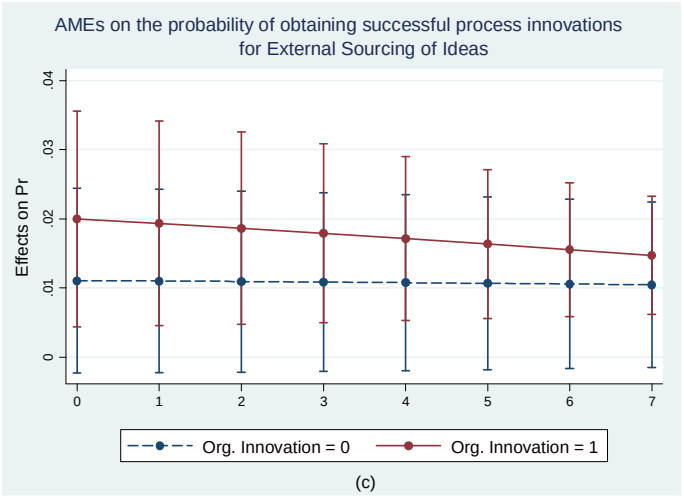
Figure 4. Contrasting AMEs in presence and in absence of organizational innovation, for external sourcing of ideas (obtained from the bivariate probit model)



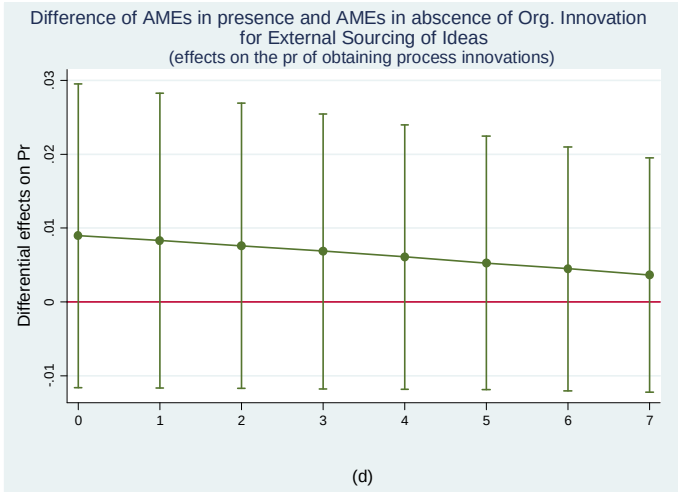
(a)



(b)

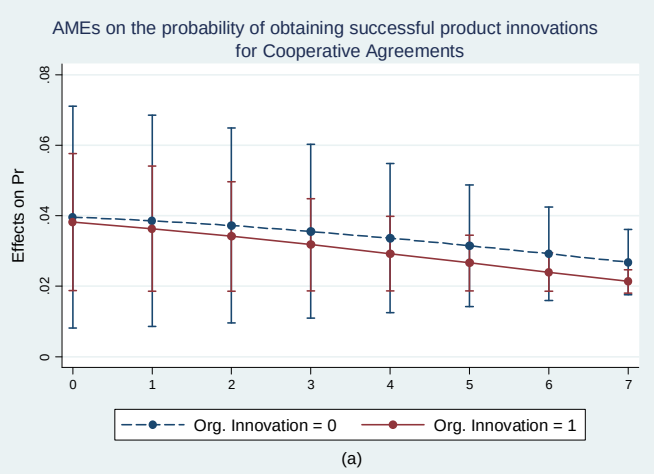


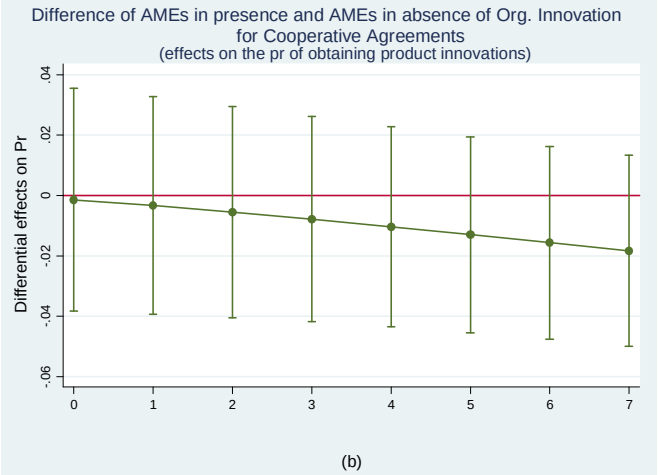
(c)

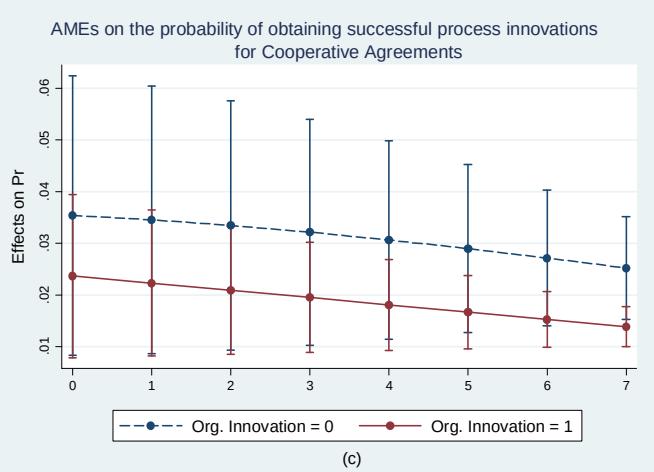


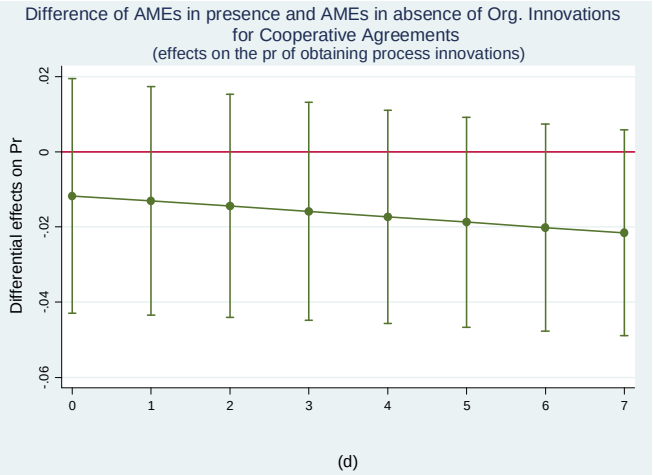
(d)

Figure 5. Contrasting AMEs in presence and in absence of organizational innovation, for cooperative agreements (obtained from the bivariate probit model)









The hypotheses on the moderating effect of organizational innovation (hypotheses 4 and 5) have therefore not been confirmed by the results derived from the estimation of the bivariate probit model. While it remains clear that the three different types of innovation practices targeted in this research independently enhance the innovative performance of firms, the combination of organizational and technological innovation activities does not seem to present any complementary effect.

Finally, it is worth noting that size and sector seem to play a very specific role depending on the type of technological innovation obtained, with each of these control variables affecting the probability of generating only one of the types. Indeed, while performing in high-tech and medium-tech industries is a factor positively influencing the likelihood of obtaining product innovations, it is the size of the firm that plays a role when determining the generation of process innovations (large and medium sized firms having more probability than small firms of doing so).

4.2. Effects on the likelihood of obtaining complex technological innovations (both product and process innovations)

In order to complement the analysis, as pointed out in the previous section, yet another model was estimated, this one aiming to capture the effects on the probability of obtaining both product and process innovations simultaneously, whose estimations are shown in Table 4. The values of the Pseudo R^2 measure indicate, as in the bivariate model, a notorious increase of the explicative capacity of the model when introducing the independent variables representing the innovation practices, not as much when introducing the interaction terms.

Table 4. Estimations for the random effects univariate probit model

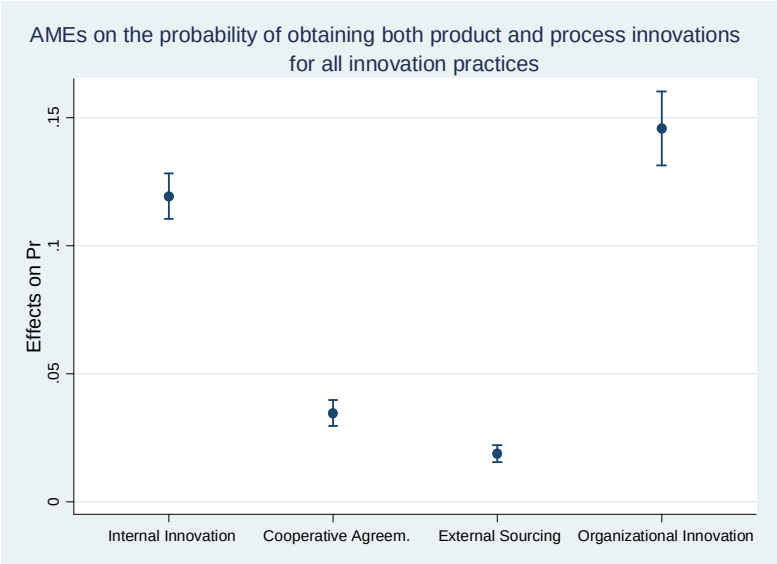
	Model 2.1	**Model 2.2**	**Model 2.3**
DEPENDENT VARIABLE			
JointTechInn			
INDEPENDENT VARIALES			
IntInn		0.45***	0.41***
ExtSour		0.07***	0.06***

CoopAgr		0.15***	0.15***
OrgInn		0.53***	0.35***
IntInnxOrgInn			0.08*
ExtSourxOrgInn			0.02*
CoopAgrxOrgInn			-0.01
Size_large	0.43***	0.42***	0.42***
Size_medium	0.37***	0.21***	0.21***
Sector_hightech	1.19***	0.35***	0.34***
Sector_mediumtech	0.75***	0.33***	0.32***
Year dummies	Yes	Yes	Yes
Constant		-2.43	-2.35
Pseudo R2	-19,151.701	-15,692.489	-15,686.59

*p <0.05; **p <0.01; ***p <0.001

The coefficients of the explanatory variables IntInn, ColInn, ExtSour and OrgInn in the model without the interaction terms are all positive and significant. Also, the confidence intervals for the estimation of the AMEs of these variables depicted in Figure 6 are all above zero. As shown for the generation of product and process innovations separately, the engagement in internal R&D activities, the development of externally sourced innovation practices and the implementation of organizational innovations enhance the probability of obtaining both product and process innovations simultaneously. The AME of organizational innovation is particularly notorious, as the introduction of this practice implies an average increase in the probability of obtaining a double-type technological innovation of approximately 15%. These results confirm the existence of a positive direct effect on technological innovation performance of the three sets of innovation practices analyzed in this work, thus confirming hypotheses 1, 2 and 3.

Figure 6. AMEs for all innovation practices (obtained from the univariate probit model)



An interesting aspect arises regarding the effect of the joint implementation of organizational innovation and R&D practices. Indeed, when firms pursue the generation of complex technological innovation outputs, results show a consistent positive moderating effect of organizational innovation on internal innovation and external sources of innovation (see Figures 7 and 8). This contrasts with the findings obtained for the case of generating product and process innovations independently. Regarding cooperative agreements, the variable performs better in presence of organizational innovation only up to a point of its range of values (i.e., 2); from then on, the implementation of organizational innovation seems to start posing a substitution effect (see Figure 9a). However, the differential effect posed by the implementation of organizational innovation cannot be said to be significantly different to zero (see Figure 9b), thus suggesting that in the case of cooperative agreements, there is no moderating effect of organizational innovation.

Figure 7. Contrasting AMEs in presence and in absence of organizational innovation, for internal innovation (obtained from the univariate probit model)

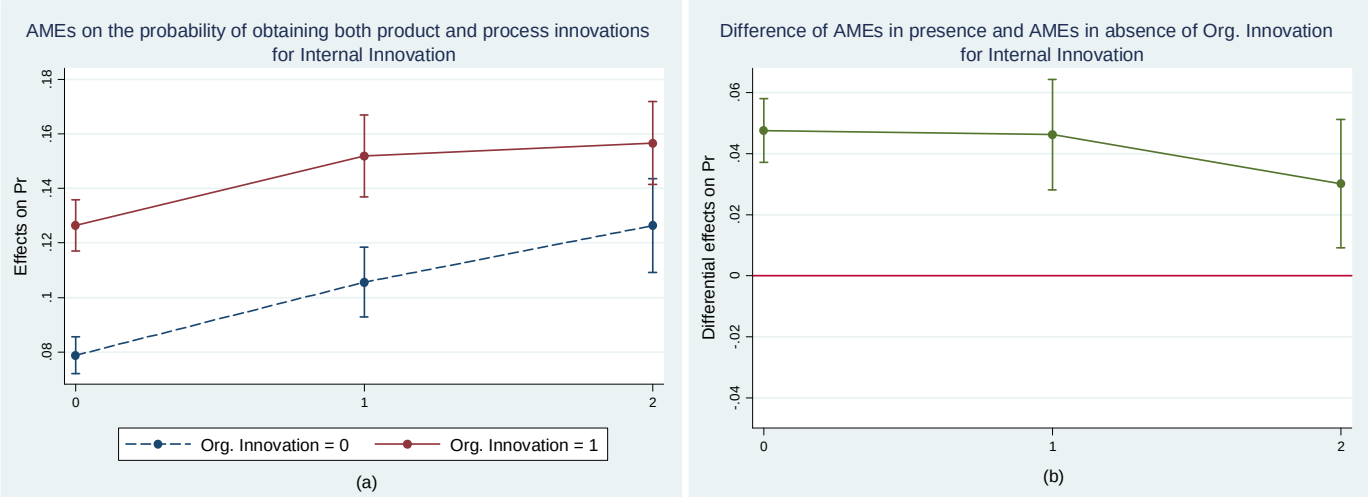


Figure 8. Contrasting AMEs in presence and in absence of organizational innovation, for external sourcing of ideas (obtained from the univariate probit model)

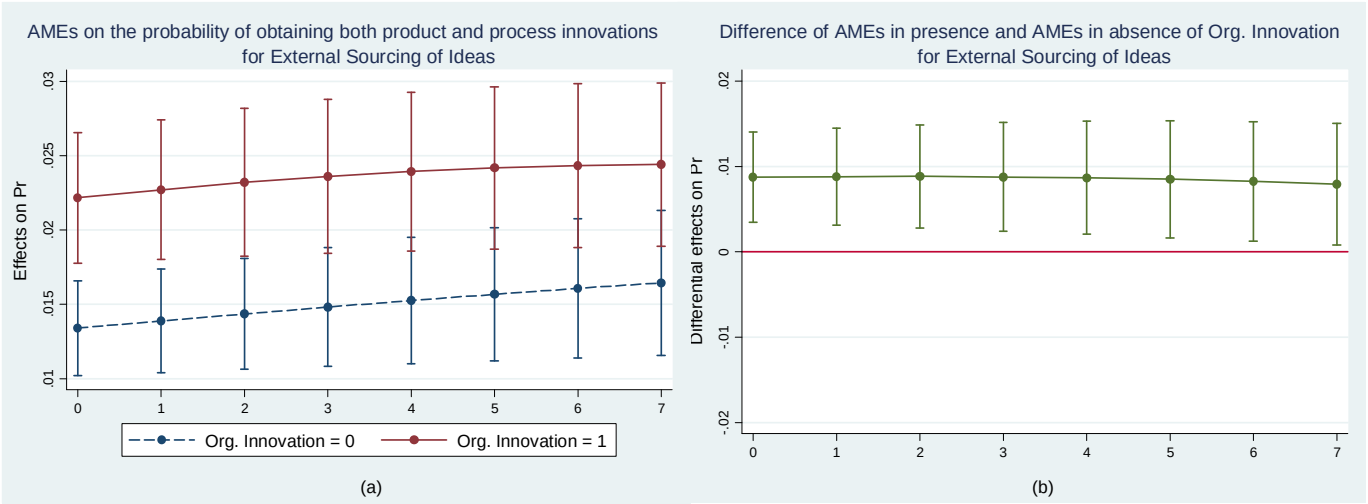
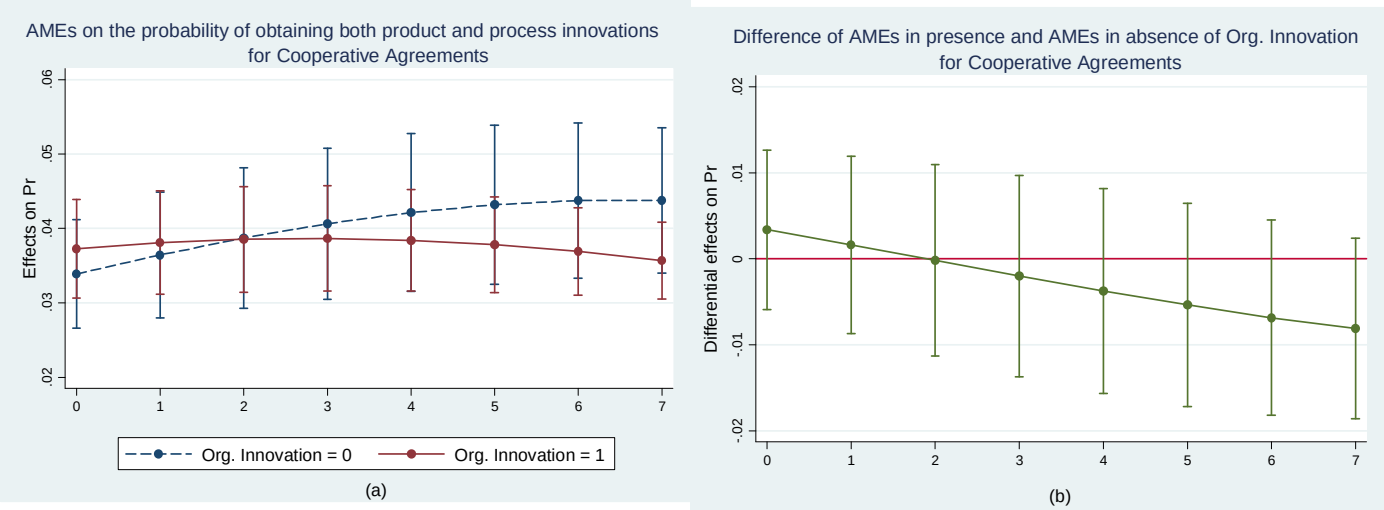


Figure 9. Contrasting AMEs in presence and in absence of organizational innovation, for cooperative agreements (obtained from the univariate probit model)



In any case, these results support the existence of a positive moderating effect of organizational innovation on the influence of both internally and externally sourced R&D practices when pursuing the generation of complex technological innovations (i.e., the realization of both product and process innovations). This may indicate that the combination of organizational and technological innovation practices pays off whenever firms need to attain a certain level of flexibility in their innovation processes in order to obtain diversity in the output of said processes.

In this sense, the results for the variable external sourcing of ideas (see Figure 8a) seem to corroborate this idea, as the marginal effects remain positive across all values, with a slight but steady increase whenever more sources are used (both in the presence and absence of organizational innovation). A wide set of innovation sources and types (i.e., technological and organizational) that brings diversity to the innovation process is thus beneficial to enhance diversity also in the innovation outputs. This appears not to be the case for the innovation practices carried out through collaborative agreements. Organizational innovation does not seem to significantly moderate the effect of such practices on innovative performance (see Figure 9b), which nevertheless remains positive along the whole range of values of the variable.

5. CONCLUSIONS

The purpose of this research was to determine the effect on innovative performance derived from the adoption of internal R&D practices, externally sourced innovation activities and organizational innovation, focusing especially on the latter. Moreover, the study also focused on the moderating effect that organizational innovation might have on the other two types of practices.

The positive influence of internal R&D activities has been well documented by previous research, as well as the beneficial effect of collaborative and other externally sourced innovation practices on innovative performance. As for organizational innovation, some studies have shown that the introduction of said practices is closely related to the generation of technological innovations. The complementarities between organizational and technological innovation have also been explored in previous studies. However, no quantitative research has focused on the effects of combining organizational and internal R&D practices on innovative performance, nor any study dealing with the combination of organizational innovation and externally sourced innovation practices relying on panel data methodology.

The results obtained in this research posit some interesting considerations. First, they confirmed the existence of positive direct effects of internal R&D and externally sourced innovation practices on the generation of technological innovations. Second, evidence was found for the direct positive influence of organizational innovation on the probability of obtaining successful product and process innovations, both in the case of pursuing their development independently and in the case of intending to obtain complex technological innovations. This beneficial effect of organizational innovation appeared particularly relevant with regard to the rest of innovation practices studied in this work when pursuing the realization of process innovations, which highlights the ideas posited in previous literature that organizational and process innovations share common characteristics and imply a set of capabilities that usually reinforce each other (Hollen et al., 2013). It is also worth noting that the results confirmed a significant positive influence of organizational innovation on the likelihood of obtaining product

innovations, an effect already found by Mothe and Nyungen-Thi (2010 and 2012) which has nevertheless been questioned by previous empirical studies (i.e., Gunday et al., 2011; Cozzarin, 2017).

Third, regarding the combination of organizational and technological (be it internally or externally sourced) innovation practices, no evidence of a moderating effect was found for the case of obtaining product or process innovations independently. Moreover, the findings provide some evidence that, in order to obtain product innovations, the efforts made in internal R&D practices pay off better in the absence of organizational innovation, particularly when engaging more frequently in internal innovation. This points to the existence of a certain substitution effect between internal R&D and organizational innovation when pursuing product innovations. In this sense, firms with a strong focus on their internal technological innovation activities should be careful when implementing organizational innovations, so as to avoid the risk of collision of the latter with the ongoing R&D practices.

However, results show that organizational innovation leverages the effect of technological (internally and externally sourced) innovation practices when pursuing the generation of complex technological innovations (i.e., the realization of both types, product and process innovations, simultaneously). These findings imply that acquiring diversity in the set of innovation sources and types (i.e., technological and organizational) pays off when aiming to obtain diversity in the innovation outputs (i.e., product and process innovations).

The results and analysis carried out in this work contribute to better understanding the systemic nature of the innovation phenomenon and specifically add to the knowledge regarding the complementarities between different types of innovation practices, particularly with respect to the under-researched combination of the engagement in technological (internally and externally sourced) innovation practices and the introduction of organizational innovations and its effect on innovative performance. Also, the analysis of the causal effects was carried out through the estimation and interpretation of AMEs, as the interpretation of the coefficients of non linear models such as the one estimated in this work, especially when including interaction terms, has

proven to be misleading. Thus, the study aims to contribute to the consolidation of AME analysis methodology, which is appropriate when dealing with the outcomes of non linear models, in the field of innovation management.

Finally, by enhancing the understanding of the intricate nature of the relationships arising between organizational and technological innovations, this work aims to help practitioners and policy makers alike to make decisions regarding the implementation and fostering of innovation practices. Indeed, the results of this research clearly highlight the existence of the positive effects of implementing organizational innovation practices, for the generation of product and process innovations. They also support the existence of important benefits of combining R&D and organizational innovation practices when pursuing the realization of complex technological innovations, while warning about the existence of a potential substitution effect when combining internal R&D and organizational innovation activities for the generation of product innovations.

The limitations of this work consist mainly in the use of the measure for innovative performance, as the dichotomous variables employed do not allow for testing the intensity of the effects of the innovative practices studied. Also, the contrasting results regarding the complementarities between organizational and technological innovation practices when pursuing the generation of a diverse typology of innovation outcomes, on the one hand, or the realization of any kind of technological innovation outputs, on the other, call for further research.

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CHAPTER IV: TECHNOLOGICAL PROXIMITY AND THE INTENSITY OF COLLABORATION ALONG THE INNOVATION FUNNEL: DIRECT AND JOINT EFFECTS ON INNOVATIVE PERFORMANCE

1. INTRODUCTION

Collaboration across organizational boundaries for R&D&I purposes has become commonplace in the last decades (Powell and Grodal, 2005), a fact that has been widely acknowledged in management literature. In fact, scholars have recognized for a long time now that companies typically innovate in collaboration and interdependence with various agents (other businesses, customers, suppliers, governments, universities, etc.), thus pointing out the systemic nature of innovation processes (e.g., Dyer and Singh, 1998; Nooteboom, 1999). Accordingly, literature has extensively emphasized the importance of R&D inter-organizational collaborations, in order to succeed in the implementation of innovation strategies (e.g., Arora and Gambardella, 1994; Veugelers and Cassiman, 1999), and it can be stated that there is a general agreement on considering that collaborative innovation practices have a positive effect on innovative performance (Un et al., 2010).

In line with the logics inherent to combinative capabilities theories (Kogut and Zander, 1992), prominent contributions in the field of management research address the importance of complementing assets and activities (e.g., Stieglitz and Heine, 2007) and of combining internal and external capabilities to innovate. Indeed, a firm's innovativeness is constrained by its existing capabilities (Teece, 1986); thus, complementing internal capabilities with those that can be obtained through external sources plays a crucial role in firms' innovative performance. In this sense, when pursuing the development of joint R&D activities, selecting the partner who provides the necessary skills and knowledge to complement the firm's own resources is a determining factor for the success of an innovation project (Gassman and Enkel, 2004).

The analysis of the occurrence of complementarities when pursuing knowledge and technology sharing in collaborative R&D activities has benefited from the proximity approach, brought to the front line by the special issue of *Regional Studies* on 'The Role of Proximity in

Interaction and Performance' (2005). The proximity perspective seeks to shed light on the relative position of economic agents with respect to each other (Boschma, 2005; Cassi and Plunket, 2015) and how these relatedness (or distance) informs the configurations of partnerships and networks and influences the outcomes of such ventures.

Regarding this last aspect, it has been widely acknowledged that proximity between R&D collaborators facilitates knowledge sharing and innovation, as it mitigates the negative effects derived from uncertainty and coordination problems (Boschma, 2005) and guarantees solid levels of understanding needed in complex and high-risk processes (Menzel, 2008). In this same sense, Boschma and Frenken (2010) stated that proximate agents are better positioned than distant ones to benefit from moderately complex knowledge transfers.

However, literature has also accounted for the negative effects of proximity, which might imply a lock-in problem, thus hindering flexibility and creativity and leading to negative results in innovativeness (Boschma, 2005). This 'proximity paradox', as coined by Boschma and Frenken (2010) is lucidly displayed through the lens of the innovation logics by Mattes (2012) when she states that innovation requires both renewal based on heterogeneity and the integration of knowledge guaranteed by proximity.

This reasoning has since been tested by several studies (e.g., Broekel and Boschma, 2011; Huber, 2012; Cassi and Plunket, 2015), leading to inconclusive results that nevertheless suggest that the 'proximity paradox' is particularly relevant for technological (or cognitive) proximity (Broekel and Boschma, 2011; Huber, 2012) and thus calling for further research on the topic (Balland et al., 2015; Bouba-Olga et al., 2015).

On another note, when tackling the concept of proximity, there is a strong consensus that the phenomenon exceeds mere spatial considerations, and that non-geographical factors have to be taken into account in order to fully account for the effects of proximity on innovativeness (Boschma, 2005; Mattes, 2012; Bouba-Olga et al., 2015). In broad terms, this consensus implies the distinction between two canonical dimensions; i.e., geographical and organizational, the latter

a term comprehending aspects related to similarities due to being part of the same organization or to the sharing of codes and norms, and still subject to much discussion and refinement (Bouba-Olga et al., 2015). Indeed, the conceptualization and characterization of the different dimensions of proximity have been the focus of several works (e.g., Boschma, 2005; Torre and Rallet, 2005; Knoben and Oerlemans, 2006). The typologies originated from these works identify, along with the prevalent distinction of the geographical dimension, several others, such as cognitive, social, institutional or technological aspects.

In any case, most authors come together in pointing out that geographical proximity, while usually being essential to explain the initial connections to partner up, is not sufficient per se to enable interactive learning and innovation (Boschma, 2015; Mattes, 2012; Cassi and Plunket, 2015) and that this dimension of proximity has been probably '*overemphasized to the detriment of other proximity forms*' (Bouba-Olga et al., 2015).

Despite the interest shown by academics on the phenomenon of proximity and it being regarded as essential to explain innovation outcomes, there is still limited understanding, on the one hand, on how non-geographical dimensions of proximity affect innovative performance, and on the other, on how the aforementioned 'proximity paradox' plays out according to empirical evidence (Huber, 2012; Bouba-Olga et al., 2015).

In this sense, this work focuses on the relatedness between the focal firm and its partners, understood as closeness in terms of knowledge bases (technological proximity). Furthermore, it adopts the perspective of the innovation phenomenon as a process, thus taking into account the existence of different phases in the collaborative innovation practices (Zahra and George, 2002; West and Bogers, 2014). By bringing together these two aspects, the present study aims to advance the understanding of how innovative performance might be affected by complementarities enhanced by non-geographical proximity when engaging in R&D partnerships along the innovation funnel.

In particular, the purpose of this research is to clarify how technological proximity affects innovative performance, in terms of efficiency and generation of technological innovation outputs. The analysis aims to unveil both the direct effects and the potential joint influence of technological proximity and the intensity of collaboration the along the innovation funnel.

The understanding of the aforementioned phenomenon enlightened by the results obtained in this work will be of great interest for practitioners and policy makers alike, as it provides clarity for decision making regarding relevant aspects of collaborative innovation practices; particularly, the search for and selection of optimal partners. In general terms, the evidence found here suggests seeking for collaborating intensely along the whole process with partners whose technological bases presents a tight matchup with that of the focal firm. Results also call for awareness of the potential drawbacks derived from intense collaborations with close partners in the late phases of the process, thus hinting towards the convenience of developing protection mechanisms.

Also, this work presents evidence and interpretation of how firms might profit from collaborative innovation practices and, especially, of how technological proximity affects this profiting. Therefore, it contributes to the literature on innovation management, providing interesting insights that challenge the notion of 'proximity paradox' and set out further questions that might be worth considering for future research.

The structure of the remaining paper consists on a section devoted to the revision of extant literature, the proposal of hypothesis and the configuration of the theoretical framework for the research, followed by a section explaining the methodology. Results and their discussion will be presented immediately afterwards. Finally, a closing section will present the conclusions of the study.

2. THEORETICAL FRAMEWORK AND HYPOTHESIS DEVELOPMENT

2.1. Technological proximity and innovative performance

The notion of technological relatedness used in this work draws on the conceptualization offered by Knoben and Oerlemans (2006). The authors define technological proximity as '*the level of overlap of the knowledge bases of two collaborating actors*', referencing Laneh and Lubatkin (1998). This concept is much in line with notions of cognitive proximity used by other authors. From the seminal works by Nooteboom (1999, 2003) on cognitive distance to other studies proposing categorizations for the different dimensions of proximity (e.g., Boschma, 2005), cognitive proximity has been used to address the sharing of similar knowledge bases and expertise.

This aspect has been acknowledged as the type of proximity most closely linked to innovation (Huber, 2012). Indeed, the knowledge needed to carry out innovative activities often has a tacit and idiosyncratic nature (Boschma, 2015), and its effective transfer requires proximity in terms of the partners' technological and knowledge bases, while at the same time the reason to partner up for innovation purposes is to get access to alien knowledge in the first place.

Different streams of literature has tackled this issue, providing theoretical and empirical support to the rational explaining the controversial effect of reaching out towards sources with knowledge and capabilities substantially distant from the focal firm's knowledge base.

Literature on partner diversity (e.g., van Beers and Zand, 2014; Parida et al., 2016, García-Martínez el al., 2017) often argue that high levels of this variable broaden the resources accessible to the firm, thus bringing in learning benefits and innovative capabilities, but also imply added complexity and difficulties for profiting from the external knowledge source (van Beers and Zand, 2014; Parida et al., 2016, Jiang et al., 2010). Hence, they usually posit the existence of a curvilinear relationship between homogeneity/diversity and innovative performance.

Nooteboom's (1999, 2003) cognitive theory illustrates this same rationale. According to the author, for low levels of cognitive distance, its increase has a positive effect on learning, due

to the interaction of agents with different knowledge and perspectives who connect complementary resources. However, once a certain level of distance is reached, further increases imply difficulties for the mutual understanding required to seize the opportunities derived from diverse knowledge. The key argument of the theory is thus that '*while larger distances in cognition have a negative effect on absorptive capacity, they have a positive effect on the potential for novelty creation*' (Gilsing et al., 2008). This model has been since tested in several studies (e.g., Wuyts et al., 2005; Nooteboom et al., 2007; Sampson , 2007; Gilsing et al., 2008; Nambisan, 2013).

In line with the logics behind the cognitive theory, studies focusing specifically on technological proximity usually justify its positive effect on learning and innovativeness by the implications of absorptive capacity (Cohen and Levinthal, 1990), in the sense that the capacity of firms to absorb new knowledge from external sources requires the ability to identify, interpret and exploit the new knowledge (Boschma, 2005). On the other hand, the postulates of the resource-based view theory can be summoned to explain the pertinence of searching for heterogeneous R&D sources. According to this perspective, whose main seminal contribution dates back to Penrose (1959), the difference in performance across firms is due to the resource heterogeneity they possess. As Kor and Mahoney (2004) explain, Penrose (1959) unravels the logic behind links among resources, capabilities and competitive advantage, concluding that new combinations of resources generate innovations and lead to value creation.-In search for new combinations of resources, the logic behind partnering up with external agents for R&D purposes is precisely the objective of obtaining complementary resources and know-how (Teece, 1986). The heterogeneity in the technological and knowledge bases of the partners would thus imply a chance to access supplementary resources upon which to build innovation capabilities and obtain a sustainable competitive advantage.

As Knoben and Oerlemans (2006) explain, when carrying out collaborative R&D activities, partners' knowledge bases need to be similar enough so as to recognize opportunities and seize them, but different enough so that there are contributions of complementary knowledge.

This reasoning accurately reflects the arguments of the aforementioned 'proximity paradox', coined by Boschma and Frenken (2010).

Taking all of the above into account, we propose the following hypothesis.

H1: The effect of technological proximity between partners on the innovative performance bears an inverted U-shape.

2.2. Collaborating along the innovation funnel: interactions with technological proximity

The definition of the stages of the innovation process has been a prominent subject of reflection in the research field, from the Schumpeter's early model proposing the distinction of invention, innovation and diffusion to proposals directly tackling the use of external sources of innovation (e.g., Zahra and George, 2002; West and Bogers, 2014). Although sequential models have been criticized for being too simplistic, the practicality of dividing the process into the traditional stages of research and development -thus covering the idea generation phase and its later completion and manifestation in a technological innovation- has also been acknowledged (Knudsen, 2007).

In this sense, Lazzarotti and Manzini (2009) stated that collaborative innovation practices can be studied, among other factors, taking into account the different phases of the process open to external sources. The framework established by the authors contemplates the 'innovation funnel openness' as a prominent variable defining different modes of collaborating for R&D purposes, and includes the following phases in which firms can partner up in order to carry out the development of new technologies, product and process innovations: idea generation, experimentation, engineering and manufacturing.

The impacts of collaborating with external agents when pursuing innovative strategies has been widely studied and there is abundant literature backing up the idea of the positive effect of the degree of openness throughout the innovation process on innovative performance. For instance, co-creation practices in early stages of the process have been acknowledged as beneficial for generating innovative ideas (Witell et al., 2011) and leading to successful new product

developments (Lilien et al., 2012). Also, literature has addressed the benefits of partnering with external sources for prototype engineering and validation and subsequent manufacturing (e.g., Vuola and Hameri, 2006; Bogers and Horst, 2014).

The degree of openness along the innovation funnel can be captured by the level of involvement between the focal firm and its partners (Berchicci, 2011), thus providing a measure of the intensity of the collaboration in different stages.

Hsieh and Tidd (2002) argued that jointly developed complex and iterative tasks, such as those characteristic of R&D partnerships, require intensive collaboration. Also, in order for complex and tacit knowledge to be transferred effectively, close or intense collaboration among the partners is needed, so that the joint efforts can be capitalized (Hagedoorn, 1993; Mattes, 2012). Precisely, the abilities to access complementary knowledge and expertise depend on tacit elements (Lundvall and Johnson, 1994), and the type of knowledge usually shared in R&D partnerships has a tacit and idiosyncratic nature (Boschma, 2005). This difficulty in transferring knowledge between firms was also pointed by Berchichi (2011) to explain why, in order to benefit from external technology sources, firms needs to develop and manage deep interactions and iterative exchanges with key partners. Therefore, when developing R&D collaborative activities, obtaining and integrating effective knowledge from external sources requires building deep and meaningful relationships.

Several studies provide evidence on the relationship proposed by this arguments. Results obtained by Santoro (2000) showed a positive linkage between the intensity of collaborations and tangible outcomes in industry-university collaborative ventures, thus sustaining the rationale that more intense relationships imply a deeper commitment, more resources devoted to the project and more meaningful personal interactions, and therefore derive in a better performance. In a more general study covering a wide range of partnerships, Brettel and Cleven (2011) proposed and confirmed that collaboration intensity with customers, suppliers and universities has positive effects on new product development performance. The aforementioned work by Bechicci (2011) also provided results confirming that drawing deeply from key and preferred partners has a

positive effect on innovative performance. In the same sense, Chen et al. (2011) also showed that the intensity of collaboration is a paramount factor influencing innovation performance; particularly, the authors distinguished two modes for managing innovation (i.e., one based on codified scientific knowledge and the other more experience-based) and found evidence that firms benefit from intense and strong ties with external partners in both of the modes identified.

In light of the theory and evidence mentioned, it is straightforward to expect a positive effect of the intensity of R&D collaborations on innovative performance, and thus the following hypothesis is proposed:

H2: Intense collaboration with outside parties has a positive effect on innovative performance, independently of the stage of the innovation process.

As for the interaction of the intensity of collaboration with technological proximity, this work proposes that its relationship with innovative performance will be different depending on the stages of the innovation process (i.e., an earlier phase devoted to generating ideas and experimenting and a later one for engineering prototypes, validating them and manufacturing).

Indeed, the early stage of the process is arguably more dependent than the later phase on knowledge recombination and complex forms of interaction between partners (Lakemond et al., 2016). As Fleming and Sorenson (2004) point out, research on technological advance has traditionally conceptualized the invention phase as a process relying heavily on the recombination of existing knowledge in a novel manner. This implies the coordination of complex dynamics deeply ingrained in tacit communication and knowledge transfer. In this context, mutually shared knowledge bases help overcoming the difficulties arising from such situations of complex interdependencies (Srikanth and Puranam, 2011). In this sense, existing literature generally suggests that the overlapping of knowledge bases helps in dealing with the problems derived from ambiguous and uncertain contexts (Ritala and Hurmelinna-Laukkanen, 2013).

Indeed, technological proximity provides a common ground that enables communication and the transfer of tacit information between partners, thus reducing the costs of coordinating

such a complex process (Lakemond et al., 2016). In other words, when bringing together teams from different organizations to come up with new ways of configuring knowledge and experiment with new potential technologies, a high degree of intensity in such collaboration would benefit from the overlap of the knowledge bases of the partners, which in turn enables the effective understanding of the other's proposals and facilitates the recombination of the existing knowledge. Collaborating intensely with the partners of the joint innovation project in the early stage of the process would thus leverage the benefits derived from having overlapping knowledge bases.

On the other hand, the early stage of the R&D collaborative process tends to be precompetitive, and is thus characterized by lower risks of opportunistic behavior of the partners, that are more likely to arise on a later phase (Lakemond et al., 2016). This risk is directly related with the appropriability problem, which '*refers to the difficulties firms face in earning the full return upon their own innovative activities*' and to the eventuality that partners might take for themselves an oversized share of the benefits derived from the joint project (Tomlinson, 2010); which in turn places firms in a position prone to reduce their own efforts, with the subsequent detrimental effect on the innovation outcome (Ritala Hurmelinna-Laukkanen, 2013). Thus, appropriability problems arise in the event of involuntary knowledge leaks spreading to the partners (Bönte, 2008).

In this sense, Laursen and Salter (2014) acknowledge this as one of the major problems associated with using external sources for innovating. The authors refer to the existence of a 'paradox of openness', in the sense that firms pursuing to obtain knowledge from external sources must face the risk of revealing part of their own knowledge to a certain extent, which implies considerable costs and efforts in order to appropriate the benefits derived from the join innovation practice.

This involuntary leakage of critical knowledge, together with the likelihood of the opportunistic behavior of the partner, is thus a prominent factor shaping the dynamics of the relationship in the late stage of the collaborative innovation process. The occurrence of such

involuntary spillovers responds to a variety of causes, such as the mobility of employees, the sharing of patent information or the informal transfer of sensitive information and critical knowledge between members of the R&D teams pertaining to different organizations (Mansfield, 1985). As explained above, the transfer of complex, idiosyncratic and tacit knowledge is favored by technological proximity among partners. Therefore, technological base overlap increases the risk of involuntary spillovers (Boscha, 2005; Boschma and Frenken; 2010).

Firms collaborating in the implementation stage of the innovative process, thus, face risks due to appropriability problems and partners' opportunistic behavior. This circumstance is aggravated by the risk of involuntary spillovers, which are in turn more likely to arise if partners are proximate in technological terms. Therefore, collaborating intensely with proximate partners in this late phase will prove to have joint detrimental effects on firm performance.

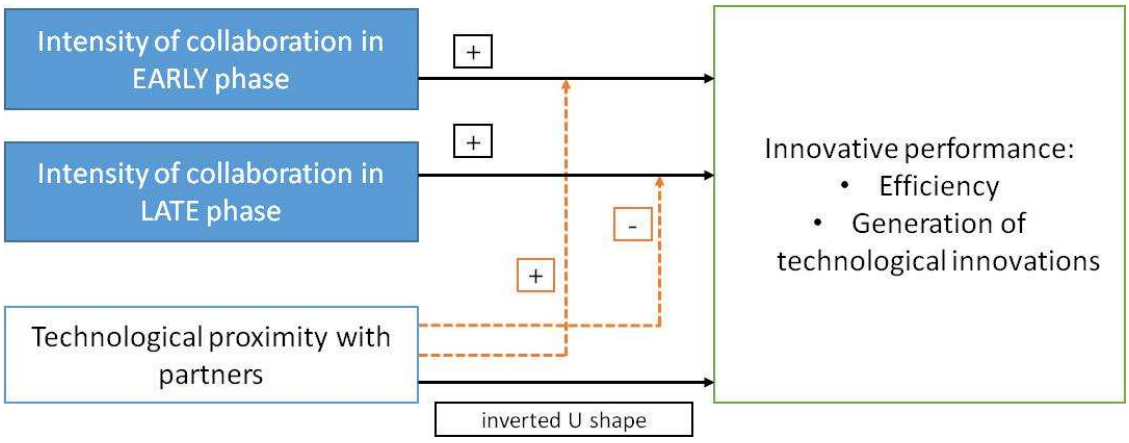
The rationale developed above regarding the effects of the interaction of the variables of collaboration intensity in different phases and technological proximity results in the following hypothesis:

H3a: The interaction of intense collaboration in the early phase of the process and of technological proximity has a positive effect on innovative performance.

H3b: The interaction of intense collaboration in the late phase of the process and of technological proximity has a negative effect on innovative performance.

The conceptualization of the hypotheses presented are illustrated by the following figure.

Figure 1. Conceptualization of the theoretical framework



3. METHODOLOGY

The conducted research aims to estimate the direct and joint effects of technological proximity and of collaboration intensity along the innovation process on innovative performance, in terms of efficiency and generation of innovation outputs.

Said quantitative analysis relies on data obtained from an international open innovation survey designed by researches from universities in Italy, Sweden, Finland and the UK and collected during 2012 and 2013, gathering information in all these four countries. Each country framed a target population of manufacturing firms with more than 10 employees, from which a randomized sample of 1,000 firms was selected. Questionnaires were distributed by email to the participants, who were R&D managers or similar roles familiar with collaborative innovation projects. These questionnaires cover aspects such as strategy, context, openness, relational factors (collaboration modes) and performance, and uses a 7-point Likert-type scale ranging from 'strongly disagree' to 'strongly agree' to measure the items. The total number of respondents amounted to 467 firms, from which 152 came from Italy, 176 from Sweden, 87 from Finland and 52 from the UK[11].

[11] For more details on the project, see Manzini et al. (2013).

In order to perform the analysis of the causal effects focus of this research, a linear regression model was estimated, which can be formulated as follows:

$$\begin{aligned} Inn\_perf^{*}_i = \alpha &+ \beta_1 * Int\_Phase1_i + \beta_2 * Int\_Phase2_i + \beta_3 * Tech\_prox_i + \beta_4 * Tech\_prox^2_i \\ &+ \beta_5 * Int\_Phase1xTech\_prox_i + \beta_6 * Int\_Phase2xTech\_prox_i + \beta_7 * Size\_small_i + \\ &\beta_8 * Size\_med_i + \beta_9 * Sector\_lowtech_i + \beta_{10} * Innovat_i + \beta_{11} * Extern_i + \beta_{12} * Ita_i + \beta_{13} * Swe_i + \\ &\beta_{14} * Fin_i + \varepsilon_i \end{aligned}$$

* The analysis implies the estimation of two models, as it uses two different dependent variables framed by the concept of innovative performance, namely, the efficiency of the innovation process (**Effi**) and the generation of technological innovations (**Tech_inn**).

Regarding the construction of the variables, the set of dependent variables (**Inn_perf**) is based on the questions of the survey asking about how well collaboration with external partners in innovation activities had performed against several objectives over the precedent three years. The scale of response indicates the extent of the agreement with the statements, from 1 'not at all' to 7 'to a great extent'.

The set of items used corresponds to two different aspects of innovative performance, namely, efficiency and generation of technological innovation. Regarding the measure of the variable **Effi**, the questionnaire inquires about the following items: (a) reducing innovation risks, (b) reducing new product/process development costs and (c) reducing time to market. A variable was generated by means of factor analysis technique in order to obtain a linear combination of these three items. The coefficients of the factor variable were obtained by the regression scoring method (Thomson, 1951) [12]. Table 1 shows that the exploratory factor analysis extracted one single factor from the items, representing the entirety of the variance. It also displays the factor loadings and the scoring coefficients resulting from the analysis.

Table 1. Factor loadings and scoring coefficients for Efficiency

	Factor 1	
	Factor loadings	Scoring coeff.

[12] Same applies for all subsequent techniques for estimating scoring coefficients for factor variables in this work.

Items		
Reducing risks	0.7070	0.28432
Reducing costs	0.7985	0.43914
Reducing times	0.7091	0.28663
Eigenvalue	1.64045	
% Variance explained	100.00	

As for the variable **Tech_inn**, respondents are asked whether they have successfully introduced (a) new or significantly improved products or services; and (b) new or significantly improved process of producing their products or services, which account for the fact of having or not obtained product and process innovations, respectively. The third edition of the Oslo Manual (OECD and Eurostat, 2005) defines product innovation as the introduction of a new (or significantly improved) good or service, that newness being related to the characteristics or the use of the product; and process innovation as the introduction of a new (or significantly improved) production or delivery method. Thus, the items account for the introduction of successful product and process innovations, which, also according to the Oslo Manual, constitute a comprehensive categorization of technological innovations. As for the previous construct, the variable was generated using a factor analysis technique, which resulted in the same factor loading for the two items (see Table 2).

Table 2. Factor loadings and scoring coefficients for Technological Innovation

	Factor 1	
	Factor loadings	Scoring coeff.
Items		
Product innovations	0.6501	0.42037
Process innovations	0.6501	0.42037
Eigenvalue	0.84537	
% Variance explained	100.00	

The variables related to the intensity of collaboration in the different stages of the innovative process were constructed based on the survey question about the extent to which the firms had collaborated with external partners in the different phases of the innovation process over the previous five years. The question contains four different items to assess the extent of the

agreement with the statement, from 1 ‘not at all’ to 7 ‘to a great extent’, accounting for the phases of ‘idea generation’, ‘experimentation’, ‘engineering’, ‘manufacturing’ and ‘commercialization’. In order to reduce these dimensions, an exploratory factor analysis was conducted, and three factors were retained. The factor loadings were obtained after an orthogonal varimax rotation (Kaiser, 1958).

Table 3. Factor loadings and scoring coefficients for Intensity of collaboration

	Factor 1		**Factor 2**	
	Factor loadings	Scoring coeff.	Factor loadings	Scoring coeff.
Items				
Idea generation	**0.6344**	**0.36598**	0.1574	-0.02119
Experimentation	**0.6688**	**0.42275**	0.1787	-0.02128
Engineering	0.4037	0.12523	**0.5576**	**0.41747**
Manufacturing	0.0690	-0.06950	**0.5369**	**0.35946**
Eigenvalue	1.35100		0.32236	
% Variance explained	80.74		19.26	

As table 3 shows, the items related to the phases ‘idea generation’ and ‘experimentation’, strongly load on the first factor, while the items for engineering’ and ‘manufacturing’ strongly load on the second.

As for the construct related to technological proximity, the survey asks the respondents to indicate their agreement with several statements related to their firm’s partners. The fourth item of the question, which reads ‘*partners’ technological competences match up*’, is used to construct the variable **Tech_prox**. The scale of the response ranges from 1 ‘strongly disagree’ to 7 ‘strongly agree’. A quadratic term for this variable was also included, with purposes of testing the existence of an inverted U-shape relationship.

Also, the model includes the corresponding **multiplicative variables** (i.e., **Int_Phase1xTech_prox** and **Int_Phase2xTech_prox**), for purposes of capturing the joint effect of technological proximity and collaboration intensity in the different phases.

A model containing just the precedent variables, which constitute the focus of the research, could imply the risk of attributing causal effects to a covariate that could in fact be due

to some other aspects not introduced in the model but still affecting the independent variable while being related to the covariate of interest. Therefore, in order to avoid biases in the estimation of the coefficient of said covariates, the models include control variables measuring factors that scholarly practice traditionally understands as likely to have an impact on innovative performance and also as related to firms' behavior towards innovation activities. For instance, the study introduces a measure for the innovativeness of the firm (**Innovat**), which collects the responses to the survey question '*we prioritize new product and service development and innovation to meet new and changing consumer demands*', ranging from 1 'strongly disagree' to 7 'strongly agree'. It is reasonable to expect that firms cultivating a solid innovation culture would perform better in terms of innovative outcomes, independently of their engagement in collaborative innovation practices; also, those firms would likely be prone to engage in such practices.

An indicator of the externalization of the firm (**Extern**) was also included. It corresponds to an item of the survey questioning about the number of different countries in which the company operates with a proprietary branch, ranging from 0 (if the firm operates in just one country) to 12 (it operates in 13 or more). Externalization being a measure of the success of the firm, its high scoring would be related to other successful activities, such as those related to innovation practices.

Finally, dummy variables were introduced in order to control for the effect of firm size, the technology intensity of the industry sector, and the country where the firm is sited, all them well know aspects traditionally linked to innovative practices and outcomes.

The detail of the variables used for the estimation linear regression can be consulted in table 4.

Table 4. Indicators used in the quantitative analysis

Variable	Label	Description
DEPENDENT VARIABLE		
Efficiency	Effi	Factor variable referring to how well the firm has performed in the last three years in terms of reducing

Technological innovations	Tech_inn	risks, costs and development times in the innovation process. Factor variable referring to how well the firm has performed in the last three years in terms of introducing successful product and/or process innovations.
INDEPENDENT VARIABLES		
Technological proximity	Tech_prox	It captures the degree of the technological proximity between the firm and its collaboration partners.
Technological proximity (quadratic)	$Tech\_prox^2$	Quadratic term.
Collaboration intensity in early phases	Int_Phase1	Factor variable capturing the extent to which the firm has collaborated with external partners the early phases of the innovation process over the last 5 years.
Collaboration intensity in late phases	Int_Phase2	Factor variable capturing the extent to which the firm has collaborated with external partners in the late phases of the innovation process over the last 5 years.
Collaboration intensity in phase 1x Technological proximity	Int_Phase1xTech_prox	Multiplicative variable.
Collaboration intensity in phase 2x Technological proximity	Int_Phase2xTech_prox	Multiplicative variable.
Innovativeness (control variable)	Innovat	It captures whether the firm sports a innovation culture.
Externalization (control variable)	Extern	It captures the number of different countries in which the company operates with a proprietary branch.
Firm size (control variable)	Size_small	Dummy
	Size_med	Dummy
Firm sector (control variable)	Sector_lowtech	Dummy
Country: Italy (control variable)	Ita	Dummy
Country: Sweden (control variable)	Swe	Dummy
Country: Finland (control variable)	Fin	Dummy

4. RESULTS AND DISCUSSION

The following table shows descriptive statistics and the pairwise correlation coefficients (including significance level) of the variables in the model.

Table 5. Descriptive statistics, correlations and VIFs

Variables	Obs.	Mean	St. D.	Pairwise correlations													VIF
				1	2	3	4	5	6	7	8	9	10	11	12	13	
11. Effi	463	$8.66e^{-10}$	0.87	1													-
12. Tech_inn	463	$-4.49e^{-09}$	0.74	0.57 ***	1												-
13. Tech_prox	463	4.54	1.41	0.35 ***	0.30 ***	1											1.14
14. Int_Phase1	467	$-7.84e^{-10}$	0.75	0.29 ***	0.30 ***	0.19 ***	1										1.22
15. Int_Phase2	467	$2.15e^{-10}$	0.65	0.24 ***	0.28 ***	0.34 ***	0.15 **	1									1.21
16. Innovat	467	5.40	1.52	0.30 ***	0.34 ***	0.20 ***	0.11 *	0.26 ***	1								1.12
17. Extern	458	2.94	3.56	0.01	-0.02	0.04	0.01	0.07	0.08 ^	1							1.70
18. Size_small	467	0.43	-	-0.09 *	-0.06	-0.09 *	-0.05	-0.04	-0.06	-0.41 ***	1						2.68
19. Size_med	467	0.25	-	0.04	-0.03	0.03	0.00	0.04	0.07	-0.08	-0.50 ***	1					2.09
20. Sector_lowtech	467	0.36	-	0.02	0.11 *	0.04	-0.06	-0.02	0.01	-0.04	-0.04	0.05	1				1.05
21. Ita	467	0.32	-	-0.00	0.20 ***	0.08 ^	-0.02	0.05	0.04	-0.29 ***	0.19 ***	-0.01	0.08 ^	1			4.03
22. Swe	467	0.38	-	0.01	-0.13 **	-0.07	0.06	0.09 ^	-0.06	0.26 ***	0.06	0.06	-0.15 ***	-0.54 ***	1		4.39
23. Fin	467	0.18	-	-0.08	-0.14 ***	0.01	-0.15 **	-0.16 ***	0.01	-0.03	-0.06	0.10 *	0.13 **	-0.33 ***	-0.37 ***	1	3.13

^ p<0.1; * p <0.05; **p <0.01; ***p <0.001

Correlation values among independent variables are generally low to moderate suggesting low multicollinearity risks. The highest correlation between two pairs of explicative variables is 0.54 (in absolute terms, and between the country dummies for Italy and Sweden), far less than the problematic level of 0.75 (Tsui et al., 1995). This is confirmed by the analysis of the variance of inflation factors (VIF): the maximum VIF value is 4.38 (for the country dummy for Sweden), below the rule of thumb cut-off of 10, which again indicates that there are no serious multicollinearity problems in the models (Neter et al., 1996).

Turning now to the analysis of the causal effects, table 6 shows the estimations for the linear regression, displayed as hierarchical models adding covariates progressively, from a model with only the control variables (model 1) as predictors to the complete model proposed above (model 4). As it can be seen, R^2 measure reflects an increase of the explicative capacity of the hierarchical model when progressing in the introduction of variables up until the configuration of model 4 (the F-test of overall significance confirms that the indicator is statistically significant in all cases). This is generally also true for the adjusted R^2 measure, which takes into account the number of predictors incorporated to the model, and is thus a better indicator to assess the explanatory capacity of models that containing different numbers of covariates. This is also consistent with the Wald tests performed in order to test the joint significance of the newly added variables in each model. In this sense, the only case for which the progression in the hierarchy does not yield a better performance of the model is model 3 for the dependent variable Tech_Inn; thus challenging the significance of the introduction of the quadratic term of technological proximity, an aspect which will be further commented on below.

Table 6. Results for the estimation of the hierarchical models

	Model 1	**Model 2**	**Model 3**	**Model 4**
DEPENDENT VARIABLE #1 Effi				
INDEPENDENT VARIALES				
Tech_prox		0.16***	-0.11	-0.12
Tech_prox2			0.03*	0.03*
Int_Phase1		0.19***	0.18**	-0.08

Int_Phase2		0.15*	0.15*	0.58**
Int_Phase1xTech_prox				0.06
Int_Phase2xTech_prox				-0.09*
Innovat	0.18***	0.12***	0.12***	0.12***
Extern	-0.02	-0.02	-0.02	-0.02
Size_small	-0.17	-0.09	-0.11	-0.11
Size_med	-0.03	0.01	-0.02	-0.04
Sector_lowtech	0.04	0.05	0.04	0.05
Ita	-0.21	-0.26	-0.24	-0.21
Swe	-0.11	-0.15	-0.14	-0.09
Fin	-0.34^	-0.24	-0.22	-0.18
Constant	-0.66**	-1.08***	-0.59^	-0.60^
R^2	0.1133	0.2346	0.2421	0.2511
Adjusted R^2	0.0975	0.2157	0.2216	0.2274
F-test (overal significance) [13]	4.17***	12.43***	11.84***	10.61***
F-test (Wald test) [14]		23.55***	4.40*	2.67^

DEPENDENT VARIABLE #2

Tech_inn

INDEPENDENT VARIALES

Tech_prox		0.09***	0.02	0.01
Tech_prox2			0.01	0.01
Int_Phase1		0.13**	0.13**	-0.11
Int_Phase2		0.20***	0.20***	0.54***
Int_Phase1xTech_prox				0.05^
Int_Phase2xTech_prox				-0.07*
Innovat	0.16***	0.12***	0.12***	0.12***
Extern	-0.01	-0.01	-0.01	-0.01
Size_small	-0.22*	-0.16	-0.17	-0.17
Size_med	-0.21*	-0.19^	-0.19^	-0.21
Sector_lowtech	0.16*	0.17**	0.17**	0.17**
Ita	0.12	0.12	0.13	0.15
Swe	-0.11	-0.12	-0.12	-0.07
Fin	-0.30*	-0.20	-0.19	-0.15
Constant	-0.69***	-0.94***	-0.80**	-0.82**
R^2	0.1871	0.2894	0.2902	0.2990
Adjusted R^2	0.1726	0.2718	0.2710	0.2768
F-test	12.92***	16.51***	15.16***	13.50***
F-test (Wald test)		21.40***	0.51	2.78^

^ p<0.1; * p <0.05; ** p <0.01; *** p<0.001

[13] The F test performed tests for the overall significance of the model, providing the implicit null hypothesis that the fit of the intercept-only model and the estimated model are equal, thus indicating whether the R^2 measure is statistically significant.

[14] The Wald test performed shows whether the newly introduced variables in the model (with respect to precedent model) are simultaneously equal to zero or if that null hypothesis can be rejected.

The calculation of the beta coefficients and their significance is complemented with the calculation of average marginal effects (AMEs) on the two measures of innovative performance. As the models in this work involve multiplicative terms, the estimated regression coefficients cannot be read as the predicted change the dependent variable due to a unit change in the covariate of interest; thus, the interpretation of the relationship between the dependent and the independent variables benefits from the display of AMEs (Leeper, 2017). While scholars generally recognize that the analysis of the results yielded by non linear models calls for the calculation of indicators beyond the estimated coefficients of the covariates, because these do not communicate the unconditional average effects, this awareness should arise also in the case of linear interaction regressions; in this sense, indicators such as the aforementioned AMEs provide relevant information to perform accurate and meaningful interpretations of the causal relationships in the linear models (Brambor et al., 2006).

The AMEs displayed in the following figures are obtained from the complete estimated model (model 4) and with confidence intervals of %95.

Figure 2. AMEs of the three independent variables of interest

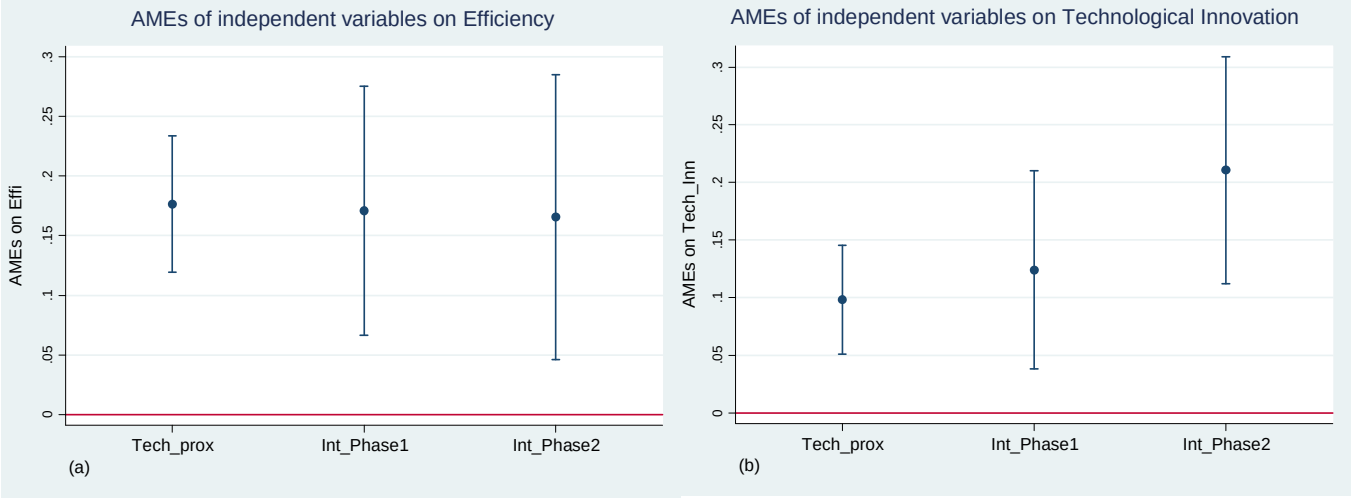
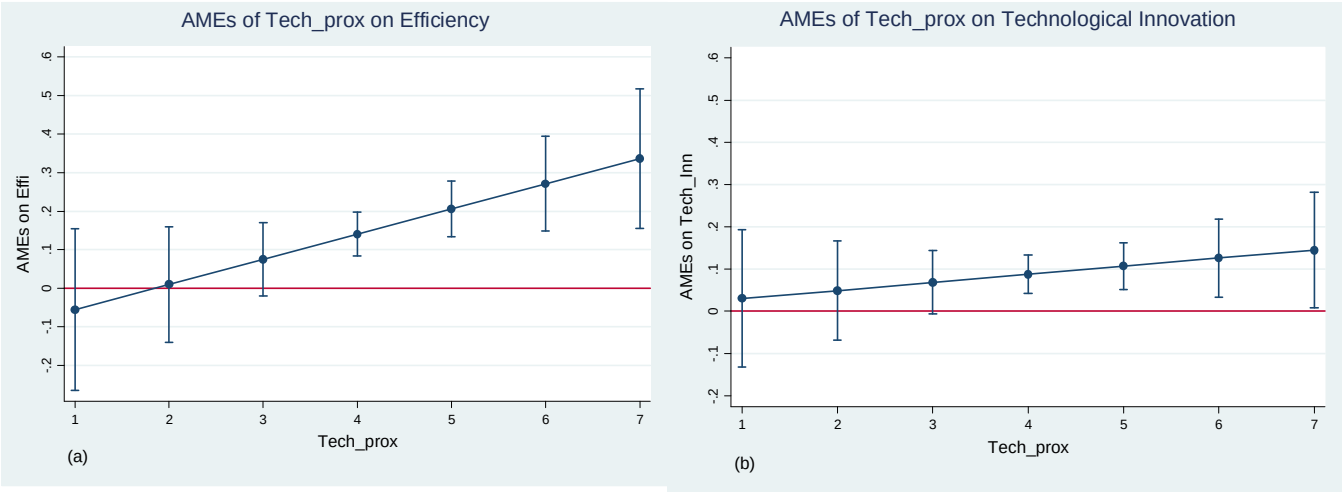


Figure 3. AMEs of technological proximity along its rage of values



Figures 2a and 2b show the average unconditional effect of all three independent variables (technological proximity and intensity of collaboration in the two phases), while figures 3a and 3b display the AMEs of technological proximity along its own range of values. Regarding the specific relationship between technological proximity and innovative performance, both the beta coefficient estimated (see results for models 3 and 4) and the AMEs of the variable for different values of its range show no evidence of the existence of an inverted U-shape with none of the measures of performance. The relationship between technological proximity and the generation of technological innovation seems to be merely linear. On the one hand, while the estimated coefficient of technological proximity is positive and significant in model 2, nor the simple variable nor the quadratic term show significant estimated betas in models 3 and 4. On the other hand, although the AMEs show increasing punctual estimations along the range of values of the variable, the estimated intervals do not seem to support the existence of significant differences among them, thus leading to conclude that those AMEs are in fact of the same magnitude. As commented above, this observations are consistent with the measures of the goodness of fits and the results of the Wald test. As for the effects on efficiency, results somehow suggest a positive curvilinear relationship, with a significant coefficient for the quadratic term of technological proximity in models 3 and 4 (and non-significant for the simple variable), and increasing positive AMEs along the range of values of the variable. In any case, both for efficiency and for the

generation of technological innovations, the findings do no support the existence of a saturation point from which more technological proximity with R&D partners leads to worse innovative performance. This leads to **the rejection of hypothesis 1**.

As commented in the theoretical framework of this work, the theory of absorptive capacity (Cohen and Levinthal, 1990) posits that a low level of knowledge overlap between partners implies greater challenges for identifying, acquiring and assimilating that distant knowledge (Parida et al., 2016). Indeed, when pursuing to profit from collaborative innovation practices, there is a need to understand the source's knowledge base, which in turn requires a certain technological proximity to it. In this sense, Perez and Soete (1988) claimed that there is a minimum level of shared knowledge under which firms are not capable of bridging their technological gap, and Boschma and Lambooy (1999) concluded that firms' own knowledge base should be close enough to the new knowledge in order to understand and process it successfully.

According to the evidence found here, there is a positive relationship between technological proximity and innovative performance, in line with the theoretical arguments based on absorptive capacity. However, it challenges the rationale of the 'proximity paradox' (Boschma and Frenken, 2010), feeds the polemic around this notion and provides new insight to propose new approaches to this phenomenon. Indeed, it might be interesting to determine whether firms that benefit from ever growing levels of technological proximity with their partners are still able to obtain related yet complementary knowledge from such partners. That is, whether in situations of high technological relatedness, there is still room to benefit from the existence of complementary resources derived from combining internal and external sources of innovation, an aspect which has been signaled as one of the main foundations for the success of collaborative innovation practices (e.g., Gassman and Enkel, 2004). After all, the foundation of the resource-based view is precisely that firms perform differently and that these differences are due to the resource heterogeneity they possess (Penrose, 1959).

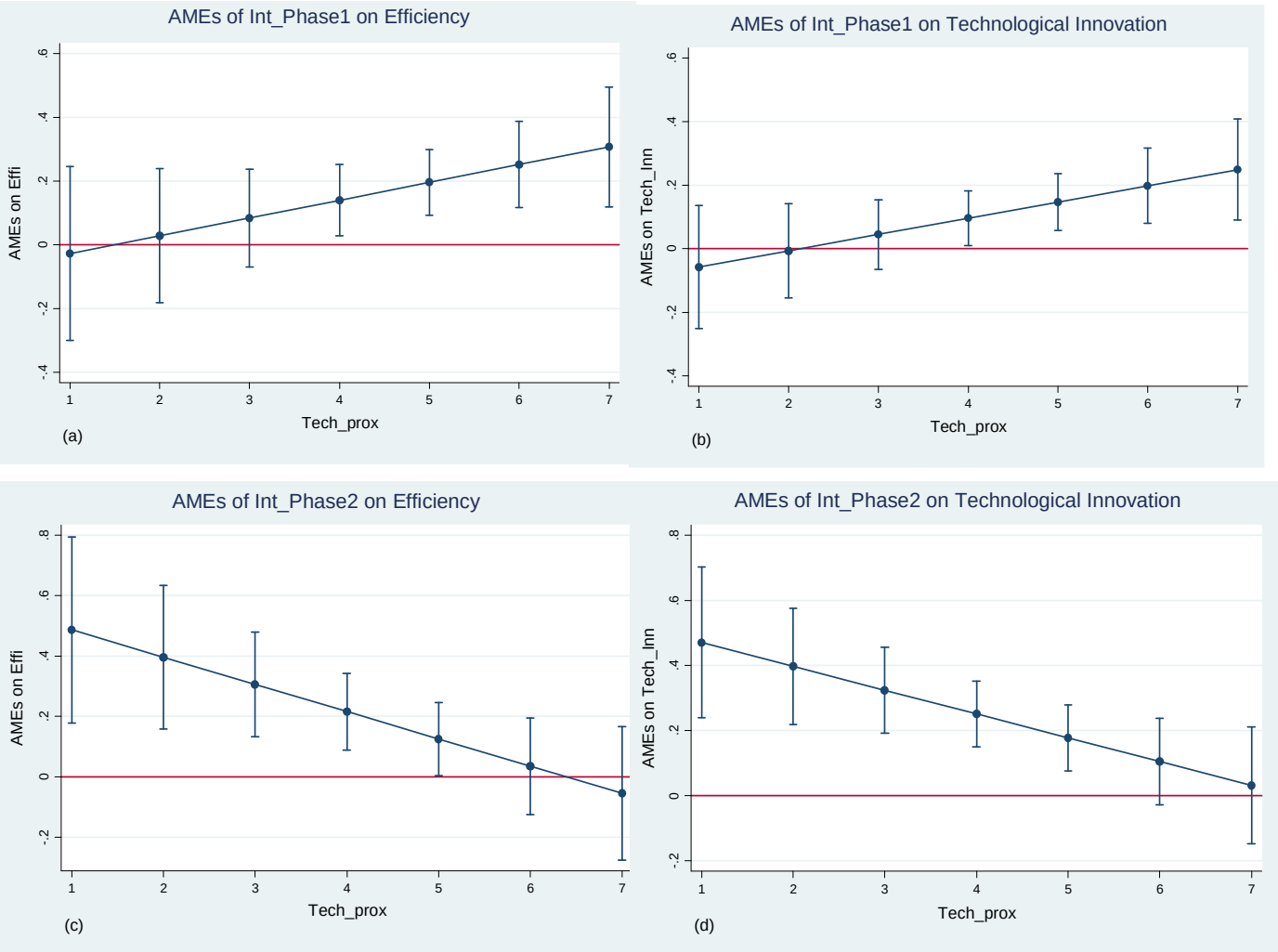
These considerations would constitute a valuable basis for future research.

Turning now to the effect of the intensity of collaboration in the early and late phases of the innovation funnel, figures 2a and 2b clearly show that it is positive and significant both for the efficiency of the process and for the generation of technological innovations, thus **confirming baseline hypothesis 2** and providing further support to the theories claiming that, in order to transfer tacit knowledge and develop complex tasks, as it is common in R&D partnerships, firms need to commit to the project and engage meaningfully in the relationship with the external sources of innovation (Berchichi, 2011; Hsieh and Tidd, 2012). These findings lead to a similar conclusion as that posited for technological proximity; that is, the more intense the relationship with the collaborators of the R&D partnerships, the better in terms of innovative performance. A refinement of such conclusion regarding whether it is sustained for partnerships portfolios diverging in terms of diversity and number of partners would be undoubtedly valuable. This would provide further understanding on the benefits of collaborating intensely with R&D external sources; i.e., determining whether firms should commit to deep relationships with a wide range of partners or if they should focus on collaborating intensely with key and preferred partners, as stated by Berchichi (2011).

Figures 4a and 4b provide the graphic representation for interpreting the joint effect of the intensity of collaboration and technological proximity in the early phase of the innovation process. In both cases, the AMEs of the intensity of collaboration increase along the range of values of technological proximity. The estimated coefficients of the corresponding covariate give valuable information too; in the model for the effect on efficiency, such coefficient is non-significant, while in the model for the effect on the generation of technological innovations, it is positive and significant. These findings imply **some evidence to support hypothesis 3a**. Also, the graphical depiction and the estimated coefficients of the simple covariate for the intensity of collaboration in the early phase in model 4 (non-significant for both measures of performance) hint that firms need a certain level of technological proximity in order to profit from collaborating intensely with their innovation partners. This idea is consistent with literature stressing that overlapping technological bases enable the transfer and recombination knowledge and help in

managing complex interactions, which are indeed characteristics of the early stages of the collaborative innovation process (e.g., Srikanth and Puranam, 2011; Lakemond et al., 2016).

Figure 4. AMEs of the Intensity of collaboration in the early and late phases, depending on the values of technological proximity



More conclusive are the findings for the joint effect of technological proximity and collaboration intensity, in the case of the later stages of the innovation process. Figures 4c and 4d, portraying the AMEs of the intensity of collaboration in the late phase for different values of technological proximity, show that the higher the matchup between the firms' technological base and their partners, the lower the positive effect of collaborating intensively. This holds for both measures of innovative performance. Also, the estimated coefficients of the interactive covariate

are both negative and significant. Therefore, the results of this work fully **support hypothesis 3b**: collaborating very intensely in the later stages of the innovation process with very close partners, in terms of technological bases, is detrimental for innovative performance. An explanation for this phenomenon would be, as commented above, that involuntary spillovers and collaborators' opportunistic behavior are more likely to arise in the late phase of the innovative process and, also, if those collaborators are proximate in technological terms (Lakemond et al., 2016; Boschma and Frenken; 2010). The appropriability problems derived from such circumstance would thus affect firms' willingness to fully engage and contribute to the project, which would in turn negatively affect the outcomes of said project (Ritala Hurmelinna-Laukkanen, 2013). The problematic scenario set by appropriability for collaborative innovation practices has been treated in scientific literature; however, further research is needed regarding the relationship of such practices and appropriability with performance (Laursen and Salter, 2014; Stefan and Bengtsson, 2017). More specifically, and in line with the findings for this work, such research would benefit from taking into consideration the use of appropriation mechanisms in different stages of the collaborative innovation process (Zobel et al., 2017).

Finally, it is worth offering some comments on the estimated coefficient of the control variables. As it can be seen in table 6, only innovativeness and technological sector have a significant effect on performance, the latter only for the generation of technological innovations (not for efficiency) and of a sign contrary to the one expected: the coefficient implies a positive influence of the firms of low technological sectors with respect to firms of high technological industries. This hints towards a potential interesting further research dealing with the questions of this work applied to a study distinguishing clusters according to the technological sector.

5. CONCLUSIONS

The work has focused on understanding how the intensity of collaboration along the innovation funnel and the proximity between the partners' technological bases influence the outcomes of collaborative innovation process, in terms of efficiency and generation of technological

innovations. In particular, it aimed to determine the nature of the relationship between the aforementioned variable of interest and innovative performance regarding the following aspects: what is the unconditional effect of technological proximity on performance?; what is the unconditional effect of the intensity of collaboration in different phases of the process on performance?; and, what is the joint effect of technological proximity and collaboration along the innovation funnel on performance?

In order to answer these questions, regression models were estimated over a dataset with more than 400 firms sited in different European countries (i.e., Italy, Sweden, Finland and UK), and results were interpreted analyzing both the estimated coefficients and the AMEs of the covariates of the models.

Said analysis led to the following conclusions. Regarding the first question, results showed that technological proximity has a positive relationship with innovative performance. This finding was somehow contradictory with the expectations of the study, whose theoretical framework relies heavily on the notion of 'proximity paradox' (Boschma and Frenken, 2010) and thus predicted an inverted U-shape relationship. The evidence found here, however, excluded the existence of a saturation level of proximity from which the positive effects on performance would start to diminish.

On the other hand, findings on the effects of collaboration intensity matched the predictions derived from the theoretical framework; i.e., collaborating intensely with the partners of the innovation projects, no matter the stage of the funnel, is beneficial both in terms of efficiency and of generation of technological innovations.

Results on the joint effect of the intensity of collaboration and technological proximity were interpreted as follows. In the early stage, there is some evidence to sustain that such joint effect is positive and that firms indeed need to have a certain level of technological overlap with their innovation partners in order to benefit from collaborating intensely with them. However, in the later stages of the innovation process, collaborating very intensely with very technologically

close partners proves to be detrimental for innovative performance. Involuntary spillovers due to closeness and collaborators' opportunistic behavior, which are more likely to arise in the late phase of the innovative process, would explain this negative joint effect and warn about potential appropriability problems.

The analysis of the findings of this research is valuable to practitioners, policy makers and, in general, agents involved with innovation management, as it provides relevant recommendations regarding collaborative innovation practices. In general terms, evidence was found to suggest that firms should try to collaborate intensely with technologically related partners, and pay attention to proper protection mechanisms, especially when collaborating in the later stages of the innovation process.

Also, this research adds to innovation management literature by providing interesting contributions, as it delves into the phenomenon of proximity and tries to unravel how non-geographical proximity (which is said to be disregarded with rapport to geographical proximity) is relevant for innovation outcomes, bringing surprising evidence to the debate around the 'proximity paradox', which is still led by inconclusive results. Besides, the study takes into account the collaborative innovation practices as a process and provides insight on how innovative performance might be affected by complementarities enhanced by technological proximity along the different phases of the innovation funnel.

The findings of this work provide further contribution to the academic community by suggesting some interesting lines for future research. First, the evidence found here is challenging for the notion of the 'proximity paradox' and provides interesting insight regarding the polemic; i.e., is there really no saturation point for technological proximity?, does that mean that firms are never 'too close' in technological terms?; would that imply that firms do in fact benefit from R&D partnerships just because these ventures perform better in terms of efficiency or are firms so unique that even a high technological matchup leaves room for heterogeneity?

Second, research on proximity would benefit from introducing a perspective on appropriability; that is, linking the effects of technological proximity with the use of protection mechanisms in the different stages of the collaborative innovation process.

Finally, results hinted that considering different clusters according to the technological sector might refine the conclusions of this study.

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GENERAL CONCLUSIONS

The research carried out in the frame of this thesis pursued to advance the understanding on the effects of the implementation of innovation practices (taking into account the diverse nature of such concept) on innovative performance and value generation by firms. In particular, the studies presented before focused on technological and non-technological innovation practices, and on R&D&I practices carried in-house and developed with the participation of external agents.

In order to adopt a holistic and systematic perspective over the innovation phenomenon and therefore encompass the complexity and variety of these processes, the research made use of qualitative and quantitative methodological tools. The results from the qualitative analysis, carried out in the first stage of the investigation and based on case studies analysis, informed the direction and the research questions formulated for the second stage, whose analysis was conducted through the estimation of causal effects.

In this sense, the conclusions from the study presented in the first chapter highlighted the relevance of the implementation of organizational innovation practices for value generation in firms, in line with extant literature on the field of non-technological innovations (e.g., Schmidt and Rammer, 2007; Sapprasert and Clausen, 2012). Furthermore, they suggested that organizational innovations allow for better exploitation of the results of technological innovation practices, both those carried out inside the boundaries of the firm and those developed in collaboration with external sources.

These conclusions were subsequently tested in the quantitative study described in chapter three. Through the estimation of coefficients of probit models and the corresponding average marginal effects of the covariates, the findings confirmed that all innovation practices (i.e., internal R&D&I activities, collaborative technological innovation practices and organizational innovation practices) have a positive effect on the generation of product and process innovations, also in line with previous research (e.g., Conte and Vivarelli, 2014; Bayona-Sáez et al., 2017). Results also provide some evidence supporting the main findings from the aforementioned

qualitative analysis, as they also point to a complementary effect of technological (be it internal or collaborative) and organizational innovation practices when pursuing the generation of complex technological innovations (both product and process innovations).

The multiple case study presented in chapter two resulted in the proposal of a theoretical framework on how organizational context factors influence the profiting of collaborative innovation practices along the stages of the process, thus addressing the call for further consideration of the contingent effect of the internal context on these practices (e.g., Lazzarotti et al., 2016). In this sense, teamworking was found to positively affect the relationship between the partners' background diversity and the successful development of collaborative innovations, in an early stage of the process. As for the integration stage, an open and permeable organizational culture was signaled as the success factor influencing a complementary effect between the use of both internal and external sources of innovation, thus contributing to the generation of marketable innovations. Finally, in the commercialization phase, the organizational factor moderating the relationship between the obtaining of marketable collaborative innovations and the financial outcome of the firm was the adoption of a strategic market approach by the firm.

Also with purposes of better understanding how firms may profit from collaborative innovation practices, taking into account the potential influence of strategic decisions and internal context contingencies, the study described in chapter four presents a quantitative analysis on the causal effects on innovative performance of technological proximity and the intensity of collaboration in different stages of the process. The evidence found here suggests that firms should try to collaborate intensely with related technological partners, and pay attention to proper protection mechanisms, especially when collaborating in the later stages of the innovation process.

The findings of this research provide relevant insight into the processes and contingencies influencing the generation of value and the realization of technological innovations derived from the implementation of innovation practices of diverse kind. In this sense, these studies enhance the understanding of the intricate nature of the relationships arising between organizational,

internal R&D&I and technological collaborative innovations activities, and between them and innovative performance. Thus, the conclusions present a valuable chance for practitioners and policy makers to reflect upon, with regard to making decisions about the implementation and fostering of innovation practices. In particular, the innovation practices described in the qualitative research constitute a sound catalogue of good practices that might serve as inspiration and guidance. On the other hand, the conclusions of the quantitative studies detailed above imply some interesting recommendations for firms, regarding the joint implementation of innovation practices and the strategic choice of partners in the different stages of the collaborative innovation process.

They also contribute to the literature on innovation management, as the research has delved into under-researched aspects, especially with respect to the combination of the technological (internally and externally sourced) innovation practices and the introduction of organizational innovations. Besides, by addressing the organizational context and strategic decisions affecting the profiting of said practices, this thesis offers new knowledge that advances the understanding of the innovation phenomenon and poses challenging opportunities to approach future research lines on the subject. The holistic approach adopted in the thesis implied to take into account also the idea of innovation practices as a process; consequently, two of the studies presented here take special care in including the particularities of the different phases into the analysis. Furthermore, in terms of assessing the influence of the innovation practices, the measures of performance employed in the studies were carefully designed in order to capture the effect of interest; i.e., the qualitative studies relied in the concept of value generation and on constructs measuring the success of the innovation practices in each stage of the process, and the quantitative studies introduced variables measuring the generation of product and process innovations and the improvements in costs and times. Finally, it is also worth noting that this thesis intends to bring forward the consolidation of the average marginal effects as a methodological instrument to use when interpreting the causal effects of both linear and non linear models.

The results obtained provide interesting suggestions for future research. First, the contrasting results regarding the complementarities between organizational and technological innovation practices when pursuing the generation complex innovations, on the one hand, or the realization of product or process innovations, independently, on the other, present undoubtedly a subject that requires further investigation. Last, future studies on collaborative innovation practices would benefit from linking the effects of technological proximity with the use of protection mechanisms in the different stages of the collaborative innovation process.

CONCLUSIONES GENERALES

La investigación llevada a cabo en el marco de esta tesis ha tenido como objetivo avanzar en la comprensión de los efectos de la implementación de las prácticas de innovación (teniendo en cuenta el carácter complejo de las mismas) en el desempeño innovador y en la generación de valor por parte de las empresas. En particular, los estudios aquí presentados se han centrado en prácticas de innovación tecnológicas y no tecnológicas, y en actividades de I+D+i desarrolladas tanto internamente como en colaboración con agentes externos.

Al objeto de adoptar una perspectiva holística y sistemática sobre el fenómeno de la innovación y abarcar la complejidad y la diversidad de estos procesos, la investigación ha hecho uso de herramientas metodológicas cualitativas y cuantitativas. Los resultados del análisis cualitativo, llevado a cabo en la primera etapa de la investigación y basado en el análisis de casos de estudio, sirvieron de orientación para la formulación de las líneas y preguntas de la investigación desarrollada en la segunda fase, cuyo análisis se realizó a través de la estimación de efectos causales.

En este sentido, las conclusiones del estudio presentado en el primer capítulo subrayaron la relevancia de la implementación de prácticas de innovación organizativa a efectos de generar valor por parte de las empresas, en línea con anteriores trabajos en el campo de las innovaciones no tecnológicas (e.g., Schmidt y Rammer, 2007; Sapprasert y Clausen, 2012). Además, sugirieron que las innovaciones organizativas permiten una mejor explotación de los resultados derivados de las prácticas de innovación tecnológica, tanto las desarrolladas en el interior de las fronteras de la empresa como las llevadas a cabo en colaboración con fuentes externas.

Estas conclusiones fueron testadas en el estudio descrito en el capítulo tres. A través de la estimación de coeficientes de modelos probit y de los correspondientes efectos margines de sus variables independientes, los resultados confirmaron que las prácticas de innovación (i.e., actividades internas de I+D+i, prácticas de innovación tecnológica en colaboración y prácticas de innovación organizativa) tienen un efecto positivo en la generación de innovaciones de producto

y de proceso, también en consonancia con investigaciones precedentes (e.g., Conte and Vivarelli, 2014; Bayona-Sáez et al., 2017). Los resultados aportan también evidencia que apoya las principales conclusiones del análisis cualitativo anteriormente descrito, pues señalan la existencia de un efecto complementario entre las prácticas de innovación organizativa y tecnológica (tanto internas como colaborativas) a la hora de obtener innovaciones tecnológicas complejas (innovaciones de producto y de proceso conjuntamente).

El estudio múltiple de casos presentado en el capítulo dos desembocó en la propuesta de un marco teórico sobre la influencia de factores contextuales organizativos en el aprovechamiento de las prácticas de innovación en colaboración a lo largo de las distintas etapas del proceso innovador. De esta forma, el estudio se adentraba en la consideración del efecto contingente del contexto interno en este tipo de prácticas, cuestión que había sido destacada como necesaria por investigadoras anteriormente (e.g., Lazzarotti et al., 2016). En este sentido, se determinó que la consolidación de una cultura de trabajo en equipo en la empresa focal tiene un efecto positivo en relación entre la diversidad de los socios y el desarrollo exitoso de avances tecnológicos en colaboración, en una primera etapa del proceso. Por lo que respecta a la etapa de integración de dichos avances tecnológicos, una cultura organizativa abierta y permeable fue el factor identificado como clave a la hora de garantizar la complementariedad entre el uso de fuentes internas y externas de innovación, y así contribuir a la generación de innovaciones comercializables. Finalmente, en la fase de comercialización, se determinó que el factor organizativo que modera la relación entre la obtención de dichas innovaciones y el resultado financiero es la adopción de una visión estratégica de mercado por parte de la empresa focal.

De nuevo con intención de avanzar en la compresión de cómo las empresas pueden beneficiarse del desarrollo de prácticas de innovación colaborativas, teniendo en cuenta la influencia de las decisiones estratégicas y las contingencias del contexto interno, se desarrolló el estudio descrito en el capítulo cuatro, que presenta un análisis cuantitativo sobre los efectos causales en el desempeño innovador de la proximidad tecnológica y de la intensidad de la colaboración en las distintas fases del proceso. La evidencia hallada en este estudio sugiere que

las empresas deberían intentar colaborar intensamente con socios tecnológicamente próximos. Y prestar atención a los mecanismos de protección, especialmente cuando se colabora en las fases tardías del proceso innovador.

Los resultados de esta investigación aportan información relevante sobre los procesos y las contingencias que influencian la generación de valor y la obtención de innovaciones tecnológicas cuando se ponen en marca prácticas de innovación de diverso tipo. En este sentido, estos estudios profundizan en la comprensión de la intrincada naturaleza de las relaciones que surgen entre las actividades de I+D+i internas, colaborativas y de innovación organizativa, y entre éstas y el desempeño innovador. Por lo tanto, las conclusiones presentan una oportunidad valiosa para la reflexión por parte de las personas a cargo de decisiones empresariales y de política económica, en relación con la implantación e impulso de prácticas de innovación. En particular, las prácticas de innovación descritas en los análisis cualitativos suponen un sólido catálogo de buenas prácticas que puede servir de inspiración y guía. Por otra parte, las conclusiones de los estudios cuantitativos detalladas anteriormente sugieren interesantes recomendaciones para las empresas en cuanto a la implementación conjunta de prácticas de innovación y a las decisiones estratégicas sobre con qué socios colaborar en las diferentes etapas del proceso innovador.

La investigación también supone una importante contribución a la literatura científica sobre gestión de la innovación, pues se ha adentrado en cuestiones infra investigadas, especialmente por lo que respecta a la combinación de prácticas de innovación tecnológica y no tecnológica. Además, al tener en cuenta el contexto organizativo y las decisiones estratégicas que influencian el aprovechamiento de dichas prácticas, esta tesis ofrece conocimiento que avanza la comprensión del fenómeno de la innovación y plantea nuevas oportunidades para futuras líneas de investigación en la materia. La perspectiva holística adoptada en la tesis ha supuesto también que se tenga en consideración la idea de las prácticas de innovación como un proceso; consecuentemente, dos de los estudios presentados introducen en el análisis las particularidades de las diferentes fases del proceso innovador. Además, las medidas de desempeño utilizadas en los estudios para valorar el impacto de las prácticas de innovación fueron cuidadosamente

diseñadas para capturar los efectos de interés; i.e., los estudios cualitativos se basaron en la idea de la generación de valor y en constructos que medían el éxito de las prácticas de innovación en cada etapa del proceso, y los estudios cuantitativos introdujeron variables que reflejaban la generación de innovaciones de producto y proceso y medidas de eficiencia como la reducción en costes y tiempos. Finalmente, cabe destacar que esta tesis pretende contribuir a la consolidación del uso de los efectos marginales como instrumento metodológico apropiado para la interpretación de efectos causales en modelos tanto lineales como no lineales.

Como se ha manifestado anteriormente, los resultados obtenidos plantean interesantes sugerencias para futuras investigaciones. Los resultados contradictorios con respecto a la complementariedad entre prácticas de innovación tecnológica y organizativa cuando se pretende conseguir innovaciones complejas (de producto y de proceso conjuntamente), por una parte, y cuando se pretende obtener innovaciones de producto y/o proceso de forma independiente, por la otra, plantean una cuestión que merece la pena investigar más en profundidad. Además, los estudios que se desarrollen en el futuro sobre prácticas de innovación en colaboración sin duda podrían beneficiarse de vincular los efectos de la proximidad tecnológica con el uso de mecanismos de protección en las diferentes fases del proceso.

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