INNOVATION PERFORMANCE AND TECHNOLOGICAL COLLABORATION WITH BUSINESS PARTNERS IN FAMILY FIRMS

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Article info

Abstract

This research examines how the family firm status of the business and the level/degree of family management moderate the relationship between business partner collaboration and technological innovation performance. We provide empirical evidence by using a panel data of around 12,000 observations on Spanish manufacturing firms via regression analysis. Results show that the family firm status moderates the relationship between technological collaboration with business partners and innovation in a way that reduces the likelihood of achieving higher innovation performance. Furthermore, within the group of family firms, the interaction between the level/degree of family involvement in the management and the business partners' technological collaboration has a negative and significant impact on the innovation performance.

1. Introduction

Firms increasingly establish technological collaborations with external partners to improve their innovation performance (Chesbrough, 2003). However, the adoption of an open behavior in innovation processes is still controversial in family firms. On one hand, some studies provide evidence that these firms are more open compared to other forms of organizations as they may rely on a higher number of external partners thanks to their human, social and marketing capital (Llach and Nordqvist, 2010). On the other hand, papers based on the socio-emotional wealth (SEW) approach suggest that family firms are less open compared to the non-family ones (Classen et al., 2012, Kotlar et al., 2013; Lazzarotti et al., 2017) as non-economic goals characterizing the SEW approach (e.g. the desire to maintain the control of the firm) restrain the attitude towards collaboration in innovation activities.

Moreover, De Massis et al. (2015) show that some partners (the "business" partners such as suppliers, customers and competitors) are considered more critical than others (the "scientific" partners such as universities), since the latter contrast the pursuing of non-economic goals more and thus they may cause high loss of SEW in terms of firm control, sense of identity, family emotions and bonds. Recent studies (Brinkerink et al., 2017; Feranita et al., 2017) claim that, even when family firms decide to collaborate with this type of business partners, the relationship with them remains complicated since the family nature of the firm's governance and management obviously continues to exert an influence. As a consequence of the difficult working relationship, the resulting innovation performance may be negatively affected, with undesirable effects on the family firm's performance in general.

Given the relevance of a good technological collaboration, it is thus crucial to shed light on the family factors that may affect it. Considering that in this regard the extant studies are still anecdotal (Brinkerink et al., 2017; Perri and Peruffo, 2017), we aim to further investigate the topic. In particular we focus on collaborations that family firms activate with business partners in order to pursue technological innovation. In such a setting, the goal of the paper is twofold: first, it examines how the family nature of the firm's ownership (i.e. family status) affects the technological innovation performance obtainable from collaborations with business partners and, second, it investigates the influence on these results exerted by an increasing level of family member involvement in firm management.

The hypotheses are tested on a sample of around 1,200 Spanish manufacturing firms, observed over the period 2008-2014. To pursue the first goal, we consider the entire sample, composed of family and non-family firms, while for the second goal the analysis is focused only on the group of

family firms. Results show that both the family nature of the business (i.e. family status) and family involvement in management (i.e. level of family member involvement in the firm management) weaken the impact of business partners' collaboration on innovation performance by reducing the marginal benefits of acquiring external knowledge through technological collaboration.

The paper contributes to enhancing the understanding of the difference between family and non-family firms regarding the benefit in terms of technological innovation deriving from collaborations with business partners. In addition, it allows us to analyze more in depth what happens within the family firms themselves, by enriching the empirical quantitative evidence about the family factors that explain why family firms are heterogeneous subjects.

The paper is structured as follow. First, we provide a review of the literature on the above-mentioned topics and we develop the hypotheses; then we describe the methodology; lastly, we discuss the results, conclude and outline the main limitations of the study.

2. Literature review and hypotheses

2.1. *Technological collaboration with external partners and innovation*

Technological collaboration with external partners is a form of strategic alliance where firms can enter voluntarily into a relationship with one another in order to sustain rapid technological change and, more specifically, new product development (Deeds and Rothaermel, 2003). Since the seminal work of Chesbrough (2003), the amount of literature regarding the benefits deriving from technological collaboration with external partners has increased dramatically (Baum et al., 2000; Deeds and Hill, 1996; Rogers, 2004; Shan et al., 1994; Stuart, 2000). Indeed, extant research has shown that these forms of partnerships offer an easier access to complementary assets, useful for commercializing firms' new products (Hagedoorn, 1993; Teece, 1986). They imply the access to resources and skills that reside outside the firm (Camisón and Forés, 2010); they encourage the transfer of tacit knowledge (Ahuja, 2000; Doz and Hamel, 1997; Eisenhardt and Schoonhoven, 1996; Lambe and Spekman, 1997); they reduce R&D costs (Hagedoorn, 2002); they generate higher revenues (Faems et al., 2005) and so on. In short, it seems that these forms of open innovation strategies greatly improve and sustain innovation performance, that in turn leads firms to achieve a competitive advantage over their competitors.

In this regard, prior studies have emphasized the importance of collaborations with different types of partners as they provide diverse sources

of knowledge with different possible benefits on innovation results. For example, Nieto and Santamaria (2007) investigate both the type of partner selected (e.g. suppliers, customers, competitors, etc.) and the diversity of the network (e.g. firms that collaborate with more than one type of partner). Their results show that in general technological collaboration with external partners has a positive impact on innovation performance and that the effect is even stronger when the network diversity is greater, since a higher richness of knowledge contribution may be achieved.

Although the partner-type diversity is recognized as a crucial factor in enhancing innovation performance, the need to study the contributions provided by specific types of partners still remains a relevant focus for scholars' attention. For instance, Du et al. (2014) distinguish between business (e.g. customers and suppliers) and scientific partners (e.g. universities and research centers) in the strong belief that their peculiarities also require different approaches to managing the collaboration in order to achieve satisfactory innovation results. Scientific partners are in general considered more problematic than business partners for the successful working of the collaboration because of cultural issues and distance from business logic (Pertuzè et al., 2010; Lazzarotti et al., 2016). However, where family firms are involved, the greater "closeness" with the business partners may become critical. Indeed, some authors (Brinkerink et al., 2017; Feranita et al., 2017) suggest that a collaborative relationship with them generates a great concern since they may cause fear of SEW loss. At the same time, it is however undeniable that business partners may play a significant role in enhancing innovation performance in family firms as they may complement the lack of internal family resources, (Bayona-Sáez et al., 2002).

Thus, as business partners seem to be both critical for the collaboration management and crucial for innovation performance, in the following we focus our attention on them. First, we analyze the main contributions regarding technological collaboration with business partners and its effect on innovation performance, to move them to ground this form of partnership in the peculiar setting of the family firms.

2.2. Technological collaboration with business partners and innovation

Technological collaboration with business partners entails the involvement in the innovation process of customers, suppliers, external consultants and also competitors. This set of players is defined as business partners because their close link to the market is crucial for the firms' innovation performance (Du et al., 2014). For example, collaboration with customers is aimed at searching for new ideas as they provide firms with valuable information on market needs (von Hippel, 1988). In contrast, collaboration with suppliers helps the firm in identifying technical problems

in the innovation process in order to improve the quality of the product (Hagedoorn, 1993). In addition, competitors may be selected as partners in a technological collaboration because of synergy effects (Das and Teng, 2000) and sharing of R&D costs.

To sum up, these collaborations enrich the firm with a pool of new and external knowledge that may improve innovation and at the same time increasing its performance as well. However, there are also some disadvantages to be considered. Although the business partners are similar to the focal firm as they belong to the same competitive context and they have the same business culture (Lazzarotti et al., 2016), the risks of asymmetric information and consequent potential opportunistic behavior remain (Jensen and Meckling, 1976). As a result, transaction costs (Williamson, 1998; Chen and Yuan, 2007) may increase and with them also the need to coordinate, to manage and to monitor the behavior of the different actors involved in the technological collaboration.

Prior research has empirically studied the relationship between technological collaboration with business partners and innovation performance for manufacturing firms in general (Faems et al., 2005; Lasagni, 2012; Bianchi et al., 2016), revealing in most cases a positive relationship (Lettl et al., 2006; Song and Di Benedetto, 2008). On the other hand, when the focal firms involved in such collaborations are family-type, the evidence is still scarce. The urgent call to enrich this line of research (e.g. Feranita et al., 2017) encourages us to study more in detail the peculiar setting that involves family firms.

2.3. Family firms, technological collaboration with business partners and innovation

Scholars recognize the fact that family firms represent a peculiar organizational setting where preferences, values and goals differ from those of non-family firms as well as from other family firms, leading them to be highly heterogeneous (Chua et al., 2012; Chrisman et al., 2013). It is thus expected that this set of preferences, values and goals in family firms, compared to non-family ones, affect strategic decision-making as well as their decision to enter into a collaboration or to involve a particular type of partner for fostering innovation. For example, Gomez-Mejia et al. (2007) show that family businesses hesitate to join a cooperative since it threatens and/or it restrains the family control over their own business although this choice might lead to lower financial performance. In a similar way, Cassia et al. (2012) suggest that family firms are more "inward-looking" than non-family firms, thus involving business partners at a lower extent when the discretion and the know-how/secrets of the family are at risk.

Previous research also provides the opposite evidence by showing a more open attitude of family firms to collaborate with respect to non-fa-

mily firms (Llach and Nordqvist, 2010; Pittino et al., 2013). It emerges that family firms consider factors such as trust and the existence of long-term relations with the possible partners to be of crucial relevance in setting-up a partnership. Indeed, family firms, unlike non-family ones, may decide to involve those customers and/or suppliers with whom they share similar goals and values and whose relationship is nurtured across generations (Roessl, 2005; Arregle et al., 2007; Pittino et al., 2013). Therefore, family firms' ability to develop external social capital (Sirmon and Hitt, 2003) is determinant for encouraging alliances and partnerships (Llach and Nordqvist, 2010; Lazzarotti and Pellegrini, 2015).

However, this does not mean that once the family firms have entered into a collaboration with a business partner the relationship is free from drawbacks. There is also a dark side. Business partners, who share similar economic goals and values with the family firms, may entail a great risk of spillovers. In addition, they may threaten the family firm's desire to exert control over the innovation projects. Furthermore, transaction costs may increase because of the control mechanisms necessarily adopted for avoiding opportunistic behaviors. In other words, although factors such as a long-term trusting relationship and sharing of values and goals may favor the collaboration set-up, the managing of the collaboration itself remains complicated (De Massis et al, 2015). Shedding light on the family factors that influence the working of the collaboration is the scope of this paper, thus hypotheses are coherently developed.

2.4. Hypotheses development

To investigate the relationship between technological collaboration and innovation performance, by considering the family factors that may affect it, we develop two hypotheses. The first concerns a comparison between family and non-family firms in order to test whether the relationship between technological collaboration with business partners and innovation performance is influenced by the fact that the focal firm is family-type. This is defined as family firm "status". The second is grounded in the group of family-firms only, in order to test whether a specific family factor, i.e. the level/degree of family involvement in the management, plays a further role in shaping the relationship mentioned above.

2.4.1 The family firm status

An important characteristic differentiating family from non-family firms is the presence of family members in the ownership. Indeed, this feature provides an interaction between two systems, the family and the business, that leads to the creation of peculiar characteristics in family firms in

turn affecting firms' performance. With regard to innovation behavior, an extant strand of the literature has already investigated whether the family nature of the ownership impacts on the innovation input (Block et al., 2012; Kotlar et al., 2013) or on innovation output/performance in general, with positive and negative evidence (Rod, 2016).

When, instead, the innovation performance specifically derives from technological collaboration with business partners, studies on the impact of family-type ownership are still very scant. What we may suppose by relying on previous works (e.g. Niemela, 2004; Kotlar et al., 2013; De Massis et al., 2015) is only that the critical nature of SEW preservation, determined by a family-type ownership, continues to exert its influence in a collaboration setting. Indeed, partners of a technological collaboration gain and lose power through continuous processes of bargaining, negotiation and compromise (Niemela, 2004), which in turn leads to restriction of the family firms' control over the product innovation project thus generating fear of SEW loss also in the management phase of collaboration. As a consequence, the context in which the collaboration is carried out is likely to become very challenging, complex and potentially conflictual; thus, a negative impact on the result of the collaboration itself, i.e. the innovation performance, can be expectable too.

Based on these arguments we posit that:

H1: The family firm status moderates the relationship between technological collaboration with business partners and innovation performance, in such a way that this relationship is weakened.

2.4.2 Level of family involvement in the management

Despite the fact that studies on family involvement in the management (hereinafter: family management) are quite common, results on whether and how family management affects innovation performance are still controversial (Matzler et al., 2015). To explain the relationship between family management and innovation performance, scholars basically rely on two important theories, i.e. agency theory and behavioral theory. Agency theory (Jensen and Meckling, 1976), which identifies the asymmetric information between owners and managers as the cause of agency costs and of potential opportunistic behaviors, suggests that the level of family involvement in the management decreases the agency costs, having in turn a positive impact on firm's innovation performance (Matzler et al., 2015). Indeed, family members who own the family business and at the same time also occupy managerial positions facilitate the alignment of goals between managers and owners, by improving communication and decision-making speed through close family bonds (Gersick, 1977).

However, agency theory ignores a relevant part of the complexity of family firms' dynamics. To compensate this lack, some scholars (e.g. Schulze et al., 2001, 2003) have contributed to the development of the behavioral theory that complements the agency perspective by also emphasizing some negative aspects of the family involvement. For example, a higher level of family involvement in the management, measured for instance through the number of family members participating in the firm's boards, may reflect a higher goal-diversity among family members that in turn may make the decision-making process more complex, also regarding innovation choices (Kotlar and De Massis, 2013). Furthermore, arguments related to non-economic goals of family members, such as fear of SEW loss, e.g. control preservation, identity, perpetuation of family dynasty through future generations, may lead family firms to be more prone to appoint family members to strategic and managerial roles, instead of selecting external managers. This may likely in turn reduce the expertise and the competencies necessary to achieve technological innovation (Classen et al., 2012; Lazzarotti and Pellegrini, 2015; Filser et al., 2018).

To sum up, high levels of family management can be carriers of a negative impact on innovation performance and it is reasonable to suppose that this also occurs in a collaboration context. While on one hand technological collaboration with business partners may compensate the lack of resources in family firms and is beneficial for innovation performance, on the other, a higher involvement of family members in the management may be detrimental. Indeed, it may increase the potential goal-diversity and thus the complexity of the collaboration management and/or the lack of competencies required.

Based on these arguments, it is possible to suppose that higher levels of family management reduce the effect of business partners' technological collaboration on innovation performance.

We thus suppose that:

H2: The level of family management moderates the relationship between technological collaboration with business-partners and innovation performance, in such a way that this relationship is weakened.

Figure 1 summarizes the above-mentioned arguments: technological collaboration with business partners acts as a driver of innovation performance while the family firm status and the level of family management act as negative moderators in the relationship between collaboration and innovation performance. In the following sections, we describe data and methodology applied to test the hypothesized relationships.

Fig. 1: Research framework
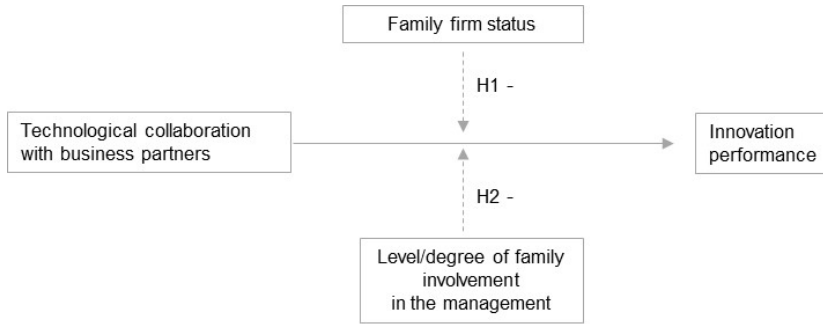
3. Data and methodology

3.1 Sample and data

We tested our hypothesis by using data from the annual Spanish Business Strategies Survey (SBSS), i.e. a longitudinal database of Spanish manufacturing firms that contains data from 1990 up to 2016. The survey is carried out yearly by SEPI, Foundation, which is financed by the Spanish Ministry of Industry. It is designed to gather data from a representative sample, by industry and by size, on different topics such as internationalization, innovation, market, performance, technological collaborations and so on. Moreover, this database also distinguishes family firms from non-family ones and it has been used by a wide number of scholars for academic research in the field of innovation and family business (Fernandez and Nieto, 2005; Kotlar et al., 2013; Nieto et al., 2015; Bianchi et al., 2016; Dieguez-Soto et al., 2016). Indeed, in line with previous studies, the main reasons that suggest the use of this database are: i) the database is public and thus easily accessible by many scholars; ii) it provides a large sample of firms with a wide set of data on different family-business features; iii) the longitudinal nature of this database allows the collection of the same type of information over many years.

All these features ensure the reliability and the replicability of the study. Furthermore, as the survey is designed to gather data from manufacturing firms, it represents an appropriate setting for studying technological collaboration with business partners in which product innovation typically includes elements developed by other players (Almirall and Casadesus-Masanell, 2010; Kotlar et al., 2013).

The data for this study were collected in February 2018 and they cover the period from 2008 to 2014. Throughout these seven years of observations firms may enter and exit the survey, thus the nature of our panel data

is quite unbalanced and also characterised by missing values. Our initial sample includes on average 1,750 Spanish private firms and around 12,000 observations from 2008 to 2014, while the subsample of family firms includes on average 752 firms and around 3,500 observations over the period 2008-2014. Table 1 presents industry and some sample descriptive statistics both for the full sample and for the subsample of the family firms.

4. Dependent variable

The dependent variable is related to the innovation output, namely innovation performance, of the firm i in a specific period t. Scholars have used different measures of innovation performance such as the number of patents or the percentage of sales derived by new products. In this paper we measure the innovation performance by the number of new innovative products developed and commercialized by the firm i at time t (Bianchi et al., 2016). Indeed, the number of new and innovative products developed by the firm represents the ability to introduce new products on the market (radical innovation) and also to improve the existing products (incremental innovation) and as such is an important indicator of innovation performance (Schoonhoven et al., 1990). The nature of this variable is that of "count data" with a minimum value of 0 and the maximum value of 299 product innovations over the period 2008 to 2014.

Tab. 1: Sample descriptive analysis

| Industry	Percentage of firms	Avg. employees	Avg. number of product innovation	Percentage of firms	Avg. employees	Avg. number of product innovation
	Full sample (1,750 average n. of firms from 2008-2014)			Family-managed firms (752 average n. of firms from 2008-2014)		
1. Meat products	3.83%	302	0.88	4.44%	338	1.35
2. Food and tobacco	12.11%	158	0.63	14.36%	131	0.40
3. Beverage	2.33%	126	0.61	3.25%	107	0.84
4. Textiles and clothing	6.62%	81	0.52	7.69%	96	0.82
5. Leather, fur and footwear	2.86%	43	0.66	2.74%	40	0.81
6. Timber	3.16%	40	0.07	2.56%	33	0.07
7. Paper	4.36%	138	1.27	4.27%	83	1.56
8. Printing	3.68%	65	0,12	2.91%	27	0.06
9. Chemicals and pharmaceuticals	7.29%	236	1.44	5.81%	203	0.94
10.Plastic and rubber products	5.26%	236	0.69	5.47%	56	0.56
11. Nonmetal mineral products	6.84%	133	0.59	8.03%	132	0.98
12. Basic metal products	3.38%	437	0.23	2.22%	295	-
13. Fabricated metal products	12.56%	94	0.11	13.68%	78	0.16
14. Machinery and equipment	5.86%	148	1.13	5.64%	128	0.94
15. Computer products, electronics etc.	1.58%	751	1.52	0.68%	185	-
16. Electric materials and accessories	3.83%	267	3.12	2.91%	114	0.50
17.Vehicles and accessories	5.26%	750	0.24	4.10%	514	0.08
18. Other transport equipment	2.18%	709	0.29	1.37%	196	0.75
19. Furniture	4.14%	72	0.42	4.27%	109	0.40
20. Other manufacturing	2.86%	52	0.97	3.59%	39	0.43

5. Independent variables

Regarding the family nature of the business we identified two independent variables, the first refers to the family firm status (Classen et al., 2012; Brinkerink, 2018; Brinkerink and Bammens, 2018) as it investigates differences between family and non-family firms; the second refers to the level of family management in order to explore differences within the group of family firms. Starting from the first independent variable, that is the family firm status, the SBSS survey adopts a dichotomous variable to distinguish between family and non-family firms. In this regard, respondents have to indicate if the firm "belongs to a family group" (i.e. yes if it belongs to a family group, and no if it does not belong to a family group) without specifying the percentage of the family ownership. Despite this limitation of the data, it can be inferred that the term "belongs to" entails possession and respondents who indicate they belong to a family group perceive themselves as a family firm. Hence, in order to define the family firm status, in this study we adopt a less stringent definition of family firm by including only the perception criteria and neglecting a precise ownership-percentage criterion (Brinkerink, 2018). This dichotomous variable takes value equal to 1 if a family group is actively involved in the control or management of the firm and 0 otherwise.

Referring to the family management variable, the existing literature suggests that it reflects family goals, values and vision that influence strategic decision-making (Chua et al., 1999), such as innovation. However, the SBSS survey does not include a direct measure that represents the family firm goals, vision and values. It reports only the number of owner and owners' relatives who hold a managerial position. Therefore, according to

previous studies and taking into account that family involvement in the firm is highly related to the family goals, vision and values (Chrisman et al., 2013) our measure of family management follows that of Kotlar et al. (2013). Thus, we measure the level/degree of family involvement in the management by considering the number of owner and owner's relatives who occupy managerial positions within the family firm (Kotlar et al., 2013). Figure 2 describes the identification process of the two independent variables, representative of the family firms' factors.

Fig. 2: Identification process of independent variables regarding family firms
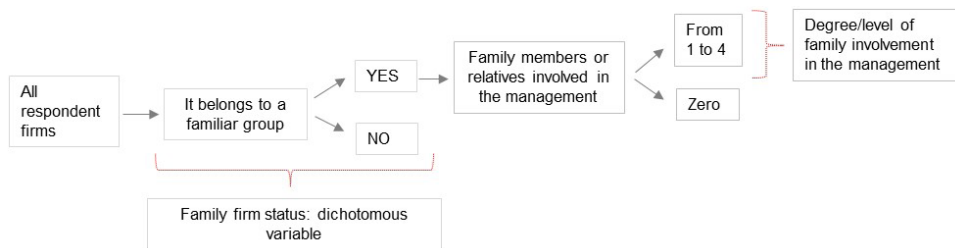
An additional independent variable is the technological collaboration with business partners. Indeed, firms that aim to be successful over time in such competitive and dynamic markets have to rely on a more open approach, such as collaboration with business partners, in order to foster innovation and thus to gain competitive advantage. Hence, we construct a dichotomous variable that measures the heterogeneous nature of the collaborative network (Nieto and Santamaria, 2007). It takes value of 1 if the firm has worked with at least one partner out of customers, suppliers, competitors and/or external advisors; otherwise it takes value 0.

6. Control variables

In addition to the key variables for testing our hypotheses, we employ a variety of control variables that may influence the innovation performance of the firm. We control for size measured by the number of employees' logarithm (*Size*). Indeed, larger firms are more likely to innovate for two reasons: first, because this process is considered a natural step to growth and, second because larger firms usually accumulate more resources compared to smaller firms and in turn are more able to innovate. Thus, size is one of the most important control variables for the firm technological innovation behavior (Becheikh et al., 2006). We also introduce the variable R&D intensity, measured as the total expenditure on R&D to total sales (*R&D intensity*). Scholars also suggest that firms engaged in export activities have a higher probability to innovate. Thus, we include a variable that

captures firms' *export intensity*, defined as the percentage of exports out of total sales. Moreover, we include an additional variable that is, *market dynamism* to control for specific environmental determinants of the studied market, i.e. the Spanish market. This variable is an aggregate index that indicates the dynamism of all markets covered by the firm *i* in the year *j*. Lastly, scholars suggest that the ownership structure may also represent an important variable that affects innovation performance. Empirical studies also highlighted the relevance of the impact of foreign ownership on innovation. The latter may increase managerial capabilities of the firm and thus play a role in innovation behavior.

To control for this effect the percentage of direct or indirect participation of foreign capital in the social capital of the company was also included (*Foreign ownership*). Years and industry dummy variables were also included.

7. Interaction effect

The contribution of this study is to explore the moderation effect of family firm status and the level of family management on the relationship between technological collaboration with business partners and innovation performance. To assess the moderation effect of family firm status and the level of family management we follow the methodology suggested by Dawson (2014), that is a two-way moderation effect. In other words, we test firstly the main effects of technological collaboration with business partners and the family firm variables, independently, on innovation performance, and then we observe if there exists a moderation effect of the family firm status and the level of family management on the relationship between business partners' technological collaboration and innovation. In order to test moderation two additional variables, i.e. the interaction term, have been calculated as the product of the originating variables that is: 1) *family firm status x business partners' technological collaboration; 2) level of family management x business partners' technological collaboration*. Table 2 presents a summarized description of all variables illustrated above.

8. Data Analysis

A negative binomial estimation model (Greene, 1999) is used. This is suitable given the count data nature of the dependent variable, predicting innovation performance. The average number of product innovations implemented by the firms in our sample equals 1.16. Table 3 presents descriptive statistics and table 4 reports correlations of the variables.

The variance inflation factor was calculated to check for multicollinearity.

According to Neter et al. (1989), individual VIF values greater than ten and average VIF values greater than six reflect multicollinearity problems. In our study values are within these limits so multicollinearity is not an issue.

Tab. 2: Description of variables

Variables	*SBSS* Items	Variable definition	Type of the variable and/or calculation	Abbreviation
Dependent variable: Innovation performance	NIP	Number of product innovations which the company achieved in the financial year.	Count data response format: units	NIP
Independent variable:	Business partner collaborations	Technological collaborations with customers and/or suppliers and/or competitors and/or external consultants	Dichotomous variable that takes value 1 when the firm declares it collaborates at least with one of these partners; 0 otherwise	B-partners
Moderating variable	PAFDG	Number of owners and relatives who hold managing positions in year 20XX	Count data response format: units	Family member involved in the management
	FAMILI	Categorical variable that indicates whether a familiar group is actively involved in the control or management of the firm	Dichotomous variables that take value 1 when the firm declares it is a family firm otherwise 0	Family firm status
Control variable	PERTOT	Number of total employees	ln (employees)	Firm size
	GTID	Total expenses in R&D activities	R&D expenditures/total sales	R&D intensity
	IDMERPN	Aggregate index of dynamism of all the markets covered by the company during the year. The index is obtained adding the products of the variables: Market Weighting and Situation of Dynamism of the Market	Percentage	Mkt dynamism
	PX	State whether the company, either directly or through other companies belonging to the same group, exported goods in 20XX (even to the European Union), and their value.	Exports/total sales	Export intensity
	PCAEXT	Direct or indirect participation of foreign capital in the share capital of the company	Calculated as the percentage of direct or indirect participation of foreign capital in the firm's capital	Foreign ownership

Tab. 3: Means, Standard deviation, Min and Max values of the selected variables

Variables	Mean	Standard Deviation			Min	Max
		Overall	Between	Within		
Number of product innovations	1.1645	8.1727	6.7038	5.3029	0	299
Business-partner collaboration	0.3036	0.4598	0.3956	0.2384	0	1
Family firm status	0.3363	0.4725	0.4401	0.1845	0	1
Level of family management	0.8508	1.0165	0.8997	0.4857	0	4
R&D intensity	0.0055	0.0187	0.0176	0.0095	0	0.58
Market dynamism	33.4528	31.798	23.9187	22.5759	0	100
Export intensity	22.8175	29.1571	27.3507	8.8649	0	100
Foreign ownership	14.2218	34.1712	32.3722	9.9845	0	100
Firm size	201.1701	687.961	645.1547	72.5693	1	13.091

Tab. 4: Correlations

Variables	1	2	3	4	5	6	7	8	9
Number of product innovations	1								
Business-partner collaboration	0.1072	1							
Family firm status	-0.0184	-0.0036	1						
Level of family management	-0.0146	-0.1427	0.2897	1					
R&D intensity	0.0519	0.3115	0.0053	-0.0420	1				
Market dynamism	-0.0010	0.1059	0.0197	0.0069	0.0577	1			
Export intensity	0.0544	0.3095	-0.0558	-0.1575	0.1688	0.1683	1		
Firm size	0.0934	0.4598	-0.1014	-0.2697	0.1561	0.1451	0.4146	1	
Foreign ownership	0.0768	0.2108	-0.2375	-0.3025	0.0286	0.0437	0.3084	0.4362	1
VIF (mean VIF: 1.27)		1.39	1.13	1.20	1.12	1.04	1.29	1.63	1.37

9. Empirical results

Table 5 presents the results of the random effects of the negative binomial regressions testing our H1. Model 1 presents the results of the control variables. Model two adds independent variables. Model 3 includes the interaction term between family management and business partner collaboration. Hypothesis 1 predicts that family firms moderate the relationship between technological collaboration with business partners and innovation in such a way that the relationship will weaken. Starting from the main effect, both independent variables, business partners' technological collaboration and the family firm status show a positive and significant impact on innovation performance, in line with some previous literature in the topic (Lasagni et al. 2012; Diuegez-Soto et al., 2016). The moderation effect, on the other hand, tested by including in the regression model the interaction term between the family firm status and business partners' technological collaboration shows a significant value equal to p<0.1. As

hypothesized the sign of the coefficient of the interaction term is negative, suggesting that family firm status weakens the relationship between business partners' collaboration and innovation performance confirming H1.

Table 6 presents the results of analysis conducted within the group of family firms and tests our H2. Also, in this analysis Model 1, Model 2 and Model 3 introduce respectively control variables, adding the independent variables and finally the moderation effect calculated through the interaction term. Models 4 and 5 introduce our estimations testing for robustness. That is, in these models we introduce another variable that accounts for all family members working in the family business, for example while a family firm may have only one family member on the management, it may also have other two members working in the family business without managerial roles.

Tab. 5: Estimating number of product innovations (negative binomial regression) – family firm status

		Model 1		**Model 2**		**Model 3**	
Variables	B-partners			1.27232	***	1.37626	***
	Std. error			*0.06626*		*0.08369*	
	Family firm status			0.21884	***	0.36598	***
	Std. error			*0.06427*		*0.09584*	
Interaction terms	Family firm status*B-partners					-0.23658	**
	Std. error					*0.11450*	
Control variables	N. of employees	0.42127	***	0.28979	***	0.28991	***
	Std. error	*0.02913*		*0.02936*		*0.02943*	
	R&D intensity	9.84619	***	6.47625	***	6.50412	***
	Std. error	*1.11525*		*1.03267*		*1.02985*	
	Exp intensity	0.00358	***	0.00306	**	0.00305	**
	Std. error	*0.00120*		*0.00119*		*0.00119*	
	Foreign ownership	-0.00388	***	-0.00204	**	-0.00203	**
	Std. error	*0.00093*		*0.00095*		*0.00095*	
	Mkt dynamism	0.00067		-0.00001		0.00005	
	Std. error	*0.00079*		*0.00078*		*0.00078*	
	Constant	-2.854248	***	-2.85171	***	-2.91148	***
	Std. error	*0,22792*		*0.22678*		*0.22958*	
	Year dummy	YES		YES		YES	
	Industry dummy	YES		YES		YES	
	N. of observations	12,105		12,105		12,105	
	N. of firms	2,420		2,420		2,420	
	Log likelihood	-8804.308		-8597.1224		-8594.990	
	*** p<0.01, ** p<0.05, * p<0.1						

The independent variables referring to the business partners' technological collaboration and to the level of family management show that the direct effect is positive and significant implying that innovation outcome will benefit from a business partner's technological collaboration and will benefit also from a higher number of family members involved in the management.

Focusing in detail on the moderation effect of the level of family management, H2 predicts that a higher level/degree of family involvement in the management negatively moderates the relationship between technological collaboration with business partners and innovation performance. As the number of family members involved in the management increases, its interaction with business partners' collaboration decreases the likelihood of having a greater number of innovative products.

Hence H2 is confirmed. In terms of control variables in both Table 5 and Table 6 results show a positive and significant coefficient, except for the variable market dynamism.

Furthermore, for a better explanation of the moderating effect of family management, in Figure 3 we represent graphically the marginal effect of business partners' technological collaboration on innovation performance depending on the level/degree of family management. Figure 3 shows that innovation output/performance benefits more from technological collaboration with business partners rather than no collaborations at all.

However, the slope of the red line, representing the cases of 4 family members actively involved in the management when collaboration with business partners is in place, is shallower than that of the black line, representing the case where only 1 family member is involved in the management. This evidence supports our H2 since it shows that the higher family involvement is, the lower is the likelihood of achieving new innovative products through collaborations with business partners.

		Number of family owners and relatives holding managing positions as moderator					Robustness check: Number of all family members and relatives working in the family business			
		Model 1		Model 2		Model 3		Model 4		Model 5	
Variables	B-partners			1.10808	***	1.89548	***	1.15664	***	1.31261	***
	Std. error			0.13338		0.26654		0.10239		0.14000	
	Level of family management			0.12386	*	0.36409	***	0.20464	***	0.09375	***
	Std. error			0.06790		0.09568		0.05979		0.05253	
Interaction terms	Level of family manag. *B-partners					-0.39963	***			-1.10089	*
	Std. error					0,11545				0,06062	
Control variables	Firm size	0.50063	***	0.35857	***	0.35082	***	0.33600	***	0.33724	***
	Std. error	0.05083		0.07674		0.07640		0.05049		0,05063	
	R&D intensity	5.97503	***	2.83850	*	2.83818	*	4.24727	***	4.33771	***
	Std. error	1.46917		1.45968		1.47852		1.38269		1.39003	
	Export intensity	0.00532	**	0.00553	**	0.00504	*	0.00425	**	0.00429	**
	Std. error	0.00192		0.00266		0.00267		0.00186		0.00186	
	Foreign ownership	-0.00486	**	-0.01214	*	-0.01121	*	-0.00426	**	-0.00442	**
	Std. error	0.00218		0.00645		0.00646		0.00213		0.00213	
	Market dynamism	-0.00053		-0.00128		-0.00133		-0.00138		-0.00140	
	Std. error	0.00119		0.00159		0.00157		0.00118		0.00118	
	Constant	-2.59482	***	-2.43997	***	-2.83305	***	-2.47336	***	-2.59733	***
	Std. error	0.37026		0.41940		0.43667		0.35589		0.36493	
	Year dummy	YES		YES		YES		YES		YES	
	Industry dummy	YES		YES		YES		YES		YES	
	N. of observations	3,515		3,515		3,515		3,515		3,515	
	N. of firms	934		934		934		934		934	
	Log likelihood	-3783.151		-2285.234		-2279.276		-3717.505		-3716.120	

*** p<0.01, ** p<0.05, * p<0.1

Fig. 3: Effects of level of family management on the business partners collaboration-IP relationship
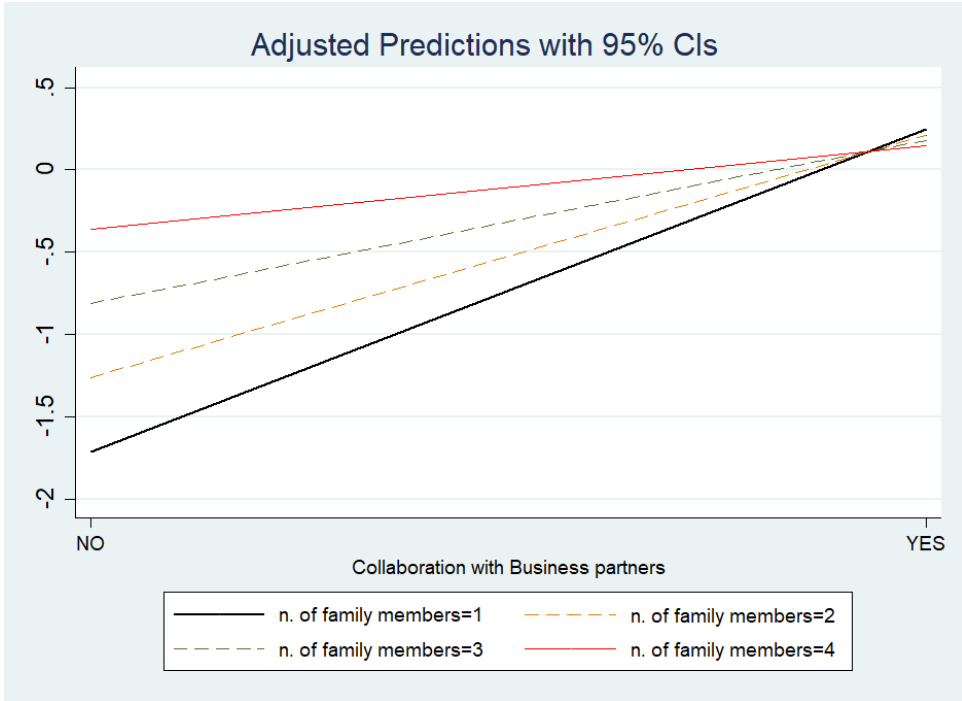
10. Discussion

Our results provide two types of evidence: the first regards the moderating effect of the family firm status on the relationship between technological collaboration with business partners and innovation performance; the second, examines whether the number of family members involved in the management moderates the relationship. In doing so, the study first compares family and non-family firms and then, by focusing on the group of family firms, explores their heterogeneity deriving from the number of family members involved in the management.

Similar to some previous works, our findings confirm the positive main direct effect of the independent variables (i.e. technological collaboration with business partners, family firm status and the level/degree of family management) on innovation (Nieto and Santamaria, 2007; Lasagni, 2012; Du et al., 2014; Maztler et al., 2015; Dieguez-Soto et al., 2016). Focusing instead on the family firm status and on the level of family management as moderator variables, results show a negative effect exerted on the link between technological collaboration with business partners and innovation

performance (H1 and H2, confirmed). These findings lead to some interesting suggestions. Referring to the first hypothesis, it seems that the likelihood of achieving new product innovation increases by depending on the main effect of the business partners collaboration and the family firm status independently. In particular, family firms seem to show a better innovation performance in comparison to non-family firms as the main effect of the family firm status on the dependent variable is positive. However, the interplay between collaboration and family status is negative: the family firm status weakens the effect of business partners' technological collaboration on innovation performance. In other words, it seems that family firms benefit less from technological collaborations with respect to non-family firms. It is likely that the family status exacerbates the criticality of SEW preservation in the collaboration context, in which by definition family firms lose full control over the product innovation project and technology trajectory (Kotlar et al., 2013). As a final consequence, a negative impact on the result of the collaboration itself (i.e. the innovation performance) occurs.

Concerning the second hypothesis, our evidence suggests a negative moderating role exerted by the level of family management. In other words, while technological collaboration with business partners seems to be beneficial for innovation performance in family firms, a higher involvement of family members in the management emerges as detrimental. A possible explanation resides in the higher complexity of the relationship caused by the goal-diversity which increases when the number of family members involved in the management grows (Kotlar and De Massis, 2013). This can easily occur in situations where family branches increase (Miller and Le Breton-Miller 2011; Le Breton-Miller and Miller 2013; Sciascia et al. 2014) and their involvement in the firms reflects individual goals and resources, which may also affect innovation choices and outcomes. A second possible explanation is related to the expertise and competencies required to satisfactorily pursue technological innovation. Indeed, a higher level of family members' involvement may impoverish the knowledge wealth of the family firm, if they are not selected on competence-based criteria, with negative consequences also in terms of innovation performance deriving from collaboration (Classen et al., 2012; Lazzarotti and Pellegrini, 2015; Filser et al., 2018).

11. Theoretical and managerial implications

Our findings have theoretical and practical implications. From a theoretical point of view our study contributes to the ongoing discussion about the possible influence of family factors on innovation performance. In particular, we enrich the current literature by investigating the inter-

play between technological collaboration with business partners and two specific aspects of family firms (i.e. the family firm status and the level of family management) and we provide evidence on whether the interaction between these predictors affects innovation performance. To the best of our knowledge, this is the first research that analyzes such a moderating role. Indeed, despite the fact that previous literature recognizes the strategic importance for family firms of collaborating with external partners (Classen et al., 2012), the study of the results obtainable from collaborations due to specific family factors has been overlooked.

More in general, our findings can be positioned with respect to other studies (e.g. Serrano-Bedia et al., 2016), which already analyzed the moderating effect of family factors on the relation between external sources of knowledge and innovation performance. In particular, while Serrano-Bedia et al. (2016) studied the moderating effect of family factors only in contractual collaborations, our work enriches this stream of research by exploring data concerning also informal relationships with business partners, considered more complex by many scholars (Du et al., 2014; De Massis et al., 2015; Serrano-Bedia et al., 2016).

From a managerial point of view, practitioners should encourage family firms' CEOs (Chief Executive Officers) to better understand the goals, both economic and non-economic ones, and the attitudes of each family member involved in the management to avoid conflicting situations, which makes the management of collaborative innovation projects complex, with negative consequences in terms of innovation results. This need is even more important for the oldest family businesses, characterized by many family branches involved both in the ownership and in the management of the firm. Family owners and family members who manage the firm should be increasingly aware of those family factors, such as values, goals and long-term trusting relationships with a diverse set of players, which are crucial to foster innovation, thus in turn sustaining the firm's competitive advantage. At the same time, this awareness should encourage family members to avoid those behaviors that are too conflicting and to promote an alignment of their goals so as to benefit from collaboration with business partners, as this may lead to higher innovation performance.

Finally, policy makers and industrial associations should stimulate family firms to set up technological collaboration with business partners and more in general with other types of external partners, by means, for instance, of dissemination conferences, which emphasize the relevance of collaboration to enhance innovation, and/or contractual frameworks and tax incentives which facilitate the creation of a collaborative context.

12. Limitations, conclusion and agenda for further research

Our work suffers from several limitations.

First, the sample relies only on Spanish manufacturing firms. Taking a cross-country perspective, further insights may emerge.

Second, the study relies on secondary data sources and thus it may be affected by data-availability constraints. Hence it has not been possible to employ a precise measure of the family firms status in order to include both ownership and perception criteria as in previous studies (Classen et al., 2012; Brinkerink, 2018; Brinkerink and Bammens, 2018) as well as a more precise measure of the level of family management (e.g. the percentage of family members in the top management team with respect to the total number of managers), which could allow us to grasp the studied moderating role more in detail. Lastly, as explained in the result section, the unbalanced nature of our sample and the missing values evidenced by the survey have prevented the significance of further analysis splitting the business partners construct in single partner-type (e.g. technological collaboration only with customers, only with suppliers and so on) collaboration. Thus, it has not been possible to investigate more thoroughly the effect of the family factors on the relationship between specific collaboration-types and innovation performance.

Furthermore, it would also be interesting to learn more about the moderating effects of other family firm variables, such as the family education level or family members' tenure within the family business, on the relationship between technological collaboration with business partners and innovation performance.

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