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Product innovation: testing the relative influence of industry, institutional context and firm factors

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This article analyses the influence of industry characteristics (concentration and technological opportunity), the institutional framework (social capital and spillovers from the public sector) and some firm factors (external and internal R&D) on product innovation in a unique integrated framework. Based on a sample of Spanish industrial firms, these variables were found to be positively related to firms' product innovation. Also, results show that in institutional environments with significant levels of social capital and spillovers, firms change their innovation strategy focusing on external R&D.

Keywords: product innovation; external and internal R&D; technological opportunity; concentration; social capital; spillovers

Introduction

Understanding the determinants of technological innovation has been an important and fecund source of inquiry in the management and economics literatures (Ahuja, Lambert, and Tandon 2008). The main question about innovation asked in previous research has been, 'What factors exert the greatest influence on firm innovation and on the results they achieve?' Different answers have been obtained depending on the approach adopted. From the industrial economics perspective, previous research has shown that there are many relations and interactions among certain structural variables in the industry and firms' innovation activity (e.g. Arora and Gambardella 2010; Cohen 2010). On the other hand, in the management field, research has emphasised the key role played by firms' strategies and internal organisation in their innovation behaviour. Identifying the distinguishing characteristics of highly innovative companies at the micro/firm level has been the aim of organisational theorists since the late 1960s (e.g. Souitaris 2002; Becheikh, Landry, and Amara 2006). Finally, over recent years, attention has focused on the impact that factors relating to the geographical location and institutional environment of firms can have on innovation behaviour.

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Institutional environments are a key determinant of innovation efforts and the productivity of such efforts (e.g. Ahuja, Lambert, and Tandon 2008; Kasabov and Delbridge 2008).

Different research traditions and the difficulty of performing empirical studies taking into account these three sets of factors – industry, firm and territory – have led researchers to analyse their effects separately. This has led to partial visions of the determinants of innovation in firms. Some researchers have analysed empirically the effect of industry structure variables and firm variables together (e.g. Veugelers 1997; Galende and Suárez 1999; Nieto and Quevedo 2005). Other researchers have studied the effect of territorial variables and firm variables on innovation (Romijn and Albaladejo 2002; Cabrer-Borrás and Serrano-Domingo 2007). However, there has been practically no research that includes all three groups of variables. The difficulty of quantifying some of these variables and of integrating them in a single model remains a major hurdle to sound research on this topic.

The aim of this paper is to make a theoretical and empirical contribution towards filling this gap in the literature. Its main contribution is to explore in depth the joint influence of some variables relating to industry structure, the institutional context and firms' innovation efforts on innovation performance. We propose and test empirically an integrated model that shows the influence on product innovation (innovation output) of variables representing (a) industry structure, (b) institutional context and (c) firms' innovation efforts.

The article is structured in five sections. In the following section, the characteristics of each of the variables involved in the model and the relations expected between them are analysed. In the third section, the sample is described and the measures taken to make each of the variables operative are defined. In the fourth section, we present the results obtained. We finish with the main conclusions, implications and recommendations for managers, researchers and policy-makers.

Theoretical framework

Industry structure

As we mention above, certain structural factors in industry – technological opportunities within the sector, profits expected from innovations (e.g. Geroski 1990; Klevorick et al. 1995), the level of industry concentration (e.g. Scherer 1965; Tang 2006) and the conditions for accumulation and appropriation of technology (e.g. Arrow 1962; Levin et al. 1987) – are typically considered when explaining the disparities among sectors in technological innovation (Dosi 1988).

Of all of the above-mentioned factors, the degree of concentration of the industry and the stock of technological opportunities are the most relevant because of their impact on innovation activities and the interest they have aroused in the literature. On the one hand, Cohen (2010) notes that the market structure and innovation literature (together with the size–innovation relationship) has become the second largest body of empirical literature in the field of industrial organisation. However, this vast body of research has, in general, proved inconclusive, with market structure not being found to be strongly or consistently related to innovation (Becheikh, Landry, and Amara 2006; Ahuja, Lambert, and Tandon 2008).

Regarding technological opportunity, despite nearly four decades of empirical analysis, it is still difficult to define the concept and to establish appropriate measures for different types of samples (Geroski 1990).

We will analyse, in detail, what the literature has to say about the role both variables play on innovation determinants.

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Industry concentration

Industry concentration is a function of the number of firms and their respective shares of total production in an industry. Industry concentration has been argued to both enhance (Schumpeter 1942) and depress incentives to invest in innovation (Arrow 1962; Scherer and Ross 1990). On the one hand, previous research suggests that market concentration provides firms with profits and security to finance risky activities such as innovation (Schumpeter 1942), firms in concentrated industries can benefit from high economies of scale or a high level of technology and monopolies have more to lose (in terms of market power) than competitive firms and therefore are more motivated to invest in innovations to preempt competition (Ahuja, Lambert, and Tandon 2008).

On the other hand, the Hicksian argument that 'the best of all monopoly profits is a quiet life' suggests that the 'security' provided by a monopoly may be carried too far. Monopolies that are in a comfortable position with little immediate threat from competition may feel less 'pressured' to invest in R&D and innovate (Scherer and Ross 1990; Ahuja, Lambert, and Tandon 2008).

Major innovations like the development of new products usually require extensive resources that only large firms tend to have, most of which are located in concentrated industries. Small firms that are most likely to be located in less concentrated industries do not have enough resources to produce major innovations. In this paper, since we use the development of new products as innovation output, we argue that firms in highly concentrated industries will develop more new products because they are likely to be large firms that can achieve economies of scale and scope, have more and cheaper financial resources, are able to spread risk and have a greater capacity for specialisation, in people as well as equipment (Nooteboom 1994). In contrast, firms in less concentrated industries are likely to be small and medium enterprises rather than large firms so they do not have access to plentiful resources.

Based on these arguments, the following hypothesis can be posed:

H1: Firms in industries with high levels of concentration are more likely to develop new products.

Technological opportunity

The concept of technological opportunity is associated with the probability that resources dedicated to the development of innovation processes will generate real technological advances (Dosi 1988).

Numerous empirical studies have verified the existence of positive relations between the level of the industry's technological opportunity and R&D activities (Scherer 1965; Levin, Cohen, and Mowery 1985; Jaffe 1989; Geroski 1990; Klevorick et al. 1995). However, very few studies have sought to identify the relationship between technological opportunities and a firm's innovative performance. Adaptation of knowledge drawn from the stock of technological opportunities expands the firm's capacity, thus increasing the likelihood that its innovations will be successful (Klevorick et al. 1995). It can therefore be assumed that adaptation of external knowledge constitutes a key element in the development of new products, thus positing a positive relationship between technological opportunity and innovation outputs. On the basis of this argument, we pose the following hypothesis:

H2: Firms in industries with large stocks of technological opportunity are more likely to develop new products.

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Institutional context

Previous literature suggests that innovation and competitiveness lie not in the isolated efforts of individual organisations or industries, but in the deep and continued involvement in networks of interactions and exchanges with the environment (Kasabov and Delbridge 2008). Several studies have shown that proximity advantage (Jaffe, Trajtenberg, and Henderson 1993; Stuart 1998; Singh 2005), geographic location of the firm (Sternberg and Arndt 2001), the number of patents in a region (Hagedoorn and Wang 2012), social capital (Lundvall 1992; Landry, Amara, and Lamari 2002), government and public policies (David, Hall, and Toole 2000; Broberg et al. 2013) and surrounding culture (Shane 1993), among others, have a direct influence on innovation activities.

In this study, we analyse two elements representing the geographical and institutional environments: spillovers from the public sector and social capital. These variables were selected because they can both help firms to have access to new external information and knowledge but through different sources (public sources and regional networks). The importance of geographical spillovers from innovation activities was initially recognised by Marshall (1890) and is one of the elements that characterise industrial districts. Empirical research also considers the role of public institutions on the innovative output of firms but is not conclusive (see David, Hall, and Toole 2000 for a review). On the other hand, the influence exerted on economic activities by social assets has also been acknowledged (Guiso, Sapienza, and Zingales 2004; North 2005)

Spillovers from the public sector

The existence and effects of knowledge spillovers as sources of innovative output and productivity growth have been an important research issue in the economics of technology (see Griliches 1992; Nadiri 1993 for reviews). Jaffe (1989) and Jaffe, Trajtenberg, and Henderson (1993) have explored to what extent spillovers associated with R&D activity are geographically localised. Although spillovers may discourage investment in R&D and reduce innovation efforts if firms consider they cannot utilise their investment in R&D exclusively (Bernstein and Nadiri 1989), most empirical studies have found positive relations between public spillovers in a territory and the innovation performance of firms located in it (Tappeiner, Hauser, and Walde 2008). Since spillovers are combined with the knowledge the firm already has, they create opportunities for developing new products (Yli-Renko, Autio, and Sapienza 2001; Cohen, Nelson, and Walsh 2002) and they stimulate innovation and improve firms' innovation performance (Ahuja, Lambert, and Tandon 2008). Based on these arguments, the following hypothesis can be posed:

> *H3: Firms located in institutional environments with large spillovers from the public sector are more likely to develop new products.*

Social capital

Social capital is an asset that stimulates cooperation and leads to trust among individuals in a society by strengthening social networks. It has been stated that environments with high levels of social capital reduce the risk involved in innovation activities (Lundvall 1992; Landry, Amara, and Lamari 2002), stimulate the creation and dissemination of new knowledge and have a positive effect on the results of the innovation process (Nahapiet and Ghoshal 1998). Innovation is highly dependent on the way the different participants interact, and the notions of relationships and interactions become central to the study of the subject (Tappeiner, Hauser, and Walde 2008). The strengthening of inter-firm networks, which reflects an increase in the stock of social capital in a specific geographical location, leads to collective learning and creates a climate that is suitable

for the development of new products (Capello and Faggian 2005). Such arguments lead to the following hypothesis:

H4: Firms located in institutional environments having large stocks of social capital are more likely to develop new products.

The firm's innovation strategy

The intensity and results of the innovation process are not just influenced by external factors but depend on a broad set of internal factors. Previous research has studied the relations among innovation and a large number of firm variables such as size (Schumpeter 1942; Cohen and Klepper 1996; Camisón et al. 2004), the degree of diversification (Nelson 1959; Miller, Fern, and Cardinal 2007), organisational structure (Burns and Stalker 1994; Tushman et al. 2010), the nature of competencies (Henderson and Cockburn 1994), corporate governance (Hoskisson et al. 2002) and remuneration systems (Balkin, Markman, and Gomez-Mejia 2000), among others. It has been acknowledged that achieving innovations is determined by the firm's capacity for utilising the knowledge it possesses (Subramaniam and Youndt 2005) and combining it with other, outside knowledge (Yli-Renko, Autio, and Sapienza 2001). Therefore, a key aspect in the design of a firm's innovation strategy is related to the decision on whether the innovation effort should focus on exploiting its internal technological capacity (internal R&D) or on utilising external technological knowledge and outsourcing (external R&D).

Internal R&D

In recent years, literature on innovation considers that innovations do not arise exclusively from new knowledge generated by formal R&D activities (Kline and Rosenberg 1986). It has been shown that the innovations that have the greatest competitive impact come from improvements in existing products and from utilisation of the stock of existing technological knowledge (Cohen and Levinthal 1990).

However, the production of innovations by recombining external knowledge requires a minimum of technological capacity. In order to develop and maintain such capacity over time, firms have to carry out internal R&D activities (Cohen and Levinthal 1990). Cohen and Levinthal (1990, 128) defined this capacity as absorptive capacity, that is, 'the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends'. Absorptive capacity results from performing in-house R&D activities, is critical to the innovative capacity of the firm and is a key pre-condition for firms to internalise external knowledge (Spithoven, Clarysse, and Knockaert 2011). Through R&D activities, firms combine their internal assets and capabilities with external knowledge in order to develop new products. So R&D activities allow firms to achieve open innovation by bringing external sources of innovation into the firm and identifying external markets on which they can sell internally developed products.

On the basis of this argument, the following hypothesis can therefore be framed:

H5: Firms that devote a larger proportion of their innovation effort to internal R&D are more likely to develop new products.

External R&D

As we mention above, a large proportion of innovations come from the combination of sources of knowledge both within and outside the firm (Fey and Birkinshaw 2005). Previous studies

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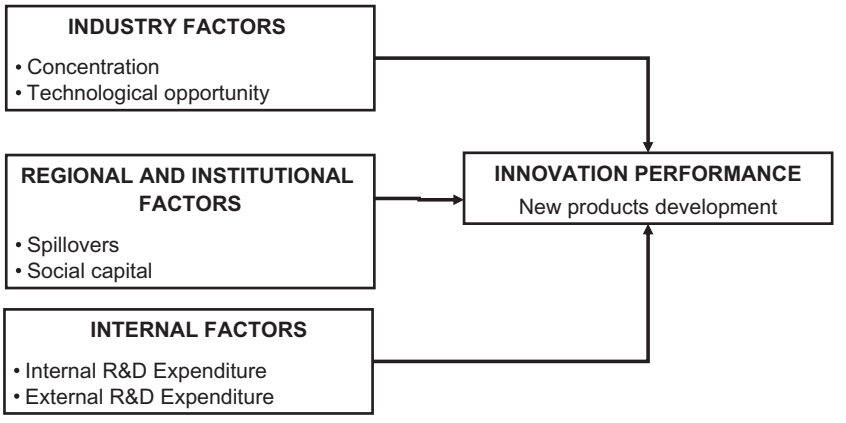

Figure 1. Theoretical model.

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investigating the decisions of firms to make or buy innovations have mainly been supportive of both the transaction costs theory (Williamson 2000) and the property rights approach (Grossman and Hart 1986; Hart and Moore 1990). Pisano's (1990) study of R&D projects in the biotechnology industry is one of the first studies to empirically test the use of external knowledge by approaching external knowledge sourcing from a transaction cost perspective. Studies suggest that the importance of external R&D has been increasing in recent years. For example, in an industry-level longitudinal study, Bönte (2003) suggests that the share of external R&D gradually increased from the 1980s into the mid-1990s.

One way of gaining access to external knowledge, in addition to spillovers, is to outsource R&D activities to another firm. In this way, firms typically engage in the trading of knowledge on the technology market and cooperate actively in R&D with other firms and research organisations (Cassiman and Veugelers 2006). The increase in technology outsourcing has been attributed to the growing complexity, speed and uncertainty of technological developments, combined with greater codification of R&D processes that has facilitated R&D contracting and segmentation of R&D activities (Narula 2001). External R&D allows the firm to gain access to new technological areas and to respond fast to innovations introduced by competitors (Haour 1992). The following hypothesis can therefore be posed:

H6: Firms that devote a larger proportion of their innovation effort to external R&D are more likely to develop new products.

The relations among the variables included in our study define the theoretical model for analysis that we propose as shown in Figure 1.

Methodology

Sample and data

The data set used in this study was drawn up from the 2007 Community Innovation Survey (CIS) conducted in Spain in 2007 by the Spanish National Institute of Statistics (INE). The CIS is coordinated by the Statistical Office of the European Communities (Eurostat) and carried out

every four years in all the European Union (EU) countries. Since the CIS data were made publicly available for research purposes in most EU countries, academics have been able to perform large-scale, firm-level studies on innovative activities across a variety of sectors and countries (Paananem 2009). In Spain, the purpose of the survey, called PITEC,[1] was to collect detailed information about the innovation activities of Spanish firms in all sectors of the economy during the period 2005–2007. Of the total of 12,124 firms forming part of the sample in 2007, manufacturing firms were chosen, that is, those whose CNAE-93[2] activity code at the two-digit level falls between 15 and 37. This gave a sample of 6047 firms, of which 3547 (59%) stated they had achieved a product innovation.

The data set was completed with data from other secondary sources. These included the Social Capital Series estimated by the Valencian Institute for Economic Research (IVIE) for the BBVA[3] Foundation (Pérez, Serrano, and Fernández de Guevara 2008) and R&D Statistics for 2007 and the 2007 Industrial Survey of Firms. The latter two were drawn up by the Spanish National Statistics Institute.

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Variables

Dependent variable

In order to measure the dependent variable, we use a dichotomous variable, 'development of product innovations'. This variable, included in CIS, takes value 1 when the firm states it has made a product innovation over the last 2 years, and 0 otherwise.

Independent variables

Concerning the variables relating to the industrial sector to which the firm belongs, the degree of concentration of each of the industries present in the sample for 2007 was measured using the Hirschman–Herfindahl Index according to the turnover published in the INE Industrial Survey of Firms for 2007. The concept of technological opportunity was represented by classifying the sample firms among three groups depending on whether they operate in high, medium or low technological opportunity industries following Scherer (1965). So, in order to measure the technological opportunity of the sector, we used the list of high and medium-high technology sectors published by the INE. Other sectors not included in this list were considered low technology.

Regarding independent variables relating to the territory and the institutional environment, social capital was measured based on the estimate made by the IVIE (Pérez, Serrano, and Fernández de Guevara 2008) for the BBVA Foundation of social capital per capita in a region. Moreover, the volume of public knowledge or spillovers, as in other research (Mamuneas 1999), was estimated on the basis of investments in R&D made from public funds. Specifically, we used the expenditure on R&D per capita as drawn up by the public administrations in the different Spanish Autonomous Communities and included in the R&D Statistics for 2007 published by the INE.

Firms' innovation effort was measured by their internal and external R&D expenditure. The data on the two variables were taken from PITEC 2007.

Control variables

Finally, the control variables used were the logarithm for number of employees and turnover of the firm following the example of previous studies on similar topics (Becheikh, Landry, and Amara 2006).

Table 1. Descriptive statistics.

	N	Min.	Max.	Mean	St. deviation
Sales (ln)	6047	7.58	23.20	16.06	1.80
No. of employees (ln)	6047	0	9.20	4.06	1.37
Concentration	6041	2.50	50.00	10.34	11.43
Technology opportunity	6047	1.00	3.00	1.44	0.60
Spillovers from public sector	6047	0.00	15.00	2.87	3.49
Social capital	6047	0.00	1791.49	707.98	649.27
External R&D	6047	0.00	100.00	46.26	43.01
Internal R&D	6047	0.00	100.00	8.68	20.54
Product innovation	6047	0	1	0.59	0.49

Table 2. Correlations.

	Sales	No. of employees	Concentration	Tech. opportunity	Spillovers	Social capital	External R&D	Internal R&D	Product innovation
Sales	1								
No. employees	0.70**	1							
Concentration	0.12**	0.14**	1						
Tech. opportunity	−0.02	−0.03*	0.18**	1					
Spillovers from public sector	0.09**	0.08**	0.09**	0.25**	1				
Social capital	0.01	0.03*	0.03*	0.18**	0.31**	1			
External R&D	0.00	0.01	0.06**	0.22**	0.41**	0.40**	1		
Internal R&D	0.02	0.05**	0.08**	0.02	0.03*	0.03**	−0.10**	1	
Product innovation	0.03*	0.06**	0.07**	0.17**	0.31**	0.38**	0.35**	0.06**	1

*$p < 0.1$.
**$p < 0.05$.

Moreover, the descriptive statistics of the variables involved in the study and the correlations are given in Tables 1 and 2.

Results

In order to test the hypotheses proposed and bearing in mind that the dependent variable, product innovation, is a dichotomous variable, four logistic regression analyses were performed (Table 3). In the first analysis the variables relating to the industry structure were used as independent variables. The variables relating to the institutional environment and the territory were included in the second model. The third model contained the variables for the firm's innovation effort (internal R&D and external R&D) as explanatory variables. Finally, the last model included all the independent variables involved in the research.

The results of Model 1 indicate the existence of a positive relation between the degree of concentration of the industry and the probability of obtaining better product innovation results, confirming H1. The results also show a positive relationship between technological opportunity and the development of product innovations, confirming H2. Model 2 reflects the effect on the firm's innovation performance of the two territorial variables analysed. The results show that firms belonging to environments with high stocks of social capital and spillovers are more likely

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Table 3. Logistic regressions.

	Model 1: Industry		Model 2: Region		Model 3: Firm		Model 4: All variables	
	Coefficient	Wald	Coefficient	Wald	Coefficient	Wald	Coefficient	Wald
Intercept	−3.570***	80.696	−2.315***	206.617	−2.375***	34.613	−2.918***	47.869
No. of employees (ln)	−0.054	1.483	−0.046	0.986	−0.040	0.775	−0.037	0.616
Sales (ln)	0.199***	34.964	0.121**	11.740	0.128***	13.393	0.122**	11.590
Concentration	0.006**	7.188					0.006**	5.971
Tech. opportunity	0.627***	165.363					0.347***	43.512
Social capital			0.001***	336.503			0.001***	126.862
Spillovers from public sector			0.009***	70.282			0.007***	37.724
External R&D					0.008***	39.667	0.004**	9.055
Internal R&D					0.018***	686.531	0.002	2.102
R^2 Cox and Snell	0.05		0.16		0.13		0.17	
R^2 Nagelkerke	0.07		0.22		0.18		0.23	
χ^2	309.432***		1054.07***		861.956***		1127.644***	
Global % correct predictions	62.0		71.8		70.7		71.5	

**$p < .05$.
***$p < .01$.

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to obtain product innovation results than firms in environments with lower levels of these two variables. These results confirm H3 and H4.

The relation between the firm's innovation effort and performance was covered by Model 3. The coefficients for the two variables were significant and positive, indicating that firms that make both internal and external R&D efforts are more likely to obtain product innovation results. These two results corroborate the ideas expressed in H5 and H6.

Finally, when all the variables involved in the study (Model 4) are included, the results are the same except for internal R&D expenditure for which the coefficient is not significant, indicating that the internal factors can perhaps be substituted by the industry and/or territory factors. Moreover, collinearity diagnostics based on tolerance and variance inflation factor (FIV) indicate an absence of multicollinearity (FIV <5; Tolerance > 0.1) for all independent variables included in the study.

In order to make this result more robust and determine which of the variables were making internal R&D no longer relevant, another five models were specified. In addition to the control variables, each of them included the variable for internal R&D expenditure and a single variable relating to external factors (social capital, R&D expenditure by public administrations, concentration or technological opportunity). The results for all the models showed that internal R&D expenditure was statistically significant and positive, indicating that none of the variables considered was causing on its own the effect of substituting internal R&D with external factors. These findings allow us to assert that the effect of reducing the effect of internal R&D in the model that includes all the variables may be caused by a combination of all the variables considered. Therefore, the substitution of this effect was not caused by any of the variables considered on its own but only appeared when the variables were combined.

Concerning the markers for the goodness of fit of the model, the χ^2 values in all four models reject the null hypothesis. It can therefore be concluded that the overall explanatory power of the four models is good. Moreover, the two pseudo-R^2 measures that are widely used are the Cox and Snell R^2 coefficients and the Nagelkerke R^2 coefficient. In this case, the latter reached values of between 6% and 24%.

Discussion and conclusions

The results obtained confirm the hypotheses proposed. First, with regard to the influence of structural factors of the industry on the product innovation behaviour of firms, a positive relation was found between the degree of concentration in the industry and firms' product innovation, confirming our initial argument. It can therefore be stated that firms operating in concentrated industries are more likely to develop new products than those in more competitive sectors. We can find an explanation for these results in the literature. Since our measure of innovation is the development of new products, we argue that firms in highly concentrated industries will develop more new products because they are likely to be large firms with plentiful material resources (Nooteboom 1994). Moreover, this result can be explained because, according to Schumpeter, both the ability to earn large profits and expectations of a temporary monopoly lead firms to introduce innovations.

Regarding technological opportunity, the results show that firms installed in very technologically dynamic industries obtain better innovation performance than firms in sectors that are not so technologically active. This supports the idea expressed in prior studies (Levin, Cohen, and Mowery 1985; Jaffe 1989; Geroski 1990; Klevorick et al. 1995). It can be explained because, in industries with greater technological opportunities, firms have more resources that can be transformed into new processes and products (Griliches 1992).

Secondly, regarding variables for the territory and the institutional environment, it was found that spillovers have a positive impact on the results of the innovation process. This can perhaps be explained by the fact that firms are able to combine spillovers to which they have access with their own skills and knowledge and use them to develop new innovations (Yli-Renko, Autio, and Sapienza 2001; Cohen, Nelson, and Walsh 2002). Regarding social capital, the results of the study support the idea that environments with high social capital favour the generation and sharing of knowledge, thus contributing to the development of innovations within firms (Nahapiet and Ghoshal 1998).

Third, regarding the impact of internal and external R&D effort on firms' innovation performance and in line with previous studies (Hirsch-Kreinsen, Jacobson, and Robertson 2006), the results show that firms that make a greater effort in internal R&D will obtain greater returns from their innovation activity. In addition, they indicate the importance of utilising external resources for developing product innovations. This supports the idea that most innovations are the result of combining both types of knowledge (Fey and Birkinshaw 2005).

Finally, the main contribution of this study, bearing in mind that previous studies along the same lines were not found, is that it analyses the influence on the results of the innovation process of three groups of factors taken together – industry structure, institutional environment and the firm's strategy. The results point to the importance of the three groups of factors on firms' innovation performance and are similar to those obtained in the partial models. The only difference lies in the coefficient for the internal R&D effort, which is no longer significant when factors representing the industry and the territory are considered. This result may indicate that, in the presence of certain external industry and/or territorial factors, the importance of the internal factors decreases as they

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might be substituted by the former. A debate is ongoing in the literature about the relationship between internal and external innovation sources. On the one hand, some recent research has found that internal and external factors are complementary innovation activities. These studies suggest the interrelatedness of both variables for improving a firm's innovation performance (see e.g. Cassiman and Veugelers 2006; Schmiedeberg 2008). On the other hand, however, other empirical research focusing on the relationship between internal and external resources for innovation demonstrates substitutability between these sources (Hess and Rothaermel 2011). So, the previous empirical research is not conclusive about complementarity or substitutability between the two innovation sources (Hagedoorn and Wang 2012). Our results can contribute to the debate about the relationship between internal and external innovation sources since we found a possible substitution effect. However, this result must be taken cautiously because some previous empirical research has demonstrated the existence of a combination effect. In the future, we should focus on the study of the substitutability or complementarity between internal and external innovation factors in different samples and with different measures of innovation performance in order to confirm these preliminary results.

This result may also be based on the idea that firms located in territories where there are greater spillovers need to make less internal R&D effort because the environment offers them a greater diversity of external knowledge that they can utilise for developing their innovations (Tappeiner, Hauser, and Walde 2008). Moreover, firms operating in environments with high levels of social capital develop mechanisms for social integration that allow external knowledge to be easily transformed into distinctive capabilities in the firm which may then lead to new products or processes.

Regarding managerial implications, managers should take into account that some factors from the institutional framework, from the industry and internal to the firm can help them in the development of new products. Managers should encourage internal and external knowledge development in parallel so as to build and hone their innovative capabilities.

Moreover, policy-makers should take into account that, in industries with high levels of technological opportunity and in environments with significant volumes of spillovers and social capital, firms may focus on assimilating knowledge from external sources. Taking into account our results, policy-makers should develop policies that stimulate the development of social networks and increase the volume of public spillovers.

Interpretation of the results and conclusions of this research must take into account a number of limitations, many of which stem from the data used. The first limitation relates to the proxies used as measures of some variables considered in the study. For example, the development of product innovations, measured as a dichotomous variable, served as the basis for the study. Clearly, however, additional information on the volume of such innovations or the way in which they were carried out would allow much greater knowledge of this phenomenon. Another possible limitation is the fact that the study was carried out on data from a specific country (Spain) at a specific time (2007). For future research, it would be useful to expand the time frame of the study in order to work with a data panel, and to include new dependent and independent variables in the model in order to increase its explanatory power. Also, the study of real business cases would be useful for verifying our conclusions. Finally, we must take into account that we have not examined all variables from industrial economics, management and institutional perspectives. This is an important limitation to be considered. In the future, we could study more variable in order to complete our model. On the other hand, we hope to continue investigating the applicability to innovation issues of 'logistic regression', which is mainly applied in medical fields at present.

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Notes

1. The Spanish National Institute of Statistics (INE) constructs the database called PITEC (Panel de Innovación Tecnológica) on the basis of the annual Spanish responses to the CIS.
2. CNAE is the Spanish National Classification of Economic Activities.
3. BBVA Foundation is a Spanish foundation that is financed by one of the major Spanish banks (Banco Bilbao Vizcaya Argentaria).

Notes on contributors

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