UNIVERSITÀ DELLA CALABRIA | DIPARTIMENTO DI ECONOMIA, STATISTICA E FINANZA "GIOVANNI ANANIA"

Working Paper Series

WP n° 2, febbraio 2020

DOES EXTERNAL R&D MATTER FOR FAMILY FIRM INNOVATION? EVIDENCE FROM THE ITALIAN MANUFACTURING INDUSTRY

Francesco Aiello

University of Calabria, Department of Economics, Statistics and Finance "Giovanni Anania" – DESF
(e-mail: francesco.aiello@unical.it)

Paola Cardamone

University of Calabria, Department of Economics, Statistics and Finance "Giovanni Anania" – DESF
(e-mail: paola.cardamone@unical.it)

Lidia Mannarino

University of Calabria, Department of Economics, Statistics and Finance "Giovanni Anania" – DESF
(e-mail: lidia.mannarino@unical.it)

Valeria Pupo

University of Calabria, Department of Economics, Statistics and Finance "Giovanni Anania" – DESF
(e-mail: valeria.pupo@unical.it)

This working paper has been published in *Small Business Economics*.

Please cite as follows:

Aiello F., Cardamone P., Mannarino L., Pupo V., 2021, "Does external R&D matter for family firm innovation? Evidence from the Italian manufacturing industry", Small Business Economics, 57, 1915–1930.

Info
Via Pietro Bucci, Cubo **0/C**
87036 Rende (Cs) - Italia
tel. (+39) 0984 492434 / 492422

http://www.unical.it/desf

Does external R&D matter for family firm innovation? Evidence from the Italian manufacturing industry.

Francesco Aiello, Paola Cardamone, Lidia Mannarino and Valeria Pupo
francesco.aiello@unical.it; paola.cardamone@unical.it;
lidia.mannarino@unical.it; valeria.pupo@unical.it

Department of Economics, Statistics and Finance "Giovanni Anania"
University of Calabria
Arcavacata di Rende (Cosenza) – Italy

Abstract
This article focuses on the relationship between external research and development (R&D) and firm innovation output. Using a sample of Italian manufacturing firms in the period of 2007-2009, the role played by external R&D is evaluated, investigating differences between family and non-family firms. Results show that the R&D acquired from external sources has a positive impact, especially on family firms, suggesting that family companies have a greater capacity to translate external R&D into tangible economic benefits. This result is consistent with those obtained when we consider the combination of internal and external R&D, as well as the family involvement in governance and management.

JEL codes: O32, G34, C24
Keywords: Family firms, R&D investment, Innovative sales, Italian manufacturing industry

1. INTRODUCTION

The importance of the cooperation between firms and external partners is unquestionable. This holds particularly true when the scope is to boost the innovation potential. Indeed, collaborative innovation is a source of competitive advantage, since it enables firms to externally find financial, material and human resources that complement internal resources, permitting the sharing of the risk associated with innovative activities and tapping into (having access to) the knowledge from other organizations (Cassiman and Veugelers, 2002).

Theoretical arguments suggest that family firms (FF) have different characteristics compared to their non-family counterparts. Indeed, strategic choices in FFs tend to reflect both the family's desire to accomplish family-centred, noneconomic goals and economic utilities (Berrone et al., 2012; Gomez Mejia et al., 2007; Zellweger et al., 2019). As a result, their ability to manage and

their willingness to engage in collaborative innovation potentially differs from non-FFs (Bigliardi and Galati, 2017).

However, although many studies investigate the impact of the use of external knowledge sources on a firm's innovative performance (for a review, see Vivas and Barge-Gil, 2015), the existing research on collaborative innovation in FF is still in its infancy (Alberti et al., 2014; Bigliardi and Galati, 2017; Classen et al., 2012; De Massis et al., 2013; Feranita et al., 2017). This probably depends on two factors. On the one hand, mainstream innovation researchers have largely overlooked family variables in their studies (Calabrò et al., 2018). On the other, the family business literature also devotes rather limited attention to the analysis of innovation processes. Indeed, family firm innovation literature is relatively recent, and only in the last decade have FF scholars investigated the extent to which family involvement enables or hampers innovation (for a review, see Calabrò et al., 2018; De Massis et al., 2013; Röd, 2016).

Differently from previous studies, this paper builds a bridge between the two strands of literature by comparing the role of collaborative innovation in family and non-family firms. Specifically, it uses a sample of about 3,000 Italian firms to analyse whether the effect of R&D acquired from abroad (universities, research centres and other companies) on innovation performance is different between family and non-family firms. The variable used to measure the innovation output is the proportion of innovative sales with respect to total sales.

In this way, this study accepts and addresses the call for additional investigations into the innovation dynamics in family firms (Calabrò et al., 2018; Duran et al., 2016) by contributing to filling the gap in the literature on collaborative innovation in family firms, noted by Feranita et al. (2017). This constitutes a valuable contribution, because no analysis has yet been carried out in this field.

The main result of our econometric analysis is that the R&D acquired from external sources has a positive impact, especially on FFs. This result is confirmed when we consider the degree of family participation in the supervisory and management boards, as well as the influence of the combination of internal and external R&D.

The paper is organized as follows. Section 2 present a literature review on the collaborative innovation in family firms and on the impact of external cooperation on firm performance. Data, variables and econometric model are described in Section 3, while the results are presented and discussed in Section 4. Section 5 concludes.

2. Literature Review and Hypothesis

Theoretical and empirical research on innovation in FFs has grown in recent years in response to the significant gap in the prevailing theories and frameworks regarding the effect of different corporate governance systems on innovation (Urbinati et al., 2017). To fill this gap, many scholars have aimed to analyse the differences between the innovation processes of family versus non-family firms, with the result that this topic has become an important area of research in economics and in the literature on family business innovation. The revived interest has translated into a number of papers explaining why family and non-family firms differ in terms of innovation (recent reviews are Carney et al., 2015; Duran et al., 2016; Urbinati et al., 2017).

From this literature, one learns that family business research has neglected to analyse how external R&D investment influences family firms' innovation. Therefore, the current understanding of the collaborative innovation in FFs is very limited (Feranita et al 2017; De Massis et al., 2013). Among many others, the works by Classen et al. (2012) and Alberti et al. (2014) highlight the need to delve more deeply into the understanding of family firms' propensity to engage in collaborative innovation projects, as this research is still considered to be in its embryonic stage.

The theoretical arguments on the role of collaborative innovation present conflicting viewpoints. On the one hand, innovating alone has the advantage of fully appropriating the benefits of the research investment by limiting leakage of information and intellectual property to other firms, as well as of reducing coordination difficulties and maintaining greater control over innovation activities. On the other hand, a fertile innovation environment requires a constant inflow of knowledge from other places (Fey and Birkinshaw, 2005). Indeed, collaborative innovation leads to time gains and lower innovation costs. It also allows firms to share the risk inherent in the innovation process and combine resources and skills, thereby exploiting complementarities, becoming a source of competitive advantage (Cassiman and Veugelers, 2002).

These view-points have been developed without explicitly considering FFs, thereby overlooking the unique characteristics of FFs and their distinctive advantages and limits in the context of collaborative innovation. Family business literature highlights how these firms have a different behaviour in terms of collaborative innovation when compared to the non-family counterparts (Bigliardi and Galati, 2017) and suggests that their typical characteristics can improve or worsen efficiency in turning collaborative innovation into performance.

On the one hand, it is known that family firms focus on family goals, values and preservation of socio-emotional wealth (Gomez-Mejia et al., 2007), and they are aware that external cooperation limits family autonomy regarding the decision-making processes and may introduce organizational changes. Because they direct their attention to stability rather than renewal, this can result in superficial learning, which might decrease their ability to fully exploit the positive effects of collaboration (Zahra, 2012). Moreover, the lack of merit, expertise or talent in family-managed businesses (Lubatkin et al., 2005) might decrease their ability to improve the innovative performance based on collaborations with external sources (Zahra, 2012; Kraus, 2012).

On the other hand, the abundant social capital of family firms (Arregle et al., 2007; Carney, 2005b; Dyer, 2006) exposes them to greater connections with external stakeholders (Miller and Le-Breton Miller, 2005), which involves significant market knowledge and stronger relationships with clients. These elements allow them to more quickly detect market niches and to adapt new technologies to the needs of clients (Uhlaner et al., 2013). This ensures that innovative collaboration is aimed at obtaining products that adapt to specific customer requirements, making collaborative innovation a commercial success. Furthermore, external collaboration may supply the firm with resources that are not available internally, thereby overcoming resource constraints shaped by their governance structures and size (e.g. Carney, 2005a). Also, it makes it possible mitigate the low propensity to use investment capital to fund innovation projects (Block et al., 2013) in order to avoid the loss of control (e.g. Gómez-Mejía et al., 2007). Taken together, this may positively influence the relationship between innovative collaboration and performance.

From the empirical point of view, the aspects that have been examined so far focus on how collaborations with external organizations lead to access to resources such as capital, information, knowledge and technology (Feranita et al., 2017). In particular, some papers investigate the differences in the diversity of innovation partners between family and non-family firms (Classen et al., 2012; Alberti et al., 2014), whereas others explore FF peculiarities in the pursuit of collaborative technology strategies (Pittino et al., 2013). Classen et al. (2012) – examining how family involvement in business influences the depth and breadth of the search for external resources, leading to innovation in Belgian and Dutch family and non-family owned Small and Medium Enterprises (SMEs) – find that FF have a lower search breadth in comparison to their non-family counterparts. Alberti et al. (2014) confirm these outcomes for a sample of Italian SMEs competing in mid-high tech industries. Pittino et al. (2013) use a sample of SMEs located in the northeast of Italy and find that FFs, compared with non-family firms, rely on external collaboration

when more discontinuous technological changes are needed (exploration activities), while the technology-sourcing strategy tends to shift towards exploitation goals. Nieto et al. (2015) show that Spanish family companies are less inclined to turn to external sources of innovation than non-family firms. Others have examined the behavioural barriers that prevent FFs from acquiring external technology (Konig et al., 2013; Kotlar et al., 2013). Block et al. (2013) have studied the role of FFs in promoting knowledge spillovers within a region, where the propensity of FFs to collaborate with other firms has contributed to the regional innovation output by boosting successful patent applications. Manzaneque et al. (2018) analyse the influence of family management on the relationship between the external networks and technological innovation for Spanish manufacturing firms. Finally, Dieguez-Soto et al. (2019) and Muñoz-Bullón et al. (2019) have analysed the effects of combining internal and external R&D on Spanish firm performance. Muñoz-Bullón et al. (2019) show that family firms are more likely to record better innovation performance than non-family firms, while Dieguez-Soto et al. (2019) find opposing results.

Although there is a rich body of literature on this topic, research on collaborative innovation in family businesses has not fully investigated what effect family ownership has on the relationship between collaborative innovation and company performance. More specifically, to the best of our knowledge, no study deals with the impact of technological collaboration on FF performance, with the only exception being the work of Serrano-Bedia et al. (2016), which analyses the impact of different knowledge sources on the innovation performance of Spanish FFs.

Our research aims to contribute to this topic, delving more deeply into the understanding of the influence of family on the effect of external R&D on firms' performance and exploring potential differences between family and non-family firms.

In a nutshell, the primary research question is: do family firms using external knowledge sources achieve better results than non-family firms?

3. Empirical Context

This section provides information on the data, variables and econometric model implemented in the analysis.

The empirical analysis is based on the EU-EFIGE/Bruegel-Unicredit dataset, which contains data from surveys and balance sheets. Data were collected in 2010 and cover the years from 2007 to 2009. The EFIGE survey was conducted on a representative sample of manufacturing firms with more than ten employees in seven European countries (Austria, France, Germany, Hungary, Italy,

Spain and the UK). The firms included in the dataset were selected using a sampling design that stratifies companies by industries (11-NACE classification), regions (NUTS-1 level of aggregation) and size class (10–19; 20–49; 50–250; more than 250 employees). The dataset comprises a significant amount of quantitative and qualitative information, covering the firm's proprietary structure, workforce, investment, innovation, internationalization, finance, market and pricing.[1]

In order to analyse the relationship between collaborative innovation and firm innovation performance, the following model is estimated:

$$INNO\_SALES_i = \beta_0 + \beta_1 FAM_i + \beta_2 D\_RD^{EXT}{}_i + \beta_3 ln(E) + \beta_4 RD^{INT}{}_i + \beta_5 EXPORTER_i + \beta_6 GROUP_i + \beta_7 TURN1_i + \beta_8 TURN2_i + u_i \quad [1]$$

where *INNO_SALES* is the average percentage of turnover from innovative products sales (it is averaged over the three-year period of 2007-2009); *FAM* is a dummy equal to one if the firm is directly or indirectly controlled by an individual or family-owned entity; D_RD^{EXT} is a dummy equal to one if the firm acquired R&D from external sources; RD^{INT} is the percentage of the total turnover that the firm has invested in in-house R&D (average in 2007-2009); *ln(E)* denotes the number of employees in 2008; *EXPORTER* is a dummy for exporter, that is, it is equal to one if the firm is a direct exporter in 2008 or has been actively exporting before 2008; *GROUP* is a dummy equal to one if the firm belongs to a group; *TURN1* is a dummy assuming the value of one when the turnover in 2008 is less than 1 million euro; and *TURN2* is a dummy equal to one if annual turnover in 2008 is more than 1 million euro and less than 10 million euro. In addition, industry fixed-effects are included. This model is also estimated separately for family and non-family firms.

Table 1 reports the main descriptive statistics of the variables used in the model. What emerges is that 74% of the firms in the sample are FFs. The percentage of innovative sales (*INNO_SALES*) is, on average, slightly higher for FFs than non-family firms, while the R&D intensity (RD^{INT}) is higher for the latter; the percentage of firms cooperating with other agents in R&D (D_RD^{EXT}) is, on average, equal for both groups of firms. Moreover, non-family firms are, on average, larger and more likely to belong to a group than FFs.

[1] See Altomonte and Aquilante (2012) for an in-depth description of the dataset.

As regards the estimation method, the model is firstly estimated through the ordinary least squares (OLS) method. Then, since the dependent variable ranges between 0 and 100, *INNO_SALES* is censored from both left and right. Hence, a two-limit tobit model is considered.

In more detail, denoting with y_i* the latent variable, the observed dependent variable y_i (that is *INNO_SALES)* is given by (Maddala, 1983):

$$y_i = \begin{cases} a, & if \;\; y_i \leq a \\ y_i^*, & if \;\; a < y_i^* < b \\ b, & if \;\; y_i \geq b \end{cases} \qquad [2]$$

with *a* and *b* denoting lower and upper bounds, respectively.

Before proceeding with the OLS and tobit estimations, we have tested whether in model [1] there is an endogeneity issue regarding external and internal R&D. Following Wooldridge (2002), we have first estimated the probit and tobit model for the likelihood to carry out external R&D and for the determinants of R&D intensity, respectively. Hence, the fitted probabilities to carry out external R&D retrieved from the probit estimates and the predicted values of R&D intensity, retrieved from the Tobit estimates, are then used as instrumental variables for D_RD^{EXT} and RD^{INT}, respectively.[2] The endogeneity test shows that the exogeneity of the two variables cannot be rejected.

4. RESULTS

In this section, we present the empirical results of the analysis. OLS estimates show that innovative sales are positively influenced by both internal and external R&D (Table 2). Small firms (less than 1 million euro of turnover) seem to perform worse than large firms. As expected, exporting firms tend to have higher innovative percentage sales, *ceteris paribus*. When splitting the sample between family and non-family firms, it emerges that R&D intensity and being an exporter are positively related to innovative output in both groups of firms. However, belonging to a group and registering higher turnover is positively associated with higher innovative sales in

[2] Besides the other regressors included in equation [1], in the probit and tobit model carried out in the first steps, the following variables are also considered: a dummy equal to one if the firms benefitted from tax allowances and financial incentives for R&D activities; a dummy for human capital, i.e. equal to one if the firm has a higher share of graduate employees with respect to the national average share of graduates; short term bank debt (%); medium- to long-term bank debt (%); and regional fixed effects. Similarly to innovative sale percentage, since R&D intensity cannot assume a value below 0 and above 100, in this case a two-limits tobit model is also employed.

the FF sample only. Importantly, R&D acquired from external sources has a positive impact on innovation in FFs only (Table 2).

Table 3 reports results from the tobit model. The estimates mainly confirm those obtained via OLS. Both internal and external R&D positively influence innovative sales. This is in line with the pre-existing evidence of a positive effect on innovative output of both R&D investment (Conte, 2009; Love et al; 2014) and R&D cooperation between firms and public research institutions (Fritsch and Franke 2004; Monjon and Waelbroeck 2003; Lööf and Broström 2008; Robin and Schubert, 2013; Belderbos et al 2004). Moreover, small firms register a lower percentage of innovative sales, in line with the Schumpeterian assumption (Schumpeter, 1942) on the key role of firm size in the field of innovation. Exporting firms have higher innovative output, and similarly to Conte (2009), we found that belonging to a group matters. Finally, the results confirm that FFs register, on average, higher innovative sale percentages than non-family firms. There is a number of papers explaining why family and non-family firms differ in terms of innovation, although the existing results are still ambiguous and somewhat contradictory (reviews are Carney et al., 2015; Duran et al., 2016). We do not enter in this debate, because this is not the focus of our work. We explain this result by attributing it to the major market knowledge of FFs, due to the active social participation of family members and their relationships with key stakeholders, especially clients (Alberti and Pizzurno, 2013). The stronger relationship with customers and the offering of a wider range of products, which are distinctive characteristics of FFs (Llac and Nordqvist, 2010), allow for more rapid detection of market niches and the adaption of new technologies to the needs of clients (Uhlaner et al., 2013), thereby avoiding competition pressures and achieving better firm performance.

As far as the main scope of the paper is concerned – that is, the relationship between external R&D and FF performance – the analysis indicates that innovative sales increase with external R&D efforts. This also holds true for non-family firms. However, for FFs, this relationship is more important, as emerges from a strongly significant marginal effect: for non-family firms, the effect is lower and only weakly significant, highlighting that FFs benefit more than non-family counterparts from R&D cooperation with external parties.

As this represents original evidence regarding family business innovation, no comparison with the existing literature is possible. The only exceptions are the recent papers by Dieguez-Soto et al. (2019) and Serrano-Bedia et al. (2016), whose results are partially different from ours. The former finds that external R&D – although positive – is not significant, while the latter shows that

family involvement exerts negative effects. Our results could be driven by higher social capital of family firms than non-family firms (Arregle et al., 2007; Carney, 2005b; Dyer, 2006), which exposes them to greater and more stable connections with external stakeholders (Miller and Le-Breton Miller, 2005). This allows family members to acquire new knowledge and to decrease the rigidity of the mental models of family decision-makers, thereby increasing performance (Chrisman et al., 2015). Moreover, external R&D may supply the firm with resources that are not available internally (Weigelt, 2009) and may help to overcome the intrinsic uncertainty and loss of control often attached to R&D investments that contribute to disjointed economic and non-economic goals (Duran et al., 2016). In this way, collaborative innovation can be an effective firm strategy for overcoming innovation barriers, as well as a source of competitive advantage for innovation in FFs (De Mattos et al., 2013; Hitt et al., 2000; Sirmon et al., 2008).

4.1 ROBUSTNESS CHECKS

We conducted additional tests to check the robustness of results.

An initial robustness check investigates how the degree of family participation in the supervisory and management board affects the results, which is an important factor of heterogeneity in FFs (Chua et al., 2012; Matzler et al., 2015).[3] To identify family members' participation in the top management team (Family Management) and the supervisory board (Family Governance), two dummy variables are used. The dummy "Family Management" (*fam_managed*) is equal to one if the firm's share of managers related to the controlling family is larger than the national average. The dummy "Family Governance" (*fam_ceo*) is equal to one if the CEO is the individual who controls the firm, or if it is a member of the controlling family. The tobit results are reported in Table 4 and show that there is no statistically significant difference between family and non-family enterprises: external R&D always play a significant role, regardless of the firm-type. This is a robust result, as it holds both when using the proxy of family management and the proxy of family governance. Importantly, Table 4 indicates that the previous results shown in Table 3 are confirmed.[4]

[3] For example, the behavior of FFs with a family member as CEO has been shown to differ from that of family firms with an external CEO, because, for instance, of the different goals that those CEOs pursue (Miller et al., 2014).

[4] As a further robustness check, we have inserted a dummy for internal R&D instead of the R&D intensity (RD^{INT}). In other words, instead of the R&D variable, we have considered a dummy equal to one if the firm carried out internal R&D over the last three years, and zero otherwise (D_RD^{INT}). The tobit estimation results are not reported here, but are available upon request. Overall, our results confirm that FFs register, on average, higher innovation sales, and that internal R&D and being an exporter are positively associated with innovation of family and non-family firms, while lower total turnover influences innovation of FFs only, with a negative effect. As regards external R&D, it plays a

Another test of robustness is aimed at taking into account the influence of the combination of internal and external R&D on innovation performance in family and non-family firms. The debate on the implications of internalizing innovation activities and outsourcing technology acquisition is ongoing, and the literature on this issue is full of countervailing theoretical arguments and mixed empirical evidence (e.g. Dieguez-Soto et al., 2019; Hagedoorn and Wang, 2012; Muñoz-Bullón et al., 2019; Vega-Jurado et al., 2009).

On the one hand, combining both internal and external R&D can undermine the capacity of FFs to enhance performance, because this strategic option typically requires high levels of managerial diligence and attention, which is often lacking in family firms (Schulze et al., 2003). On the other, it may contribute to improving the ability of the family to ameliorating firm performance, because external R&D may supply the firm with resources that are not available internally (Weigelt, 2009), and internal R&D may become more important when they cooperate with external R&D (De Sarbo et al., 2005).

In order to disentangle the effect of internal and external R&D, we have inserted three dummy variables in the place of variables regarding internal and external R&D: a dummy equal to one if the firm carried out internal R&D only, and zero otherwise ($D\_RD^{INT\ only}$); the second dummy is one if the firm carried out external R&D only and zero otherwise ($D\_RD^{EXT\ only}$); and the third dummy is equal to one if the firm carried out both internal and external R&D, and zero otherwise ($D\_RD^{INT\ \&EXT}$). The tobit estimation results are reported in Table 5. It is found that family and non-family firms carrying out internal R&D only, or both internal and external R&D, have a significantly larger intensity of innovative sales. FFs with both internal and external R&D have a higher average marginal effect (21.61) than non-family firms (15.02). While if we consider firms which carry out external R&D only, it is solely FFs who seem to significantly benefit from external cooperation, suggesting the important role of R&D cooperation for FFs.

Finally, we consider both the combination of internal and external R&D and the degree of family participation in the supervisory and management boards. Our findings are consistent with those obtained previously and reported above. When we consider the issue of a family chief executive officer (CEO), firms which carry out only internal R&D or both internal and external R&D register higher innovative output in both groups of firms (i.e. family and non-family), while if we consider firms which carry out external R&D only, they have higher innovative sales only

significant role for FFs only, with both the related coefficient and the average marginal effect being not significant for non-family firms.

when the subgroup of FF is considered (Table A1 of Appendix A). If we consider family management, we find that firms which carry out only external R&D, those with only internal R&D and those which carry out both internal and external R&D have significantly higher innovative sales in both groups of firms, family and non-family (Table A2 of Appendix A). As regards external R&D, it is worth noting that the average marginal effect is higher for family-managed firms than that observed for the other firms, suggesting that family-managed firms gain more from R&D cooperation.

5. CONCLUDING REMARKS

The aim of this article is to study the role played by collaboration innovation in R&D in family firms compared to non-family firms on the basis of an empirical survey of approximately 3,000 manufacturing firms from Italy. More specifically, using a two-limit tobit model, the relationship between external R&D and firm innovation performance has been investigated, providing an analysis on the differences between family and non-family firms.

While there are many studies investigating the innovative behaviour of family businesses, few studies deal with the impact of innovative cooperation on economic performance.

In this study, we argue that the distinctive features of family firms are likely to positively influence the relationship between innovative collaboration and performance. Thus, the findings of the present paper support the results of a strand of the literature demonstrating that the high level of "familiness" are likely to be better in terms of transformation and utilization of external knowledge (Andersén, 2015). "Familiness" can be a strength as well as a weakness (Sirmon et al., 2008). Firms with high levels of "familiness" are likely to be less able to identify and understand external knowledge, because of a lack of merit, expertise or talent in family-managed businesses (Lubatkin et al., 2005). However, when the knowledge has been assimilated, it is likely to improve firms' possibilities to combine and exploit this knowledge (Andersén, 2015). Consistent with this logic, our results show that collaborative innovation has a positive impact, especially on family firms, suggesting that family companies have a larger capacity to translate external R&D into tangible economic benefits. Thus, complementing the internal knowledge base with externally sourced technology is an excellent mode to improve the innovation performance of FFs. This result is confirmed when we investigate for the degree of family participation in the supervisory and management boards and when we disentangle the effect of internal and external R&D on innovative performance. This means that the constraints claimed by the literature on the limited

innovative capacity of FFs are potentially counterbalanced by certain strategic and intangible resources, which facilitate a more effective use of innovation input.

This research contributes to the field of family business scholarship because it illustrates how family firms' collaborative innovation can result in a performance advantage. Our study therefore has important implications both for policy-makers and for managers. On the one hand, this research sheds additional light on the distinctive traits of family businesses by extending our understanding of how their attributes enable FFs to benefit from external knowledge. On the other, it may help family business managers to recognize and address specific constraints and opportunities in the development of cooperation-based competitive advantages. Moreover, this perspective can provide interesting suggestions to policy-makers to design appropriate measures and incentives that foster effective external growth strategies. For instance, they should favour the performance of FFs by offering incentives to relationships between firms and universities, and they should ease inter-firm relationships and knowledge-sharing by empowering FF associations and professional networks.

Our study has some obvious limitations. First, it focuses on a specific form through which technology can be acquired from an external locus, namely, R&D acquired from external sources. Future research is thus needed to extend our findings to other forms of innovative cooperation, such as business-network contract, strategic alliances and joint ventures. Second, industry-specific studies could be necessary, because sectors are characterized by different technological regimes, paces of innovation and dynamics that might have an impact on the type of knowledge required, whether that be technology- or market-based knowledge. Given that in FFs, innovation is expected to be mostly driven by customers and the market (i.e. market knowledge), this may influence results.

Despite these limitations, our results illuminate several aspects of the relationship between knowledge sources and innovation performance in FFs, triggering new lines of further research on the topic.

REFERENCES

Alberti, F.G., Ferrario, S., Papa, F. Pizzurno, E. (2014). Search breadth, open innovation and family firms: evidences in Italian mid-high tech SMEs. International Journal of Technology Intelligence and Planning, 10 (1), 29-48.

Alberti, F. G., Pizzurno, E. (2013). Technology, innovation and performance in family firms. International Journal of Entrepreneurship and Innovation Management, 17(1-3), 142-161.

Altomonte C., Aquilante T., 2012, The EU-EFIGE/Bruegel-Unicredit dataset, Bruegel Working paper 13.

Arregle, J.L., Hitt, M.A., Sirmon, D.G. Very, P. (2007). The development of organizational social capital: attributes of family firms. Journal of Management Studies, 44 (1), 73-95.

Belderbos R., Carree M. Lokshin B. (2004). Cooperative R&D and firm performance. Research Policy, 33: 1477–1492.

Berrone, P., Cruz, C., Gómez-Mejia, L. R. (2012). Socioemotional wealth in family firms: A review and agenda for future research. Family Business Review, 25(3), 258–279.

Bigliardi B., Galati F. (2018). Family firms and collaborative innovation: present debates and future research, European Journal of Innovation Management. 21, 2, 334-358.

Block, J., Miller, D., Jaskiewicz, P., Spiegel, F. (2013). Economic and technological importance of innovations in large family and founder firms: An analysis of patent data. Family Business Review, 26(2), 180-199.

Calabrò, A., Vecchiarini, M., Gast, J., Campopiano, G., De Massis, A., Kraus, S. (2018). Innovation in family firms: A systematic literature review and guidance for future research. International Journal of Management Reviews. DOI: 10.1111/ijmr.12192.

Carney, M., M. Van Essen, E.R. Gedajlovic, Heugens P.P.M.A.R. (2015). What Do We Know About Private Family Firms? A Meta-Analytical Review. Entrepreneurship Theory and Practice 39 (3): 513–44.

Carney, M. (2005a). Globalization and the renewal of Asian business networks. Asia Pacific Journal of Management, 22(4), 337–354.

Carney, M. (2005b). Corporate governance and competitive advantage in family-controlled firms. Entrepreneurship Theory and Practice, 29, 249–265.

Cassiman, B., Veugelers, R. (2002). R&D cooperation and spillovers: Some empirical evidence from Belgium. American Economic Review, 92(4), 1169–1184.

Chrisman, J. J., Fang, H., Kotlar, J., De Massis, A. (2015). A note on family influence and the adoption of discontinuous technologies in family firms. Journal of Product Innovation Management, 32, 384-388.

Chua, J. H., Chrisman, J. J., Steier, L. P., Rau, S. B. (2012). Sources of heterogeneity in family firms: An introduction. Entrepreneurship Theory and Practice, 36(6): 1103–1113.

Chua, J.H., Chrisman, J.J., Sharma, P. (1999). Defining the family business by behavior. Entrepreneurship Theory and Practice, 23 (4), 19-39.

Classen, N., Van Gils, A., Bammens, Y. Carree, M. (2012). Accessing resources from innovation partners: the search breadth of family SMEs. Journal of Small Business Management, 50 (2), 191-215.

Conte A. (2009). Mapping innovative activity using microdata. Applied Economics Letters, 16 (18): 1795-1799.

Dyer, W.G. (2006). Examining the 'family effect' on firm performance. Family Business Review, 19 (4), 253–273.

De Massis, A., Frattini, F. Lichtenthaler, U. (2013). Research on technological innovation in family firms: present debates and future directions. Family Business Review, 26 (1), 10-31.

De Mattos, C., Burgess, T. F., Shaw, N. E. (2013). The impact of R & D-specific factors on the attractiveness of small- and medium-sized enterprises as partners vis-a-vis alliance formation in large emerging economies. R&D Management, 43(1), 1–20.

DeSarbo, W. S., Anthony Di Benedetto, C., Song, M., Sinha, I. (2005). Revisiting the Miles and Snow strategic framework: uncovering interrelationships between strategic types, capabilities, environmental uncertainty, and firm performance. Strategic management journal, 26(1), 47-74.

Diéguez-Soto, J., Manzaneque, M., González-García, V. Galache-Laza, T. (2019). A study of the moderating influence of R&D intensity on the family management-firm performance relationship: evidence from Spanish private manufacturing firms, BRQ Business Research Quarterly, 22, 2, 105-118.

Duran P, Kammerlander N, van Essen M, Zellweger T. (2016). Doing more with less: innovation input and output in family firms. Academy of Management Journal, 59 (4), 1224–1264.

Fey, C.F. Birkinshaw, J. (2005). External sources of knowledge, governance mode, and R&D performance. Journal of Management, 31 (4), 597-621.

Feranita F., J. Kotlar, and A. De Massis. 2017. "Collaborative Innovation in Family Firms: Past Research, Current Debates and Agenda for Future Research." Journal of Family Business Strategy 8:137-156.

Fritsch, M., Franke, G. (2004). Innovation, regional knowledge spillovers and R&D cooperation. Research Policy, 33, 245–255

Gómez-Mejía, L. R., Takács Haynes, K., Núñez-Nickel, M., Jacobson, K. J. L., Moyano-Fuentas, J. (2007). Socioemotional wealth and business risks in family-controlled firms: Evidence from Spanish olive oil mills. Administrative Science Quarterly, 52, 106–137.

Hagedoorn, J., Wang, N. (2012). Is there complementarity or substitutability between internal and external R&D strategies? Research Policy, 41(6), 1072–1083.

Hitt, M., Dacin, M. T., Levitas, E., Arregle, J. L., Borza (2000). Partner selection in a merging and developed market context: Resource-based and organizational learning perspectives. Academy of Management Journal, 43(3), 449–467.

König, A., Kammerlander, N. Enders, A. (2013). The family innovator's dilemma: how family influence affects the adoption of discontinuous technologies by incumbent firms. Academy of Management Review, 38, 418–441.

Kotlar, J., De Massis, A., Frattini, F., Bianchi, M., Fang, H. (2013). Technology acquisition in family and nonfamily firms: A longitudinal analysis of Spanish manufacturing firms. Journal of Product Innovation Management, 30(6), 1073–1088.

Llach, J., Nordqvist, M. (2010). Innovation in family and non-family businesses: A resource perspective. International Journal of Entrepreneurial Venturing, 2(3-4), 381-399.

Lööf H. and Broström A. (2008). Does knowledge diffusion between university and industry increase innovativeness? Journal of Technology Transfer, 33: 73-90.

Love J. H., Roper S., Vahter P. (2014). Learning from openness: The dynamics of breadth in external innovation linkages. Strategic Management Journal, 35: 1703–1716.

Lubatkin, M.H., Schulze,W.S., Ling, Y., Dino, R.N. (2005). The effects of parental altruism on the governance of family-managed firms. Journal of Organizational Behavior. 26 (3), 315-330.

Maddala G.S. (1983). Limited-dependent and qualitative variables in econometrics. Cambridge University Press, UK.

Manzaneque, M., Diéguez-Soto, J., Garrido-Moreno, A. (2018). Technological innovation inputs, outputs and family management: evidence from Spanish manufacturing firms. Innovation, 20 (4), 299-325.

Matzler, K., V. Veider, J. Hautz, C. Stadler. (2015). The Impact of Family Ownership, Management, and Governance on Innovation. Journal of Product Innovation Management 32 (3): 319–333.

Miller, D., Le Breton-Miller, I., Minichilli, A., Corbetta, G., & Pittino, D. (2014). When do non-family CEOs outperform in family firms? Agency and behavioural agency perspectives. Journal of Management Studies, 51(4): 547–572.

Miller, D., Le-Breton Miller, I. (2005). Managing for the long run: Lessons in competitive advantage from great family businesses. Boston, MA: Harvard Business School Press,

Monjon S. Waelbroeck P. (2003) Assessing spillovers from universities to firms: evidence from French firm-level data. International Journal of Industrial Organization, 21, 1255-1270.

Munoz-Bullon, F., Sanchez-Bueno, M. J. (2011). The Impact of Family Involvement on the R&D Intensity of Publicly Traded Firms. Family Business Review, 24(1), 62–70.

Muñoz-Bullon, F. Sanchez-Bueno, M. J. De Massis, A. (2019) Combining internal and external R&D: The effects on innovation performance in family and non-family firms. Entrepreneurship: Theory & Practice. DOI: 10.1177/1042258719879674.

Nieto M. J., Santamaria L., Fernandez Z. (2015) Understanding the Innovation Behavior of Family Firms. Journal of Small Business Management, 53(2), 382–399.

Pittino, D., Visintin, F., Baù, M. Mazzurana, P. (2013). Collaborative technology strategies and innovation in family firms. International Journal of Entrepreneurship and Innovation Management, 17, 8-27.

Robin S., Schubert T. (2013). Cooperation with public research institutions and success in innovation: Evidence from France and Germany. Research Policy, 42: 149– 166.

Röd, I. (2016). Disentangling the family firm's innovation process: A systematic review. Journal of Family Business Strategy, 7(3), 185-201.

Schulze, W.S., Lubatkin, M.H., Dino, R.N. (2003). Toward a theory of agency and altruism in family firms. Journal of Business Venturing. 18 (4), 473-490.

Schumpeter J.A. (1942). Capitalism, Socialism and Democracy. New York, Harper and Brothers.

Serrano-Bedia, A. M., López-Fernández, M. C., Garcia-Piqueres, G. (2016). Analysis of the relationship between sources of knowledge and innovation performance in family firms. Innovation, 18(4), 489-512.

Sirmon, D. G., Arregle, J. L., Hitt, M. A., Webb, J. W. (2008). The role of family influence in firms' strategic responses to threat of imitation. Entrepreneurship: Theory and Practice, 32(6), 979–998.

Uhlaner, L. M., van Stel, A., Duplat, V., Zhou, H. (2013). Disentangling the effects of organizational capabilities, innovation and firm size on SME sales growth. Small Business Economics, 41, 581-607.

Urbinati, A., S. Franzò, A. De Massis, F. Frattini. (2017). Innovation in Family Firms: A Review of Prior Studies and a Framework for Future Research. In Revolution of Innovation Management edited by A. Brem and E. Viardot. London: Palgrave Macmillan.

Vega-Jurado, J., Gutiérrez-Gracia, A., Fernández-de-Lucio, I. (2009). Does external knowledge sourcing matter for innovation? Evidence from the Spanish manufacturing industry. Industrial and Corporate Change, 18(4), 637–670.

Vivas C., Barge-Gil A. (2015). Impact on firms of the use of knowledge external sources: a systematic review of the literature. Journal of Economic Surveys, 29 (5), 943–964.

Weigelt, C. (2009). The impact of outsourcing new technologies on integrative capabilities and performance. Strategic Management Journal, 30 (6), 595.

Woldridge J. (2002). Econometric analysis of cross section and panel data. The MIT Press, Cambridge.

Zahra, S. A. (2012). Organizational learning and entrepreneurship in family firms: Exploring the moderating effect of ownership and cohesion. Small business economics, 38(1), 51-65.
Zellweger, T., Chrisman, J. J., Chua, J. H., Steier, L. P. (2019). Social structures, social relationships, and family firms. Entrepreneurship Theory and Practice, 43(2), 207–223.

Table 1 – Descriptive statistics

	ALL FIRMS					FAMILY FIRMS					NON-FAMILY FIRMS				
	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
FAM	3,021	0.74	0.44	0	1										
INNO_SALES	3,020	11.67	20.41	0	100	2,243	12.06	20.61	0	100	777	10.54	19.78	0	100
D_RD^{EXT}	3,020	0.12	0.33	0	1	2,243	0.12	0.33	0	1	777	0.12	0.32	0	1
lnl(E)	3,021	3.44	0.90	2.30	8.74	2,244	3.35	0.79	2.30	8.41	777	3.70	1.11	2.30	8.74
RD^{INT}	3,020	3.43	6.95	0	100	2,243	3.37	6.47	0	60	777	3.60	8.18	0	100
EXPORTER	3,021	0.74	0.44	0	1	2,244	0.74	0.44	0	1	777	0.74	0.44	0	1
GROUP	3,021	0.17	0.38	0	1	2,244	0.12	0.32	0	1	777	0.34	0.47	0	1
TURN1	3,021	0.07	0.25	0	1	2,244	0.07	0.25	0	1	777	0.07	0.25	0	1
TURN2	3,021	0.71	0.45	0	1	2,244	0.73	0.44	0	1	777	0.65	0.48	0	1

Note: authors' elaboration on data from EU-EFIGE/Bruegel-Unicredit dataset

Table 2 – OLS estimation results

VARIABLES	ALL Mod.1 - OLS coefficients	FAMILY Mod.1 - OLS coefficients	NON-FAMILY Mod.1 - OLS coefficients
FAM	2.2515***		
	(0.8049)		
D_RD^{EXT}	5.9980***	7.1194***	2.3027
	(1.2487)	(1.5490)	(2.0223)
ln(E)	0.1590	0.5018	-0.7176
	(0.5504)	(0.6691)	(0.9550)
RD^{INT}	0.7014***	0.7556***	0.5960***
	(0.1031)	(0.0966)	(0.2062)
EXPORTER	4.6198***	4.3923***	4.7998***
	(0.7991)	(0.9158)	(1.5186)
GROUP	2.7898**	3.1340**	2.3536
	(1.1328)	(1.4694)	(1.8977)
TURN1	-3.0937**	-3.5744**	-1.5057
	(1.5115)	(1.7185)	(3.2471)
TURN2	0.9265	1.3357	-0.6522
	(1.0551)	(1.2304)	(2.1100)
Constant	-1.0868	-0.5015	4.1637
	(2.6306)	(3.0214)	(4.5902)
Observations	3,020	2,243	777
R-squared	0.114	0.122	0.109

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1**;** Industry fixed effects included

Table 3 – Tobit estimation results

VARIABLES	ALL Mod.1 - Tobit coefficients	ALL Mod.1 - Tobit AME	FAMILY Mod.1 - Tobit coefficients	FAMILY Mod.1 - Tobit AME	NON FAMILY Mod.1 - Tobit coefficients	NON FAMILY Mod.1 - Tobit AME
FAM	5.4855***	2.3185***				
	(1.7207)	(0.7036)				
D_RD^{EXT}	13.9290***	6.8451***	15.5006***	7.8615***	8.2335*	3.6345*
	(2.0755)	(1.1290)	(2.3679)	(1.3391)	(4.3250)	(2.0432)
ln(E)	1.7499	0.7636	2.4266*	1.0810*	0.0854	0.0350
	(1.0902)	(0.4755)	(1.3521)	(0.6020)	(1.8966)	(0.7771)
RD^{INT}	1.3367***	0.5833***	1.4600***	0.6504***	1.1017***	0.4514***
	(0.0972)	(0.0414)	(0.1202)	(0.0521)	(0.1665)	(0.0669)
EXPORTER	15.0620***	5.9745***	14.2117***	5.7981***	16.7824***	6.1394***
	(1.8619)	(0.6653)	(2.1327)	(0.7897)	(3.8075)	(1.2347)
GROUP	4.3073**	1.9416*	5.2304*	2.4384*	2.8366	1.1749
	(2.1376)	(0.9947)	(2.7006)	(1.3151)	(3.5766)	(1.4984)
TURN1	-12.5966***	-4.7853***	-14.2989***	-5.4481***	-7.3081	-2.7591
	(4.1394)	(1.3453)	(4.8074)	(1.5322)	(8.2258)	(2.8439)
TURN2	0.3841	0.1673	1.0271	0.4549	-2.2200	-0.9168
	(2.2780)	(0.9902)	(2.6025)	(1.1462)	(4.7116)	(1.9611)
Constant	-34.5718***		-31.6111***		-26.5701**	
	(5.7448)		(6.5018)		(10.5871)	
Observations	3,020	3,020	2,243	2,243	777	777

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Industry fixed effects included; AME: average marginal effects

Table 4 – Robustness checks: family managed and family controlled firms. Tobit estimation results

VARIABLES	ALL Tobit coefficients	ALL Tobit AME	ALL Tobit coefficients	ALL Tobit AME	FAMILY MANAG. Tobit coefficients	FAMILY MANAG. Tobit AME	NON FAMILY MANAG. Tobit coefficients	NON FAMILY MANAG. Tobit AME	FAMILY CEO Tobit coefficients	FAMILY CEO Tobit AME	NON FAMILY CEO Tobit coefficients	NON FAMILY CEO Tobit AME
fam_managed	1.8361	0.8057										
	(1.6235)	(0.7162)										
fam_ceo			5.1474***	2.1913***								
			(1.6623)	(0.6899)								
D_RD^{EXT}	14.0722***	6.9233***	13.9783***	6.8718***	18.8655***	9.1505***	11.2487***	5.5772***	15.9471***	8.0785***	9.1370**	4.1632**
	(2.0772)	(1.1321)	(2.0754)	(1.1297)	(3.6811)	(2.0360)	(2.5037)	(1.3499)	(2.4695)	(1.3980)	(3.8167)	(1.8720)
ln(E)	1.7329	0.7563	1.7243	0.7525	6.7268**	2.7799**	0.5383	0.2426	2.6040*	1.1546*	0.1759	0.0739
	(1.1168)	(0.4872)	(1.0896)	(0.4753)	(3.1085)	(1.2826)	(1.1895)	(0.5359)	(1.4477)	(0.6414)	(1.6829)	(0.7067)
RD^{INT}	1.3375***	0.5837***	1.3368***	0.5834***	1.2230***	0.5054***	1.3802***	0.6219***	1.4115***	0.6258***	1.1892***	0.4994***
	(0.0973)	(0.0415)	(0.0972)	(0.0414)	(0.1686)	(0.0684)	(0.1186)	(0.0521)	(0.1247)	(0.0539)	(0.1546)	(0.0634)
EXPORTER	15.1687***	6.0130***	15.1051***	5.9899***	11.8452***	4.6019***	17.6740***	7.0274***	14.3897***	5.8452***	16.0391***	6.0228***
	(1.8642)	(0.6651)	(1.8620)	(0.6649)	(3.0215)	(1.0968)	(2.3838)	(0.8257)	(2.1988)	(0.8110)	(3.4828)	(1.1595)
GROUP	3.1234	1.3957	4.5526**	2.0560**	1.1795	0.4934	3.4180	1.5710	5.2403*	2.4363*	3.9388	1.6772
	(2.1037)	(0.9622)	(2.1582)	(1.0078)	(5.5981)	(2.3706)	(2.2224)	(1.0421)	(2.9684)	(1.4442)	(3.1822)	(1.3752)
TURN1	-13.6248***	-5.1156***	-12.6815***	-4.8132***	-7.6208	-2.9183	-12.7901**	-4.9711***	-14.7991***	-5.5837***	-7.5980	-2.9293
	(4.1424)	(1.3111)	(4.1376)	(1.3419)	(7.2787)	(2.5707)	(5.5417)	(1.8193)	(5.0342)	(1.5788)	(7.3257)	(2.5751)
TURN2	-0.1819	-0.0795	0.2200	0.0959	7.3700	2.8702	-2.2633	-1.0274	1.1338	0.4994	-2.9958	-1.2699
	(2.2784)	(0.9962)	(2.2752)	(0.9907)	(5.1861)	(1.8987)	(2.4945)	(1.1403)	(2.7279)	(1.1935)	(4.1332)	(1.7681)
Constant	-30.8573***		-34.0575***		-46.5401***		-27.9246***		-31.3671***		-28.2513***	
	(5.6793)		(5.7104)		(12.6516)		(6.2981)		(6.8593)		(9.4392)	
Observations	3,020	3,020	3,020	3,020	1,140	1,140	1,880	1,880	2,117	2,117	903	903

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Industry fixed effects included; AME: average marginal effects

Table 5 – Robustness checks: internal R&D only, external R&D only and both internal and external R&D dummies. Tobit estimation results

VARIABLES	ALL Tobit coefficients	ALL Tobit AME	FAMILY Tobit coefficients	FAMILY Tobit AME	NON FAMILY Tobit coefficients	NON FAMILY Tobit AME
FAM	4.5442***	1.9260***				
	(1.7237)	(0.7117)				
$D\_RD^{EXT\ only}$	22.0582***	11.7361***	26.2752***	14.7024***	7.6088	3.3483
	(3.6695)	(2.2819)	(4.1770)	(2.7617)	(7.8304)	(3.7096)
$D\_RD^{INT\ only}$	29.2932***	13.1528***	30.3488***	13.9449***	25.5310***	10.6581***
	(1.6990)	(0.7658)	(1.9382)	(0.8910)	(3.5148)	(1.4825)
$D\_RD^{INT\&EXT}$	34.7406***	19.8612***	36.7899***	21.6137***	28.7084***	15.0159***
	(2.6762)	(1.8049)	(3.0254)	(2.0849)	(5.7303)	(3.5607)
ln(E)	-0.0595	-0.0259	0.2357	0.1048	-1.0721	-0.4356
	(1.1010)	(0.4786)	(1.3549)	(0.6024)	(1.9511)	(0.7930)
EXPORTER	11.6956***	4.7281***	11.5544***	4.7872***	11.6982***	4.4022***
	(1.8881)	(0.7043)	(2.1465)	(0.8219)	(3.9612)	(1.3727)
GROUP	4.6244**	2.0785**	4.1456	1.9083	4.5169	1.8654
	(2.1334)	(0.9906)	(2.6836)	(1.2775)	(3.6252)	(1.5229)
TURN1	-7.1043*	-2.8680*	-8.9227*	-3.6175**	-2.0881	-0.8297
	(4.1763)	(1.5572)	(4.8283)	(1.7697)	(8.4001)	(3.2627)
TURN2	2.7881	1.1957	3.1293	1.3684	0.4700	0.1906
	(2.2860)	(0.9671)	(2.5988)	(1.1175)	(4.7878)	(1.9390)
Constant	-38.4922***		-35.2735***		-31.7759***	
	(5.8054)		(6.5377)		(10.8637)	
Observations	3,020	3,020	2,243	2,243	777	777

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Industry fixed effects included; AME: average marginal effects

Appendix A

Table A1 – Robustness checks: internal R&D only, external R&D only and both internal and external R&D dummies, family controlled firms. Tobit estimation results

VARIABLES	ALL Tobit coefficients	ALL Tobit AME	FAMILY CEO Tobit coefficients	FAMILY CEO Tobit AME	NON FAMILY CEO Tobit coefficients	NON FAMILY CEO Tobit AME
fam_ceo	4.5518***	1.9376***				
	(1.6657)	(0.6939)				
$D\_RD^{EXT\ only}$	22.1256***	11.7764***	27.2635***	15.3156***	8.4879	3.8517
	(3.6707)	(2.2841)	(4.3270)	(2.8822)	(7.0868)	(3.4835)
$D\_RD^{INT\ only}$	29.3397***	13.1733***	29.6075***	13.5877***	28.0512***	11.9146***
	(1.6989)	(0.7657)	(1.9977)	(0.9212)	(3.2210)	(1.3681)
$D\_RD^{INT\&EXT}$	34.8032***	19.9012***	35.7558***	20.8164***	32.9941***	18.0935***
	(2.6753)	(1.8046)	(3.1404)	(2.1472)	(5.0876)	(3.3192)
ln(E)	-0.0675	-0.0293	0.2345	0.1038	-0.9554	-0.3973
	(1.1002)	(0.4782)	(1.4497)	(0.6419)	(1.7286)	(0.7190)
EXPORTER	11.7194***	4.7364***	11.6785***	4.8197***	10.8846***	4.2069***
	(1.8881)	(0.7040)	(2.2082)	(0.8425)	(3.6209)	(1.2929)
GROUP	4.9160**	2.2138**	3.7906	1.7352	5.6037*	2.3739*
	(2.1537)	(1.0039)	(2.9458)	(1.3927)	(3.2301)	(1.3953)
TURN1	-7.1259*	-2.8758*	-10.6053**	-4.2041**	-0.1937	-0.0804
	(4.1745)	(1.5557)	(5.0582)	(1.7736)	(7.4492)	(3.0849)
TURN2	2.6657	1.1438	2.9040	1.2650	0.1992	0.0828
	(2.2830)	(0.9670)	(2.7196)	(1.1652)	(4.2032)	(1.7457)
Constant	-38.3490***		-33.7305***		-35.3343***	
	(5.7736)		(6.8752)		(9.7124)	
Observations	3,020	3,020	2,117	2,117	903	903

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Industry fixed effects included; AME: average marginal effects

Table A2 – Robustness checks: internal R&D only, external R&D only and both internal and external R&D dummies, family managed firms. Tobit estimation results

VARIABLES	ALL Tobit coefficients	ALL Tobit AME	FAMILY MANAGED Tobit coefficients	FAMILY MANAGED Tobit AME	NON FAMILY MANAGED Tobit coefficients	NON FAMILY MANAGED Tobit AME
fam_managed	1.4260	0.6225				
	(1.6295)	(0.7142)				
$D\_RD^{EXT\ only}$	22.0003***	11.6994***	33.7091***	18.4613***	13.1624***	6.7144**
	(3.6694)	(2.2801)	(5.8556)	(3.8830)	(4.7637)	(2.7125)
$D\_RD^{INT\ only}$	29.4071***	13.2069***	33.8474***	14.9750***	26.1871***	11.8840***
	(1.7006)	(0.7666)	(2.8575)	(1.2999)	(2.1169)	(0.9509)
$D\_RD^{INT\&EXT}$	35.0272***	20.0584***	38.6923***	21.5237***	32.1844***	18.6423***
	(2.6777)	(1.8088)	(4.6803)	(3.1033)	(3.2672)	(2.2178)
ln(E)	-0.0936	-0.0407	2.9724	1.2218	-0.9822	-0.4408
	(1.1272)	(0.4901)	(3.0636)	(1.2585)	(1.2173)	(0.5464)
EXPORTER	11.7664***	4.7548***	8.8720***	3.4845***	14.1389***	5.7569***
	(1.8897)	(0.7043)	(2.9806)	(1.1130)	(2.4574)	(0.8974)
GROUP	3.6396*	1.6244*	0.8937	0.3707	3.8901*	1.7843*
	(2.0990)	(0.9613)	(5.4739)	(2.2904)	(2.2489)	(1.0541)
TURN1	-7.9185*	-3.1691**	-2.7240	-1.0912	-6.9637	-2.8974
	(4.1782)	(1.5290)	(7.1770)	(2.8003)	(5.6457)	(2.1644)
TURN2	2.3389	1.0053	9.4064*	3.5933**	0.1858	0.0834
	(2.2856)	(0.9713)	(5.0951)	(1.8016)	(2.5355)	(1.1368)
Constant	-35.3618***		-45.9134***		-32.6114***	
	(5.7459)		(12.4463)		(6.4676)	
Observations	3,020	3,020	1,140	1,140	1,880	1,880

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Industry fixed effects included; AME: average marginal effects