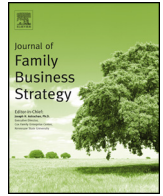




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Propensity to patent by family firms

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ABSTRACT

This paper provides new evidence of innovation processes in family firms by investigating their attitude toward the protection of innovation outputs. More specifically, the main objective is to understand, through the SEW (Socioemotional Wealth) lens, whether innovative family firms tend to use patents as a tool for protecting intellectual property. Based on a sample of 229 Italian companies that make R&D investments, our analysis highlights that degree of alignment with the family business model is a significant predictor of a firm's attitude toward protecting innovation with patents, even though not all of the dimensions of a family business have the same effect. When disentangling the effect of three different indicators (i.e., family ownership, family governance and the presence of young successors), family involvement in the board of directors is a negative significant driver, the presence of young successors is a positive driver, and ownership has no effect.

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1. Introduction

Although an important driver of diversity in managing innovation is firms' varying ability both to protect themselves from imitation and to appropriate a satisfactory proportion of innovation returns (Thomä & Bizer, 2013), managing innovation inside family firms requires consideration of such firms' long-term survival (D'allura, 2015). Accordingly, it is an integral part of family firms' innovation and survival policy to foster the use of patents as a tool to protect firm property. Indeed, it is widely acknowledged that similar to nonfamily firms, family firms target technological innovation to develop competitive advantages (McCann, Guerrero, & Haley, 2001). Nevertheless, because family ownership and involvement affect business processes (Zahra, 2005; Romano, Tanewski, & Smyrnios, 2001), we argue that family firms take a different approach than nonfamily firms to managing technological innovation and particularly in strategically choosing appropriate tools for protecting their intellectual property. That notwithstanding, with only a few exceptions, family firms' management of technological innovation and the peculiarities of family firms' innovation process have not received very much attention in the literature (De Massis, Kotlar, Chua, & Chrisman, 2014). Based on that assumption, this paper aims to provide new evidence on innovation processes in family firms by investigating their attitude towards the protection of innovation outputs. More

specifically, the primary objective is to understand, through the SEW (Socioemotional Wealth) lens, whether innovative family firms tend to use patents as an intellectual-property protection tool.

Innovators – that is, firms that develop technological innovations – aim to maximize revenues from their R&D efforts (Granstrand, 1999; Teece, 1986). This project involves managing the issue of appropriability, i.e., the degree to which returns from investments in R&D accrue to innovators or to other market participants (Levin, Klevorick, Nelson, & Winter, 1987). Although the patent system was developed to address this problem (Kitch, 1977), it is not the only or necessarily the best solution. More specifically, innovators must contemplate whether it is better to capture profit from innovations by protecting them with patents or by other means such as industrial secrecy, lead time, first-mover advantages or complementary products and services (Mäkinen, 2007).

Although the patent system is one of the most utilized intellectual-property protection tools, previous empirical literature highlights that the relationship between inventions, innovation and patents is not as simple as the one predicted by economic and innovation theories (Cohen, Nelson, & Walsh, 2004). Because not all inventions are patentable¹ and because patenting is not always perceived by firms as the most efficient and effective protection tool, only some inventions are protected by patents. In

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¹ Only inventions that are novel, industrially applicable, and substantially different from existing technologies may be patented.

short, firms have heterogeneous attitudes towards patenting; the strategic decision to patent depends on the expected benefits compared to the attitude toward risk and disclosure associated with the use of this intellectual-property protection tool.

In the empirical literature, patents have habitually been used as a measure of product of innovation. Nevertheless, the fact that not all innovations are patented is often noted as a major limitation on the use of patent statistics as an indicator of innovation (e.g., Mäkinen, 2007; Kleinknecht, Van Montfort, and Brouwer, 2002; Griliches, 1990). One concern about the validity of a patent for this purpose refers to differences in what Scherer (1983) has called the propensity to patent, which is suggested to vary among firms (Brower and Kleinknecht, 1999). In other words, with a given innovation intensity measured, for example, through R&D expenditures, different firms may patent with different levels of intensity. Whereas the number of patents is used as a measure of innovation output, the number of patents over R&D expenditures is a good measure of the propensity to use a patent (Scherer, 1983; Taylor & Silberston, 1973). In other words, the second measure evaluates the attitude towards using the patent as an intellectual-property protection tool, not the attitude towards innovating.

Accordingly, we want to know whether firms with given innovation activities differ with respect to their actual patenting intensity. Many researchers have demonstrated that the propensity to patent differs across firms, industries and type of innovation. However, little is known about the role of family firms in this strategic choice, and several issues remain ambiguous in both the empirical and theoretical literature. The interesting question is, of course, whether differences in the propensity to patent among individual firms can be ascribed to factors related to family firms.

Acknowledging the need for focused empirical research to support empirical and theoretical studies on the drivers underpinning family firms' management of technological innovation, this paper investigates how the distinctive characteristics of innovative family firms affect the strategic choice to use patents as intellectual-property protection tool (i.e., propensity to patent). In line with authoritative contributions to the literature on family businesses (Sciascia, Mazzola, Astrachan, & Pieper, 2013; Litz, 2008; Klein, Astrachan, & Smyrniotis, 2005; Sharma, 2004; Chua, Chrisman, & Sharma, 1999), we argue that creating a dichotomous contrast between family firms and nonfamily firms does not allow the distinctive features of family firms to be captured. In contrast, a multi-dimensional characterization can enrich our understanding of how different family firm models affect the propensity to patent. In particular, we focus our analysis on key organizational attributes highlighted in the literature, namely, ownership, participation of family members on the board of directors and the presence of young successors.

This study makes several contributions to the research on family business. First, the paper is the first to investigate family firms' propensity to patent within the general conceptual framework of SEW. We decide to use this theoretical lens because the common theme across almost all studies (see, e.g., the review by Berrone, Cruz, & Gomez-Mejia, 2012) is that in family firms, SEW protection represents a key non-economic reference point that is always present for decision making, which can lead the firm to make strategic and managerial decisions that cannot be understood through traditional economic logic. In other words, we believe that the SEW approach seems to be a suitable perspective for advancing the field of management of innovation because it illustrates the distinctiveness of family firms' identity through the consideration of non-economic factors. Second, by analyzing patenting activities, which imply key strategic and risk-taking decisions, we provide a better understanding of how family presence and influence affect strategic choices, in this case related to how to protect innovation. In other words, we focus on the

innovative family firm in an attempt to examine whether family affects the strategic decision to adopt patenting as an intellectual-property protection tool. Third, our study examines the separate effects of three attributes of family firms, assuming that the degree of alignment with family firm characteristics can vary across different family firm dimensions. By adopting this approach, we acknowledge the heterogeneity of the family firm and can assess which and how various dimensions of family ownership and family involvement in the firm's operations influence the management of technological innovation. Fourth, we examine the consequences of family firms' propensity to patent for management and policy making.

The analysis is conducted using a database of 229 innovative Italian companies. The dataset is heterogeneous in terms of degree of family ownership and involvement and therefore includes pure family firms, pure nonfamily firms and a wide range of intermediate situations.

Our findings show that the degree of alignment with the family firm model is a significant predictor of the propensity to patent even though not all dimensions of the family firm have the same effect. When disentangling the effect of three different indicators (i.e., family ownership, family governance structure and the presence of young successors), family members' involvement in the board of directors is a negative significant driver and the presence of young successors is a positive driver, whereas ownership has no effects. The results hold for various model specifications.

The rest of the paper is organized as follows. Section 2 surveys the existing literature on family firms and innovation, focusing on family firms' patenting practices, and identifies the key organizational dimensions of family firms as defined in the literature. The hypotheses that drive our empirical analysis are then derived by discussing the potential impact of family firm dimensions on the propensity to use patents as an intellectual-property protection tool. The third section presents the sample and the empirical methodology. The fourth section discusses the results of the empirical analysis and the fifth section provides our concluding remarks.

2. Family business and patents: literature review and hypotheses

2.1. Family firms and propensity to patent

Decades of research on innovation and family firms have produced contrasting results. For a conceptual framework see De Massis et al. (2014); for a review, see De Massis, Frattini, and Lichtenhaler (2013). In particular as concern existing studies on family involvement on innovation are limited and have focused so far on the effect on innovation input, outputs and activities (De massis, Di Minin, & Frattini, 2015). In particular, in this paper we focus on innovation activities and how those are handled differently in family firms. A recent review article by De Massis et al. (2013) indicates that studies concerning family firm innovation management is very much in its early stage and, when present, results are mixed and sometimes inconsistent. Moreover, although De Massis et al.'s (2013) in the same literature review underlines that prior studies provide strong evidence of a relationship between family involvement in a firm and the firm's innovation process, it presents no evidence about the strategies adopted to protect the output of that innovation process (De Massis et al., 2014). Indeed, empirical studies on propensity to patent generally have been confined to the use of industry- and firm-level data (Mäkinen, 2007); thus, we have no idea of how propensity to patent varies across family and non-family firms. What we do know is that studies using patents as a proxy of a firm's

innovation performance provide contrasting results (Arora, Ceccagnoli, & Cohen, 2003). Whereas some studies find that family ownership is of no importance to the size of a firm's patent portfolio (Boh, Wu, & Huang, 2012; Choi, Park, & Hang, 2012), others highlight that family firms' innovative performance is particularly likely to be lower if either the CEO or the chair of the board of directors is a family member (Chin, Chen, Kleinman, & Lee, 2009). In relation to patent characteristics, previous analyses observe that although family involvement does not influence either the breadth of a patent or whether that patent is basic (Tognazzo, Destro, & Gubitta, 2013), it negatively affects patent quality, particularly if family members sit on the board (Anderson, Duru, & Reeb, 2012). Finally, Jell, Block, Henkel, Spiegel, and Zischka (2015) find that cross-functional patent management is more frequent in family than in nonfamily firms.

The choice of patenting as an intellectual-property protection tool is unique in family firms because family interests and values are an integral part of such firms' strategies and managerial practices (Sharma, 2004). However, there is little literature on the specific relationship between family firms and the propensity to patent; moreover, the literature that does exist presents contradictory arguments (Tognazzo et al., 2013). As previously argued, this paper is the first to investigate family firms' propensity within the general conceptual framework of SEW.

Family firms may patent for several reasons. Accordingly to the SEW framework, patents and the protection that they provide can be viewed as a means not only to affirm the family name and reputation in a competitive environment but also to preserve the family's wealth. It is likely that family members intervene and influence the patenting process more often than their nonfamily counterparts because of family members' desire to preserve their investments and strong commitment to affirming themselves in all business activities (Carney, 2005). In this way, family firms may obstruct rivals' development of competing products. Patent protection and its potential for preventing imitations of the innovation are useful for preserving the family's SEW (Gomez-Mejia, Cruz, Berrone & De Castro, 2011) and reputation, thus affirming the family's name in the market. Finally, the use of patents, which provide up to twenty years of protection, can be stimulated by the long-term orientation typically found in family firms and their business-transfer process through hereditary succession, especially when the new generations are open-minded (Hauck and Prügl, 2015).

That notwithstanding, there are numerous reasons that family firms might decide not to patent. Chen and Hsu (2009) show that the close control characterizing the ownership structure of family firms inhibits their innovativeness: family involvement and its concentration of governance are negatively associated with the quantity and the quality of any patents received.

In accordance with the SEW perspective, families can impose either risk aversion or risk avoidance on their firms (e.g., Abdellatif, Amann and Jaussaud, 2010; Fernández & Nieto, 2006), along with a parsimonious attitude that can discourage the firm to engage in the patenting process, which requires uncertain and significant investments not only for the patent application but also for the renewal fees. Indeed, maintaining a patent requires financial resources that family firms often have difficulty finding (Carney, 2005). Therefore, firms (e.g., family firms) with stronger financial constraints and limited human resources are less likely to use patents as an intellectual-property protection tool (Gomez-Mejia, Cruz, Berrone & De Castro, 2011). Moreover, family firms' natural unwillingness to disclose information can decrease their propensity to patent. The conservatism often associated with these businesses may encourage family managers to keep their innovative ideas secret and to choose not to enjoy the potential benefits of patent protection (Chen and Hsu, 2012). In summary,

we argue that from a behavioural theory perspective, family firms may protect their SEW by decreasing their propensity to patent, which requires the provision of information to outside parties (Gomez-Mejia, Cruz, Berrone & De Castro, 2011).

2.2. Hypotheses

The identification of the key dimensions that characterize family firms is the first building block to focus our research hypothesis. This is a challenging task because there is no clear consensus on the theoretical definition of a family firm, and agreement on an operational definition has not yet emerged (see, e.g., Di Toma & Montanari 2010; Astrachan, Klein, & Smyrnios, 2002). Most researchers agree that the empirical identification of family firms must account for multiple dimensions, usually including family ownership and family involvement in the firm's operations (Bannò & Sgobbi, 2015; Block, 2012; Graves & Thomas 2008; Villalonga & Amit 2006). Studies on family business and innovation also usually identify family firms according to the above organizational attributes. De Massis et al. (2012) review of 23 studies of technological innovation in family firms reports that all papers adopt an operational definition that is based on family involvement in ownership and management, accompanied in very few cases by further criteria.

In addition, researchers are careful to avoid artificially dichotomous categorizations between family and nonfamily firms that may bias the outcomes of empirical analyses (Chua et al., 1999). Rather than opposite categories, family firms and nonfamily firms are perceived as the extremes of a continuum along which the degree of membership in the family firm model is driven by the interplay among the different dimensions that shape business behaviour.

Drawing on the above suggestions, our empirical analysis adopts an operational definition of the family firm based on multiple dimensions of family ownership and family involvement in the firm's operations, including the share of equity controlled by the owner family, the participation of family members in the board of directors and the involvement of successors (Sciascia et al., 2013; Klein et al., 2005).

Our hypotheses on how these dimensions are expected to impact family firms' attitudes towards the protection of innovation output are based on both the family firm and the SEW literature.

Family owners frame problems in terms of assessing how actions will affect socio-emotional endowment (Berrone et al., 2012). When there is a threat to that endowment, the family is inclined to make decisions that are not driven by the maximization of profit; conversely, the family would be disposed to place the firm at risk if necessary to defend that endowment. In general, however, ownership significantly influences a firm's strategic choices, especially when the family owns a significant equity stake (Zahra, 2005). When the family has a high stake in a firm's ownership, the firm tends to avoid implementing strategies that could decrease the family's control of the business and increase the risk (Casillas, Moreno, & Acedo 2010). If ownership remains in family hands, the firm can experience a convergence around norms and values (Thusman & Romanelli 1985). However, ownership concentration limits the firm's ability to react promptly to the need for change and more generally, to take advantage of new business opportunities. For the same reasons, family-owned firms are reluctant to disclose information based on the founder's preference for privacy (Gersick, 1997). Changes in ownership are likely to provide more financial resources, encourage the adoption of a more dynamic and competitive business model and increase responsiveness to market changes (Goodstein & Boeker, 1991). Based on the considerations presented above, we believe not only that the family ownership dimension is extremely important but also that

there is a substantial degree of dependence between ownership and strategy. We argue that although patents originate a temporary monopoly right on the economic exploitation of an innovation in exchange for its disclosure, the SEW and conservative attitude that accompany with family involvement in ownership can obstruct the decision to patent.

Accordingly, our first hypothesis is as follows.

Hypothesis 1. In innovative firms, family ownership limits the propensity to patent.

The participation of family members in the board of directors is our second dimension of analysis. The composition of the board of directors impacts how decisions are made (Goodstein & Boeker, 1991). Specifically, most researchers show that external members can be considered a fundamental resource for strategic and decision-making process within a family firm (Corbetta & Salvato, 2004; Fiegner, Brown, Dreux, & Dennis, 2000). They think more freely about different strategic alternatives because they have no family ties and similarly, they can focus on providing top management with independent advice (Westphal, 1999). External board members can represent an important resource in the firm's strategic process; indeed, outsiders bring a range of resources such as expertise, skills and information that can support the adoption of risk. Past studies have demonstrated that family involvement in the board of directors reduces the managerial team's strategic independence and limits the firm's access to critical resources for innovation. The absence of nonfamily members on the board of directors limits the firm's access to external critical resources and therefore reduces the scope of protection of innovation, whereas the presence of nonfamily directors can provide greater access to knowledge and capabilities useful to use of patent as knowledge protection tool (Sciascia et al., 2013).

In capturing the affective endowment of family members, SEW implies that family members frame problems in terms of assessing how actions may or may not affect their bequest. Thus, preserving this endowment is at the roots of the risk-averse attitude that characterizes their strategic actions (Bannò, Dallura, Faraci, & Pisano, 2016). Compared to firms in which no family members act, family firms show a parsimonious attitude towards the patenting process, which requires uncertain and significant investments both for the application and for the renewal fees. Although this decision might be not economically rational, it does ensure the preservation of SEW (Block, Miller, Jaskiewicz, Spiegel, 2013; Gómez-Mejía et al., 2007). In summary, according to the SEW, when there is high family involvement, firms are more likely to accept the cost and uncertainty involved in following certain actions, driven by the principle that the risks that such actions necessitate are counterbalanced by noneconomic benefits. Accordingly, the concentration of governance in the hands of the entrepreneurial family can limit the propensity to patent if we take into account not only their natural unwillingness to disclose information but also their conservative, risk-averse attitude (Berrone et al., 2012).

These observations lead to the following hypothesis.

Hypothesis 2. In innovative firms, family members' participation in the board of directors limits the propensity to patent.

Families exhibit a long-term orientation and commitment to transfer their business and SEW to future generations (Brigham, Lumpkin, Payne, & Zachary, 2014; Zellweger, Nason, Nordqvist, & Brush, 2011). To measure this feature, we focused on the appointment of a successor as evidence of the family's intention to continue its dynasty. From an SEW perspective, family firms can even decide to give up strategic choice if they sense a risk of potential losses, performance variability, or a general threat to their SEW; generational transfer entails uncertainty and risk. To preserve their SEW, family firms need to select the property-

protection tool that is the most suitable to their contingent situation, meaning that they can be risk seekers depending on the contingent threat to their SEW (Gomez-Mejia et al., 2011). Accordingly, in a generational-transfer situation, a family firm might decide to adopt the patent as an intellectual-property protection tool.

The presence of young successors in the family is also a determinant of the use of patents because the new generation is associated with discontinuity with the previous strategy (Graves & Thomas, 2008). In the transition phase, when the power is shifted from one generation to the next, ideally the new generation's strategic participation should increase while the older generation decreases its involvement and decisional power (Hauck and Prugl, 2015). Younger successors often represent a source of discontinuity with past strategies. Indeed, the entry of successors is frequently associated with both the introduction of new business ideas and at least partial delegation of power and openness by the previous generation of firm owners (Sardeshmukh & Corbett, 2011).

Moreover, we argue that family firms increase the heterogeneity of the power coalition through the inclusion of the new generation in management, thus aggravating conflicts that can also produce new ideas and solutions in the case of intellectual-property management (Eisenhardt, Kahwajy, & Bourgeois, 1997). Newer generations tend to push for new ways of doing things, and the presence of multiple generations of family members creates an organizational culture that encourages risk taking and exploring new opportunities, encouraging better understanding of the available choices and a more effective decision-making process (D'allura, 2015). This dynamics create a favourable situation for the development of new ideas that can encourage the use of patenting as an intellectual-property protection tool.

Finally, in accordance with a family's SEW, the long-term nature of family commitment through the presence of a young successor creates an environment that promotes substantive discussion and either minimizes or resolves disruptive relational issues far better than a nonfamily setting.

All of the above, based on considerations of SEW and heterogeneity, suggest that the presence of a successor has a positive impact on the probability of adopting patenting as an intellectual-property protection tool.

Accordingly, our final hypothesis is as follows.

Hypothesis 3. In innovative firms, the participation of successors favours the propensity to patent.

3. Empirical setting

3.1. Data and sample

The empirical sample used to investigate the impact of family firm dimensions on the propensity to patent consists of 229 Italian companies, all of which engage in R&D activities. The inclusion of pure family firms, nonfamily firms and a large variety of intermediate situations makes our sample an interesting context in which to determine how multiple dimensions of the family firm model impact the propensity to patent. The impact of the family firm model on patenting practices is analyzed by controlling for other firm-specific characteristics that are generally included in empirical studies of the propensity to patent: R&D effort, firm size and age, firms' internationalization, financial constraints, profitability, productivity, geographical localization and industry.

Data on propensity to patent are measured by the ratio between the number of patent applications and a firm's R&D expenditure. Patent applications were obtained from the Espacenet database, which provides information approximately 90 million patent documents worldwide, including information about inventions

and technical developments from 1836 to today. Espacenet is a free online service for searching patents and patent applications. It was developed in 1988 by the European Patent Office and the member states of the European Patent Organisation.

R&D expenditures were retrieved from notes on the accounts, the firms' Websites and applications for public financial incentives to engage in innovative projects.

Data on firms' family characteristics (i.e., ownership structure, composition of the board of directors and the presence of a young successor) were retrieved from the AIDA (Bureau van Dijk) database. More specifically, the AIDA database reports the company name, the year it was founded and the family name of each board member and shareholder with the respective ownership share, thus allowing us to identify kinship relations on the basis of family names.

Balance sheet data (i.e., size, age, financial constraints, profitability and productivity, industry) were also obtained from the AIDA database (Bureau van Dijk).

Information on firm internationalization, here measured by the number of foreign direct investments (FDIs), is drawn from Reprint, which provides a census of Italian outward investments. Reprint classifies FDIs based on the actual location of economic activities. Consequently, we were able to exclude foreign investments made by financial firms, investment funds, private equity funds and merchant banks as part of a management buy-out and when there is no direct participation in the management of the investee company. For additional details, see Mariotti and Mutinelli (2012).

Finally, firms' data refers to 2008, before the start of the economic and financial crisis. This means that any contingent effects of the economic cycle on our results can be excluded. All patents from 2008 through 2012 are considered.

3.2. The econometric model

The estimated model assesses the impact of family firm characteristics on the attitude towards the use of patents as an intellectual-property protection tool, controlling for firm-specific effects. The model tests hypotheses 1 through 3 by assessing the separate impact of the share of equity controlled by the owner family, the presence of family members on the board of directors and the involvement of successors on the attitude toward patenting. The propensity to patent is estimated by an ordinary least squares given the continuous nature of the dependent variable (Green, 1993).

Propensity to patent = fn (Ownership; Governance structure; Successors; Control variables)

3.3. The dependent and independent variables

The dependent variable for the proposed model is the propensity to patent (variable *Propensity to patent*), here measured as suggested by Scherer (1983), namely, by the ratio between the number of patent applications and the firms' R&D expenditures.

In line with our hypotheses, we operationalize family businesses through the key dimensions of ownership, presence of family members on the board of directors and involvement of successors. First, we identify family control as the power to appoint the board of directors, both directly and through financial holdings. This definition is in line with previous studies, according to which family control can be identified as the fractional equity holding by family founding members or descendants (Bannò & Sgobbi, 2015; Tognazzo et al., 2013; Lee, 2006; Anderson & Reeb, 2003). The variable *Ownership* assesses whether a family owns the parent

firm. It is a binary variable equal to 1 either if a nonlisted firm is majority owned by the family or if no less than 20% of a listed firm is owned by the family, and zero otherwise (Cascino, Pugliese, Mussolino, & Sansone, 2010). The share of family representatives who are members of the board of directors (variable *Governance structure*) is a proxy for the governance structure (Carney, 2005). Perfect managerial governance is characterized by complete separation of ownership and control, thereby splitting management and risk-bearing functions (De Kok, Uhlaner, & Thurik, 2006; Fama & Jensen 1983). The final family firm attribute included in our analysis is the participation of at least one young family successor in the business. *Successors* is a binary variable equal to 1 if at least one young family member plays an active role in the firm, and zero otherwise.

In addition to family firm-specific characteristics, firm-specific variables are included in the analysis as control variables. As previously stated, the literature demonstrates that firms have a heterogeneous attitude towards patenting, leading to several studies aimed at identifying the factors that affect the degree of exploitation of patenting as an intellectual-property protection tool. Because of these studies, we know that the propensity to patent depends on the following factors: R&D effort, firm size and age, firms' internationalization, financial constraints, profitability, productivity, geographical localization and industry (e.g., De Rassenfosse, 2010; Chabchoub & Niosi, 2005; Arundel & Kabla, 1998; Mansfield, 1986; Horstmann, MacDonald, and Silviniski, 1985).

We include as the control variable a firm's R&D effort (i.e., its R&D expenditure as a percentage of sales). Mäkinen (2007) states that the relationship between patents and R&D effort is very complex to interpret because it can be influenced by R&D productivity. The ratio of patents and R&D and the scale of R&D activities, as frequently observed, arise as a result of declining R&D productivity (i.e., decreasing propensity to patent) (e.g., Bound, Cummins, Griliches, Hall, & Jaffe, 1984; Griliches, 1990). This suggests that the propensity to patent increases with less spending on innovation. In addition, if R&D activities are particularly efficient, the savings made can translate into the possibility of patenting more, if R&D investment is equal. Because of the uncertainty and delay of the returns, despite the large amount of resources employed, it is quite normal for the resulting number of innovations (and therefore the number of patents) to be low, decreasing the value of the propensity to patent ratio despite a substantial economic effort in terms of R&D.

Further control variables are firm size and firm age, which proxy for accumulated knowledge and experience and usually display a positive correlation with propensity to patent (Brouwer & Kleinknecht, 1999). Large firms are more likely than small ones to patent routinely instead of carefully evaluating the need to patent each innovation. The reason for this phenomenon is the possibility of spreading the fixed cost of maintaining in-house patent expertise that manages intellectual property rights (Arundel & Kabla, 1998). Another explanation is that large firms are better at enforcing their patents, even when their potential area of use (i.e., the production line of competitors) should largely be hidden from scrutiny (Scherer, 1983). Firm size (variable *Firm size*) is measured by the logarithm of the number of employees, whereas the variable *Firm age* is defined as the logarithm of firm age in 2008.

We enrich the estimation by including the firm's international presence via FDI. The literature suggests that by acting in international markets, firms can better capitalize on the exclusive rents of R&D expenditures and of patents. Multinational firms offer products to a larger number of potential buyers, thus enhancing profits based on innovation efforts and spreading innovation costs. Internationalization lowers the risk of R&D by avoiding fluctuations and business cycles that are specific to a single market

Table 1
Definitions and sources of the variables used in the empirical analyses.

Variable	Definition	Source
<i>Dependent variables</i>		
Propensity to patent	Ratio of the number of patent applications at European Patent Office and the firm's R&D expenditure (patents/thousand euros)	European Patent Office, ESPACENET
<i>Family firm variables</i>		
Ownership	Dummy variable taking the value 1 if a nonlisted firm is majority owned by the family or a listed firm is 20% owned by the family, and 0 otherwise	AIDA
Governance structure	Share of family representatives who are members of the board of directors (%)	AIDA
Successors	Dummy variable taking the value 1 if at least one younger family member has an active role in the firm, 0 otherwise	AIDA
<i>Control variables</i>		
R&D effort	Percentage of firm's R&D expenditure over turnover (%)	AIDA, Website, applications for public funding
Firm size	Logarithm of firm size (employee)	AIDA
Firm age	Logarithm of firm age (years)	AIDA
FDI	Logarithm of the number of past FDIs (number of FDIs)	REPRINT
Financial constraints	Ratio between bank debt and total assets	AIDA
Profitability	Return on equity (%)	AIDA
Productivity	Logarithm of the value added per employee (in thousands of euros)	AIDA
North	Dummy variable taking the value 1 if the firm is located in the North of Italy, 0 otherwise	AIDA
Pavitt traditional	Dummy variable if the firm is in a supplier dominated industry, 0 otherwise	AIDA
Pavitt scale intensive	Dummy variable if the firm is in a scale dominated industry, 0 otherwise	AIDA
Pavitt specialized supplier	Dummy variable if the firm is in a specialized supplier industry, 0 otherwise	AIDA
Pavitt science based	Dummy variable if the firm is in a science based industry, 0 otherwise	AIDA
Pavitt other	Dummy variable if the firm is in an industry not listed above, 0 otherwise	AIDA

(Kafourous, Buckley, Sharp, & Wang, 2008). Furthermore, international investments enhance a firm's knowledge about the environment and competition in various countries. This knowledge drives the firm's efforts into the most promising innovative objectives (Filippetti, Frenz, & Ietto-Gillies, 2009). Above all, patents can be a good intellectual-property protection tool in foreign markets, particularly in developed ones, when R&D investments are equal. We proxy international presence through the variable *FDI*, here measured as the logarithm of the number of the firm's foreign subsidiaries.

Firms may be unable to cover the costs of filing a patent application or paying patent maintenance fees (Carney, 2005). Because the effective cost of patenting may vary across firms because of differences in the availability and cost of financial resources, we proxy firms' financial constraints by the ratio between their bank debt and total assets (variable *Financial constraints*).

The literature documents a propensity to use patents as an intellectual-property protection tool in the case of firms that have high profitability and productivity (Hanel & St-Pierre, 2002). Specifically, the variable *Profitability* is measured by the ratio between equity and total assets (i.e., the return on equity) and *Productivity* is measured by the logarithm of value added per employee.

We also control for geographical localization. The binary variable *North* takes the value one when the firm is located in the North of Italy, and zero otherwise.²

Finally, we include industry dummies as further controls not only because of the significant impact of the industry on the management of innovation (Scherer, 1983) but also because patenting is more extensively used as an intellectual-property protection tool in science-based industries. The analysis controlled for the industry by resorting to Pavitt taxonomy (1984). Five binary

variables signal whether the firm belongs to a traditional sector, a scale-intensive sector, a specialized supplier sector, a science-based sector or some other sector (the variables are *Pavitt traditional*, *Pavitt scale intensive*, *Pavitt specialised supplier*, *Pavitt science based* and *Pavitt other*, respectively).

We express all continuous independent variables as logs both to decrease the impact of outliers and to reduce heteroscedasticity.

Table 1 reports the definitions of both the dependent and independent variables that account for family firm-specific and firm-specific effects in the proposed empirical analyses.

4. Results of the empirical analysis

4.1. Descriptive statistics

The overall descriptive statistics reported in Table 2 show that the average of the propensity to patent is equal to 0.18 patents per thousand euros of R&D spent.

While fewer than 65% of firms in our sample are family owned, one out of three of the sampled firms have a majority of family members involved in firm governance. Moreover, note that one out of three of the firms has a young successor on the board of directors.

A preliminary test of our research question is provided by crossing the propensity to patent between two clusters of firms characterized by their different alignment with the family firm model. Specifically, we considered family-owned firms, when nonlisted, to be those that are either majority owned by the family or (when listed) 20% owned by the family (Cascino et al., 2010). Table 2 displays the distribution of sampled companies between the two extremes of family-owned firms (147 out of 229 companies) and nonfamily-owned firms (82 companies). The second panel of Table 2 suggests that family-owned firms do not differ significantly from nonfamily-owned firms in terms of propensity to patent. On average, family-owned firms are smaller than nonfamily-owned firms and are less internationalised. Moreover, family-owned firms show a higher degree of profitability. In contrast, there is no significant difference between the two

² Wright, Westhead, and Ucbasaran (2007) and Bannò, Piscitello, and Varum (2013), for example, discuss how context may impact a firm's performance and strategy.

Table 2
Descriptive statistics.

	Whole sample [229 firms]				Family-owned firms [147 firms]		Nonfamily-owned firms [82 firms]		Sign.
	Mean/%	Std. Dev.	Min.	Max.	Mean/%		Mean/%		
<i>Dependent variables</i>									
Propensity to patent ^a	0.18	0.89	0	9.00	0.19		0.15		
<i>Family firms variables</i>									
Ownership ^b	64.2%	0.48	0	1	–		–		–
Governance structure ^a	32.2%	0.33	0	1	45.1%		9.4%		***
Successors ^b	32.7%	0.47	0	1	46.9%		7.3%		***
<i>Control variables</i>									
R&D effort ^a	3.79%	0.07	0.04e ^{-6%}	60.0%	3.47%		4.38%		
Firm size ^a	2.56	0.89	0.30	4.90	2.56		2.86		**
Firm age ^a	1.50	0.42	0	2.44	1.53		1.46		
FDI ^a	0.67	0.64	0	2.78	0.61		0.79		**
Financial constraints ^a	34.06	19.17	0	86.83	34.48		33.29		
Profitability ^a	6.19%	18.46	–96.9%	54.0%	8.0%		2.9%		**
Productivity ^a	0.77	0.25	0.18	1.72	0.78		0.74		
North ^b	82.5%	0.38	0	1	88.4%		71.9%		***
Pavitt traditional ^b	14.8%	0.35	0	1	17.7%		9.7%		*
Pavitt scale intensive ^b	10.9%	0.31	0	1	14.3%		4.9%		**
Pavitt specialized supplier ^b	31.5%	0.45	0	1	29.9%		34.1%		
Pavitt science based ^b	31.0%	0.46	0	1	29.9%		32.9%		
Pavitt other ^b	11.8%	0.32	0	1	8.2%		18.3%		**

^a Significant at the 10% level; ^{**} significant at the 5% level; ^{***} significant at the 1% level.

^a t-test between the two subsamples Family owned and Non family owned firms (mean).

^b Proportion test between the two subsamples Family owned and Non family owned firms (%).

Table 3
Correlation matrix.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	VIF	1/VIF
1 Propensity to patent	1																	
2 Ownership	0.02	1															1.62	0.62
3 Governance structure	–0.09	0.52	1														1.94	0.51
4 Successors	0.12	0.40	0.36	1													1.27	0.79
5 R&D effort	–0.07	–0.07	–0.06	0.03	1												1.14	0.87
6 Firm size	0.08	–0.16	–0.35	–0.09	–0.24	1											2.03	0.49
7 Firm age	0.06	0.08	0.13	0.02	–0.10	0.32	1										1.36	0.73
8 FDI	0.17	–0.13	–0.16	–0.05	–0.13	0.56	0.37	1									1.70	0.59
9 Financial constraints	0.05	0.03	0.12	0.02	0.01	0.08	0.14	0.21	1								1.17	0.86
10 Profitability	–0.04	0.13	–0.01	0.02	–0.05	0.19	0.12	0.19	0.14	1							1.21	0.83
11 Productivity	0.02	0.07	–0.07	0.04	–0.12	–0.04	–0.02	0.06	0.02	0.10	1						1.19	0.84
12 North	0.04	0.21	0.24	0.08	0.05	–0.20	0.06	–0.01	0.07	0.14	0.07	1					1.18	0.85
13 Pavitt traditional	–0.04	0.11	0.09	–0.03	–0.08	0.07	0.17	0.14	0.16	0.02	0.15	–0.00	1				2.40	0.42
14 Pavitt scale intensive	–0.02	0.14	0.18	0.05	–0.10	0.07	0.17	0.11	0.03	0.03	0.05	0.05	–0.15	1			2.09	0.48
15 Pavitt spec. supplier	–0.09	–0.04	0.02	–0.01	0.01	0.09	0.10	0.02	–0.16	0.19	–0.03	0.06	–0.28	–0.24	1		2.94	0.33
16 Pavitt science based	0.19	–0.03	–0.09	0.03	0.16	–0.26	–0.22	–0.18	0.05	–0.21	0.07	0.06	–0.28	–0.23	–0.45	1	2.99	0.33
Mean VIF																	1.75	

samples in terms of other structural characteristics. Family-owned firms are older, more financially constrained and more productive than the other firms, even though these differences are not statistically significant. The two groups also differ in terms of their geographical distribution and industry composition.

4.2. Regression analysis

The regressions to test the research hypothesis via econometric estimates were run using STATA 12.0. The correlation matrix shows acceptable correlation indexes between all regressors (Table 3). To examine multicollinearity, we calculated the variance inflation factor (VIF), which is equal to 1.75, below the rule-of-thumb cutoff of 5. Thus, issues of multicollinearity are not a matter of concern (Table 3).

The econometric results presented in Table 4 highlight both that only some of the traditional variables included as

determinants of propensity to patent have the expected effect and that not all of the family firm dimensions considered have the same impact.³

Disaggregating the family firm model by considering the various dimensions of ownership, governance structure and succession, instead of the use of a synthetic indicator, was a good choice because the impact of the three variables on the strategic decision to use patenting as an intellectual-property protection tool is not the same.

³ As a robustness check, we run three additional models: the logit regression with a new dependent variable defined as a dummy variable if the firm patents, and zero otherwise; a GLM model; and finally an estimation of the main model with the dependent variable logged, because we include most of the independent variables in logs. In all the three models the results are the same. The results are available upon request.

Table 4
Econometric analysis.

	Propensity to patent (Linear regression)			
	Coeff.	Std err.	Coeff.	Std err.
<i>Family firms variables</i>				
Ownership	0.08	0.15	0.12	0.15
Governance structure	−0.47 ^b	0.21	−0.47 ^b	0.24
Successors	0.32 ^b	0.14	0.29 ^b	0.14
<i>Control variables</i>				
R&D effort			−1.33	0.93
Firm size			−0.03	0.09
Firm age			0.09	0.16
FDI			0.27 ^b	0.12
Financial constraints			0.01	0.01
Profitability			−0.01	0.01
Productivity			−0.16	0.25
North			0.11	0.16
Pavitt traditional			0.04	0.25
Pavitt scale intensive			0.05	0.26
Pavitt specialized supplier			0.07	0.21
Pavitt science based			0.45 ^b	0.21
Const.	0.17 ^a	0.10	−0.35	0.340
Number of observations: 229				
	Prob > F = 0.034 Pseudo R2 = 0.038		Prob > F = 0.022 R-squared = 0.218	

^a Significant at the 10% level.^b Significant at the 5% level.

The impact of the family firm model is driven both by the involvement of family members in the board of directors (the coefficient of *Governance structure* is negative and significant at $p > 0.05$) and by the presence of young successors (the coefficient of *Successors* is positive and significant at $p > 0.05$). In contrast, the share of equity directly controlled by family members (i.e., *Ownership*) is non-significant, albeit positive. Thus, these findings suggest that the involvement of family members in the firm's governance affects how innovation outputs are protected. According to the SEW theory, family firms may not wish to disclose information that is needed to obtain the patent. Indeed, to obtain exclusive rights, the inventor must describe the details of the invention in the patent document so that others may learn from it and build upon the new technology. Second, from a strategic point of view, it is confirmed that the conservative and risk-averse attitude caused by the uncertainty of the expected returns of family members has a negative impact on the propensity to patent. Furthermore, in the specific case of family-owned firms, which are a very large proportion of the entire sample, the propensity to be parsimonious (Carney, 2005) and to engage in careful use of resources can lead to more efficient investments in strategic choice because doing so maintains a low level of investment in the intellectual-property protection of innovation (Chen & Hsu, 2009). Moreover, a family firm might be unable to cover the costs of filing a patent application or maintenance fees (Carney, 2005).

The positive impact of the presence of a young successor is also confirmed. This is in line with previous findings (e.g., Bannò & Sgobbi, 2015; Alderson, 2011; Graves & Thomas, 2008; Astrachan et al., 2002), which state that the firm's generational transition may not only strengthen it but also be valuable in terms of renewal. Indeed, new generations have a more open mindset; they foster discontinuity from past strategies and overcome the traditional conservative attitude and unwillingness to disclose information by encouraging the use of patents as an intellectual-property protection tool. More specifically, firms use patents to profit from both the commercialization and licensing of an innovation (Tognazzo et al., 2013). In this sense, propensity to patent seems to have a positive relationship with the willingness to cede

information to outside parties that can be understood by successors.

Only two of the control variables are significant: FDI and Pavitt science-based sectors. International presence is important because the coefficient of *FDI* is positive and significant at $p < 0.05$. Unsurprisingly, there are significant differences among sectors. High technological and science-based opportunity sectors tend to have a higher propensity to patent than do other sector (the coefficient of *Pavitt science based* is positive and significant at $p < 0.05$).

Finally, the other coefficients displayed by the control variables show that firm size and age have no significant effect. Similarly, other firms' structural and balance-sheet data (i.e., *Financial constraints*, *Profitability*, *Productivity* and *North*) are not significantly different from zero.

5. Concluding remarks

This paper's empirical analysis provides interesting results. First, our assumption that family presence in the firm's operation influences the management of technological innovation is confirmed. In particular, the family firm model is an explanatory variable for the propensity to use patents as an intellectual-property protection tool. Even if it is widely acknowledged that family ownership and family involvement affect the management of innovation, to the best of our knowledge, this is the first paper to investigate whether differences among firms' propensity to patent can be ascribed to family firms' influence. Second, because of the various degrees of alignment with the family firm model among the sampled firms, a disaggregated analysis of the impact of multiple family firm dimensions has great explanatory power because the family firm dimensions have a different impact. Indeed, family firms cannot be simplistically viewed as uniform entities. The failure to recognize the existence of different types of family firms that do not fit the stereotypical family firm profile proposed by Zahra (2003) can result in inappropriate academic outcomes, encouraging practitioners to provide inappropriate assistance to categories of family firms that do not fit the profile

(Bannò et al., 2016). This is an interesting contribution because empirical investigations on family firms have typically distinguished between family and nonfamily firms without further differentiating the former category and treating it as a homogeneous group. This might have been the primary reason for the discrepancies in the empirical results that characterize family firms' management innovation. We believe that this classification is our paper's first strength. More specifically, when analyzing the propensity to patent, we disentangle the effect of three indicators: (1) ownership has no impact; (2) the involvement of family members in the board of directors is a negative significant driver; and (3) the presence of young successors is a positive driver. In contrast with our expectations that ownership composition would affect the attitude towards propensity to patent, our results show that only the family governance structure has a significant and negative effect. As already stated by Block et al. (2013) most prior research neglects this distinction, while they show is an important one as the family firms effect in terms of technological importance of innovations is mainly driven by family management rather than by family ownership. This finding suggests that the ownership composition of family firms can reflect the need for representativeness instead of the actual distribution of decisional power in terms of managing innovation. Given these results and through the lens of SEW, we confirm that innovative family firms make strategic and managerial decisions that differ from nonfamily firms because such choices cannot be enlightened through traditional economic logic. More specifically, in accordance with the SEW conceptual framework, family governance of a firm imposes both risk aversion and a parsimonious attitude that discourages the use of an expensive intellectual-property protection tool such as the patent. This attitude is coherent with the natural unwillingness to disclose information in favour of keeping an innovative idea secret and choosing not to benefit from patent protection. The presence of a successor in the family is a positive determinant of the propensity to patent. This result implies that the participation of at least one younger family member on the board can be a source of open-minded initiatives, new information, knowledge and resources. Therefore, a young family member should promote investments in innovation and the use of patents by encouraging risk taking and overcoming the traditional conservatism of family firms (D'allura, 2015). Coherent with most studies on heterogeneity, this result confirms that diversity induced by the presence of a young family member enhances the creative problem-solving process because of the variety of ideas generated by that family member. This result is also consistent with family business researchers, who note that when multiple generations are involved in firm management, the organization has greater innovative output and better management of innovation (Salvato, 2004).

The above empirical findings have additional significant managerial and strategic consequences. Firms should be increasingly aware that patents are a critical source of competitive advantage in both global and multi-domestic markets. This general indication applies to both family and nonfamily firms. However, our results stress that the degree of alignment with specific dimensions of the family firm model is important to the design of a coherent approach to managing innovation. A specific feature of the family firm model emphasizes a focus on patenting as a means of controlling innovative products, and family managers should be aware that such an attitude could become a barrier to the ability to protect the firm's innovation outputs. More specifically, our findings suggest that the inclusion of a successor in firm management can be a positive element. However, although the presence of multiple generations can provide the team with a variety of resources, cognitive perspectives and knowledge, differences between the generations can also have problematic consequences. Thus far, the family firm literature on succession has

primarily treated generational transfer as a problem-ridden threat instead of as an opportunity (Hauck and Prugl, 2015). On the contrary, for this reason the family can promote the participation of new generations. Indeed, in Italy, generational transfer is a thorny process: only 50% of firms make a successful transition from the first to the second generation and only 15% survive the passage from the second to the third generation. The involvement of young heirs allows adequate planning of the generational transfer while potentially encouraging the adoption of a strategy to protect intellectual property.

A thorough understanding of the variations in the propensity to patent should also be of great value to researchers and policy makers. First, the finding that family firms show a lower propensity to patent than nonfamily firms should be comforting news from the perspective of using and interpreting patents as an economic indicator of innovation because it implies that family firms' innovations enter the patent indicator at a relatively low probability. This should have important implications for the optimal design of the patent system because it is highly probable that it is not always necessary to provide incentives for family firms to develop their valuable firm-originated ideas into innovations. Second, the patent system is an important policy indicator that can be employed to determine the allocation of resources for developing and disseminating innovative activities. Variations in the propensity to patent can be indicative of differences in the extent to which the patent system is utilized by different firms to appropriate returns on different innovations and can aid in the understanding of the family firm's level of innovation when using patents as proxy for the measure of innovation output. Finally, our empirical results have interesting implications for the growing supply of private and public services that support innovation. The proposed findings can help consultants, family therapists and patent agencies understand what occurs within the boundaries of family firms. More specifically, differentiated patterns of protection of innovation also imply diversified training needs in the case of family firms. Training programs in the field of innovation should avoid segmenting potential candidates primarily based on size. Initiatives should be tailored to more specific features, including the governance model.

Like all research papers, this study is not immune from limitations and future research could expand the present analysis in several directions. First, the results should be interpreted with caution because the sample is composed exclusively of Italian firms and might not reflect the situation of other countries. The replication of the proposed analysis in a wider set of parent companies located in different countries could account for cross-national differences in the attitude towards propensity to patent. Second, it would be interesting to check whether our results also apply to trademarks. As recent research has shown, trademarks might be particularly suited for smaller firms and perhaps also for family firms that aim to strengthen their intellectual-property rights (Thoma and Bizer, 2013; Block, Fisch, Hahn, & Sandner, 2015). Third, innovation and internationalization are commonly recognized as key factors in economic growth and industrial competitiveness (UNCTAD, 2010). The literature suggests that by acting in international markets, firms can not only better capitalize on the exclusive rents of research and development expenditures but also offer products to a larger number of potential buyers, thereby enhancing profits from innovation efforts and spreading innovation costs (Bannò, Morandi, & Varum, 2013). Furthermore, international investments enhance a firm's knowledge about the environment and competition in various countries. Given this virtuous relationship between innovation and internationalization, we suggest developing and analyzing the relationship between innovation management and family firms by investigating foreign subsidiaries' propensity to patent. Fourth, the

differentiated impact of the dimensions used to define family businesses in the context of the strategy to protect innovation output suggests the opportunity to extend this line of analysis to additional key features of family firms such as heterogeneity, organizational experience and culture. Finally, our study's findings stress the need for additional theoretical and empirical research in the area of the management of intellectual protection and FB, possibly addressing the impact of patenting policies on firm performance. In summary, our study's findings stress the need for additional theoretical and empirical research in the area of managing technological innovation and family firms.

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