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THE IMPACT OF FAMILY TIES AND FOUNDER INVOLVEMENT ON INNOVATION IN HIGH-TECH FIRMS

This paper investigates the impact of family participation and founder involvement in business on innovation in high-tech companies from the S&P500 index over the period 1999–2017. We demonstrate that the family firm paradox (family firms tend to invest less in innovation while remaining more efficient in innovation output) is not so obvious for technological companies. We conclude that founder involvement and CEO ownership leads to higher R&D expenditures and income margins in the pharma and IT sectors. However, consistent with previous studies of family participation, family ownership and holding the offices of CEO and chairman, has a negative impact on amounts spent on innovation.

JEL Classification: G30, G39
Keywords: Family firms, founder, risk-taking, behavioral finance, corporate governance

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1. Introduction

Family involvement in business is not an uncommon thing—a large number of technological companies were founded by families and some of them are still governed by family members. In most countries, from 50% to 80% of GDP is produced by family companies and they frequently provide higher returns than local stock market indexes (Cruz, 2013). However, stereotypes that characterize family businesses as inefficient and inert to innovation are persistent. Family participation in business is often associated with risk-averse and biased decision-making, the exploitation of minority shareholders, and nepotism which results in unprofessional management and governance (Jiang, Jiang, Kim, & Zhang, 2015). This contradiction has drawn the attention of researchers from different fields of studies.

The definition of a family firm is inconsistent (Scholes et al., 2021)—from family ownership and family management and governance to having the next generations involved in the firm. Among them there are more traditional—holding 20% (in some research 50%) of shares and having a family member in the board of directors or in the management team (Wadhwa, Syamala, 2022; Liu, Zhou & Li, 2023; Scholes et al., 2021) or just 25% of shares by controlled one or two closely related families (Tenuta, Rocco Cambrea 2022). However, more specific definitions are sometimes used: having founder or founder's relatives as officers, directors, or owning of at least 5% of the firm's equity (Villalonga, Amit, 2006, Zhou et al, 2017) or leader/owner firms, where the CEO or a board member is a shareholder with an ownership stake of at least 5% (Zhou et al., 2017).

This paper's central proposition is motivated by three main facts. First, high-tech companies are leaders in capitalization, most S&P500 companies are representatives of innovative industries (following the definition of OECD Directorate for science). Second, around 30% of the companies from S&P500 are family controlled. This proportion is substantial, showing that such corporate governance may be an effective formula for success. Third, it seems that in technological firms in the US, family ownership is becoming popular once again (Kokoreva, Stepanova, & Karnoukhova, 2016; ValueWalk, 2017). In this case, information on how technological companies, which need to survive in a highly competitive environment, deal with the problems and advantages arising from family involvement in all possible forms is of great importance.

The role and the effect of family ownership and involvement on business have been assessed from different perspectives: from psychological to economic. Strengthening the

family ties between management and governance by including family members on the board is believed to be a way of enhancing the interaction between the senior management and the board (Chahine & Goergen, 2014). Such ties or one large (family) shareholder leads to a lack of monitoring and ability to expropriate minority investors, especially in countries with weak legal protection (Amit, Ding, Villalonga, & Zhang, 2015).

Regarding innovation, family involvement results in smaller investments in innovation, but their R&D is at least as effective as in companies without family participation (Chen & Hsu, 2009; Classen, Carree, van Gils, & Peters, 2014; Matzler, Veider, Hautz, & Stadler, 2015). Researcher opinions about such a paradox differ: it can be partly explained by non-economic goals and a willingness to preserve their socio-emotional endowment, however, it may be due to realizing their advantages in interactions and the specific social capital inherent to family firms (Chen & Hsu, 2009; De Massis, Frattini, & Lichtenthaler, 2013; Isakov & Weisskopf, 2015; Minin, 2015).

Starting from this point, we assume that family involvement in businesses dependent on innovation (i.e., technological companies) will result in more efficient R&D due to the fact that in such circumstances investing is vital for the company's survival. Family involvement will have a positive impact on innovation input—money invested—and innovation output—measured in profit margins, patents, and patent applications.

Nevertheless, previous research was limited to an overall assessment of the possible impact of family ownership or governance and management on distinct aspects of company activities in public firms from all industries or limited to privately held companies in one industry. In this work, companies from S&P500 operating in the pharmaceutical and ICT industries, which are classified as high-technology industries by the OECD Directorate for science, are considered.

To test the proposition that family involvement in technological companies positively influence R&D, data on 108 companies regarding family ownership, family ties, and characteristics of the management and governance structure were manually collected from filings published on the US Securities and Exchange Commission website and analyzed using OLS or the Prais-Winsten regression approach. The results show that founder involvement in management and governance and CEO ownership have a positive influence on investments in R&D, while chair ownership, accompanied with a family member as CEO and chair, or family ties within the firm decrease investment in R&D. We also find significant positive effects of the founder's involvement, family ties, and

ownership by CEO or chair, proving the idea of special social capital, smooth interconnection, and leadership benefits for innovation.

Unfortunately, information about patents was provided by few companies. However, a positive effect of family ties and family power on the number of patent applications and founder involvement and ownership on income margins was observed reaffirming the proposition of more effective innovation within firms with family involvement (the results are provided in the appendices).

This paper makes several important contributions to the literature on innovative companies and the managerial literature concentrating on the influence of family participation. Using this specific dataset, we were able to reaffirm the results from the literature connected with innovation output and provide new evidence on specific investment behavior for technological companies. These findings might help companies in enhancing corporate governance by providing an understanding of the most suitable structures for companies with different types of family involvement. Moreover, a better understanding of possible difficulties arising from family involvement may help governments to find appropriate policies for stimulating innovation activities and to build more accurate forecasts for investors and analysts.

The paper is structured as follows. Section 2 provides an overview of the literature on family business and innovation and introduce the hypotheses. Section 3 discusses the data, the main variables, and methods. Section 4 presents the results of empirical research and Section 5 concludes.

2. Literature review and hypotheses development

2.1 The influence of family ownership and involvement on firm performance and agency theory

Agency theory, one of the perspectives most frequently used in family business analysis, says that the separation of ownership and control leads to misuse of cash flows and the financing of projects that may not be economically profitable in the long run. Family ownership and control may solve this problem as it can provide powerful monitoring of management (Delbufalo, Poggesi, & Borra, 2016; Isakov & Weisskopf, 2015).

This statement was proved by recent research concerning investments during recessions. Agency theory implies that while family wealth is connected to firm

performance dependent on investments, family firms will invest more during crises comparing to non-family rivals. An analysis of US family and non-family firms' investments in R&D during the Great Recession proved that family firms are ready to take more risks when business is underperforming their long-term aspirations (Sun, Lee, & Phan, 2018).

Conflict between majority and minority stakeholders may arise negatively affecting the efficiency of decision-making inside the firm (Delbufalo et al., 2016).

2.2 The influence of family ownership and involvement on firm performance and socio-emotional wealth in prospect theory

One of the propositions of agency theory is that for family companies to mitigate financial risks, they should diversify in terms of regions and products. However, this hypothesis was not confirmed on a sample of Italian firms, confirming the socio-emotional wealth (SEW) theory. SEW theory considers a diversification strategy as hazardous to SEW and family control (Delbufalo et al., 2016, p.663).

Main idea of SEW theory is that in family companies, non-economic utilities may be more important for decision-makers, resulting, for example, in taking excessive or economically needless risks to preserve socio-emotional endowment or not taking risky but profitable potentialities which can appear to be a threat to the firm (Gómez-Mejía, Haynes, Núñez-Nickel, Jacobson, & Moyano-Fuentes, 2007).

Nepotism, which is common in family business recruitment policies, is an example of how socioemotional gains may outweigh future losses from lack of experience and expertise (Firfiray, Cruz, Neacsu, & Gomez-Mejia, 2018). In the case of nepotism, SEW gains are clearly observed, while risks are not as evident.

The risks for family capital are obvious for investment in R&D, which takes time to bear profit, while future gains are unclear.

SEW theory may also explain why family firms are reluctant to use patents as a protection tool for their intellectual property. They consider patents as a threat to the privacy of their information and tend to apply other ways of gaining advantages from inventions: first-mover advantages, commercial secrets, complementary products, etc., probably gaining fewer profits but protecting their SEW (Bannò, 2016).

Following SEW theory, a family-member CEO should gain less satisfaction from economic performance compared to a non-family CEO as their SEW is dependent on

different personal goals (the expansion of the business, acquiring more control, the ability to pass business to future generations). However, a recent study of companies from high- and medium-high technology sectors found that there is no such difference, contradicting the ideas of SEW theory (Garcés-Galdeano, Larraza-Kintana, Cruz, & Contín-Pilart, 2017).

2.3 Social capital, a resource-based view and other perspectives explaining family business peculiarities

Although the agency model and prospective theory provide researchers with credible explanations for the impact of family involvement, more perspectives are usually used, concerning decision-making in family businesses. Loss avoidance was added to the behavioral agency model to explain the two-stage gamble occurring when a family firm decides to have an IPO and resulting in underpricing (Kotlar et al, 2018). This addition provides a better understanding of the decisions of family firms when there is a choice between financial and SEW, and endowment.

Some studies mention that family involvement in business leads to longer investment horizons (Stein, 1989). Family participation in business, such as those where a substantial number of shares are held by family members or associating the company's success with the personal achievements of the founding CEO, anticipate that these individuals will behave like investors with long-term horizons. This assumes that maximizing profits in the long run will be stimulated by these family members through monitoring or encouraging investment in innovation (Harford, Kecskés, & Mansi, 2018).

Family participation corrects informational asymmetry (Anderson, Mansi, & Reeb, 2003; Chahine & Goergen, 2013) and provides a better understanding of strategic goals, also using their specific social capital (Cabrera-Suárez & Martín-Santana, 2015). Families, as a source of resources from interaction between family members and the business as a whole, is a central point in resource-based, social capital, and systems perspectives (Daspit, Long, & Pearson, 2018). The interrelated nature of the collective vision, trust, the language of kin, and social understanding raises the efficiency of internal information exchange and helps to create and reach collective goals (Pearson, Carr, & Shaw, 2008). This resource, especially information exchange and accessibility, can be the main factor for success in innovation production efficiency, while sharing goals and collective vision can help in decision-making when it is time to decide on the reasonableness of investing in innovative projects.

2.4 Innovation and family involvement

Innovation in the literature is often divided into following parts: innovation inputs or money invested in R&D activities, innovational activities or how processes in the company are organized, and what innovation mainly focuses on (this part is often omitted in empirical literature) and innovation outputs or the results of these activities (often measures in patents, patent applications, new products issued or profit margins) (Minin, 2015). The main paradox widely analyzed in family business studies—the willingness-ability paradox—is that family involvement has a negative impact on the first part of innovation process, but often provide better results on the second, outperforming non-family competitors (Chrisman, Chua, De Massis, Frattini, & Wright, 2015; De Massis, Frattini, Pizzurno, & Cassia, 2015).

For technological companies with strong competition, producing new products is a question of importance, thus, family members will tend to invest in innovations to protect and maintain their SEW. However, they also try not to get into risky and costly projects which may be a cause of financial distress, lessening the control (when attracting investor capital), and potential losses in the case of failure. This may be a good explanation for the fact that companies with family involvement tend to invest smaller but still positive amounts in R&D activities (Classen et al., 2014). Unfortunately, there are few studies concentrating on R&D activities in family high-tech companies. Nonetheless, there is an opinion that family involvement may result in more active investing in innovation, when it is considered vital for surviving in a competitive environment (De Massis et al., 2013).

Another explanation of the smaller amounts invested by family-controlled firms lies in their conservatism and the realization of their advantages in communications and process-building. However, such conservatism may be a problem when all the power is concentrated in one person (especially in case of CEO duality) and there is a lack of expertise and independent opinions. In such a situation, having an independent director with adequate experience and an autonomous vision of the industry can help to lessen these negative effects (Chen & Hsu, 2009).

2.5 CEO Duality

Many companies separate the roles of CEO and chair to ensure that the CEO will be focused on the day-to-day business, allowing the chair and the board to provide advice and

independent oversight of management.[3] Separating these roles is also believed to encourage free and open dialogue.[4]

On the other hand, CEO duality may unite the management and governance function, resulting in better understanding of global strategic goals (Cabrera-Suárez & Martín-Santana, 2015). The knowledge- and resource-based views say that specific capital relating to human resource characteristics and organizational structure contributes to creativity and trust among the employees due to interconnection of the management and governance functions (Chrisman et al., 2015; Matzler et al., 2015). Among other things company governance mentions is that having one person serve as both chair and CEO provides clear leadership, ensures accountability for successes and failures, and creates a link between management and the board with a regular flow of information, enabling it to perform its monitoring function with the benefits of management's perspective on business, and involving independent directors provides strong oversight of the management team.

Separating positions may result in divided leadership, interfering with good decision-making and weakening the ability of developing and implementing strategy, while combining them will provide a clear chain of command to execute strategic initiatives. In the case of a founder serving as CEO, it may be better to use their knowledge and experience rather than that of a less informed but independent chair.

2.6 Family involvement types

A crucial factor often missed by researchers is the heterogeneity of family involvement. The absence of unified definition of family firm and family involvement has been widely discussed (Harms, 2014; Kraiczy & Hack, 2013; Zhou et al., 2017), and is considered to be of a great importance for estimating the willingness to take risks and pursue noneconomic goals and for understanding inside the system (Rondi, Massis, & Kotlar, 2017). Family involvement may be provided by ownership, management, or governance.

The resource-based view explains why active family participation in managing and supervising helps in enhancing the efficiency of R&D. On a dataset consisting of large German publicly traded companies, it has been shown that family engagement in management and governance has a positive effect on innovation output (R&D results), and negatively on innovation input (R&D investment) (Matzler et al., 2015). This result

[3] https://www.sec.gov/Archives/edgar/data/1396814/000104746913004862/a2214633zdef14a.htm
[4] https://www.sec.gov/Archives/edgar/data/1596783/000119312516709810/d253874ddef14a.htm

reaffirms the prevalent opinion about the family firm paradox; however, they have also shown that separate ownership has no significant effect on any of these parameters.

Dissecting family firm involvement into more specific types provides the opportunity for a more detailed analysis of the "black box" of family firms. Such an approach was used by (Villalonga, Amit, 2006), where starting point of defining family firms was the founder or a member of their family as an officer, director, or blockholder (not regarding ownership and voting rights). Adding after new conditions including 20% of vote ownership or including the next generations, they show that, compared to nonfamily firms, family firms can be more or less valuable depending on the definition we choose for the analysis.

2.7 Family involvement and innovation: hypotheses

In this work we classify a firm as a family one, if the family owns at least 5% of the voting rights, following (Anderson et al., 2003 and Cronqvist & Nilsson, 2003), and that a member of this family serves as chair or CEO (making our definition consistent with EU definition 20095). This leads to the interest of management in high performance, making appropriate investments in R&D and controlling and managing innovation to get the most gains from the investment (Chahine & Goergen, 2014). Family ownership is an essential condition for bringing non-economic community and family goals together to enhance the business performance as found by (Randolph, Alexander, Debicki, & Zajkowski, 2019).

H1a Family firms invest more in innovation.

H1b Family firms have more patent applications and higher margins.

Following the broader definition of a family firm used by (Villalonga, Amit, 2006) we also consider founder- and next generation-led firms (even without voting rights). The involvement of the founder in the management and governance is associated with a clear understanding of strategic goals and better market performance (Gill & Kaur, 2015). This means that having the founder as CEO results in better leadership and a better understanding of the business by senior management. Therefore, two hypotheses follow:

H2a. Having the founder as the CEO leads to more active investment in R&D.

H2b. Having the founder as the CEO results in more effective investment: more patents, patent applications, and higher margins.

[5] https://ec.europa.eu/growth/smes/promoting-entrepreneurship/we-work-for/family-business_en

Adding to different family firm types, we consider one more case—family ties within the firm. Family ties between top management and the board lead to smoother interaction between them (Chahine & Goergen, 2014). Therefore, it would be easier to come to an agreement on R&D strategy and organize the process more effectively. Family ties within the company's management and governance may make CEO regard the company as a family one, so that protecting SEW will be more important than purely rational economic estimates. In the case of high-tech firms, where producing innovations is vital to survival, we expect higher R&D expenditures and results when family ties exist, following (De Massis et al., 2013).

H3a. Family ties between the CEO and the board lead to higher R&D investment.

H3b. Family ties between the CEO and the board result in a greater number of patent applications and higher margins.

The case of CEO duality seems to be an example of corporate management and a governance type which provides an analogous situation to that of family involvement. CEO duality is also associated with the performance alignment of strategic goals and more effective decision-making, while having more power within the firm, similar to family firms where family involvement exist in ownership and management. (Cabrera-Suárez & Martín-Santana, 2015). So next hypotheses are:

H4a. CEO duality leads to higher R&D expenses.

H4b. CEO duality provides better innovation outcomes (more patent applications, and higher margins).

3. Data and methodology

3.1 Data sources

Data on companies with the highest capitalization was obtained using information about S&P500 companies from the Capital IQ database. Companies from pharmaceutical and ICT industries were selected, as the most numerous representatives of high-technology companies, following the OECD definition of high-technology industries. All financial data, and data on ownership and board composition from 1999 to 2017 was obtained from Capital IQ. The data on family ties and family involvement, including the ownership of voting power was collected manually from filings published on the US Securities and Exchange Commission site (form SCHEDULE 14A proxy statement) which give family involvement in ownership, management, and governance. Company histories were reviewed to resolve descendent issues. We follow the US Securities and Exchange Commission definition of a family member, which includes children, stepchildren, grandchildren, parents, stepparents, grandparents, spouses, former spouses, siblings, nieces, nephews, mothers-in-law and fathers-in-law, daughters-in law, sons-in-law, brothers-in-law and sisters-in-law. The final dataset includes data on 108 companies. However, six companies were excluded from the analysis due to changes in the organizational form within selected time period (e.g., PayPal was acquired by eBay, but then separated again) or a lack of information about R&D activities. This yields 1,757 firm year observations for the period 1999 through 2017.

Surprisingly, only one company from our sample is consistent with family firm definition requiring the firm management role to be passed to the next generation. In QUALCOMM Incorporated (NasdaqGS:QCOM) the founder and CEO's son served as Executive Vice President, then became CEO, with his father playing the role of chair and his brother working as a senior director. In other cases, family ties mostly included spouses, brothers and sisters, and were not common. Furthermore, most of the companies have the CEO's or a director's family members employed by the company but not as senior managers directors.

3.2 Measuring family involvement and innovation input and output

As mentioned, the US Securities and Exchange Commission definition of a family member was used to reveal family ties and involvement. Dummy variables were created to indicate founder involvement, CEO duality, and CEO-board family ties. For the measurement of family involvement characteristics connected with ownership, a categorical variable was created where 0 was assigned to companies where neither the CEO, nor the chair owns more

than 5%, 1 if the CEO owns > 5%, 2 if the chair owns > 5% and 3 if the CEO plays the dual role and owns > 5% of the shares.

To measure innovation input we used the ratio of the logarithm of R&D expenditures to the previous year's revenues. However, as R&D expenditure cannot be an estimation of innovation effectiveness, we had to find other measures for innovation output. Past studies of innovation have developed diverse ways to measure its productivity. Patent applications seem to be a good estimation of CEO incentives, but they are often unequal (some of them are completely useless, while others are extremely valuable (Berrone, Makri, & Gomez-Mejia, 2008)). Moreover, as mentioned, family firms are less likely to use patents, in order to preserve their privacy (Bannò, 2016). Data on new product issuance was not available, so we decided to use data on income margins, which can show the quantitative estimation of advantages of the firm due to creating new innovative products, patents, and patent applications. Innovations are sometimes divided into science-based and technological-based, but this distinction is not made in this paper.

Controls for firm performance, size, age, leverage, country, and industry are also included.

3.3 Methodology

To examine the influence of family involvement on innovation input and output, we use variables and equations described in Table 1:

Table 1. Main variables

Variables	***Description***
Dependent variables	
RDRev	$\log\left(\frac{R\&D\ exp}{Revenues_{t-1}} + 1\right)$
incmar	Net income margins, %
Pat	Number of patents company has
patapp	Number of patent applications made this year
Independent variables	
faminv	Categorical, 0 – neither CEO, nor chairman owns >5% of voting power; 1 – if CEO owns >5%; 2 – if Chairman owns >5%; 3 – if CEO serves as Chairman and owns > 5%.

Found	Dummy variable, 1 if founder performs CEO role, 0 – otherwise
Duality	Dummy variable, 1 – if CEO serves as Chairman, 0 – otherwise
Ties	Dummy variable, 1 – if CEO has family ties within the board

Control variables

ind	Categorical, industry: 1 – pharmaceutical, 2 – IT
coun	Categorical, country of incorporation, 1 - United States, 2 – Netherlands, 3 – Ireland, 4 – Cayman Islands, 5 – Singapore, 6 – Switzerland
Age	Age of the company
cap	Logged market Capitalization, $USD mm
rev	Logged revenue of the previous period, $USD mm
DEq	Total debt to equity, logged %
RD	Logged R&D expenditures in $USD mm

To evaluate the impact of family involvement on innovation input and output, we propose the following equations for regression analysis:

$$RDRev = \alpha_0 + \alpha_1 faminv + \alpha_2 age + \alpha_3 rev + \alpha_4 ind + \alpha_5 coun + \alpha_6 DEq \quad (1)$$

$$incmar = \alpha_0 + \alpha_1 faminv + \alpha_2 age + \alpha_3 rev + \alpha_4 ind + \alpha_5 RD + \alpha_6 DEq \quad (2)$$

$$patapp = \alpha_0 + \alpha_1 faminv + \alpha_2 age + \alpha_3 cap + \alpha_4 ind + \alpha_5 RD + \alpha_6 DEq \quad (3)$$

Here $faminv$ is the "traditional" family involvement in business (both ownership and participation in management or governance) and is a categorical variable taking following values: 0 if neither the CEO nor the chair owns > 5% of the voting power, 1 if CEO owns > 5%, 2 if the chair owns > 5%, 3 if ownership is accompanied by CEO duality (which is expected to add even more power to a CEO-owner). We expect positive coefficients for α_1 in all specifications following the idea of the positive influence of goal alignment between management and owners in family firms, which will result both in the growth of innovation input (money spent) and output (patents, income margins).

Given the heterogeneity of family firms, we also estimate the impact of the founder's involvement, with model equations similar to family involvement:

$$RDRev = \alpha_0 + \alpha_1 found + \alpha_2 age + \alpha_3 rev + \alpha_4 ind + \alpha_5 coun + \alpha_6 DEq \quad (4)$$

$$incmar = \alpha_0 + \alpha_1 found + \alpha_2 age + \alpha_3 rev + \alpha_4 ind + \alpha_5 coun + \alpha_6 DEq \quad (5)$$

$$patapp = \alpha_0 + \alpha_1 found + \alpha_2 age + \alpha_3 cap + \alpha_4 ind + \alpha_5 coun + \alpha_6 DEq \quad (6)$$

In this equation $found$ is a dummy variable taking values of 1 if the founder is the CEO, and 0 otherwise. We expect positive coefficients for α_1 in all specifications due to the more entrepreneurial nature of a founder-CEO and effective leadership and communication built within the firm while the founder is CEO.

To evaluate the impact of family ties between the CEO and the board on innovation input and output, we propose the following equations:

$$RDRev = \alpha_0 + \alpha_1 ties + \alpha_2 age + \alpha_3 rev + \alpha_4 ind + \alpha_5 coun + \alpha_6 DEq \quad (7)$$

$$incmar = \alpha_0 + \alpha_1 ties + \alpha_2 age + \alpha_3 rev + \alpha_4 ind + \alpha_5 RD + \alpha_6 DEq \quad (8)$$

$$patapp = \alpha_0 + \alpha_1 ties + \alpha_2 age + \alpha_3 cap + \alpha_4 ind + \alpha_5 RD + \alpha_6 DEq \quad (9)$$

Where $ties$ is a dummy variable, which equals 1 when there are family members in the company's management and governance (board). We also expect α_1 to take positive values due to better interconnection within the firm (Chahine & Goergen, 2014). Smoother interaction results in more efficient financial decision-making and better innovation output.

We also looked at the joint influence of the founder's involvement and family ties, and the CEO's and/or chair's ownership with family ties, adding several dummy variables into the model equation:

$$RDRev = \alpha_0 + \alpha_1 found + \alpha_2 ties + \alpha_3 age + \alpha_4 rev + \alpha_5 ind + \alpha_6 coun + \alpha_7 DEq \quad (10)$$

$$RDRev = \alpha_0 + \alpha_1 faminv + \alpha_2 ties + \alpha_3 age + \alpha_4 rev + \alpha_5 ind + \alpha_6 coun + \alpha_7 DEq \quad (11)$$

Having both types of family involvement in a firm is expected to bring more positive effects on our dependent variables through advanced interconnection and goal unity. Adding ties to a founder-led firm may help to distinguish between lone founder firms, and founder family firms, where the founder is willing to pass the business to the next generation.

To estimate the influence of CEO duality on innovation input and output, which we assume to be similar to familiar involvement, we propose the following equations with the dummy variable $Dual$ used:

$$RDRev = \alpha_0 + \alpha_1 Dual + \alpha_2 age + \alpha_3 rev + \alpha_4 ind + \alpha_5 coun + \alpha_6 DEq \quad (12)$$

$$incmar = \alpha_0 + \alpha_1 Dual + \alpha_2 age + \alpha_3 rev + \alpha_4 ind + \alpha_5 RD + \alpha_6 DEq \quad (13)$$

$$patapp = \alpha_0 + \alpha_1 Dual + \alpha_2 age + \alpha_3 cap + \alpha_4 ind + \alpha_5 RD + \alpha_6 DEq \quad (14)$$

To all the specifications, we add an age variable (firm's age) to control for the life-cycle stage of a firms, cap (logged market capitalization) to control for size, ind (industry) to switch between pharma and IT industry results, $coun$ (country) to control for country-

level effects, DEq (logged debt to equity) to control for a firm's reliance on debt financing. For innovation output equations with income margins or patent applications as dependent variables RD (logged R&D expenditures) is added to show the effect of innovation input in innovation generation.

3.4 Descriptive statistics

Table 2 shows that there is a downward trend in number of companies where the roles of CEO and chair of the board are not separated. However, the number of companies with founder involvement rises between 2008 and 2017, which can be explained by the emergence of new companies which were able to get high capitalization in a very short period. The number of companies with family ties decrease slightly from 4% to 2%, and the number of companies matching our definition of a family firm and the CEO's share of voting rights. However, the number of companies with a woman CEO increases sharply.

Table 2. Main independent variables characteristics and trends

	1999		***2008***		***2017***	
Variable	*Mean*	*std dev*	*Mean*	*std dev*	*mean*	*std dev*
CEO duality	*0.591*	*0.495*	*0.359*	*0.482*	*0.313*	*0.466*
Founder inv.	*0.197*	*0.400*	*0.157*	*0.366*	*0.186*	*0.391*
Family ties	*0.041*	*0.201*	*0.034*	*0.183*	*0.029*	*0.170*
Family firm	*0.1*	*0.301*	*0.032*	*0.177*	*0.029*	*0.169*
CEO owned	*5.474*	*14.949*	*2.129*	*6.197*	*2.671*	*10.71*
CEO woman	*0 .028*	*0 .166*	*0.033*	*0.181*	*0.069*	*0 .255*

4. Empirical results

To test our hypothesis linear regressions with panel-corrected standard errors were used.

Table 3 presents descriptive statistics for technological companies (102 companies, 40 operating in pharmaceutical industry and 62 in informational technology) in our sample. The average market capitalization is $52,732 million, revenue is $12,981 million, and age is 40 years. However, there were firms which age was just 1 year in 2016 (due to company reorganization). Table 3 also shows some characteristics of the dependent variables: R&D expenditures and income margins. Not all companies provided information about the last parameter, so it was decided to use a pairwise method of counting covariances to deal with the unbalanced panel so as to not lose observations when running the regressions.

Table 3. Main sample characteristics in 2017

VARIABLES	Observations	mean	sd	min	max
Age, years	102	40.08	35.81	1	167
Market Capitalization, $USD mm	102	52,733	115,966	262.8	718,409
R&D expense, $USD mm	101	1,539	2,864	0	13,948
Revenues t-1, $USD mm	102	12,729	28,742	0	233,715
Net income margin, %	93	18.2	275.1	-279	6,702
Number of patents	22	512.3	1,086	1	4,800

VARIABLE RDRev $=\log\left(\frac{R\&D\ exp}{Revenues_{t-1}}+1\right)$

Mean	sd	min	max	p1	p10	p25	p50	p75	p90	p95	p99
1.545	6.78	0	86	0	0.023	0.081	0.16	0.24	0.93	6.94	37.9

VARIABLE Income margin, %

mean	sd	min	max	p1	p5	p10	p25	p50	p75	p90	p95	p99
18.2	275.1	-279	6,702	-212	-32.8	-5.7	6.51	13.05	20.55	26.7	31.9	63.7

In Table 4, the main results considering investment in R&D are presented. The founder's involvement and CEO ownership of over 5% show a positive impact on innovation input, proving hypothesis *H1a* and *H2a*. Coefficients equal to 0.413 for the founder's involvement and around 0.299 for CEO owning more than 5% of the company's equity, are high considering that the mean value of the dependent variable is 1.545 and

median 0.157. Such a result seems to be of a special interest, as it can be interpreted as a two or threefold increase for more than half of the companies of our sample in R&D spending when the CEO is the founder, and twofold increase when CEO owns > 5% of the company's shares, proving the importance of founder's leadership and motivation when taking decisions on risky and long-term investment projects, as suggested by (Gill & Kaur, 2015) and (Chahine & Goergen, 2014).

However, CEO duality accompanied by share ownership, family ties between CEO and the board, and chair ownership decrease the R&D investment, contradicting (Cabrera-Suárez & Martín-Santana, 2015), who suggest there is a positive influence of uniting management and governance in understanding strategic goals. The largest impact is when the chair owns more than 5% of the shares. The coefficient is 0.988 which means that for the most companies of our sample (90% percentile shows RDrev parameter value of 0.933) such a situation leads to incredibly low spending on R&D (less than a 1% of revenues). Family ties (-0.657) and combining CEO duality with equity ownership (-0.679) also show a large negative impact on R&D expenditures even though they are less dramatic. This result contradicts hypothesis *H1a* and *H4a*, and can be explained by a lack of independent vision, as CEO duality will build the company's strategy in accordance with their own vision, limiting opportunities for independent ideas; it also explains the situation when the chair is not independent, having shares in the company. A chair who is not independent may block useful initiatives and interrupt the company's work with overactive monitoring. Therefore, we find the explanation given by Chen & Hsu, 2009 applicable for this case: in such situations, decision-making will be characterized by conservatism and a lack of independent oversight. That is why a powerful family may not help governance in technological companies. Finally, revenue of the previous period has a strongly negative effect on the R&D spending, however, this can be explained by the nature of this parameter—we use a ratio of logged R&D expenditures to the previous year's revenues, while R&D spending is always connected with long-term projects that need stable financing if company is not starting new projects.

Table 5 is dedicated to the analysis of income margins. Most coefficients used were insignificant in the prediction of income margins, as this parameter is not a direct reflection of the effectiveness of R&D process. However, family ties showed positive effects on income margins, proving hypothesis *H3b* and idea of specific social capital and the usefulness of such interconnections between the board and management (Chrisman et al., 2015; Matzler et al., 2015). Coefficient 31.25 for family ties means a more than twofold rise

in income margins if such an interconnection between management and governance exists (based on a mean and median value of parameter income margin, 18 and 13 respectively). Contrarywise, CEO duality accompanied with owning of a high share of the company's equity has negative effect (-31.16), again contradicting (Cabrera-Suárez & Martín-Santana, 2015) the idea of united management and governance teams. It contradicts *H4b*, meaning that it will have the opposite effect and can be explained by the negative effect of such governance and management schemes on R&D investments, as even with effective communication within the firm, special social capital cannot replace essential research financing and independent oversight (Chen & Hsu, 2009).

Surprisingly, in the case of income margin, chair ownership has a positive effect, which contradicts our results connected with R&D spending. We find an explanation in the ambiguous nature of the dependent parameter, as income margin depends on many factors including the overall monitoring function and all organizational processes.

Unfortunately, the data on patents and patent applications was not available for most of the companies in our dataset (only 25 companies from pharmaceutical industry have data on patents, and 19 on patent applications). The results are presented in Appendix 1 and 2.

Considering robustness checks, we can see that the estimations of coefficients are robust in different model specifications. We used linear regressions with panel-corrected standard errors that account for panel-specific autocorrelation (AR1) and the heteroscedasticity of disturbances, and we have controlled VIFs for all our variables in our model specifications. For example, market capitalization and revenues were not used at the same specification due to their high correlation (0.82). For most specifications of models for R&D expenditures estimation we have an R squared value of more than 0.74, which shows the good explanatory ability of the proposed models.

Despite the low R squared value (around 0.25) for the models with income margin, we believe that our results are significant, however more parameters should be added in the specification model considering the specific nature of this parameter. However, looking at different model specifications used for the estimation, we can say that the results are robust, and we are able to estimate the character of our parameter's influence.

Table 4. This table presents the results of linear regressions with panel-corrected standard errors (based on OLS approach) of family involvement parameters on R&D expenditures. Our sample is 97 high-tech firms from S&P500. The main dependent variable RDRev is a logged R&D expenditures in $USD million scaled by the previous year revenues, $USD million, the main independent variables: dummy Duality – 1 if CEO plays dual role, 0 otherwise, Founder CEO – 1 if founder is a CEO, 0 otherwise, TIECEOboard – dummy, 1 if CEO has family member working at the board, faminv – categorical, 1 if CEO owns > 5%, 2 if chairman owns >5 %, 3 if CEO owns >5% and serves as CEO. More information about variables (including controls is provided in chapter *3.3 Methodology*). Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

VARIABLES	(4) RDRev	(12) RDRev	(7) RDRev	(1) RDRev	(10) RDRev	(11) RDRev
CEO owns > 5%				0.299**		0.259**
				(0.130)		(0.131)
Chairman owns > 5%				-0.988***		-1.154***
				(0.167)		(0.172)
CEO-Chair owns >5%				-0.679***		-0.569***
				(0.206)		(0.179)
Founder CEO	0.413***	0.431***			0.375***	
	(0.126)	(0.126)			(0.127)	
TieCEOboard			-0.657***		-0.696***	-0.823***
			(0.202)		(0.248)	(0.219)
Duality		-0.0431				
		(0.0322)				
Total Debt to Equity	-0.00218	-0.00243	-0.00550	-0.128***	-0.00424	-0.125***
	(0.00981)	(0.00981)	(0.00970)	(0.0244)	(0.00993)	(0.0241)
Age	0.00140	0.00141	-0.000352	0.000505	-0.000729	0.000642
	(0.00185)	(0.00189)	(0.000887)	(0.00087)	(0.00187)	(0.000869)
Dummy Netherlands	-0.0528	0.0310	-0.208	-0.938***	-0.218	-0.888***
	(0.237)	(0.257)	(0.258)	(0.154)	(0.223)	(0.162)
Dummy Ireland	-0.157	-0.0682	-0.230	-0.833***	-0.222	-0.850***
	(0.181)	(0.201)	(0.214)	(0.0713)	(0.196)	(0.0787)
Dummy Cayman Islands	2.340***	2.426***	2.221***	2.246***	2.334***	2.108***
	(0.234)	(0.241)	(0.259)	(0.453)	(0.261)	(0.444)
Dummy Singapore				0.735***		0.738***
				(0.237)		(0.229)
Dummy Switzerland	-0.126	-0.127	-0.520***	-0.427***	-0.505***	-0.401***
	(0.0986)	(0.0956)	(0.132)	(0.0544)	(0.114)	(0.0500)
Revenue(t-1)	-0.467***	-0.474***	-0.445***	-0.306***	-0.420***	-0.321***
	(0.0239)	(0.0242)	(0.0289)	(0.0188)	(0.0280)	(0.0177)
Dummy Industry (IT)	0.270	0.379*	0.412**	-0.571***	0.338**	-0.636***
	(0.170)	(0.197)	(0.207)	(0.0906)	(0.147)	(0.101)
Constant	1.180***	1.156***	1.261***	1.288***	1.080***	1.453***
	(0.142)	(0.149)	(0.162)	(0.0770)	(0.147)	(0.0765)
Observations	1,247	1,247	1,247	1,266	1,242	1,247
R-squared	0.747	0.739	0.735	0.485	0.731	0.498
Number of companies	97	97	97	97	97	97

Table 5. This table presents the results of linear regressions with panel-corrected standard errors (based on OLS approach) of family involvement parameters income margin. Our sample is 95 high-tech firms from S&P500. The main dependent variable is Net income margin, measured in percent, the main independent variables: Founder CEO – 1 if founder is a CEO, 0 – otherwise, dummy Duality – 1 if CEO plays dual role, 0 – otherwise, faminv – categorical, 1 if CEO owns > 5%, 2 if the chair owns >5 %, 3 if CEO owns >5% and serves as CEO, 0 otherwise, TIECEOboard – dummy, 1 if CEO has family member working at the board, 0 otherwise,. More information about variables (including controls is provided in chapter *3.3 Methodology*). Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

VARIABLES	(5) Income margin	(13) Income margin	(8) Income margin	(2) Income margin
Founder CEO	9.259			
	(7.207)			
Duality		-1.490		
		(2.011)		
CEO owns > 5%	1.871			5.429
	(8.575)			(9.560)
Chairman owns > 5%	27.89***			18.59**
	(6.053)			(8.411)
CEO-Chair owns >5%	-16.71*			-31.16**
	(8.755)			(13.43)
TieCEOboard			31.25**	
			(14.19)	
Log R&D	-1.171	-1.392*	-1.438*	-3.135
	(0.766)	(0.804)	(0.799)	(2.254)
Total Debt to Equity	0.134	-0.198	-0.0818	-1.189
	(1.221)	(1.083)	(1.083)	(0.901)
Age	0.195***	0.183***	0.178***	0.203***
	(0.0449)	(0.0391)	(0.0427)	(0.0616)
Revenue(t-1)	-0.000304***	-0.000262***	-0.000280***	-0.000424***
	(5.90e-05)	(5.15e-05)	(5.87e-05)	(8.81e-05)
Dummy industry(IT)	22.94***	20.03***	21.08***	26.26***
	(3.686)	(3.325)	(3.516)	(6.826)
Constant	-134.4***	-118.5***	-126.7***	-173.1***
	(15.68)	(14.01)	(15.62)	(25.99)
Observations	773	773	768	774
R-squared	0.253	0.225	0.232	0.275
Number of companies	95	95	95	95

5. Conclusion

Family involvement has a contradictory influence on firm's decision-making and performance. Despite the vast amount of research on this topic, no clear resolution of this paradox has been found and it is still unclear whether family involvement is good or bad for a business. Furthermore, no clear explanation of a family firm's features that are helping them to outperform their competitors has been given.

This work aims to deliver new evidence on family firms, more precisely, technological ones in their struggle to remain competitive in rapidly changing markets by analyzing their R&D processes. We have shown that the founder's leadership and the CEO's equity ownership, as well as the shared vision of family members may be an effective way of realizing family involvement advantages in building competitive strategies and processes within the firm.

Our results show that the founder's involvement and CEO equity ownership has a positive effect on R&D spending (providing a twofold increase in the R&D spending quotient in the previous year's revenue), contradicting the idea that family firms tend to invest less, while doing so more effectively. Chair and CEO ownership of company equity, CEO duality accompanied by share ownership, and family ties between CEO and the board have significant negative effect on this parameter, consistent with the prevalent idea of the impact of family involvement on innovation input. For innovation output, family ties and the chair's ownership have the opposite effect—income margins are larger when there are family ties or chair ownership.

This can be explained by special social capital, smoother interconnection, more intensive monitoring of R&D, and by the ambiguous nature of the dependent parameter. Nevertheless it reaffirms the main thesis of the family involvement paradox. However, CEO duality with ownership has a negative effect on innovation output, which could be explained by conservative decision-making and a lack of oversight and independent expertise.

This information may be useful for business management and governance as it reveals the weaknesses and opportunities arising from family participation in ownership, management, and governance. Considering our results, company's shareholders should be aware of the negative impact of CEO duality and chair affiliation and try to avoid these risks or minimize their negative impact by adding an independent director and improving corporate rules restricting duality.

We contribute to the literature by concentrating on high-tech firms and family ties in companies which are believed to be pacemakers in modern economies. However, our study is not free from limitations—only a few of our sample had information about patents and patent applications. Not many of them had family ties, so a closer examination of these relationships should be done. In addition, for more precise evaluation of the differences between high-tech and low-tech companies' performance with family involvement, a control group should be added to the analysis.

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7. Appendix 1

Table 6. Main patents' variable characteristics

VARIABLE patents

mean	sd	min	max	p1	p5	p10	p25	p50	p75	p90	p95	p99
487.2	1,084	1	4,800	1	2	14	24	73.50	285	1,209	4,800	4,800

As it can be seen, founder's involvement, CEO's and/or Chairman ownership has robust significant negative effect on number of patents company has. For more than 75% of our sample that have information about patents, it means completely refusing of such intellectual property protection tool. While it contradicts our hypothesis *H1a, H3a, i*t can be explained by the results of the already mentioned paper of (Bannò, 2016), who proved unwillingness of family firms to disclose information through patent system.

Table 7. This table presents the results of linear regressions with panel-corrected standard errors (based on OLS approach) of family involvement parameters on patents. Our sample is 25 high-tech firms from S&P index. Main dependent variable – number of patents company has, main independent variables: Founder CEO – 1 if founder is a CEO, 0 – otherwise, dummy Duality – 1 – if CEO plays dual role, 0 – otherwise, faminv – categorical, 1 – if CEO owns > 5%, 2 – if chairman owns >5 %, 3 – if CEO owns >5% and serves as CEO, 0 – otherwise, TIECEOboard – dummy, 1 if CEO has family member working at the board, 0 - otherwise,. More information about variables (including controls is provided in chapter *3.3 Methodology*). Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

VARIABLES	(6) Patents	(14) Patents	(9) Patents	(3) Patents
FounderCEO	-453.2***			
	(131.6)			
CEO owns > 5%	143.2			-137.9**
	(95.33)			(59.65)
Chairman owns > 5%	-744.7***			-778.3***
	(127.5)			(108.7)
CEO-Chair owns >5%	-507.4**			-620.3***
	(201.3)			(136.7)
TieCEOboard			-56.31	
			(56.61)	
Duality		54.63		
		(47.54)		
Log R&D	283.7***	39.73	281.1***	215.1***
	(92.11)	(36.94)	(67.87)	(73.73)
Log Market cap	295.8***	182.7***	354.9***	340.1***
	(94.88)	(55.37)	(82.68)	(91.02)
Total Debt to Equity	21.99	31.91***	32.23**	38.90**
	(24.29)	(10.82)	(14.29)	(15.13)
Age	4.962***	-4.392**	2.293	6.951***
	(1.777)	(1.854)		(1.799)
Constant	-2,614***	-1,208***	-3,226***	-2,905***
	(456.6)	(428.4)	(410.0)	(430.1)
Observations	73	73	73	73
R-squared	0.534	0.370	0.471	0.503
Number of companies	25	25	25	25

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

8. Appendix 2

Table 8. Main patent applications' variable characteristics

VARIABLE patent applications

mean	sd	min	max	p1	p5	p10	p25	p50	p75	p90	p95	p99
298.3	538.2	1	2,100	1	3	5	19	44	245	906	2,000	2,100

Consistent with previous results considering patents, founder's involvement and CEO's ownership, as well as duality has negative impact on patent applications again approving results of (Bannò, 2016). Nevertheless, positive effects of duality accompanied with ownership and family ties can be observed. Despite the fact, that it reaffirms our hypothesis *H2a* and *H4a* it contradicts our overall findings, mostly with ones connected to patents, we find the explanation of such phenomena in overconfidence on CEO, who own's a share and plays a dual role or have ties in the board, so that the patent applications are not approved. Nevertheless, additional research should be done.

Table 9. This table presents the results of linear regressions with panel-corrected standard errors (based on OLS approach) of family involvement parameters on patent applications. Our sample is 19 high-tech firms from S&P index. Main dependent variable – number of patent applications made this year, main independent variables: Founder CEO – 1 if founder is a CEO, 0 – otherwise, dummy Duality – 1 – if CEO plays dual role, 0 – otherwise, faminv – categorical, 1 – if CEO owns > 5%, 2 – if chairman owns >5 %, 3 – if CEO owns >5% and serves as CEO, 0 – otherwise, TIECEOboard – dummy, 1 if CEO has family member working at the board, 0 - otherwise,. More information about variables (including controls is provided in chapter *3.3 Methodology*). Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

VARIABLES	(6) patentapp	(14) patentapp	(9) patentapp	(3) patentapp
FounderCEO	-89.76*			
	(46.38)			
CEO owns > 5%	-7.273			-56.59*
	(31.29)			(31.38)
Chairman owns > 5%	-18.77			
	(187.8)			
CEO-Chair owns >5%	265.8			220.8*
	(201.6)			(129.3)
TieCEOboard			114.9**	
			(45.52)	
Duality		-86.59***		
		(22.34)		
Log R&D	219.4***	213.4***	201.9***	41.18
	(61.67)	(53.26)	(51.33)	(36.06)
Log Market cap	111.8***	118.5***	130.1***	40.57***
	(26.98)	(22.06)	(26.29)	(14.08)
Total Debt to Equity	-9.495	-8.891	-11.52	-11.36
	(11.97)	(10.30)	(11.29)	(9.016)
Age	0.973	1.233	1.732	3.417
	(2.205)	(2.011)	(1.931)	(3.963)
Dummy Industry (IT)				-292.8**
				(143.4)
Constant	-1,223***	-1,269***	-1,346***	
	(216.1)	(218.8)	(231.7)	
Observations	103	103	103	104
R-squared	0.620	0.614	0.612	0.200
Number of companies	19	19	19	19

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

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