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Disentangling the Effects of Knowledge Spillovers and Family Firm Nature on Innovative Performance: a Multilevel Approach

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Abstract
The idiosyncrasies of family firms (FFs) may enable or hamper their ability to exploit the region's knowledge spillovers. To the date, this issue has not been addressed by the literature. The purpose of this paper is twofold: firstly, to explore whether FF nature influences on firm innovative performance by acknowledging the fact that firm innovation happens in a certain location where firms are exposed to knowledge spillovers; and secondly, to analyse whether FF management plays a moderating role in the effects of regional knowledge spillovers on innovative outcomes. We used multilevel modelling and panel data methodology in a sample of 1191 Spanish manufacturing firms over the period 2009–2016. By applying multilevel analysis and panel data methods, the results indicate that being part of a family group increases innovative performance, and this effect seems to be even more important in regions with low technological or human capital resources.

Keywords Family firms · Firm innovative performance · Knowledge spillovers · Multilevel modelling · Manufacturing firms

JEL Classification D21 · O32

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Introduction

A vast theoretical and empirical literature examines the determinants of firm innovation which, broadly speaking, have been classified into external and internal factors (López-Bazo & Motellón, 2018; Sternberg & Arndt, 2001). The geography of innovation associates the former with certain spatially bounded knowledge circumstances that favour knowledge spillovers (Raspe & Van Oort, 2009), whilst the latter refer to a set of firm-specific characteristics that affect a firm's absorptive capacity (Cohen & Levinthal, 1990)—that is, its ability to use and exploit those external resources to innovate (Acs et al., 2009; Jantunen et al., 2008; Srholec, 2010). Despite the extensive body of research, only in the last decade has it been possible to jointly explore both types of innovation drivers with multilevel models that acknowledge the existence of heterogeneous firms within a given location (Rodríguez-Gulías et al., 2021).

The literature on family firm (FF) innovation has grown exponentially in recent years (Aiello et al., 2020; Calabrò et al., 2019; Röd, 2016). Most research in this domain has been conducted by FF researchers (Calabrò et al., 2019), overlooking some recent advances on mainstream innovation research such as those mentioned above. Thus, in 11 reviews on FF innovation, no study addressing the effect of knowledge spillovers on FF innovation performance with multilevel models has been reported. This neglect involves overlooking that firm innovation happens in a certain location where firms are involuntarily exposed to knowledge spillovers through interactions with other external agents. The idiosyncrasies of FFs (see, e.g. Bigliardi & Galati, 2018; Feranita et al., 2017) might also shape the effect of these external sources of knowledge on innovative performance, as has recently been shown for other business characteristics (López-Bazo & Motellón, 2018; Rodríguez-Gulías et al., 2021).

The goals of this study are twofold. First, it is aimed to explore whether FF nature influences firm innovative performance by jointly considering the heterogeneity of firms (internal factors) and the region's knowledge spillovers (external factor) using data with a hierarchical structure; and second, it seeks to analyse whether FF management plays a moderating role in the effects of regional knowledge spillovers on innovative outcomes. To this end, multilevel models and panel data methods are applied in a sample of 1,991 Spanish manufacturing firms over the period 2009 to 2016. This provides insights into the determinants of firm innovation in countries like Spain, where firms traditionally show low levels of innovative activities compared to the rest of the European Union. Thus, Spanish innovative firms represented the 31.1% of the total firms in 2018, whilst in the EU 19 countries and EU 27 countries, they accounted for 56.0% and 50.3% of firms, respectively (EUROSTAT, 2021). In addition, FFs have a high relevance in the Spanish economy; it is estimated that 89% of Spanish companies are family-owned (excluding the self-employed and cooperatives) that create 67% of private employment and 57.1% of private sector GDP (KPMG, 2021). Understanding the effect of regional knowledge spillovers on FF innovation can help to design more efficient policies aimed at enabling innovation in technology-follower countries such as Spain.

The current study contributes to the literature on FF innovation along three directions. First, it extends the empirical literature on the effect of FF nature on innovative performance by jointly considering the heterogeneity of firms and locations (i.e. regions). In doing so, this paper responds to the need both to reconcile the literature on FF innovation and mainstream innovation research (Calabrò et al., 2019) and to adjust to the hierarchical structure of the data through multilevel models in studies on firm innovative performance (Autio et al., 2014; Beugelsdijk, 2007; López-Bazo & Motellón, 2018; Rodríguez-Gulías et al., 2016). Moreover, the findings show that the 'family innovation dilemma' also holds when spatially bounded knowledge circumstances are considered. Second, at a theoretical level, we elaborate upon the relationship between FF nature and the ability to exploit knowledge spillovers by considering the idiosyncrasies of FFs. The results indicate that FF nature moderates the effect of knowledge spillovers on innovative performance. Thus, the findings may help both FFs and non-FFs to increase the efficiency of their innovation activities. Third, the Spanish case during the sample period (2009–2016) provides an interesting context for such an analysis, given the above-mentioned circumstances of the Spanish economy.

The remainder of this paper is organised as follows: "Regional Knowledge Spillovers and FF Innovation" summarises the literature review and introduces the research questions. Data, variables and the estimation strategy are described in "Methodology." The results of the econometric analyses are presented in "Multivariate Analysis," and, finally, "Conclusions" concludes.

Regional Knowledge Spillovers and FF Innovation

This section provides a literature review on FF innovation pointing to the need to adopt a multilevel approach and the specificities of FFs related to knowledge spillovers.

The Need to Adopt a Multilevel Approach in the Study of FF Innovation

Although the topic of FF innovation is relatively young (Calabrò et al., 2019), in the last decade a growing number of studies have investigated the extent to which family involvement enables or hampers innovation. We found 11 studies that 'systematically' review the literature on FF innovation in the last decade (see Table 1).

We want to highlight two results from these reviews. First, despite the large number of studies on FF innovation, most of the reviews indicate that the literature is still limited and yields contradictory and inconsistent findings (Eddleston et al., 2019), especially regarding innovation outputs (Calabrò et al., 2019; Röd, 2016). Particularly controversial is the 'family innovation dilemma'—that is, FFs achieve higher innovation performance than non-FFs, despite showing a lower level of R&D investments (they 'do more with less' in the words of Durán et al., 2016).

Second, according to Calabrò et al. (2019), most research has been conducted by FF researchers, whilst mainstream innovation scholars have ignored family variables

Table 1 Reviews of the literature on FF innovation

	Time frame of reviewed studies	Number of reviewed studies	Focus of review	Research agenda (number)
Cassia et al. (2012)	n.a.	n.a.	New product development	n.a.
De Massis et al. (2013)	1997–2012	23	Technological innovation	12
Durán et al. (2016)	1981–2012	108 = 71 (articles) + 32 (working papers) + 5 (theses)	Family control: family CEOs (non-founder vs founder) and nonfamily CEOs	n.a.
Röd (2016)	2001–2015	78	Multi-staged innovation process: innovation input, activities and output	3
Brinkerink et al. (2017)	n.a.	n.a.	Open innovation	n.a.
Feranita et al. (2017)	n.a.	45 = 37 (articles) +2 (book chapters) + 3 books+ 3 (conference proceedings)	Collaborative innovation	11
Filser et al. (2016)	October 2015	81	Innovation	6
Bigliardi and Galati (2018)	n.a.	43 papers	Collaborative innovation	7
Calabrò et al. (2019)	1961–2017	118	Innovation	8
Gjergji et al. (2019)	Articles only after 2003	36 papers	Open innovation	3

The articles are arranged in chronological order. n.a. denotes not available. Focus of review refers to the topic on which the review focused; if the review simply dealt with innovation in general, innovation is indicated. Research agenda (number) indicates the number of research avenues proposed as opportunities for future research; here, n.a. indicates that the authors did not explicitly mention a number in their analysis. The first part of this statement means that the literature on FF innovation has overlooked mainstream innovation research. In this domain, a particularly relevant advance in the last decade has been the joint analysis of the effect of the external (mainly regional) and internal drivers of firm innovation by considering the hierarchical structure of the data and the dynamic nature of both firm innovative activities and the environment (López-Bazo & Motellón, 2018; Rodríguez-Gulías et al., 2021).

Broadly speaking, the external drivers of innovation refer to a variety of resources, such as regional R&D expenditures (Yi et al., 2021) and human capital resources, which are available to all firms in a particular location. Such contextual factors shape the spatially bounded knowledge circumstances of the geographically proximate firms under the assumption that they are involuntary exposed to knowledge spillovers that happens cheaply, quickly and, as it were, automatically through the interactions with other nearby agents (Rodríguez-Gulías et al., 2021). However, the exploitation of these location-bound advantages requires a set of firm-level resources and capabilities that affect a firm's absorptive capacity (Cohen & Levinthal, 1990), and they are unevenly distributed in the firms' population (Acs et al., 2009). In other words, although the external resources are available to all firms in a certain location, a firm's ability to exploit them depends on firm-specific characteristics. Disentangling the effect of regional knowledge spillovers on innovative performance at the firm level thus requires taking into account the hierarchical structure of the innovation phenomenon (Raspe & Van Oort, 2009).

At the empirical level, the recent development of multilevel analysis and panel data techniques has made possible due the joint consideration of such a hierarchical and dynamic (longitudinal) data structure. To date, few studies have applied these methodologies to the analysis of firm innovative performance (e.g. Bellmann et al., 2013; Naz et al., 2015; Rodríguez-Gulías et al., 2016; Rodríguez-Gulías et al., 2021; Tojeiro-Rivero & Moreno, 2019). To the best of our knowledge, no study has explored FF innovation with this empirical approach. This fact supports the second part of the statement by Calabrò et al. (2019)—that is, mainstream innovation scholars have overlooked family variables in their analysis. Moreover, Brinkerink et al. (2017) are the only authors in Table 1 who explicitly mention the application of multilevel analysis techniques in their proposal for future research avenues.

In view of the above, the first research question (RQ1) is as follows: does FF nature affect firm innovative performance by adopting a multilevel approach of the firm innovation processes (i.e. applying multilevel panel data methods)? In other words, do FFs continue to outperform non-FFs in terms of innovation ('family innovation dilemma') when the hierarchical and longitudinal structure of the data is considered?

The Idiosyncrasies of FFs in Accessing and Absorbing Regional Knowledge Spillovers

Another conclusion that can be drawn from Table 1 is that the literature on FF innovation has paid significant attention to collaborative innovation (see that 2 out 11 reviews put the attention on this topic). This makes sense, as mainstream innovation research agrees that firms do not innovate alone: they rely heavily on their interaction with external players. In this regard, Feranita et al. (2017) go even further and point out that collaborative innovation could be an explanation of the ‘family innovation dilemma’; if FFs are more efficient in collaborative innovation, they can outperform non-FFs using fewer resources. In a similar line of reasoning, Durán et al. (2016) also mention superior access to feedback from external networks as a potential driver of the ‘do more with less’ effect.

Particularly, this stream of the literature on FF collaborative innovation has focused on the external sources of knowledge accessed through firm-to-firm interactions, namely, suppliers, customers, competitors, and universities and public centres (Bigliardi & Galati, 2018; Feranita et al., 2017). Although it comes in many forms (Bigliardi & Galati, 2018), collaborative innovation usually implies a ‘formal engagement contract’ with these external partners that involves the exchange and sharing of resources to innovate (Miles et al., 2005).

In addition to these external agents, the mainstream innovation research has also acknowledged knowledge spillovers as an external source of firm innovation. In this regard, the most intensively researched types of knowledge spillovers have been those linked to the technological and human capital resources of the region (Feldman & Audretsch, 1999; Glaeser et al., 1992; Rodríguez-Gulías et al., 2021).

Thus, concerning technological resources, research has emphasised the role of the region’s R&D expenditures and workers in enhancing firm innovative performance (Beugelsdijk, 2007). The underlying argument is that the region’s firms can benefit from regional R&D investments (Corsi & Prencipe, 2016; Powers & McDougall, 2005) by accessing them in their innovative activities (Raspe & Van Oort, 2009).

With regard to the region’s human capital resources, the literature on knowledge spillovers and the geography of innovation acknowledges that the tacit knowledge embedded in the individual may act as a key external knowledge source. From this approach, a highly skilled workforce has high capability to absorb, exploit and exchange knowledge, becoming a key ingredient of the knowledge economy (Bellmann et al., 2013; Corsi & Prencipe, 2016; Raspe & Van Oort, 2009; Zuluaga, 2012).

Compared to collaborative innovation, the exploitation of these external sources of knowledge does not require a ‘formal engagement contract’ and shares some of the advantages of innovating alone—namely, limiting leakage of knowledge and intellectual properties to other firms, reducing coordination problems, and maintaining control over innovation activities (Bigliardi & Galati, 2018). Moreover, knowledge spillovers are often free for the firm because its cost is paid by other players (Hritonenko & Yatsenko, 2013), which makes knowledge spillovers less risky than other external sources of knowledge accessible through collaborative innovation. These characteristics of regional knowledge spillovers can make it a particularly attractive external source of innovation for FFs, given their idiosyncrasies. In the following, we discuss how these idiosyncrasies can hamper or favour FFs’ ability to access and absorb regional knowledge spillovers.

The diversity of the cognitive background of board members affects the firm’s ability to tap into external knowledge. Thus, higher diversity enhances the firm’s absorptive capacity (Cohen & Levinthal, 1990), as well as the ability to innovate based on connections amongst internal and external sources of knowledge (Zahra, 2012). In this respect, FFs exhibit limited cognitive diversity (Brinkerink et al., 2017; Nieto et al., 2015; Sirmon & Hitt, 2003) as the management positions are often 'reserved' for family members (Classen et al., 2012).

The literature on FF innovation acknowledges that the family's aim to ensure the continuity of the business often results in a risk-averse climate for innovation (De Massis et al., 2015; Gomez-Mejia et al., 2010; Gomez-Mejia et al., 2011). The conservatism and risk aversion of FFs represent a deterrent to collaboration in innovation projects with external agents (Bigliardi & Galati, 2018). This reasoning could also apply to the exploitation of regional knowledge spillovers.

In contrast, the long-term orientation has been considered fundamental for the development of strategies that are long-term in nature, such as innovation. Long-term perspectives allow employees to pursue future business opportunities and encourage them to be oriented towards exploration (Kellermanns & Eddleston, 2006), thus enabling innovation activities. Due to the main goal of transferring the business to the next generation (Hoffmann et al., 2016; Miller et al., 2008), FFs work with a long-term mindset. This long-term orientation can be seen in the higher level of employee training (Miller et al., 2008) and longer job tenures compared with non-FF counterparts (Brinkerink et al., 2017; Zahra, 2005). Pittino et al. (2013) also indicate that FFs are more likely to engage in external alliances aimed at exploration. These behaviours favour the accumulation of experience (Bigliardi & Galati, 2018) and knowledge that connects different (internal and external) sources of knowledge.

The level of social capital is a fundamental ingredient for effectively managing the links between diverse sources of knowledge because fluid interpersonal communications enhance the effectiveness of knowledge exchange, especially in the case of tacit knowledge (Gupta et al., 2006). Compared to their non-FF counterparts, FFs are able to generate greater social capital inside the company (Veider & Matzler, 2016), as well as by nurturing long-standing relationships with external stakeholders (Miller & Le Breton-Miller, 2005). In particular, FFs exhibit a more horizontal organisational structure with fewer bureaucratic constraints and greater discretion given to employees at all levels than in comparable non-FFs (Bigliardi & Galati, 2018). These characteristics allow personnel to develop external linkages autonomously (De Massis et al., 2013), thus enhancing their willingness to interact freely with other external agents and exploit regional knowledge spillovers.

The literature on FF innovation strongly agrees that FFs desire for power and control prevents them from engaging in collaborations with external stakeholders when this process involves having restricted control on the resulting activities (Bigliardi & Galati, 2018; Gomez-Mejia et al., 2014; Röd, 2016). However, exploiting knowledge spillovers does not require establishing a formal contract that restricts parties' control over process outcomes. Accordingly, the FFs' desire for power and control might precisely predispose them favourably to take advantage of knowledge spillovers in the region.

Bigliardi and Galati (2018) indicate that concerns surrounding FF prosperity due to the large overlap between firm equity and family wealth lead managers towards more careful resource allocation (propensity to parsimony) compared to non-FF counterparts. De Massis et al. (2015) indicate that this prudent behaviour in the management of resources prevents FFs from developing costly and radical activities with unpredictable outcomes such as those that often occur in cases of innovation, and especially product innovation. It is likely that this behaviour decreases the willingness of FFs to engage in collaborative innovation with external agents (Bigliardi & Galati, 2018). Leveraging freely available external knowledge does not require the development of highly costly activities by companies that, additionally, can then preserve their resources. The prudent resource allocation of family managers may lead them to rely on regional knowledge spillovers.

In sum, the limited cognitive diversity and the conservatism and risk aversion of FFs might limit their ability to detect and exploit the region's knowledge spillovers. In contrast, a long-term orientation, the level of social capital, the desire for power and control and the propensity towards parsimony may encourage FFs to take advantage of the region's knowledge spillovers. Thus, in view of the above, the second research question (RQ2) is as follows: does FF nature shape the effect of regional resources on firm innovative performance? Or, alternatively, does FF management play a moderating role in the effects of regional knowledge spillovers on innovative outcomes?

Methodology

This section provides information on the data, variables and estimation strategy used in the multivariate analysis.

Data Collection

The dataset used at the firm level was the ESEE (*Encuesta sobre Estrategias Empresariales*, or Survey on Business Strategies) that consists of an unbalanced panel of manufacturing firms surveyed yearly by the SEPI Foundation in collaboration with the Ministry of Industry. The ESEE database is formed by combining a random sampling for small firms employing 10 to 200 employees and exhaustive sampling for companies with more than 200 employees. The ESEE database is possibly the most complete survey gathering information on the innovation activities of Spanish manufacturing companies, including some context-specific variables to better capture innovation in a country in which the R&D intensity of the firms is low (Hervas-Oliver et al., 2011). Besides, this database has been used by some scholars on FF innovation in the Spanish context (e.g. Diéguez-Soto et al., 2018; Kotlar et al., 2014; Monreal-Pérez et al., 2012). In addition to data on technological activities (R&D activities, patents, innovation or collaboration), it includes accounting and organisational data.

The period under analysis was 2009–2016, the last year available. The initial sample consisted of 3004 Spanish manufacturing firms; however, the requirements

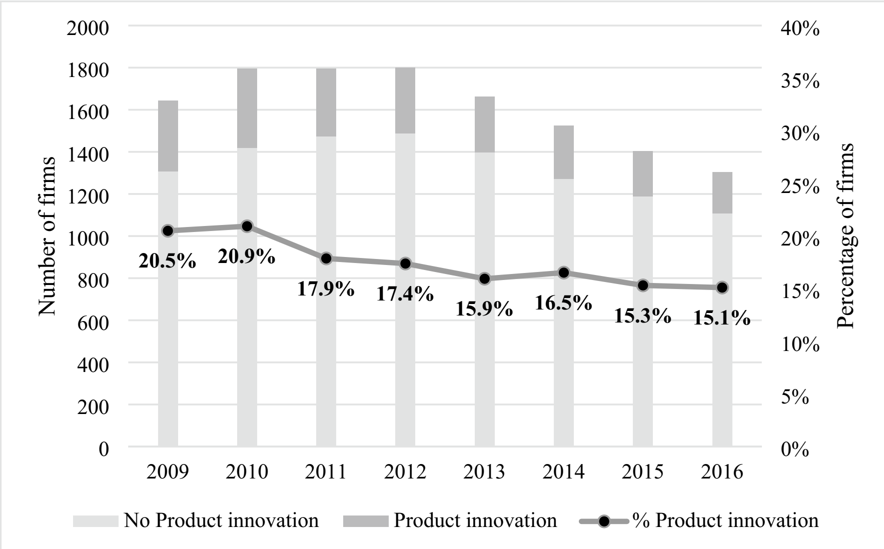

Fig. 1 Firms with and without product innovation by year

of the multilevel analysis (Snijders & Bosker, 1999) led us to drop those companies with two or fewer observations, resulting in a final sample of 1991 companies.

At the regional level, we used data from two sources: the database of the Spanish National Statistics Institute (INE) and the Spanish Patent and Trademark Office (OEPM).

Definition and Measurements of Firm-Level Variables

To answer the research questions, firm innovation performance was measured through product and process innovations. A firm was considered involved in product innovation if it introduced a good or service significantly different from the firm's previous goods or services into the market. Similarly, a firm was considered involved in process innovation if a significant modification to a business process was brought into use in the firm (OECD, 2018). Accordingly, we created two dummy variables that take the value 1 if the firm declared any product innovation (INNOPROD) or process innovation (INNOPRO) in the current year, and 0 otherwise.

In the period 2009–2016, 37.62% and 62.53% of the sample firms had one or more years with some product or process innovation, respectively. On a yearly basis, the percentage of firms with product innovation fell from 20% in 2009 to 15% in 2016 (Fig. 1), whilst the percentage of firms with process innovation remained close to 35% (Fig. 2).

At the firm level, the main independent variable is also a dummy variable that takes the value 1 for firms where a family group participates actively in the management and/or control (FAMILY) of the business in the current year, and 0 otherwise.

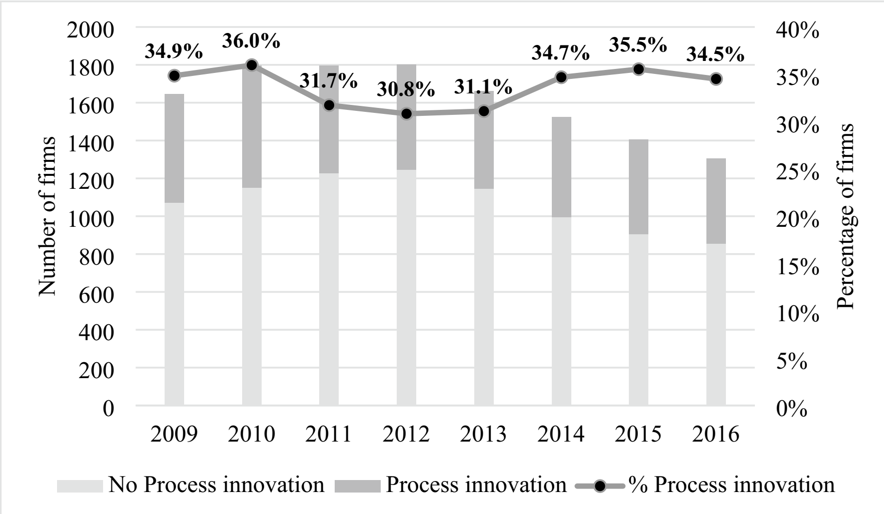

Fig. 2 Firms with and without process innovation by year

Similar variables have been used in previous studies on FF innovation that exploit the ESSE database for analysis of the Spanish context (e.g. Diéguez-Soto et al., 2018; Kotlar et al., 2014; Monreal-Pérez et al., 2012). On average, more than 44% of observations correspond to FFs. This percentage fluctuates year by year, from 42.88% in 2009 to 44.02% in 2016 (Fig. 3).

Additionally, eight explanatory variables were incorporated as internal determinants (or firm controls) of the firm's absorptive capacity (Table 2). Thus, the natural log of firm age (LNAGE) and the natural log of the number of employees (LNEMP) were considered proxies for firm age and firm size, respectively. Dummy variables were used to represent the exporters (EXPORT) and the firms in high-medium technology industries based on the Eurostat classification[1] (HIGHTECH). Technological activities at the firm level were measured through the remaining four variables. Thus, R&D expenditures divided by total sales (RD_SALES) and R&D employees divided by total employees (RD_EMP) were used as proxies of R&D intensity. Additionally, two dummy variables were employed to represent the firms with at least one patent in the current year (PAT) or engaged in technological collaboration with customers, competitors, suppliers, universities or technology centres (TCOLL), and 0 otherwise.

Table 2 displays the descriptive statistics of the dependent variables and independent internal factors for FF and non-FFs.

Table 2 shows that both types of innovation (product and process) are slightly higher in the FFs; on average, 18.34% of FFs carried out product innovation

[1] Eurostat uses the aggregation of the manufacturing industry according to technological intensity and based on the NACE Rev.2 at the two-digit level.

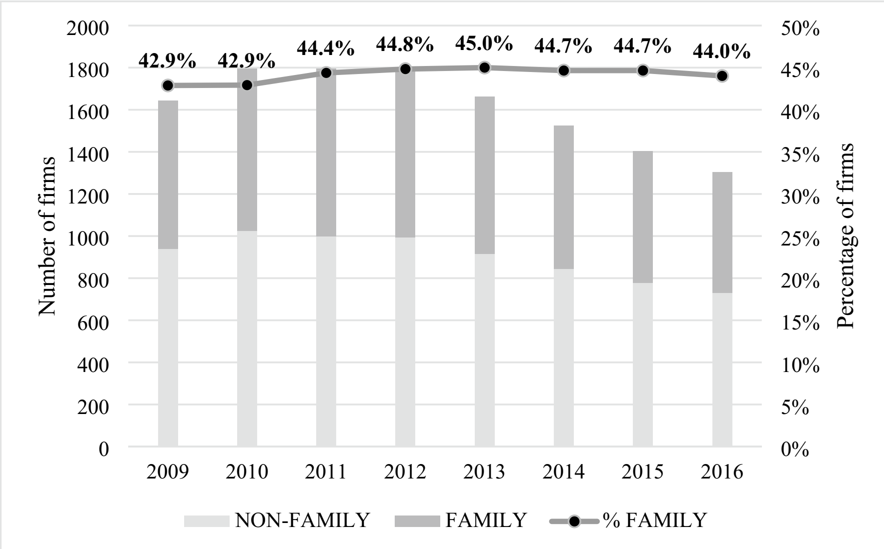

Fig. 3 Family firms by year

compared to 17.02% of non-FFs. These figures are even closer in the case of process innovation; 33.99% of FF and 33.21% of non-FFs (on average) conducted process innovation on a yearly basis.

With regard to internal factors or firm variables (Table 2), the average age of the firm was close to 35 years for FFs and 33 years for non-FFs. The average number of employees was slightly more than 125 workers in FFs, and almost twice as high in non-FFs (255 employees). Just 31% of FFs operated in high-medium technology industries, whilst almost 39% of non-FFs do so. Nearly 72% of FFs and 69% of non-FFs export. Regarding firm R&D intensity, the percentages of sales and employees devoted to R&D were close to 0.79% and 0.84% respectively in FFs, whilst these figures were 0.82% and 0.88% in non-FFs. On average, the percentage of FFs collaborating with stakeholders and specialised innovation agents (30%) is slightly lower than that of non-FFs (34%). Finally, a higher percentage of FFs registers at least one patent per year (5.83% compared to 4.78% of non-FFs).

From the previous descriptive statistics, it can be seen that the 'family innovation dilemma' holds for the sample firms. Thus, FFs achieve slightly higher innovative outcomes than non-FFs, despite showing a lower level of R&D intensity (expenditure and personnel) and of engagement in technological collaboration with external agents.

Definition and Measurements of the Regional-Level Variables

At the regional or external level, a total of three explanatory variables were included. It should be noted that these variables change across regions and years,

Table 2 Descriptive statistics of dependent variables and internal factors: FFs vs non-FFs

Variable	Obs	Mean	Std. Dev.	Min	Max
FFs					
INNOPROD	5710	0.1834	0.3870	0	1
INNOPROC	5710	0.3399	0.4737	0	1
AGE[a]	5710	34.61	20.19	3	177
EMP[a]	5710	125.59	352.66	1	9270
HIGHTECH	5710	0.3100	0.4625	0	1
EXPORT	5710	0.7201	0.4490	0	1
RD_SALES[b]	5694	0.7862	2.4553	0	62.3315
RD_EMP[b]	5687	0.8444	2.4158	0	50
PAT	5710	0.0583	0.2344	0	1
TCOLL	5710	0.2974	0.4571	0	1
Non-FFs					
INNOPROD	7221	0.1702	0.3758	0	1
INNOPROC	7221	0.3321	0.4710	0	1
AGE[a]	7221	32.33	19.64	1	173
EMP[a]	7221	254.32	851.20	1	13091
HIGHTECH	7221	0.3817	0.4858	0	1
EXPORT	7221	0.6848	0.4646	0	1
RD_SALES[b]	7183	0.8205	2.7405	0	49.59318
RD_EMP[b]	7176	0.8886	3.5855	0	41.5094
PAT	7221	0.0478	0.2133	0	1
TCOLL	7221	0.3355	0.4722	0	1

[a]Variables are not in logs. [b]Variables are in percentage terms

but not between companies from the same region in the same year. The variable referred to the region's technological resources was the percentage of gross domestic product (GDP) dedicated to R&D (RD_GDP), similarly to López-Bazo and Motellón (2018) and Rodríguez-Gulías et al. (2021). Additionally, two variables were considered to approximate the region's human capital resources: the percentage of workers in R&D (NRDE_TE), as in Naz et al. (2015) and Rodríguez-Gulías et al. (2021), and the number of researchers directly employed in full-time R&D activities over regional total employees (NRDRE_TE), as in Bellmann et al. (2013), Czarnitzki and Hottenrott (2009), Naz et al. (2015) and Zuluaga (2012).

In the period 2009–2016, the average percentage of regional GDP dedicated to R&D expenditures was 1.07% and the mean percentage of workers in R&D was 1.03% (Table 3). Additionally, the average percentage of researchers in R&D activities was 0.65%. Table 4 presents the correlation matrix of the independent continuous variables. All of them are positively correlated. To elude possible multicollinearity problems, regional variables are alternatively introduced in the empirical specifications.

Table 3 Descriptive statistics of external factors

	Variable	Obs	Mean	Std. dev.	Min	Max
External factors	RD_GDP	136	1.0738	0.4790	0.3200	2.2300
	NRDE_TE	136	1.0262	0.4577	0.3534	2.0687
	NRDRE_TE	136	0.6485	0.2887	0.2008	1.3432

Variables are in percentage terms

Table 4 Correlation matrix

		(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1)	LNAGE	1						
(2)	LNEMP	0.2274*	1					
(3)	RD_SALES	0.0333*	0.1740*	1				
(4)	RD_EMP	0.0716*	0.1145*	0.4505*	1			
(5)	RD_GDP	0.0920*	0.0859*	0.0986*	0.0854*	1		
(6)	NRDE_TE	0.1142*	0.0835*	0.1028*	0.0908*	0.9579*	1	
(7)	NRDRE_TE	0.1065*	0.0881*	0.0995*	0.0844*	0.9289*	0.9782*	1

Table 4 shows, for the continuous variables considered in the empirical analysis, the Pearson correlation coefficients. *, ** and *** denote significance at the 5%, 1% and 0.1% levels

Estimation Strategy and Model Specification

To answer whether FF nature influences innovative performance when external resources for innovation and the hierarchical structure of the data are jointly considered (RQ1), a three-level multilevel model was used. In doing so, the effects of external (regional) and internal drivers on the probability of having product or process innovation can be analysed, as the dataset includes observations (level 1) for companies (level 2) nested in regions (level 3). Furthermore, we assumed a logistic model because both dependent variables, INNOPROD and INNOPROC, are dummies. In particular, fixed slopes were assumed, and three-level logistic random intercept models (occasions-firms-regions models) were estimated. Those models can be written as a latent response.

The first model (Model 1) is the empty model without explanatory variables and with a random intercept:

$$\mathrm{INNO}^{*}{}_{\mathrm{ijk}} = \beta_0 + v_k + u_j + e^{*}{}_{\mathrm{ijk}} \tag{1}$$

where $\mathrm{INNO}^*_{\mathrm{ijk}}$ is the observed dependent variables ($\mathrm{INNOPROD}_{\mathrm{ijk}}$ or $\mathrm{INNOPROC}_{\mathrm{ijk}}$), β_0 is the overall mean of $\mathrm{INNO}^*_{\mathrm{ijk}}$ (across all groups), v_k is the level 3 random effect (region random effect), u_j is the level 2 random effect (firm random effect), and e^{*}_{ijk} is the level 1 residual (occasion residual) with mean zero and variance $\sigma^2 e^*$ (assuming a logistic distribution of σ^2) (Bellmann et al., 2013; Leckie, 2013; Steele, 2009).

The second model (Model 2) adds the firm's internal factors and the main independent variable (FAMILY), to Model 1:

$$\begin{aligned}\text{INNO}^*_{ijk} = \beta_0 + \beta_1\text{LNAGE}_{\text{ijk}} + \beta_2\text{LNEMP}_{\text{ijk}} + \beta_3\text{HIGHTECH}_{\text{ijk}} \\ + \beta_4\text{EXPORT}_{\text{ijk}} + \beta_5\text{RD\_SALES}_{\text{ijk}} + \beta_6\text{RD\_EMP}_{\text{ijk}} \\ + \beta_7\text{PAT}_{\text{ijk}} + \beta_8\text{TCOLL}_{\text{ijk}} + \beta_9\text{FAMILY}_{\text{ijk}} + v_k + u_j + e^*_{ijk}\end{aligned} \quad (2)$$

The third model (Model 3) is designed with three alternative specifications (Models 3.1 to 3.3), including regional (external) factors (third-level variables) one by one:

$$\begin{aligned}\text{INNO}^*_{ijk} = \beta_0 + \beta_1\text{LNAGE}_{\text{ijk}} + \beta_2\text{LNEMP}_{\text{ijk}} + \beta_3\text{HIGHTECH}_{\text{ijk}} \\ + \beta_4\text{EXPORT}_{\text{ijk}} + \beta_5\text{RD\_SALES}_{\text{ijk}} + \beta_6\text{RD\_EMP}_{\text{ijk}} + \beta_7\text{PAT}_{\text{ijk}} \\ + \beta_8\text{TCOLL}_{\text{ijk}} + \beta_9\text{FAMILY}_{\text{ijk}} + \beta_{10}\text{REGION}_{\text{jk}} + v_k + u_j + e^*_{ijk}\end{aligned} \quad (3)$$

where $\text{REGION}_{\text{jk}}$ refers to the three regional variables alternatively introduced in the specifications: $\text{RD\_GDP}_{\text{jk}}$, $\text{NRDE\_TE}_{\text{jk}}$ and $\text{NRDRE\_TE}_{\text{jk}}$.

To answer whether FF nature shapes the effect of regional resources on firm innovative performance (RQ2), we alternatively interacted the three regional variables and the main independent variable (Models 3.1 to 3.3 with interactions).

In all estimated models, the region variance partition coefficient (VPC) is reported to capture the proportion of the total residual variance that is due to regional level:

$$\text{VPC} = \frac{\alpha_v^2}{\alpha_v^2 + \alpha_u^2 + \alpha_{e*}^2}$$

where ${\alpha_{e*}}^2$ is 3.29 for a logit model.

Multivariate Analysis

Multivariate analyses were performed in three stages. First, multilevel panel data logit models were estimated to determine whether FF management affects firm innovative performance by considering the hierarchical structure and dynamic nature of the data (RQ1). Second, regional knowledge spillovers are interacted with the FF variable to explore whether the FF nature plays a moderating role in the effects of regional knowledge spillovers on innovative outcomes (RQ2). Third, we re-estimated the models from the second stage using alternative definitions of FF to check the robustness of the results.

The Effect of FF Nature on Innovative Performance, with Regional Knowledge Spillovers and the Hierarchical and Longitudinal Structure of Data

Tables 5 and 6 display the estimates of the empty model, namely, the model that only includes a random intercept and no explanatory variables (Model 1), the model that adds the internal drivers of innovation (Model 2) and the models that include the internal and external determinants simultaneously (Model 3) for product innovation (INNOPROD) and process innovation (INNOPROC), respectively.

Concerning Model 1 (Tables 5 and 6), the corresponding LR tests reject the null hypothesis that there are no regional supercluster effects (H_0: $\sigma^2_v = 0$) for both product and process innovation. These findings suggest that the regional dimension partly determines companies' innovation performance. It therefore seems that firms from the same region are more similar than firms from different regions in terms of innovation outcomes. In this respect, the variance partition coefficient (VPC) shows that 4.17% and 2.14% of the residual variation for, respectively, product and process innovation[2] are attributable to the region's unobserved characteristics. In general, the supercluster variance (i.e. the variance associated with the regional dimension or σ^2_v) and the VPC are reduced, but still significant, when internal and regional drivers of innovation are added to the empty model (Model 2 and Model 3 vs Model 1). Similar evidence is found by López-Bazo and Motellón (2018) and Rodríguez-Gulías et al. (2021). Previous findings lead us to conclude that the regional dimension matters in determining firm innovative performance. This level of analysis thus deserves to be properly explored in firm-centred models studying innovative performance.

The estimates of Model 2 show that the main independent variable, being a FF (FAMILY), positively affects product and process innovation when only internal factors are considered. Additionally, when the external factors are added (Model 3), the significant positive effect of being a FF (FAMILY) is still present. With regard to the first research question (RQ1), the findings indicate that FFs continue to outperform non-FFs in terms of innovation (product and process) when the hierarchical and longitudinal structure of the data is considered. Because there are no studies on FFs addressing this issue, our results cannot be compared with others. Nevertheless, they maintain the existence of the 'family innovation dilemma' even when regional knowledge spillovers are considered; they clearly indicate that FFs achieve better results than non-FFs despite allocating fewer resources to R&D.

The results of the estimation for Model 2 and Model 3 (Tables 5 and 6) also show that seven out the eight firm-level control variables have a significant effect on both product and process innovation. Hence, the probability of innovating significantly decreases with firm age (LNEMP), whilst it significantly increases with firm size (LNEMP). These findings are similar to those found by Bellmann et al. (2013) for German firms, by López-Bazo and Motellón (2018) for Spanish companies and by Zuluaga (2012) for Colombian firms' product innovation. Exporters (EXPORT) have a higher

[2] Calculated as 0.524/(0.524+8.738+3.29)=0.0417 for product innovation and as 0.199/(0.199+5.822+3.29)=0.0214 for process innovation.

Table 5 Three-level logistic random intercept model: Product innovation

	Model 1	Model 2	Model 3.1	Model 3.2	Model 3.3
Constant	− 3.594***	− 5.594***	− 8.432***	− 6.237***	− 6.019***
			(0.775)	(0.536)	(0.516)
Fixed effects					
Internal factors					
LNAGE		− 0.365**	− 0.264*	− 0.375**	− 0.374**
		(0.123)	(0.126)	(0.123)	(0.123)
LNEMP		0.506***	0.494***	0.505***	0.504***
		(0.062)	(0.063)	(0.062)	(0.062)
HIGHTECH		− 0.054	− 0.077	− 0.081	− 0.073
		(0.149)	(0.151)	(0.149)	(0.149)
EXPORT		0.713***	0.710***	0.693***	0.700***
		(0.159)	(0.161)	(0.159)	(0.159)
RD_SALES		0.190***	0.186***	0.187***	0.188***
		(0.021)	(0.021)	(0.021)	(0.021)
RD_EMP		0.028*	0.027*	0.027*	0.027*
		(0.011)	(0.011)	(0.011)	(0.011)
PAT		0.843***	0.807***	0.842***	0.846***
		(0.155)	(0.156)	(0.155)	(0.155)
TCOLL		1.862***	1.859***	1.858***	1.858***
		(0.118)	(0.119)	(0.118)	(0.118)
FAMILY		0.299*	0.308**	0.312**	0.308**
		(0.117)	(0.119)	(0.118)	(0.118)
External factors					
RD_GDP			2.089***		
			(0.430)		
NRDE_TE				0.598*	
				(0.251)	
NRDRE_TE					0.664+
					(0.374)
Random effects					
σ^2_v	0.524	0.076	0.713	0.086	0.076
σ^2_u	8.738	5.291	5.409	5.297	5.285
N° observations	12585	12484	12484	12484	12484
N° superclusters (regions)	17	17	17	17	17
N° clusters (firms)	1941	1941	1941	1941	1941
Loglikelihood	− 4212.42	− 3715.83	− 3696.42	− 3712.28	− 3714.11
WaldX^2	.	730.84	721.66	730.07	731.88
Prob>X^2	.	0.000	0.000	0.000	0.000
LR test X^2 (vs. logistic model)	3218.04	1674.91	1693.37	1669.08	1669.61
Prob≥X^2	0.000	0.000	0.000	0.000	0.000
VPC	4.17%	0.88%	7.57%	0.99%	0.87%

Standard errors in brackets; +, *, ** and *** denote significance at the 10, 5, 1 and 0.1% levels

Table 6 Three-level logistic random intercept model: Process innovation

	Model 1	Model 2	Model 3.1	Model 3.2	Model 3.3
Constant	− 1.462***	− 3.638***	− 4.123***	− 3.829***	− 3.770***
			(0.379)	(0.372)	(0.372)
Fixed effects					
Internal factors					
LNAGE		− 0.404***	− 0.390***	− 0.406***	− 0.407***
		(0.094)	(0.094)	(0.094)	(0.094)
LNEMP		0.674***	0.670***	0.674***	0.674***
		(0.048)	(0.048)	(0.048)	(0.048)
HIGHTECH		− 0.154	− 0.177	− 0.163	− 0.160
		(0.114)	(0.114)	(0.114)	(0.114)
EXPORT		0.513***	0.508***	0.508***	0.509***
		(0.111)	(0.111)	(0.111)	(0.111)
RD_SALES		0.060***	0.059***	0.060***	0.060***
		(0.016)	(0.016)	(0.016)	(0.016)
RD_EMP		0.025*	0.025*	0.025*	0.025*
		(0.011)	(0.012)	(0.012)	(0.012)
PAT		0.480***	0.471***	0.480***	0.481***
		(0.141)	(0.141)	(0.141)	(0.141)
TCOLL		1.248***	1.246***	1.247***	1.247***
		(0.090)	(0.090)	(0.090)	(0.090)
FAMILY		0.294***	0.303***	0.299***	0.297***
		(0.087)	(0.087)	(0.087)	(0.087)
External factors					
RD_GDP			0.377**		
			(0.137)		
NRDE_TE				0.179	
				(0.151)	
NRDE_TE					0.208
					(0.250)
Random effects					
σ^2_v	0.199	0.030	0.020	0.022	0.026
σ^2_u	5.822	3.775	3.798	3.777	3.777
N° observations	12585	12484	12484	12484	12484
N° superclusters (regions)	17	17	17	17	17
N° clusters (firms)	1941	1941	1941	1941	1941
Loglikelihood	− 6247.91	− 5773.70	− 5769.93	− 5773.04	− 5773.37
WaldX^2	.	757.07	763.63	759.84	758.60
Prob>X^2	.	0.000	0.000	0.000	0.000
LR test X^2 (vs. logistic model)	3540.44	2023.70	2021.59	2019.76	2022.37
Prob≥X^2	0.000	0.000	0.000	0.000	0.000
VPC	2.14%	0.42%	0.28%	0.31%	0.36%

Standard errors in brackets; +, *, ** and *** denote significance at the 10, 5, 1 and 0.1% levels probability of innovating than firms only operating in the domestic market. Similar evidence is found by Bellmann et al. (2013), López-Bazo and Motellón (2018) and Rodríguez-Gulías et al. (2021). Firms' R&D intensity, in terms of sales (RD_SALES) and employment (RD_EMP), also significantly raises the chances of company innovation. A similar effect was found for the percentage of sales dedicated to R&D by Rodríguez-Gulías et al. (2021). In the same way, firms' patent activity (PAT) increases the propensity to innovate. Regarding the influence of technological collaboration (TCOLL), the results show that it significantly increases the probability of innovation, consistently with most of the results described by Bigliardi and Galati (2018) and Feranita et al. (2017). Nevertheless, operating in a high-medium technology industry fails to be significant for product and process innovation as in the previous work of Rodríguez-Gulías et al. (2021).

Involving the regional technological resources (Models 3.1 to 3.3), the estimations in Tables 5 and 6 show that the region's R&D financial effort (RD_GDP) positively influences firm product and process innovation. Nevertheless, when the region's human capital resources are considered (NRDE_TE or NRDRE_TE), the estimates show a positive effect of the regional knowledge spillovers only on product innovation. A potential explanation for the significant relationship with product innovation but not with process innovation may lie in the fact that the two types of innovation are associated with different knowledge characteristics (Chang et al., 2015). Product innovation is related to external knowledge (Gopalakrishnan & Damanpour, 1997), and it is thus expected to be more influenced by external sources of innovation. In contrast, process innovation is linked to internal knowledge (Chang et al., 2015). The region's R&D workers and researchers refer to external knowledge, which may partly explain the lack of evidence for an effect of these variables on firms' process innovation.

The Role of the FF Nature in Shaping the Effect of Regional Knowledge Spillovers on Innovative Performance

In the second stage, we re-estimated Model 3 by interacting the three regional variables with the main independent variable, being a family business (FAMILY), to answer the second research question (RQ2). The results of these specifications are reported in Table 7.

Regarding the direct effects, the results reveal that the main independent variable (FAMILY) and the eight firm-level control variables hold the effects obtained in the previous estimations. At the regional level, the regional determinants of firm innovation maintain the positive effect previously found in the case of product innovation and new significant positive effects (NRDE_TE and NRDRE) arise in the case of process innovation.

Concerning the interaction effects, the estimations in Table 7 mostly show negative significant interaction terms. These negative relationships can also be observed in Fig. 4, which displays the marginal effects of the FF variable on product and process innovation for different levels of the three regional variables. These findings seem to indicate that being a FF plays a subtle role in shaping the effect of the region's resources on innovative performance (RQ2). Thus, the negative interaction terms indicate that, in regions with a high technological and human capital resources, the effect of knowledge spillovers

Table 7 Three-level logistic random intercept model: Interaction effects

	Product innovation: Models with interactions (FAMILYijkxREGIONjk)			Process innovation: Models with interactions (FAMILYijkxREGIONjk)		
	Model 3.1	Model 3.2	Model 3.3	Model 3.1	Model 3.2	Model 3.3
Constant	– 8.745***	– 6.525***	– 6.312***	– 4.300***	– 4.009***	– 3.975***
	(0.780)	(0.554)	(0.540)	(0.397)	(0.388)	(0.388)
Fixed effects						
Internal factors						
LNAGE	– 0.250*	– 0.363**	– 0.369**	– 0.387***	– 0.404***	– 0.406***
	(0.125)	(0.122)	(0.123)	(0.094)	(0.094)	(0.094)
LNEMP	0.480***	0.494***	0.499***	0.668***	0.671***	0.671***
	(0.062)	(0.062)	(0.062)	(0.048)	(0.048)	(0.048)
HIGHTECH	– 0.088	– 0.088	– 0.076	– 0.182	– 0.169	– 0.166
	(0.150)	(0.148)	(0.149)	(0.114)	(0.114)	(0.114)
EXPORT	0.704***	0.694***	0.692***	0.502***	0.502***	0.503***
	(0.161)	(0.159)	(0.159)	(0.111)	(0.111)	(0.111)
RD_SALES	0.184***	0.186***	0.188***	0.059***	0.060***	0.060***
	(0.020)	(0.020)	(0.021)	(0.016)	(0.016)	(0.016)
RD_EMP	0.027*	0.027*	0.027*	0.025*	0.025*	0.025*
	(0.011)	(0.011)	(0.011)	(0.012)	(0.012)	(0.012)
PAT	0.819***	0.848***	0.849***	0.476***	0.483***	0.484***
	(0.155)	(0.155)	(0.155)	(0.141)	(0.141)	(0.141)
TCOLL	1.866***	1.860***	1.864***	1.251***	1.252***	1.252***
	(0.119)	(0.118)	(0.118)	(0.090)	(0.090)	(0.090)
FAMILY	1.230***	1.080**	0.981**	0.702**	0.719**	0.780**
	(0.364)	(0.359)	(0.357)	(0.261)	(0.261)	(0.259)
External factors						
RD_GDP	2.343***			0.513**		
	(0.437)			(0.163)		
FAMILYxRD_GDP	– 0.705**			– 0.309		
	(0.263)			(0.191)		
NRDE_TE		0.846**			0.327+	
		(0.274)			(0.176)	
FAMILYxNRDE_TE		– 0.624*			– 0.346+	
		(0.277)			(0.202)	
NRDRE_TE			1.049*			0.490+
			(0.422)			(0.291)
FAMILYxNRDRE_TE			– 0.902*			– 0.652*
			(0.452)			(0.329)
Random effects						
σ^2_v	0.684	0.076	0.078	0.022	0.024	0.028
σ^2_u	5.212	5.160	5.283	3.798	3.776	3.772

Table 7 (continued)

	Product innovation: Models with interactions (FAMILYijkxREGIONjk)			Process innovation: Models with interactions (FAMILYijkxREGIONjk)		
	Model 3.1	Model 3.2	Model 3.3	Model 3.1	Model 3.2	Model 3.3
N° observations	12484	12484	12484	12484	12484	12484
N° superclusters (regions)	17	17	17	17	17	17
N° clusters (firms)	1941	1941	1941	1941	1941	1941
Log likelihood	− 3696.63	− 3713.71	− 3712.11	− 5768.62	− 5771.57	− 5771.40
Wald X^2	731.83	734.90	733.88	764.06	760.85	760.64
Prob > X^2	0.000	0.000	0.000	0.000	0.000	0.000
LR test X^2 (vs. logistic model)	1676.45	1654.94	1666.17	2021.50	2018.55	2018.59
Prob ≥ X^2	0.000	0.000	0.000	0.000	0.000	0.000
VPC	7.45%	0.90%	0.90%	0.31%	0.34%	0.40%

Standard errors in brackets; +, *, ** and *** denote significance at the 10, 5, 1 and 0.1% levels

on innovative performance is smaller for FFs than for non-FFs. This finding may be explained by the limited cognitive diversity (Brinkerink et al., 2017; Nieto et al., 2015; Sirmon & Hitt, 2003) and the conservatism and risk aversion (De Massis et al., 2015; Gomez-Mejia et al., 2010; Gomez-Mejia et al., 2011) of FFs, which prevent them from taking 'full' advantage of such regional resources.

However, the negative interaction terms have an alternative reading. They indicate that FFs located in regions with low levels of technological and human capital resources 'obtain' a higher impact of these external resources on their innovative performance than FFs in regions with high levels of knowledge spillovers. In other words, being part of a family group is even more relevant in regions with a low share of R&D workers and researchers and R&D expenditures. The long-term mindset (Hoffmann et al., 2016; Miller et al., 2008), the high social capital (Miller & Le Breton-Miller, 2005; Veider & Matzler, 2016), the desire for control (Bigliardy and Gallati, 2017; Gomez-Mejia et al., 2014; Röd, 2016) and the propensity towards parsimony (De Massis et al., 2015) could lead FFs to take advantage of these scarce external resources to a greater extent than when they are plentiful.

To sum up, being part of a family group increases innovation performance (RQ1), and, overall, this effect seems to be even more important in regions with low technological and human capital resources (RQ2).

Comparative Analysis by Alternative Measures of FF: Robustness Check

An analysis employing alternative measures of FF was conducted to check the robustness of the previous results. In particular, two different measures of FF were employed. The first one is a time-invariant dummy that takes the value 1 for firms where a family group participates actively in its management and/or control in any of the years of study

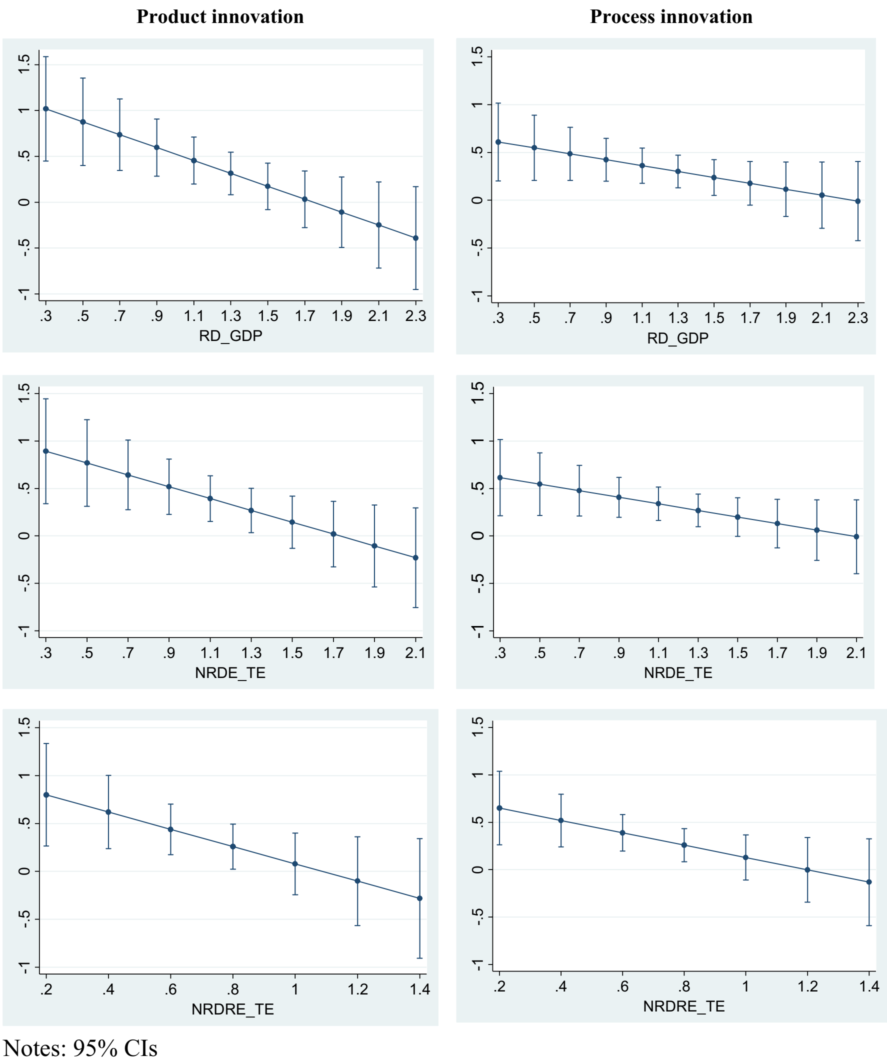

Fig. 4 Average marginal effects of the FF variable on firm innovation for different levels of regional variables. Notes: 95% CIs

(FFCONS), and 0 otherwise. The second one is a time-invariant dummy that takes the value 1 for firms where a family group participates actively in its management and/or control (FFCONS2) in at least 25% of years of study, and 0 otherwise. Table 8 summarises the results for the estimations of Model 3 with the alternative measures of FF.[3]

[3] Detailed estimations are not reported for space reasons. They can be obtained from the authors if required.

The results of three-level logistic random intercept models with cross-interactions by alternative measures of FF (Table 8) reveal that being a family business positively affects product innovation regardless of the FF measure used (FAMILY, FFCONS or FFCONS2). In the case of process innovation, when being a FF is approximated through the variable FFCONS2, it fails to be significant in two of four estimated models. So, in general, the previous findings are maintained with respect to the positive direct effect of being a FF on firm innovative performance.

Regarding the direct effect of regional factors, all of them are maintained in the case of product innovation and almost all in the case of process innovation. The only exception is the percentage of workers in R&D (NRDE_TE) which fails to be significant in some cases.

Finally, looking at the interaction terms, the robustness check shows only small differences in some of them, especially in the case of process innovation. All the differences are losses of significance or occurrences of significance in line with previous results, but never significant changes of sign in the effects.

Conclusions

The aim of this article was to explore the joint influence of the region's knowledge spillovers and FF nature on innovative performance by adopting a multilevel approach. This approach means acknowledging that innovation happens within a 'certain' firm with its specificities that, in turn, is located in a 'certain' region whose resources are available for all of the firms within that region and can differ from those available in other regions (i.e. acknowledging the hierarchical structure of levels using firm-centred models). Whilst there are many studies on FF innovation, no study has addressed such approach.

Using a sample of 1991 Spanish manufacturing firms over the period 2009–2016, we found that regional dimension matters in determining a firm's innovative performance, and the regional effect remains significant when internal drivers of innovation are considered. The results also show that being a family business positively affects product and process innovation when both internal and regional factors are jointly considered in the multilevel analyses. In other words, the 'family innovation dilemma' holds even when the region's knowledge spillovers are considered. Another relevant finding is the moderating role of FF nature in shaping the effect of the region's resources on innovative performance. Thus, the estimations indicate that in regions with high technological and human capital resources, the influence of knowledge spillovers on innovative performance is smaller for FFs compared to non-FFs. This finding leads us to hypothesise that some specificities of FFs, such as limited cognitive diversity and conservatism and risk aversion, might prevent them from taking 'full' advantage of regional resources. Alternatively, these estimations also indicate that, in regions where the environment could be less favourable for innovation, FFs 'get' a higher impact from these low external resources than FFs in regions with high levels of knowledge spillovers. In other words, belonging to a family group is even more important in regions with a low percentage of R&D expenditures and R&D workers and researchers.

Table 8 Three-level logistic random intercept model with cross-interactions by alternative measures of FF: robustness check

	Product innovation				Process innovation			
		Family	FFCONS	FFCONS2		Family	FFCONS	FFCONS2
	Direct effects	(+)	(+)	(+)	Direct effects	(+)	(+)	*(n.s.)*/(+)
RD_GDP	(+)	(-)	(-)	(-)	(+)	(n.s.)	(n.s.)	(n.s.)
NRDE_TE	(+)	(-)	(-)	(-)	(+)/*(n.s.)*	(-)	*(n.s.)*	*(n.s.)*
NRDRE_TE	(+)	(-)	*(n.s.)*	*(n.s.)*	(+)/*(n.s.)*	(-)	*(n.s.)*	*(n.s.)*

Notes: In italics, results which are different from the baseline model (with FAMILY as measure of family group linkage)

The previous findings underline the main theoretical contribution of this study: the inclusion of regional drivers of innovation in the research on FFs by applying multilevel techniques. In doing so, the literature on FF innovation would be enriched with one of the most recent developments of mainstream innovation research (Calabrò et al., 2019) such as the consideration of the hierarchical structure of the data through multilevel models, that is firms innovate whilst they are exposed to knowledge spillovers of their local environment. In a similar manner, we recommend that researchers on innovation consider the nature of FFs in their studies, which implies acknowledging another source of firm heterogeneity in exploiting available location-bound advantages.

At the political level, given that the evidence confirms that several firm-specific characteristics are positively related to innovative performance, public interventions aimed at enhancing firm innovation should be firm-centred. In this respect, policies geared towards promoting the size, export and patent activities, technological collaboration and R&D intensity of firms could be effective in increasing innovative performance.

The obtained results also show that the region's technological and human capital resources have a direct impact on firms' product and process innovation. More specifically, as the region's R&D efforts enhance firm innovative performance, public R&D expenditure, severely cut after the crisis, should be increased. Fiscal incentives can also be designed to stimulate private R&D spending. Promoting R&D employment would be a good policy for enhancing firm innovation.

At the managerial level, in view of the results, FF managers should act to better exploit regional knowledge spillovers. In this respect, FFs' level of social capital seems to be one of the most valuable intangible assets in exploiting internal and external knowledge, especially in less favourable regions for innovation. It would be advisable to improve this social capital, especially in terms of establishing long-term relationships with external agents. The cognitive diversity of boards should also be expanded.

Whilst the main results are robust to different model specifications and definitions of being a FF, this study presents some limitations. Thus, in this paper we discussed how FFs' idiosyncrasies can favour or hamper their ability to access and absorb regional knowledge spillovers. In future research, it would be advisable to collect detailed information on such specificities (e.g. diversity of cognitive background of board members, level of risk aversion) through surveys to test whether they play a specific role in the exploitation of knowledge spillovers. In doing so, it would acknowledge the fact that FFs are a heterogeneous group of enterprises. Moreover, such heterogeneity could also moderate the role of internal drivers on innovation, which is a potential line of future research. Additionally, although the analysis has emphasised a resourced-constrained context such as the Spanish economy in the period 2009–2016, additional studies of other economies and/or periods would provide useful insight into FFs' innovation and their relationships with knowledge spillovers.

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Declarations

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