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Olmos-Peñuela, J.; García Granero, A.; Castro-Martínez, E.; Deste Cukierman, P. (2017). Strengthening SMEs' innovation culture through collaborations with public research organizations. Do all firms benefit equally?. *European Planning Studies*. 25(11):2001-2020. doi:10.1080/09654313.2017.1279592



The final publication is available at

<https://doi.org/10.1080/09654313.2017.1279592>

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Additional Information

## **Enhancing SMEs firm's innovation culture through PROs collaborations.**

### **Do all firms benefit equally?**

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#### **Acknowledgements**

This work was supported by the Spanish National Research Council (CSIC) under the IMPACTO project. The authors acknowledge CSIC and other IMPACTO project researchers (from INGENIO and IESA institutes) for their hard and very satisfactory work and also to the firms, whose questionnaire answers allowed developing the database.

## **Enhancing SMEs firm's innovation culture through PROs collaborations.**

### **Do all firms benefit equally?**

#### **Abstract:**

The purpose of this paper is to explore whether collaborating with Public Research Organisations (PROs) can increase the firms' innovation culture and its determinants. To this aim, we address the following research questions: i) Do firms enhance their innovation culture because of their collaborations with research organisations? ii) If so, what are the conditions under which firms experience an increase in innovation culture because of establishing collaborations with research organisations? The empirical study is based on a unique database implemented within the framework of the IMPACTO project aimed at providing a wider understanding of the impact of the collaboration between firms and the Spanish largest PRO (CSIC). Results indicate that firms counting with a formalized innovation plan create the conditions to embrace an innovation culture provided by the collaboration with PROs. Moreover, if these firms pursue a deep search strategy the latter relationship reinforces. These findings could be of interest for managers because it enlightens them on how to increase innovation culture by collaborating with research organisations.

**Keywords** – Innovation culture, firms-PRO collaborations, collaboration benefits, formal innovation plan, search strategy, SMEs

## 1. Introduction

The role of innovation in contributing to firm's performance is a well-established relationship in the literature (Daellenbach, McCarthy, & Schoenecker, 1999). Innovation is widely "used to describe the introduction and spread of new and improved products and processes in the economy" (Freeman, 1974, p.18). On a regular basis innovation has been extolled as unavoidable in allowing organizational growth on a long term basis (Teece, Pisano, & Shuen, 1997)

To be innovative, firms need to have an organizational culture which builds around innovation, that is, increase the firm's innovative culture (Martín-de Castro, Delgado-Verde, Navas-López, & Cruz-González, 2013; Santos-Vijande, González-Mieres, & Sánchez-López, 2012). The organization needs to involve all employees in the innovation process and create a common belief based on the relevance of innovation to be successful. Moreover, recent trends on open innovation stress that innovation is an output that is only possible when external agents other than the firm are also involved in the process (Bishop, D'Este, & Neely, 2011; Chesbrough, 2003; Gulbrandsen, Mowery, & Feldman, 2011; Perkmann et al., 2013).

However, previous studies investigating the firm's innovation culture (i.e., Dobni, 2008; Hogan & Coote, 2014; Santos-Vijande et al., 2012) have not taken into account how external agents contribute to this process. In this paper, we are especially interested in the role of research organizations due to their innovative nature. Firms look out for research organizations in order to find state of the art research leading to technological breakthroughs (Miotti & Sachwald, 2003). This process entails exploratory learning, experimentation and the toleration of high risk, which allows firms to learn and become more innovative.

Moreover, in this paper we focus on SMEs. Recently, Huizingh (2011) claims that more research is necessary in order to disentangle in what sense SMEs benefit from their collaboration with external agents. Also Van de Vrande, De Jong, Vanhaverbeke, & De Rochemont (2009) call attention to the fact that small firms are increasing their collaborations with external partners and that this is especially relevant, because small firms usually suffer from limited resources and external sources emerge as potential providers of these resources.

We conduct this study focusing on Spanish SMEs that have established collaboration agreements with the CSIC<sup>1</sup>, the Spanish largest Public Research Organisation (PROs). In Spain SMEs represent more than 99.88% of the Spanish productive system (IPyme, 2015). Taking

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<sup>1</sup> Spanish National Research Council (in Spanish: *Consejo Superior de Investigaciones Científicas*)

into account this framework the paper aims to answer the following questions: 1) To what extent SMEs increase their innovative culture through their collaborations with research organisations? 2) What type of firms achieves to benefit more?

In this sense, we contribute to the literature in several ways. First, studies analysing innovation culture focus mainly within the firm's boundaries. However, we bring in open innovation contributions to claim that innovation culture can be enhanced through the leverage of external sources of knowledge. Second, we also inform the literature of open innovation by claiming that SMEs are able to benefit from research organisations not only in terms of technological innovation but also by increase their innovation culture. Finally, we contribute to the absorptive capacity literature by highlighting that research and development (R&D) is not the only facilitating factor in open innovation, but firms also need to have a formal innovation plan in place.

The paper is organized as follows. Section 2 sets out the conceptual framework highlighting the importance of innovative culture and the potential firms can accrue from collaborating with research organizations. Section 3 sets out the main research questions addressed in the paper and examines the main factors allowing firms to benefit more from their collaboration with research organization in terms of increasing their innovation culture. A description of the data used in the analysis is contained in Section 4; and Section 5 presents the main empirical results. Section 6 presents our conclusions.

## **2. Literature Review**

### *2.1 The importance of organisations' innovation culture*

The concept of organisational culture refers to a set of values and beliefs that provides norms of expected behaviour to be followed by its members and that defines the ways in which an organisation conducts its activities (Barney, 1986; Schein, 1992).

It is well recognised that individuals working at organisations are the main source of value for these organisations since they undertake the final actions that ultimately affects the overall organisation (Grant, 1996). However, there is also a wide consensus about the key role of the social context and the culture surrounding these individuals in supporting or hindering the specific actions they conduct and the way they behave to accomplish organisational goals (Menzel, Aaltio, & Ulijn, 2007). Thus, a strong culture in a firm provides shared values, rules

and norms that shape employees' behaviour, ensuring that everyone is on the same track to achieve firms' goals (Colquitt, Lepine, & Wesson, 2009; Robbins, 1996).

The influence of the culture on the employee is particularly important for firms aimed at promoting innovation processes given the uncertain, unpredictable and risky nature of innovation. The reason is that employees may face drawbacks when demonstrating an innovative behaviour<sup>2</sup> such as the exploration of new ideas within or beyond firm's boundaries and its application to organizational purposes. For instance, innovative behaviour may have attached a cost associated to proposing new ideas that questions old practices and probably supporters of these practices. Demonstrating an innovative behaviour is not always amenable across different contexts or organizational cultures since challenging established practices may create situations that arise possible conflicts with other employees within the organization (Janssen, 2003).

For this reason, in order to avoid possible conflicts to arise and legitimize innovation behaviours, firms adopt practices to signal that innovation is a desirable behaviour in the organization (Yuan & Woodman, 2010). In this sense, the way in which a firm receives new ideas and reacts to them characterises its innovation culture. Thus, innovation culture is understood as a specific facet of the organisational culture (Brettel & Cleven, 2011) referred to the shared norms, values, beliefs and assumption among employees that could facilitate the innovation process (Martín-de Castro et al., 2013; Santos-Vijande et al., 2012).

Indeed, it is widely recognised in the literature that organisational culture affects innovation (Ahmed, 1998; González de la Fe, Hernández Hernández, & van Oostrom, 2012; Martins & Terblanche, 2003; Naranjo-Valencia, Jiménez, & Sanz-Valle, 2012; Sadegh Sharifirad & Ataei, 2012) and that the existence of shared values between organization and individuals is among the factors that most affect innovation in either a positive or a negative way (Naranjo-Valencia et al., 2012). Culture shapes the way in which innovation is understood within the organisation, predisposes the way in which employees see innovation favourably, which affects their degree of commitment and their behaviours or actions undertaken to reach firm's innovation goals (Hartmann, 2006; Russell & Russell, 1992).

Indeed, previous studies highlights the relevance of having a culture that permeates all the members of an organization with an innovative attitude, thus suggesting that a positive attitude

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<sup>2</sup> Innovation behaviour has been defined as "as an employee's intentional introduction or application of new ideas, products, processes, and procedures to his or her work role, work unit, or organization" (Yuan & Woodman, 2010, p. 324).

towards the generation of new ideas, the implementation of new approaches, and working on team are key elements to stimulate and promote organisations innovative capacity (Gopalakrishnan & Damanpour, 1994; O'Reilly, 1989). This implies that firms that do not penalise the contribution of new ideas, that are tolerant with mistakes and that support and encourage employees to share their novel ideas are those firms that exhibit an innovation culture oriented towards innovation are therefore, those firms more prone to innovation.

## *2.2. Research organisations and firms collaborations and potential benefits*

External partners, such as suppliers, customers or research organisations (universities and research centres) are firm's alternatives in their search for innovative ideas (Laursen & Salter, 2004; Sánchez-González & Herrera, 2010). Innovation is not fruit of solely firm's resources, but also from those resources leveraged by their partners. Open innovation approach even suggests that external sources are sometimes even more relevant than internal sources of knowledge in innovation processes (Chesbrough, 2003).

In particular, research organisations are very interesting alternatives for firms, because those firms successfully interacting with universities and research organisations introduce innovations with a higher degree of novelty (Amara & Landry, 2005; Becheikh, Landry, & Amara, 2006). This is linked to the fact that research organisations are large repositories of knowledge, information, skills, which usually involve high-qualified workforce and broad capabilities (Santoro & Chakrabarti, 2002). Specifically, research organisations focus on the most generic or basic end of the R&D complex and entail less commercial risks as they do not follow as main objective the direct applicability and exploitation of knowledge. In this sense, co-operation with research organisations increases the firm's chance of introducing a technological breakthrough (Miotti & Sachwald, 2003).

Most of previous studies highlight the benefits of firms collaborating with research organisations in terms of technological innovations, and more specifically in terms of their degree of novelty (Belderbos, Carree, Diederer, Lokshin, & Veugelers, 2004; Lööf & Broström, 2008; Monjon & Waelbroeck, 2003). These empirical studies focus on technological innovation as a possible output of the firm's collaboration with research organisations. However, as long as there is an interaction between research organisations and firms, there is a learning process in place. Specifically, research organisations provide firms with complementary knowledge, technologies and skills that have a large potential for learning (Un, Cuervo-Cazurra, & Asakawa, 2010).

### **3. Development of hypotheses**

#### *3.1 Innovation culture as a benefit from research organisations and firm collaboration*

Firms and research organisations operate under different systems. research organisations are based on the principles of "public science", free, rapid and objective dissemination of research outputs; while firms rely on "private science" principles, that is, appropriation and private commercialization of research results (Dasgupta & David, 1994; Manjarrés-Henríquez, Gutiérrez-Gracia, Carrión-García, & Vega-Jurado, 2009). These divergent principles entail differences in terms of goals, incentives, structures and resources. Academic and commercial activities require different skills and abilities; while the former requires how to conduct rigorous research, the latter seeks commercial accomplishments (Ambos, Mäkelä, Birkinshaw, & D'Este, 2008; D'Este & Patel, 2007).

These differences entail tensions and difficulties to conduct successful interactions, but also amplifies the chances of learning. Collaborations with research organisations are related with exploratory learning, which enables problem-solving (Koza & Lewin, 1998); ability to manage unfamiliar knowledge and skills, experimentation and the toleration of high risk (Bierly & Daly, 2007). These attributes are necessary in order to increase the innovative culture of the firm. We argue that interacting with these types of organisations, helps the firm's employees to become more innovative oriented and eventually, increase the organizations' innovative culture. In the case of SMEs, this is especially relevant. Their liability of resources makes them more prone to collaborate with PROs, meaning a higher potential for learning (Van de Vrande et al., 2009) Thus, we pose the following hypothesis:

*H1: SMEs benefit from their collaboration with research organisations in terms of increasing their innovation culture.*

#### *3.2 Innovation formal plan*

Not all firms benefit equally from research organizations collaborations (Cohen & Levinthal, 1990). Eventually, firms that are intensive in R&D can take more advantage from research organisations collaborations. Using absorptive capacity as their main theoretical framework, the majority of these studies examines R&D as a condition to fully benefit from research organizations pool of knowledge, and rather ignores the role of other firm's organizational practices (Colombo, Rabbiosi, & Reichstein, 2011).



A first aspect that might facilitate firms and research organisations collaboration is the presence (and relevance) of innovation within the mission, vision and strategy of the firm. The mission and the vision of a firm determines the *raison d'être*, the main purpose that the firm exists and the future direction (where the firm wants to be in the future), both shaping the strategy of the firms and its strategic goals (Hamel & Prahalad, 1994; Mintzberg, 1989). The implementation of a strategic plan oriented towards innovation (i.e., an innovation plan) reflects firms' innovation priorities and objectives and the way to reach them.

We argue that firms making a stated and working innovation plan, when interacting with research organisations, are incentivized to learn how to generate a climate keen to promote new ideas, enhance flexibility, teamwork and freedom. In other words, these firms have a higher chance of increasing their innovation culture through their collaboration with research organisations. Thus, we pose the following hypothesis:

*H2a: SMEs that count with a formal innovation plan benefit more from their collaboration with research organisations in terms of innovation culture.*

### *3.3 Open search strategy*

Firms that have in place an open search strategy may also influence the benefits obtained from their PRO collaborations. Search strategies are “problem-solving activities that involve the creation and re-combination of technological ideas” (Katila & Ahuja, 2002, p.1184). Scholars have theorized on different categorizations towards firm's search strategies (Rosenkopf & Nerkar, 2001; Rothaermel & Deeds, 2004). Firms search strategies can be internal and external (Rosenkopf & Nerkar, 2001). Moreover, external search strategies can also be differentiated into breadth and depth (Laursen & Salter, 2006). Breadth strategy is defined as the number of different search channels that a firm draws upon in its innovation activities, and depth strategy, as the extent to which firms draw intensively from different sources.

Laursen and Salter (2004) argue that the extent to which firms rely on different types of information sources, is an important driver of collaboration and derive benefits from universities. Specifically, these authors found that openness strongly influences the probability of using university knowledge in innovation activities. In other words, firms that have adopted an “open” approach to innovative search are more likely to use universities as a source of innovation.

Thus, we argue that firms can gain much from collaborating with research organisations when having in place an open search strategy. Having experience in collaborating with other sources of innovation and handling a portfolio of collaborations have positive spillovers in benefiting from research organisations. Concretely, SMEs can access valuable resources and strengthen their innovative culture. Thus, we argue:

*H2b: SMEs that count with an active search strategy (breadth and depth) benefit more from their collaboration with research organisations in terms of innovation culture.*

### *3.4 Innovation formal plan and search strategy*

It is also reasonable to assume that firms having both, an innovation plan in place and an active open search strategy, are more prepared to take full advantage of their collaboration with research organisations. We argue that when these two characteristics are in place in a firm, they will reinforce each other, and the firms will increase more their innovative culture from research organisations collaborations. Following this line of thought we argue:

*H2c: SMEs that count with a formal innovation plan and an active search strategy benefit more from their collaboration with research organisations in terms of innovation culture.*

## **4. Methodology**

### *4.1 Population, sample and data source*

The empirical study is based on a unique database implemented within the framework of the IMPACTO project. The aim of this project was, among others, to provide a wider understanding of the impact of the collaborations between firms and the Spanish largest Public Research Organisation, the CSIC<sup>3</sup>.

Our population of study are the 1891 Spanish firms that established at least one of the 5334 formal contracts signed with CSIC during the period 1999-2010. Data was collected using a questionnaire containing general questions regarding the firm's characteristics and the management of innovation activities, and specific questions related to the firm's collaboration with CSIC, its motivations to collaborate and the benefits obtained. Data from each firm was provided by the firms' responsible of the contract signed with CSIC, since it is expected to be the person with most information (from the firm side) for assessing the development of the

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<sup>3</sup> For more details on the CSIC characteristics at the time of the study, please see Olmos-Peñuela, Benneworth, & Castro-Martínez (2014)

collaboration and its results. In case it was not possible, the manager of the firm with enough knowledge about the collaboration established with CSIC was approached to provide the unique information required.

A pre-test of the questionnaire was conducted before the data collection to ensure that its content was well understood among its potential respondents. Thus, data was gathered by conducting interviews to the abovementioned managers (usually R&D managers or technical managers). The fieldwork was conducted between the 1<sup>st</sup> October 2010 and the 31<sup>st</sup> January 2011 and we obtained a sample of 794 Spanish firms which corresponds to a response rate of almost 42%.

Harman's one-factor test was performed to assess whether there were problems of common method bias in the data collected. There are not concerns of common method bias since the result of the test was within the boundaries recommended by Podsakoff & Organ (1986).

The questionnaire information was complemented by the data provided by the Iberian balance sheet analysis system database (SABI) which provided data about firm's age, size and sector. Our final sample was made up by all the firms from which we had information from the two sources (the questionnaire and SABI) which account for a sample of 756 firms. Since this study focuses on SMEs, the final sample analysed is 610 firms.

#### *4.2 Dependent variables*

As discussed in the introduction, we are interested in examining which firms could benefit from collaborating with CSIC in terms of increasing their innovation culture. Thus, other than focusing on the benefits related to innovation widely addressed in the literature – such as product and process innovation (Aschhoff & Schmidt, 2008; Löf & Broström, 2008), here we focus on firms' innovation culture as a potential benefit from collaborating with PRO, understood as the values and beliefs shared in the firm that facilitate or promote innovation processes (Martín-de Castro et al., 2013; Santos-Vijande et al., 2012). Thus, having an innovation culture is identified as the promotion of new ideas, flexibility, freedom or teamwork (Arad, Hanson, & Schneider, 1997; Hogan & Coote, 2014; Menzel et al., 2007; Naranjo-Valencia et al., 2012; Robbins, 1996).

The dependent variable 'increase of innovation culture' is constructed using information from the questionnaire regarding the benefits that the firm experienced from collaborating with CSIC. Specifically, the respondent indicated whether the firm benefited from an increase of its

innovation culture as a consequence of its collaborations with CSIC, and the degree of importance of this benefit for the firm. The degree of importance was assessed with a four-point Likert scale ranging from 1 “no collaboration/not beneficial” to 4 “highly beneficial” (Valmaseda-Andia, Albizu-Gallastegi, Fernandez-Esquinas, & Fernandez-de-Lucio, 2015).

#### *4.3 Independent variables*

##### *Innovation plan*

The independent variable related to firm’s *innovation plan* was approximated through the firm’s availability of an innovation strategic plan. Specifically, respondents were asked to inform about the state of their innovation plan by selecting one of the four following options: a) the firm had no innovation plan; b) the firm was planning to develop an innovation plan; c) the firm was in the process of developing an innovation plan; d) the firm already counted with an innovation plan. We created a binary variable to make a distinction between those firms already involved in the process of developing an innovation plan or with implemented innovation plan, and those firms without an innovation plan or at an early stage (such as planning its implementation). Thus, we created the binary variable named *innovation plan* that takes the value 1 if the firm has an innovation plan or is implementing it, and 0 otherwise.

##### *Search strategy*

Regarding the independent variable related to “search strategy” for innovation, the respondents were asked to indicate the degree of importance they attached to different sources of information to improve their innovation processes. The sources of information provided in the questionnaire included an internal source (i.e., internal knowledge of the firm) and diverse external sources (i.e., suppliers; clients; competitors; consultants, laboratories or R&D private institutes; universities and public research bodies; technology centers; conferences, congresses, fairs and professional meetings; regional and national governments; and professional and industry associations). The degree of importance they attached to these sources was assessed with a four-point Likert scale ranging from 1 “not important” to 4 “very important”.

For the construction of the search strategy variables, we distinguish between internal and external search on the bases on whether the sources were located within the firm or outside the firms’ boundaries. Additionally, following Laursen & Salter (2006) we distinguish between breadth search and depth search and we created three variables namely: *breadth external search*; *depth internal search* and *depth external search*.

*Breadth external search* defines the variety of external sources used by the firm to and is constructed as a combination of the nine external sources abovementioned. The first step has been to code each external source (initially ranging from 1 to 4) into a binary variable that takes the value 0 if the firm has not relied on this source for innovation, and 1 otherwise. The second step has been to add up the nine variables to construct the variable *breadth external search* that takes the value 0 if the firms has not relied in any external source, and 9 in when it has relied in all of the external sources proposed.

Since *depth external search* relates to the intensity to which firms rely on external sources, the first step to construct this variable was to code each external source (initially ranging from 1 to 4) into a binary variable that takes the value 1 if the firm reported that the external source was very important for innovation, and 0 otherwise. Then we added up the nine binary variables obtained to construct our independent variable *depth external search*, that takes the value 0 if the firms has not consider very important any of the external sources, and 9 if it has considered as very important the nine external sources of information proposed.

Finally, *depth external search* was constructed as a variable ranging from 1 to 4 that captures how important was for the firm to draw on their internal sources of information for innovation.

#### 4.4 Control variables

Control variables such as intensity in R&D, previous experience of collaboration, age, size and sector were also included in the regression analysis.

First, we measure technological capacity (*intensity in R&D*) using a scale from 1 to 3, where the value 1 captures that the firm does not develop internal R&D; the value 2 indicates that the firm pursues R&D occasionally; and the value 3 reports that the firm develops internal R&D on a yearly basis. Second, we capture the *experience in collaborations* through a binary variable that takes the value 1 in the case the firm considers CSIC to be the most frequent external partner used in their collaborations, and 0 otherwise. Third, we control for the *age* of the firm using a continuous variable that counts the number of years since firm's foundation. Fourth, the size of the firm was captured through a continuous variable measuring the number of employees of the firm. We use a logarithmic transformation to match this variable with a normal distribution.

Finally we also control the firm's *industrial sector*. Firm's in our sample belong to a wide range of sectors, so we created a binary variable for each sector that take the value 1 if the firm belongs to this sector, and 0 otherwise. The sectors considered were: construction; energy and

water supply; mining industry; services; agriculture, forestry and fishing, high technology manufacturing, low technology manufacturing, and medium-high technology manufacturing.

#### 4.5 Analysis

To address our first research question, we conducted a descriptive analysis to explore the extent to which firms' collaborations with CSIC enhanced their innovation culture.

Then, in order to explore how the collaboration with PROs can support firm's innovation culture improvements, we have carried out an ordered logistic regression. More specifically we have considered *increase of innovation culture* as our dependent variable and we included *firm's innovation plan; breadth external search; depth internal search and depth external search* as the main independent variables. In particular, we have paid special attention to the firm's deliberate efforts of formulating and formalizing an innovation plan inasmuch as the firm's search strategies for improving their innovation processes. We have estimated four different specifications to test our hypotheses (as deeper explained in the result section).

Descriptive statistics and bivariate correlations of the independent variables and control variables of the study are reported in Table 1. The correlation matrix indicates weak correlation coefficients. Column 6 reports the VIF (the Variance Inflation Factor values is the reciprocal of the tolerance statistic values) which indicates whether two independent variables have a strong linear relationship. All VIF values are much lower than 10, which suggest that multicollinearity is not a concern in the regression analysis (Field, 2009; Neter, Kutner, Nachtsheim, & Wasserman, 1996). Moreover, we have used mean centered variables for the evaluation of the moderating effects in order to reduce multicollinearity problems.

**[Insert Table 1 about here]**

## 5. Results

### 5.1 Descriptive results

The descriptive statistics computed for the variable *increasing innovation culture* indicate that 38% of the firms interviewed reports that, as a result of collaborating with CSIC, the increase of innovation culture was important and highly beneficial. This result supports our first hypothesis that SMEs benefit from PROs in terms of increasing their innovation culture. However, since not all of the firms benefit or equally benefit from collaborating with a public research bodies, this leads us to our next research questions which is to identify what are the characteristics (in

terms of innovation plan and search strategies) of those firms that increase more their innovation culture as a result of collaborating with CSIC.

## 5.2 Regression results

The results of the ordered logit model are presented in Table 2. Specifically, we run four different models in order to test hypothesis 2 presented in the study. Model 1 is our baseline model and includes our four independent variables namely *innovation plan*, *breadth external search*, *depth internal search*, *depth external search* along with the control variables. Model 1 has been specified to test our hypotheses H2a and H2b. Model 2, 3, and 4 include the same variables of the baseline model, and additionally includes the interaction between innovation plan and one type of search strategies. Thus, Model 2 includes the interaction *innovation plan\*breadth external search*, Model 3 includes the interaction *innovation plan\*depth internal search*, and Model 4 includes the interaction *innovation plan\*depth external search*. The inclusion of these interactions is aimed at exploring whether search strategies can exert a moderating effect between formal innovation plan and increasing firms' innovation culture.

Results in Model 1 show that having a formal innovation plan and search strategies determine the extent to which firms take advantage of PROs collaborations in terms of increasing their innovation culture. Specifically, *innovation plan* has a significant positive effect on increasing innovation culture, which supports our hypothesis H2a and suggests that those firms having a formal strategy oriented to innovate may take more advantages from their collaborations with external research bodies.

However, not all search strategies equally affect our dependent variable. Indeed, while *breadth external search* has a significant negative effect on increasing the culture innovation of the firm, no evidence of a significant relationship is found for the other two search strategies (*depth internal search* and *depth external search*). Thus, our data does not support our hypothesis H2b that established that SMEs that count with an active breadth search strategy benefit more from their collaboration with PRO in terms of innovation culture. Regarding the control variables, results indicate that higher levels of internal R&D, a higher experience in collaborating with CSIC, and firm's age are significantly and positively related with a higher increasing of firms' innovation culture derived from their collaboration with CSIC. Moreover, the variable firm's size shows a negative significant association with increasing firms' innovation culture.

**[Insert Table 2 about here]**

Model 2, 3 and 4 are run to test the hypothesis H2c arguing that innovation plan and search strategy may be complementary strategies reinforcing each other, and that firms with both characteristics may benefit more from collaborating with CSIC in terms of increasing their innovation culture. Results from Model 3 (Model 4) show a significant positive coefficient relationship between the interaction *innovation plan\*depth internal search* (*innovation plan\*depth external search*) and increasing innovation culture. We cannot infer the same relationship in the case of the interaction *innovation plan\*breadth external search* since the coefficient is non-significant (Model 2). These results suggest that, even if depth internal search and depth external search have not a direct significant effect on increasing innovation culture, when they are combined with a formal innovation plan, the effect is significant and positive on increasing firms' innovation culture. Graphically, Figure 1 illustrates the moderating effect of *innovation plan* on *increasing innovation culture* when *depth internal search* varies. At high levels of *depth internal search* the effect of *innovation plan* on *increasing innovation culture* becomes higher. Likewise, Figure 2 illustrates the moderating effect of *innovation plan* on *increasing innovation culture* when *depth external search* varies. At high levels of *depth external search* the effect of *innovation plan* on *increasing innovation culture* becomes higher. However, in the case of *breadth*, the interaction between this type of search and having an *innovation plan* is non-significant. Thus, we can accept H2c just in the case of depth search strategies, but not in the case of breadth strategies.

**[Insert Figure 1 about here]**

**[Insert Figure 2 about here]**

## **6. Conclusions**

The relationship involving the effect of innovation culture on performance has been extensively reported in the literature; however, the conditions under which innovation culture emerges or increases still needs further attention (Hogan & Coote, 2014). Literature on PRO-firms collaborations has also stressed how research has been skewed towards analysing benefits related to technological innovations (i.e., Arza & Vazquez, 2010; Bishop et al., 2011) and hindered other relevant aspects, such as the enhancement of innovation culture. Moreover, in this paper we focus on SMEs due to the important role in establishing collaborations with external agents in order to compensate for their lack of resources (Huizingh, 2011; Van de Vrande et al., 2009). This exploratory study has addressed whether and under which conditions SMEs might enhance their innovation culture because of their collaborations with research



organisations. Particularly, this paper has explored the role of having a formal innovation plan and an active search strategy.

The first result derived from this study is that more than one third of SMEs that collaborated with research organisations experienced an increase in their innovation culture. Meaning that these firms increase practices in which innovation behaviours among employees are encouraged; these mechanisms allow individuals to outweigh the costs of generating new ideas that could question the *status quo* of the organization.

The results also indicate that SMEs counting with formal innovation plan promote the conditions to embrace an innovation culture provided by the interaction with research organisations. The generation of systematized guidelines which support innovation, signals employees that innovation is supported from the upper echelon. These results show that only in those firms with a formal innovation plan are able to take advantage of research organisations collaboration in terms of increasing their innovation culture. This effect resembles the literature on absorptive capacity which argues that a similar level of prior knowledge, skills, capabilities and culture between the firm and the partner is necessary in order to make full sense of the interaction (Cohen & Levinthal, 1990; Lane & Lubatkin, 1998).

Moreover, our findings indicate that search strategies are also relevant for SMEs that want to take most advantages of their collaboration with research organisations, however, firms do not directly benefit from their search strategies but in combination with having an innovation plan. Moreover, not all the search strategies have the same effect. While breadth search strategies are not significant, depth search strategies exert a significant and positive moderation effect between having a formal innovation plan and increases in innovation culture. In other words, when firms follow a depth search strategy, they draw intensely on internal and external sources of knowledge and innovation and this reinforces the effect of formal innovation plan on innovation culture. However, this is not the case for breath search strategies, that is, when the firm draws superficially on a variety of sources. We argue that in this case the firm does not have the chance to establish a deep relationship with the partner thus limits the chances of learning and eventually taking the maximum advantage from this interaction. In sum, firms that want to benefit more from their collaboration with research organisations should implement a formal innovation plan and deeply rely on internal and external sources of information.

Interpretation of the results would be inadequate without taking full acknowledgement of the limitations of the paper. First, this study builds on cross-sectional data, thus causal relationships cannot be fully drawn. Second, we rely on data from only one country (i.e., Spain) which do not

allow for generalization to other countries or contexts. Future studies should extend our analysis to other countries that share a similar industrial structure to Spain in order to allow for comparisons across countries and validating and generalising our findings. Undoubtedly, these limitations open up avenues for future research on innovation culture and its antecedents, paying special attention to SMEs and micro firms given their relevance in Southern countries industrial structures.

The latter idea reinforces our findings in relation to our control variables, specifically on the effect of firms' size, age and previous experience on the management of innovation culture. Smaller SMEs benefit more from research organisations contributions in terms of innovation culture, which supports the argument established in the theoretical framework that smaller firms may benefit more from these collaboration since these research institutions provide them with resources and knowledge that are not available within the firms. Moreover, the smaller is the firm, the simpler the organizational arrangements, thus managers and employees enjoy a higher degree of discretion over the creation of an innovation culture. Thus, future research should keep investigating small firms, in particular, micro firms.

Also, firms which have a record of collaborations with CSIC are more able to take advantage from these collaborations in terms of innovation culture since repeated collaborations throughout time generate a higher ability to absorb the knowledge and skills provided by the teaching partner. Another interesting finding is that older firms increase more their innovation culture from collaborating with the research organisation. This suggests that older firms might be more interested in collaborating with research organisations and generating this culture since old organizations tend to suffer from organizational rigidity and inertia. This could also be an interesting avenue for further research.

We believe that managers could benefit from our findings. Formalizing an innovation plan and putting in place an active depth search strategy are two organizational practices easily pursued by firms. If SMEs managers want to become more *innovative* when collaborating with research organisations they should pursue these practices. It is highly important to take seriously innovation by having a formalized plan in combination with an active search strategy. This search strategy should be based on strong commitment instead of multiple but superficial collaborations.

## References

- Ahmed, P. K. (1998). Culture and climate for innovation. *European Journal of Innovation Management*, 1(1), 30-43. doi: 10.1108/14601069810199131.
- Amara, N., & Landry, R. (2005). Sources of information as determinants of novelty of innovation in manufacturing firms: evidence from the 1999 statistics Canada innovation survey. *Technovation*, 25(3), 245-259. doi: 10.1016/S0166-4972(03)00113-5.
- Ambos, T. C., Mäkelä, K., Birkinshaw, J., & D'Este, P. (2008). When does university research get commercialized? Creating ambidexterity in research institutions. *Journal of Management Studies*, 45(8), 1424-1447. doi: 10.1111/j.1467-6486.2008.00804.x.
- Arad, S., Hanson, M. A., & Schneider, R. J. (1997). A framework for the study of relationships between organizational characteristics and organizational innovation. *The Journal of Creative Behavior*, 31(1), 42-58. doi: 10.1002/j.2162-6057.1997.tb00780.x.
- Arza, V., & Vazquez, C. (2010). Interactions between public research organisations and industry in Argentina. *Science and Public Policy*, 37(7), 499-511. doi: 10.3152/030234210X512728.
- Aschhoff, B., & Schmidt, T. (2008). Empirical evidence on the success of R&D cooperation—Happy together? *Review of Industrial Organization*, 33(1), 41-62. doi: 10.1007/s11151-008-9179-7.
- Barney, J. B. (1986). Organizational culture: can it be a source of sustained competitive advantage? *Academy of Management Review*, 11(3), 656-665. doi: 10.5465/AMR.1986.4306261.
- Becheikh, N., Landry, R., & Amara, N. (2006). Lessons from innovation empirical studies in the manufacturing sector: A systematic review of the literature from 1993–2003. *Technovation*, 26(5), 644-664. doi: 10.1016/j.technovation.2005.06.016.
- Belderbos, R., Carree, M., Diederer, B., Lokshin, B., & Veugelers, R. (2004). Heterogeneity in R&D cooperation strategies. *International Journal of Industrial Organization*, 22(8), 1237-1263. doi: 10.1016/j.ijindorg.2004.08.001.
- Bierly, P. E., & Daly, P. S. (2007). Alternative knowledge strategies, competitive environment, and organizational performance in small manufacturing firms. *Entrepreneurship Theory and Practice*, 31(4), 493-516. doi: 10.1111/j.1540-6520.2007.00185.x.
- Bishop, K., D'Este, P., & Neely, A. (2011). Gaining from interactions with universities: Multiple methods for nurturing absorptive capacity. *Research Policy*, 40(1), 30-40. doi: 10.1016/j.respol.2010.09.009.
- Brettel, M., & Cleven, N. J. (2011). Innovation culture, collaboration with external partners and NPD performance. *Creativity and Innovation Management*, 20(4), 253-272. doi: 10.1111/j.1467-8691.2011.00617.x.
- Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative science quarterly*, 128-152. doi: 10.2307/2393553.
- Colombo, M. G., Rabbiosi, L., & Reichstein, T. (2011). Organizing for external knowledge sourcing. *European Management Review*, 8(3), 111-116. doi: 10.1111/j.1740-4762.2011.01018.x.
- Colquitt, J., Lepine, J. A., & Wesson, M. J. (2009). *Organizational behaviour: Improving performance and commitment in the workplace*. New York, NY: McGraw-Hill.
- Chesbrough, H. W. (2003). *Open Innovation: The new imperative for creating and profiting from technology*. Boston, MA: Harvard Business School Press.
- D'Este, P., & Patel, P. (2007). University–industry linkages in the UK: What are the factors underlying the variety of interactions with industry? *Research Policy*, 36(9), 1295-1313. doi: 10.1016/j.respol.2007.05.002.
- Daellenbach, U. S., McCarthy, A. M., & Schoenecker, T. S. (1999). Commitment to innovation: The impact of top management team characteristics. *R&D Management*, 29(3), 199-208. doi: 10.1111/1467-9310.00130.
- Dasgupta, P., & David, P. A. (1994). Toward a new economics of science. *Research Policy*, 23(5), 487-521. doi: 10.1016/0048-7333(94)01002-1.

- Dobni, C. B. (2008). Measuring innovation culture in organizations: The development of a generalized innovation culture construct using exploratory factor analysis. *European Journal of Innovation Management*, 11(4), 539-559. doi: 10.1108/14601060810911156.
- Field, A. (2009). *Discovering Statistics Using SPSS* (3rd ed.). London: Sage.
- Freeman, C. (1974). *The Economics of Industrial Innovation*. Harmondsworth: Penguin Books.
- González de la Fe, T., Hernández Hernández, N., & van Oostrom, M. (2012). Innovación, cultura y tamaño: la microempresa en una región ultraperiférica. *Arbor*, 188(753), 113-134. doi: 10.3989/arbor.2012.753n1008.
- Gopalakrishnan, S., & Damanpour, F. (1994). Patterns of generation and adoption of innovation in organizations: Contingency models of innovation attributes. *Journal of Engineering and Technology Management*, 11(2), 95-116. doi: 10.1016/0923-4748(94)90001-9.
- Grant, R. M. (1996). Prospering in dynamically-competitive environments: Organizational capability as knowledge integration. *Organization Science*, 7(4), 375-387. doi: 10.1287/orsc.7.4.375.
- Gulbrandsen, M., Mowery, D., & Feldman, M. (2011). Introduction to the special section: Heterogeneity and university–industry relations. *Research Policy*, 40(1), 1-5. doi: 10.1016/j.respol.2010.09.007.
- Hamel, G., & Prahalad, C. (1994). *Competing for the Future*. Boston, MA: Harvard Business School Press.
- Hartmann, A. (2006). The role of organizational culture in motivating innovative behaviour in construction firms. *Construction Innovation*, 6(3), 159-172. doi: 10.1108/14714170610710712.
- Hogan, S. J., & Coote, L. V. (2014). Organizational culture, innovation, and performance: A test of Schein's model. *Journal of Business Research*, 67(8), 1609-1621. doi: 10.1016/j.jbusres.2013.09.007.
- Huizingh, E. K. (2011). Open innovation: State of the art and future perspectives. *Technovation*, 31(1), 2-9. doi: 10.1016/j.technovation.2010.10.002.
- IPyme. (2015). Retrato de las PYME 2015 (pp. 1-7): Subdirección general de apoyo a la PYME.
- Janssen, O. (2003). Innovative behaviour and job involvement at the price of conflict and less satisfactory relations with co-workers. *Journal of Occupational and Organizational Psychology*, 76(3), 347-364. doi: 10.1348/096317903769647210.
- Katila, R., & Ahuja, G. (2002). Something old, something new: A longitudinal study of search behavior and new product introduction. *Academy of Management Journal*, 45(6), 1183-1194. doi: 10.2307/3069433.
- Koza, M. P., & Lewin, A. Y. (1998). The co-evolution of strategic alliances. *Organization Science*, 9(3), 255-264. doi: 10.1287/orsc.9.3.255.
- Lane, P. J., & Lubatkin, M. (1998). Relative absorptive capacity and interorganizational learning. *Strategic Management Journal*, 19(5), 461-477. doi: 10.1002/(SICI)1097-0266(199805)19:5<461::AID-SMJ953>3.0.CO;2-L.
- Laursen, K., & Salter, A. (2004). Searching high and low: what types of firms use universities as a source of innovation? *Research Policy*, 33(8), 1201-1215. doi: 10.1016/j.respol.2004.07.004.
- Laursen, K., & Salter, A. (2006). Open for innovation: the role of openness in explaining innovation performance among UK manufacturing firms. *Strategic Management Journal*, 27(2), 131-150. doi: 10.1002/smj.507.
- Lööf, H., & Broström, A. (2008). Does knowledge diffusion between university and industry increase innovativeness? *The Journal of Technology Transfer*, 33(1), 73-90. doi: 10.1007/s10961-006-9001-3.
- Manjarrés-Henríquez, L., Gutiérrez-Gracia, A., Carrión-García, A., & Vega-Jurado, J. (2009). The effects of university–industry relationships and academic research on scientific performance: Synergy or substitution? *Research in Higher Education*, 50(8), 795-811. doi: 10.1007/s11162-009-9142-y.
- Martín-de Castro, G., Delgado-Verde, M., Navas-López, J. E., & Cruz-González, J. (2013). The moderating role of innovation culture in the relationship between knowledge assets and

- product innovation. *Technological Forecasting and Social Change*, 80(2), 351-363. doi: 10.1016/j.techfore.2012.08.012.
- Martins, E. C., & Terblanche, F. (2003). Building organisational culture that stimulates creativity and innovation. *European Journal of Innovation Management*, 6(1), 64-74. doi: 10.1108/14601060310456337.
- Menzel, H. C., Aaltio, I., & Ulijn, J. M. (2007). On the way to creativity: Engineers as intrapreneurs in organizations. *Technovation*, 27(12), 732-743. doi: 10.1016/j.technovation.2007.05.004.
- Mintzberg, H. (1989). *Mintzberg on management*. New York, NY: Free Press.
- Miotti, L., & Sachwald, F. (2003). Co-operative R&D: why and with whom?: An integrated framework of analysis. *Research Policy*, 32(8), 1481-1499. doi: 10.1016/S0048-7333(02)00159-2.
- Monjon, S., & Waelbroeck, P. (2003). Assessing spillovers from universities to firms: evidence from French firm-level data. *International Journal of Industrial Organization*, 21(9), 1255-1270. doi: 10.1016/s0167-7187(03)00082-1.
- Naranjo-Valencia, J. C., Jiménez, D. J., & Sanz-Valle, R. (2012). ¿ Es la cultura organizativa un determinante de la innovación en la empresa? *Cuadernos de Economía y Dirección de la Empresa*, 15(2), 63-72. doi: 10.1016/j.cede.2011.07.004.
- Neter, J., Kutner, M. H., Nachtsheim, C. J., & Wasserman, W. (1996). *Applied linear statistical methods*. Chicago: Irwin.
- O'Reilly, C. (1989). Corporations, culture, and commitment: Motivation and social control in organizations. *California Management Review*, 31(4), 9-25. doi: 10.2307/41166580.
- Olmos-Peñuela, J., Benneworth, P., & Castro-Martínez, E. (2014). Are 'STEM from Mars and SSH from Venus'? : Challenging disciplinary stereotypes of research's social value. *Science and Public Policy*, 41(3), 384-400. doi: 10.1093/scipol/sct071.
- Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Broström, A., D'Este, P., . . . Hughes, A. (2013). Academic engagement and commercialisation: A review of the literature on university–industry relations. *Research Policy*, 42(2), 423-442. doi: 10.1016/j.respol.2012.09.007.
- Podsakoff, P. M., & Organ, D. W. (1986). Self-reports in organizational research: Problems and prospects. *Journal of Management*, 12(4), 531-544. doi: 10.1177/014920638601200408.
- Robbins, S. P. (1996). *Organizational Behaviour: Concepts, Controversies, Applications* (7th ed.). Englewood Cliffs, NJ.: Prentice Hall.
- Rosenkopf, L., & Nerkar, A. (2001). Beyond local search: boundary-spanning, exploration, and impact in the optical disk industry. *Strategic Management Journal*, 22(4), 287-306. doi: 10.1002/smj.160.
- Rothaermel, F. T., & Deeds, D. L. (2004). Exploration and exploitation alliances in biotechnology: A system of new product development. *Strategic Management Journal*, 25(3), 201-221. doi: 10.1002/smj.376.
- Russell, R. D., & Russell, C. J. (1992). An Examination of the Effects of Organizational Norms, Organizational Structure, and Environmental Uncertainty on Entrepreneurial Strategy. *Journal of Management*, 18(4), 639-656. doi: 10.1177/014920639201800403.
- Sadegh Sharifirad, M., & Ataei, V. (2012). Organizational culture and innovation culture: exploring the relationships between constructs. *Leadership & Organization Development Journal*, 33(5), 494-517. doi: 10.1108/01437731211241274.
- Sánchez-González, G., & Herrera, L. (2010). The influence of R&D cooperation on innovatory effort. *Innovation*, 12(3), 337-354. doi: 10.5172/impp.12.3.337.
- Santoro, M. D., & Chakrabarti, A. K. (2002). Firm size and technology centrality in industry–university interactions. *Research Policy*, 31(7), 1163-1180. doi: 10.1016/S0048-7333(01)00190-1.
- Santos-Vijande, M. L., González-Mieres, C., & Sánchez-López, J. Á. (2012). Cultura innovadora y competitividad en las empresas de servicios intensivos en conocimiento: el papel mediador de la cultura co-creadora. *Economía Industrial*(386), 159-172.
- Schein, E. H. (1992). *Organizational culture and leadership*. San Francisco: Jossey-Bass.

- Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, 18(7), 509-533. doi: 10.1002/(SICI)1097-0266(199708)18:7<509::AID-SMJ882>3.0.CO;2-Z.
- Un, C. A., Cuervo-Cazurra, A., & Asakawa, K. (2010). R&D collaborations and product innovation. *Journal of Product Innovation Management*, 27(5), 673-689. doi: 10.1111/j.1540-5885.2010.00744.x.
- Valmaseda-Andia, O., Albizu-Gallastegi, E., Fernandez-Esquinas, M., & Fernandez-de-Lucio, I. (2015). Interaction between the Spanish firms and the CSIC: motivations, mechanisms and benefits from the firm's perspective. *Revista Española de Documentación Científica*, 38(4), 1-17. doi: 10.3989/redc.2015.4.1263.
- Van de Vrande, V., De Jong, J. P., Vanhaverbeke, W., & De Rochemont, M. (2009). Open innovation in SMEs: Trends, motives and management challenges. *Technovation*, 29(6), 423-437. doi: 10.1016/j.technovation.2008.10.001.
- Yuan, F., & Woodman, R. W. (2010). Innovative behavior in the workplace: The role of performance and image outcome expectations. *Academy of Management Journal*, 53(2), 323-342. doi: 10.5465/AMJ.2010.49388995.