The Effect of Family Involvement on Innovation Outcomes: The Moderating Role of Board Social Capital

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Innovation is an essential and yet puzzling part of family firms' strategic focus. While family firms are generally characterized as conservative regarding their research and development (R&D) activities, researchers have recently argued that family firms can still achieve innovation-based competitive advantages. Seeking to understand the link between family influence and the outcomes of innovation, we suggest that it is necessary not only to observe the depth of family involvement, but also to differentiate between technological inventions and market innovations. We further posit that the board members' social capital constitutes an important contingency for this link. We, therefore, investigate the relationship between family involvement and two different outcomes: the number of the firm's inventions and the market relevance of innovations. Our analysis of S&P 500 firms comprises 1.85 million patents and manual evaluations of 1774 product announcements. The results of our estimations suggest that family involvement is negatively related to the number of inventions and positively related to the market relevance of innovations. They further show that internal and external board social capital moderate the relationship between family involvement and the number of inventions. This study adds to the discussion about family firm innovation by using socioemotional wealth to explain heterogeneity in innovation patterns and revealing that relational resources derived from board social capital are crucial boundary conditions for families' influence on technological inventions. Taken together, it works toward a more holistic view of innovation in family-influenced firms.

Practitioner Points

- Firms with active participation of owner family members in organizational decision-making through voting rights tend to pursue fewer inventions in the form of patents.

- Board members with strong internal bonds and strong external networks can help firms to counteract this drawback.

- Family members' influence can lead to efficient innovation processes that result in products that are relevant from a market perspective. Non-family shareholders in family firms can derive that empowering family members with customer knowledge helps to realize a market-friendly innovation portfolio.

Introduction

Innovation is essential for family and non-family firms as they seek to sustain competitive advantage. Yet,

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it is an uncertain endeavor that often includes a departure from daily routines in favor of long-term research activities with difficult-to-anticipate outcomes (Cuevas-Rodríguez, Cabello-Medina, and Carmona-Lavado, 2014). Generally cautious when seeking new opportunities (Duran, Kammerlander, van Essen, and Zellweger, 2016), family firms tend to be hesitant to engage in innovation (De Massis, Frattini, Majocchi, and Piscitello, 2018). When acting, family members involved in family firms consider what is known as their socioemotional wealth, "non-financial aspects of the firm that meet the family's affective needs" (Gomez-Mejia, Haynes, Núñez-Nickel, Jacobson, and Moyano-Fuentes, 2007, p. 106). These affective needs root in transgenerational succession ambitions (Gomez-Mejia et al., 2007) and motivate family members to favor conservative strategies and tight monitoring (Duran et al., 2016). As a consequence, higher involvement by families in their businesses comes with lower investments in research and development (R&D) activities, as these activities risk technological and financial failure (Block, 2012; Chen and Hsu, 2009).

Notwithstanding the lower R&D investments, some researchers have noticed that family firms still achieve innovation-based competitive advantages (De Massis, Frattini, Pizzurno, and Cassia, 2015) and are

successful in pursuing innovations (Duran et al., 2016). They have attributed these countervailing effects on R&D outcomes to the ambiguous nature of family members' socioemotional wealth considerations (e.g., Filser, De Massis, Gast, Kraus, and Niemand, 2018; Miller, Wright, Le Breton-Miller, and Scholes, 2015). To solve the puzzle of how family firms can win at innovation with low R&D investment, more insights on their concrete innovation patterns are needed. What kinds of innovation outcomes are firms with high family influence pursuing, and why? And what contingencies affect these outcomes? Scholars suggest that families fear technological and financial failure, but that family members are particularly effective in deploying resources through (1) their superior firm knowledge, (2) their extensive market expertise, and (3) their strong customer relationships (Block, 2012;

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Rondi, De Massis, and Kotlar, 2019; Sirmon and Hitt, 2003). We argue that these three attributes of family members can influence their firms' innovation outcomes in various ways, particularly if these members are involved in strategic decision-making through voting rights. If they are, their fear of technological and financial failure will have a negative effect on the firms' *number of inventions* (measured as the number of patents), while their superior expertise will enhance the *relevance of innovations* (measured as the number of market-relevant product announcements) compared to that of firms with low *family involvement*.

Another important feature that distinguishes family firms from non-family firms is the strength of their social capital (Arregle, Hitt, Sirmon, and Very, 2007), a measure of the resources a firm can draw from its network (Nahapiet and Ghoshal, 1998). Given their unique organizational nature, with close relationships, large networks, and family succession histories, most family firms possess strong social capital (Chrisman, Chua, De Massis, Frattini, and Wright, 2015; Lester and Cannella, 2006). Researchers of this topic distinguish between *internal social capital*, which denotes the "linkages among individuals or groups within the collectivity," and *external social capital*, the "collectivity's external ties to other external actors" (Adler and Kwon, 2002, p. 21). Board members typically have higher social capital than do employees of their firm (Johnson, Schnatterly, and Hill, 2013). This *board social capital* plays an essential role since it drives decisions in the boardroom where family members can use their influence most on business strategy, designing it by the family's interest (Patel and Cooper, 2014).

Sharing tenure on a board is a significant and representative component of the internal dimension of board social capital; it generally creates collective cohesiveness and collective goals among board members. Meanwhile, a so-called board interlock, defined as "when a person affiliated with one organization sits on the board of directors of another organization" (Mizruchi, 1996, p. 271), is a significant and representative component of the external dimension of board social capital, enabling board members to access resources embedded in their networks (Adler and Kwon, 2002). *Internal* and *external board social capital* foster interorganizational and intraorganizational knowledge creation and exchange (Gedajlovic, Honig, Moore, Payne, and Wright, 2013) through facilitating the dissemination of information (Duran et al., 2016; Llach and Nordqvist, 2010); through creating

trust and friendship-based relationships between firm leaders and those involved in innovation processes (Cuevas-Rodríguez et al., 2014); and through granting board members access to external ideas, trends, and information (Barroso-Castro, Villegas-Periñan, and Casillas-Bueno, 2016). Hence, we expect that the strength of board members' internal social capital and the strength of their external social capital constitute important boundary conditions that moderate the link between family involvement and innovation-related outcomes.

Our study contributes to the literature on family firm innovation in several ways. First, we add to the discussion about family firm innovation by showing that families' depth of involvement in managerial decision-making differently affects the number of inventions and the market relevance of innovations, two distinct outcomes of firms' R&D processes. Thereby, we offer one of the few empirical family involvement studies that sheds light on the relevance of innovation output (Block, Miller, Jaskiewicz, and Spiegel, 2013) and distinguishes market-focused output from technological R&D output. In this way, we work toward a more holistic view of innovation in family-influenced firms that accounts for different types of innovation outcomes and responds to Duran et al.'s (2016) call for a better understanding of the conversion rate of innovation processes. We take up their notion that family firms are "doing more with less," and link it with market-relevant innovation (Duran et al., 2016, p. 1224).

Second, we use the concept of socioemotional wealth to explain heterogeneity in innovation patterns. We elucidate how socioemotional wealth, in the form of family involvement through voting rights and board social ties, interacts with R&D efforts and affects their outcomes. Thereby, we follow Berrone, Cruz, and Gomez-Mejia (2012) in their attempt to go beyond established theories such as agency theory (e.g., Morck and Yeung, 2003), stewardship theory (e.g., Miller and Le Breton-Miller, 2006), and the resource-based view of the firm (e.g., Habbershon, Williams, and MacMillan, 2003), and position socioemotional wealth as the key theoretical notion that fills the void of theoretical grounding original to family firm research. In this respect, we corroborate the theoretical link between socioemotional wealth considerations among family members with different degrees of business involvement and organizational innovation profiles.

Finally, we transfer the distinction between internal and external social resources on the board level to the domains of innovation and family business. We show that relational resources derived from firm tenure and board interlocks are crucial boundary conditions for families' influence on technological inventions. This finding corroborates prior evidence that social capital at the apex of the firm can be a catalyst for change (Haynes and Hillman, 2010), and facilitates a better understanding of its impact on innovation outcomes.

Theory Development and Hypotheses

Family Involvement and Outcomes of Innovation

A family firm is "a business governed and/or managed to shape and pursue the vision of the business held by a dominant coalition controlled by members of the same family or a small number of families in a manner that is potentially sustainable across generations of the family or families" (Chua, Chrisman, and Sharma, 1999, p. 25). It is widely accepted that family firms are responsible for a large proportion of the world's economic activity (Clerides, Lach, and Tybout, 1998; De Massis et al., 2018).

Distinguishing the organizational processes of family-owned and non-family firms rests upon an assessment of the degree of family members' involvement in the business (Chrisman, Chua, Pearson, and Barnett, 2012). Following the work of Zahra (2003, 2005), and Patel and Cooper (2014), we define *family involvement* as the active participation of family members in organizational decision-making through voting rights. Family involvement enhances the family's knowledge of the firm's challenges, strengths, and resources (Sirmon and Hitt, 2003; Zahra, 2003), and about trending business opportunities, technologies, and markets (Zahra, 2005; Zahra, Hayton, and Salvato, 2004). This leads to a broader set of strategic alternatives from which family firms can choose (Zahra, 2005), which, in turn, determines the level of active influence a family can take on the business. Although influential shareholders and board members rarely carry out innovation processes or market research themselves, their work in monitoring internal processes and distributing resources to achieve strategic goals is vital to innovation (Haynes and Hillman, 2010; Hillman and Dalziel, 2003). Family firm members with control of a firm's voting rights can decide

on the design of processes, the selection of strategies, and the redeployment of resources to different business units (Chrisman et al., 2012; Sirmon and Hitt, 2003; Zahra, 2003).

Family involvement constitutes an important dimension of socioemotional wealth, which is a concept that has gained traction over the last two decades in family firm research (Gomez-Mejia, Cruz, Berrone, and de Castro, 2011; Gomez-Mejia et al., 2007). Socioemotional wealth has become the key concept for explaining how and why family firms differ in their goals and behaviors from non-family firms. It is defined as the "non-financial aspects of the firm that meet the family's affective needs" (Gomez-Mejia et al., 2007, p. 106). It thus goes beyond the maximization of profits. Berrone et al. (2012) suggest a set of five dimensions for socioemotional wealth that include family involvement, identification of family members with the firm, binding social ties, emotional attachment of family members, and renewal of family bonds to the firm through dynastic succession.

Along these five dimensions, socioemotional wealth strongly influences the behavior of family shareholders and board members (Gomez-Mejia et al., 2007) and their attitude toward innovation in particular (Gomez-Mejia et al., 2011; Sirmon and Hitt, 2003). For instance, the need to maintain control of the firm, and thus, to conserve socioemotional wealth, might conflict with the unpredictability and uncontrollability of R&D efforts that are necessary to create inventions that lead to innovations (Gomez-Mejia et al., 2011, 2014). Innovations, however, are often an essential part of family firms' strategy to stay competitive and maintain their socioemotional wealth in the long term (Rondi et al., 2019). Hence, socioemotional wealth considerations are the key feature that affects how family firms approach innovation (De Massis, Di Minin, and Frattini, 2015; Zahra, 2005).

Empirical evidence by Chrisman and Patel (2012) suggests that while family firms invest less, on average, than non-family firms in R&D to develop technological inventions, they show higher variance in these investments. They attribute this phenomenon to the short- or long-term nature of R&D investments. In the short term, the investments may threaten the socioemotional wealth of the family, as they are often complex, forcing the family to turn to outside expertise; they require a willingness to experiment, and they may involve financing that entails ceding some of the

ownership to outsiders such as venture capitalists (Gomez-Mejia et al., 2011). In the long term, however, the same investments can lead to superior innovations that satisfy customers, create sustained competitive advantages, and promise socioemotional wealth in the form of long-term succession and strong family identification with leadership in innovation (Filser et al., 2018; Miller et al., 2015). If family firms succeed in setting innovation as a core strategy that secures their socioemotional wealth, they enable R&D managers to calmly carry out complex innovation projects with distant payoff periods (Miller et al., 2015; Sirmon and Hitt, 2003).

Therefore, the influence of socioemotional wealth goes beyond the decision to invest (or not) in innovation and extends to the approaches and projects that are being pursued. In that sense, socioemotional wealth affects not only the inputs, but also the outcomes of R&D efforts (Block et al., 2013). Following Artz, Norman, Hatfield, and Cardinal (2010), we examine inventions (i.e., filed patents) and market innovations (i.e., released products that are perceived as relevant from the customers' point of view), two outcomes that embody the technological and market dimensions of knowledge creation (Cuevas-Rodríguez et al., 2014). These outcomes are closely related, because inventions are a typical output of R&D activity, and, at the same time, they are an essential input into innovations (Maclaurin, 1953). Given their distinct nature, we argue that socioemotional wealth has different implications for inventions and innovations. We expect that strong socioemotional wealth decreases the number of inventions—which carry a high risk of technological and financial failure—but that it enhances the market success of innovations. This should be especially true if the family is closely involved in the managerial decision-making of the firm, because the affective needs of the family, their values, and their expertise will directly influence the allocation of resources to R&D and innovation projects (Anderson and Reeb, 2003; Carney, 2005).

While family firms tend to be less willing than non-family firms to engage in R&D projects, they often exceed them at pursuing and completing complex innovation projects, due to the family members' skills (Duran et al., 2016; De Massis, Frattini, et al., 2015). These skills are rooted in their deep knowledge of the market, and of the firm with its idiosyncratic internal affairs; in their tight monitoring of, and control over, the innovation processes; and in the passion

that comes with their socioemotional wealth (Gomez-Mejia et al., 2014; Miller et al., 2015). There is a tension between being able to engage in R&D and being unwilling to do so. Scholars of family firm innovation call this the "willingness-ability paradox" (De Massis, Frattini, et al., 2015; Rondi et al., 2019). Once the family members overcome their skepticism, they can achieve better innovation outcomes with similar inputs than non-family members (Duran et al., 2016). We argue that this paradox finds its realization in fewer inventions but more relevant innovations.

Family Involvement and Number of Inventions

We expect that a stronger involvement of family members in the decision-making processes will lead to fewer inventions. There are four main lines of argumentation supporting this view. First, while inventions are often the cornerstones of innovations that succeed on the market (Artz et al., 2010), investing and engaging in R&D to develop them carries a high likelihood of technological and financial failure (Kor, 2006), as well as uncertainty about the success of the invention. An ex-ante evaluation of an invention's added value to the innovation process is difficult to make before implementing it in a product or service (Block, 2012). R&D investments sometimes lead to nothing of any value at all. Such financial and technological failures threaten a family firm's socioemotional wealth (Berrone et al., 2012; Sirmon and Hitt, 2003). Consequently, we expect that strong family involvement will lead to protective behavior to safeguard socioemotional wealth, such as refusing to engage in too many R&D initiatives at one time, and, instead, focusing on a few projects that have the best prospects.

Second, as part of their socioemotional wealth considerations, family members seek to maintain control and influence over their firm (Berrone et al., 2012; Chua et al., 1999). Since R&D projects are complex and often involve collaboration and the sourcing of knowledge from external partners (Gomez-Mejia, Makri, and Kintana, 2010; Keil, Maula, Schildt, and Zahra, 2008; Kotlar, De Massis, Frattini, Bianchi, and Fang, 2013), they also frequently mean giving away some of the control over the firms' internal processes. The higher the number of R&D projects and the more distal the knowledge involved, the higher will be the managerial complexity (Belderbos, Faems, Leten, and Van Looy, 2010), and the lower the possibility to maintain tight control over the firm (De Massis, Frattini, et al.,

2015; Gomez-Mejia et al., 2011). To contain this loss of control, we expect that family members will use their voting power to limit engagement in multiple R&D projects leading to a low number of inventions.

Third, family members often strongly identify with their firm (Gomez-Mejia et al., 2007, 2011). They regard the firm to some degree as an extension of the family, and they care very much about its reputation (Berrone et al., 2012). If a firm loses face through financial and technological failures, the shareholding family's socioemotional wealth is diminished and the affected family members will suffer emotionally (Berrone et al., 2012; De Massis, Frattini, et al., 2015). These considerations can negatively affect how the family approaches inventions (Filser et al., 2018), leading to fewer R&D investments (De Massis, Frattini, et al., 2015) and engendering excessive monitoring of processes (Miller et al., 2015), resulting in fewer and slower R&D projects, and ultimately fewer inventions, especially if the level of family involvement in managerial decision-making is high (Zellweger, Nason, Nordqvist, and Brush, 2013).

Finally, we expect that the strong emotional attachment of the family to the firm leads to objections against external technological knowledge, which affects the number of inventions that a firm develops. Family owners have been portrayed as excessively sentimental (Miller, Lee, Chang, and Le Breton-Miller, 2009), sticking to the concepts, employees, products, and traditions that made them big (Fuetsch and Suess-Reyes, 2017), even if this conservatism is likely to harm their economic performance (Mazzelli, Kotlar, and De Massis, 2018). We expect that sentimentality reduces the total number of inventions, as family members involved in firm strategy will be less willing to support a strategic focus on R&D efforts that require a "departure from existing organizational routines" to create patentable inventions (De Massis, Di Minin, et al., 2015, p. 12). We therefore hypothesize:

> H1: Family involvement is negatively associated with the number of inventions in the form of patents.

Family Involvement and Market Relevance of Innovations

The market relevance of innovations refers to customers' perception of additional benefits provided by firm innovations relative to the previous product

generation (Chandy and Tellis, 2000). Thus, it constitutes an external user perspective on the novelty and quality of innovation activities. Distinguishing between the number of inventions and the market relevance of innovations is of particular interest in the context of family firms, as many scholars underscore that family firms invest less in R&D (Block, 2012; Block et al., 2013; Tognazzo, Destro, and Gubitta, 2013), and thus, create fewer inventions, while others argue that family businesses often create innovations with higher market potential (Duran et al., 2016). Inventions, as noted above, are not only the output of R&D activities, but also essential inputs for the creation of innovations relevant to the market. While we expect a negative relationship between family involvement and the number of inventions, we argue that the strong involvement of family members leads to greater market relevance of their product innovations. Several arguments support this claim.

First, family members who are involved in firm decisions commonly spend their whole careers working in the firm and its industry, so they are often extraordinarily knowledgeable about the business and the market it operates in (Cabrera-Suárez, De Saá-Pérez, and García-Almeida, 2001; Lumpkin and Brigham, 2011), as well as its customers' characteristics and needs (Calabrò et al., 2019; Cuevas-Rodríguez et al., 2014; Dibrell and Moeller, 2011). This knowledge makes these family members particularly effective at making decisions on resource allocation and deployment within the firm and industry (Sirmon and Hitt, 2003). While family members' involvement may choose lower resource allocations into R&D, as they fear financial and technological failures that could harm their socioemotional wealth (Rondi et al., 2019), their capabilities, expertise, and high level of involvement in the processes make them especially efficient in transforming resources and inventions into innovations that are perceived as beneficial and are, therefore, successful on the market (Duran et al., 2016).

Second, many family members who have stakes in a firm seek to ensure a long-term horizon in their R&D investments and to avoid myopia in their managerial decisions, as they want to secure their socioemotional wealth in the long run (Duran et al., 2016; Rondi et al., 2019). This desire for long-term continuity provides R&D managers in firms with high family involvement with the time and resources to carefully complete complex innovation projects with long

payoff periods (Miller et al., 2015; Sirmon and Hitt, 2003). Family members provide those carrying out the projects with the necessary knowledge on the usefulness of the technologies involved (Duran et al., 2016). Family members can also estimate the technologies' market potential based on their market expertise and customer knowledge, and use this information to create innovations with a better fit-to-market, meaning that customers will perceive these innovations as beneficial.

Finally, family members typically show high levels of identification with the family business, as the firm represents an extension of the family, with its reputation an important source of self-worth (Zellweger, Eddleston, and Kellermanns, 2010). While this identification in combination with innovation might trigger fear of destroying the firms' reputation (Block et al., 2013) and risk for families' socioemotional wealth (Filser et al., 2018), we expect that the positive image of being an innovative leader can become an essential part of the firm's identity, supporting identification, and dynastic succession over time. Firms that consistently assign new and younger family members to the board will be able to stay innovative across generations (Zahra, 2005), always seeking new ways to satisfy customers (Rondi et al., 2019). We argue that the desire to maintain innovativeness over the long term provides family members with an extra incentive to be careful when working on the few innovation projects they have and to inject their superior firm and market expertise into those projects. Through this, family members will use innovations that their customers perceive as beneficial as a means to extend the positive image of their firms' identity. Thus, we hypothesize:

H2: Family involvement is positively associated with the relative market relevance of innovations.

Board Social Capital, Family Involvement, and Outcomes of Innovation

Next to human and financial capital, social capital is one of the most important factors for successful innovation (Tsai and Ghoshal, 1998). Knowledge creation processes benefit from interactions, and firms draw extensively on external linkages (Brettel and Cleven, 2011) to develop new products and services (Stanko, Fisher, and Bogers, 2017). Nahapiet and Ghoshal (1998, p. 243) define social capital as "the sum of

the actual and potential resources embedded within, available through, and derived from the network of relationships possessed by an individual or social unit." Social capital leads to inter- and intra-firm exchanges of resources and knowledge (Cuevas-Rodríguez et al., 2014) so that these resources and knowledge can be combined to create inventions and innovations (Galunic and Rodan, 1998; Nelson and Winter, 1982).

While firm social capital has been analyzed by many scholars at the levels of the individual (Griffith and Harvey, 2004), team (Tsai, 2000), and organization (Stam and Elfring, 2008), we examine it at the level of the board of directors (Barroso-Castro et al., 2016; Carpenter and Westphal, 2001). Drawing on Carpenter and Westphal's (2001) findings that the number and the quality of board members' social ties determine the effectiveness of their involvement in managerial decision-making, we argue that *board social capital* is an important contingency for the link between family involvement and the outcomes of innovation. We acknowledge that board members' managerial decisions are essential for firm performance and processes (Johnson et al., 2013; Mahoney, 1995; Ndofor, Sirmon, and He, 2015). Hence, we expect that board social capital is a crucial factor that influences the effectiveness of these decisions when, for instance, setting a strategic agenda for innovation and providing the necessary resources to pursue it.

It is important to distinguish between board members' internal and external ties of social capital (Cuevas-Rodríguez et al., 2014). "Internal ties refer to the relationships within the social structures of a collective (i.e., group or organization), while external ties are relationships that span boundaries to other individuals or collectives" (Gedajlovic et al., 2013, p. 461). Thus, *internal board social capital* denotes the board members' internal relations—bonding— which provide the board with collective cohesiveness and the pursuit of collective goals, while *external board social capital* denotes the connections between board members and other actors in their network— bridging—which enable them to access resources embedded in that network (Adler and Kwon, 2002). Researchers have established that both bonding and bridging play important roles in innovation processes (Vanhaverbeke, Gilsing, and Duysters, 2012).

Family members typically possess strong internal and external social capital (Barroso-Castro et al., 2016). Both are rooted in the families' idiosyncratic values, goals, and networks (Sorenson, Goodpaster,

Hedberg, and Yu, 2009), and are essential features of family firm operations (Shi, Shepherd, and Schmidts, 2015; Uhlaner, Matser, Berent-Braun, and Flören, 2015). They facilitate information flows, knowledge creation (Nahapiet and Ghoshal, 1998), and creativity (Perry-Smith and Mannucci, 2017), and determine the success of external partnerships (Ireland, Hitt, and Vaidyanath, 2002). Hence, it is through their social capital that board members can effectively counsel on strategy, access external information and valuable resources, tap on skill and expertise, and provide the family firm with the necessary legitimacy for its operations (Haynes and Hillman, 2010; Pfeffer and Salancik, 1978). Board social capital is essential for strategic change (Haynes and Hillman, 2010) and determines the effectiveness with which board members set a strategic agenda, oversee its implementation, allocate resources (including to R&D projects), and monitor subsequent processes (Corbetta and Salvato, 2004; Dalziel, Gentry, and Bowerman, 2011).

Taking all these factors into consideration, we argue that internal board social capital and external board social capital are important contingencies that influence the relationship between family involvement and the outcomes of firm innovation, that is, the number of inventions and the market relevance of innovations.

The Moderating Role of Internal Board Social Capital

We expect that internal board social capital (i.e., board members' firm tenure) attenuates the negative relationship between family involvement and the number of their inventions. Two arguments support this view. First, board members' internal social capital originates from shared co-working experience (Barroso-Castro et al., 2016) and leads to shared languages and narratives, and mutual trust, which is all essential for effective decision-making at the group level (Pearson, Carr, and Shaw, 2008; Tsai and Ghoshal, 1998). Families typically follow conservative strategies that seek to reduce uncertainty (Duran et al., 2016). If family board members lack the skills to tightly monitor and evaluate R&D projects, they will probably also judge the risks of financial and technological failure to be higher (Rondi et al., 2019), and will consequently use their influence on the board to reject the more uncertain projects. When projects are proposed that align with the families' values and goals (Sorenson et al., 2009), we expect that board members will pool their complementary

skills and knowledge (e.g., Kor and Sundaramurthy, 2009), attribute less importance to uncertainty, and refrain from using their influence against these projects. We argue that such collective cohesiveness will also enable non-family board members to convince family board members to invest in new, less-developed, and promising technologies.

Second, internal board social capital is highly valuable for the diffusion of externally sourced knowledge within the firm (Tushman and Romanelli, 1983; Tushman and Scanlan, 1981). This diffusion is highly important for invention processes, and usually involves the recombination of new and existing knowledge (Adams, Bessant, and Phelps, 2006; Galunic and Rodan, 1998; Nelson and Winter, 1982). Family members are a useful part of it, as they lay the foundations for, and possess the power to pursue, strategic and operative changes (Corbetta and Salvato, 2004; Zattoni, Gnan, and Huse, 2015). High internal board social capital "ensures that any resources that owners bring in from the outside will be used for the benefit of the group or firm" (Uhlaner et al., 2015, p. 9). We argue that where there is strong internal board social capital, board members will diffuse knowledge and resources, which will reduce the uncertainty surrounding R&D projects, and thus, increase the number of inventions. We therefore hypothesize:

H3a: Internal board social capital attenuates the negative relationship between family involvement and the number of inventions in the form of patents.

We further expect that the internal board social capital amplifies the positive relationship between family involvement and the relative market relevance of innovations. There are three main points in favor of this notion. First, the internal board social capital leads to the absorption and diffusion of external knowledge within the firm and the intra-firm dissemination of internal resources and knowledge (Arregle et al., 2007). Friendly, trusting, and respectful relationships between the family and other firm members (Cuevas-Rodríguez et al., 2014) facilitate smooth information flows (Nahapiet and Ghoshal, 1998) and enable frictionless creativity (Perry-Smith and Mannucci, 2017). This is particularly true in a calm and resource-rich innovation environment (Miller et al., 2015). Under these circumstances,

family members will use the effectiveness with which they can make strategic decisions (Corbetta and Salvato, 2004; Dalziel et al., 2011; Hillman and Dalziel, 2003) to provide product developers with the necessary information and resources to create innovations that outperform those of their competitors.

Second, trusting, high-quality relationships, and cohesiveness in the boardroom lead to meaningful knowledge transfer and intense collaboration, including the exchange of the nontrivial knowledge that is critical for innovation (Chen, Chang, and Hung, 2008). At the same time, such relationships reduce the need for tight monitoring and control systems (Dakhli and De Clercq, 2004), which gives researchers more time and freedom to process internal and external knowledge, as well as to exchange ideas with family and non-family members of the firm to create meaningful innovations that appeal to customers (Cuevas-Rodríguez et al., 2014).

Finally, board members' firm tenure drives the strength of their internal relations, providing the board with collective cohesiveness, and the pursuit of collective goals (Adler and Kwon, 2002) that correspond to the family's values and goals (Sorenson et al., 2009). Shared languages and narratives, and mutual trust that come along with internal board social capital, lead to effective decision-making at the group level (Pearson et al., 2008; Tsai and Ghoshal, 1998). Since board members decide on the strategic direction of the firm and the allocation of resources to different projects (Corbetta and Salvato, 2004; Hillman and Dalziel, 2003), we expect that, given collective cohesiveness and goals, family members will use their influence on boards to jointly leverage the innovation projects that correspond best to the families' collective goals. In these projects, they will bring their full knowledge and expertise to bear on the technologies involved to make them fully successful (Rondi et al., 2019). Thus, we hypothesize:

H3b: Internal board social capital amplifies the positive relationship between family involvement and the relative market relevance of innovations.

The Moderating Role of External Board Social Capital

Lang and Lockhart (1990, p. 106) use the term "board interlock" for a situation where "two firms

share a director or when an executive of one firm sits on the board of a second." In line with prior research (e.g., Johnson et al., 2013; Zona, Gomez-Mejia, and Withers, 2018), we expect that board interlocks constitute central facets of external board social capital. We argue that these personnel constellations yield strong social ties that enable board members to draw on resources, knowledge, and expertise whenever necessary, thus, improving the effectiveness of their decision-making. We, therefore, expect that external board social capital attenuates the negative relationship between family involvement and the number of firm inventions. Several arguments support this view.

First, Adler and Kwon (2002, p. 19) note that "actions of individuals and groups can be greatly facilitated by their direct and indirect links to other actors in social networks." This is especially true with regard to R&D efforts, for which acquiring knowledge is a key success factor (Maurer, Bartsch, and Ebers, 2011), with the potential to increase the number of a firm's inventions (Brass, Galaskiewicz, Greve, and Tsai, 2004). We argue that external board social capital is particularly conducive to providing access to (1) information that complements the previous experience of the executives (Baker, Grinstein, and Harmancioglu, 2016; Geletkanycz and Hambrick, 1997), (2) new ideas and trends (Gassmann, Enkel, and Chesbrough, 2010), and (3) tacit knowledge and routines (Duran et al., 2016). Friendship-based relationships across boards mitigate concerns of sharing valuable information with external parties (Shropshire, 2010; Zona et al., 2018). External board social capital reduces uncertainties and objections among family members about current and potential R&D projects, resulting in a greater number of inventions.

Second, beyond a sheer increase in the number of accessible opportunities and ideas (Adams et al., 2006; Li, 2019), board interlocks (a central feature of external board social capital) contribute to R&D processes by offering quick and frequent feedback (Garud, Tuertscher, and Van de Ven, 2013), valuable advice and counsel (Hillman and Dalziel, 2003), insights into new corporate practices (Davis, 1991), and timely access to support from outside the firm (Baker et al., 2016). Through this, board interlocks reduce environmental uncertainty and dependence (Zona et al., 2018), which lowers the number of costly failures early in the R&D process. We thus expect that strong external board social capital inspires board members

to embrace R&D more openly, which will, in turn, enhance the number of inventions.

Finally, families' personalism, care for reputation, and long-term orientation result in exceptional levels of mutual trust in their external network (Deephouse and Jaskiewicz, 2013; Lude and Prügl, 2019). While knowledge transactions are typically subject to problems of asymmetric information, family members involved in the family's business have typically "built up a reputation for honest interaction because they have more at stake in their family-based networks" (Bennedsen and Foss, 2015, p. 74). This trustworthiness leads partners to share more information in the hope of reciprocity (Miller et al., 2009). We argue that board members in firms with high family involvement will accordingly be able to acquire more knowledge through external ties since they exhibit lower fluctuation rates than board members in firms with low family involvement (Werner, Schröder, and Chlosta, 2018). At the same time, continuity in social ties establishes enduring knowledge structures (Patel and Fiet, 2011) that yield the ability to preserve externally acquired information. Strongly involved family members will use this knowledge advantage to enhance R&D processes, and thus, reduce their inherent uncertainties. We therefore hypothesize:

H4a: External board social capital attenuates the negative relationship between family involvement and the number of inventions in the form of patents.

Along similar lines, we suggest that external board social capital enhances the positive link between family involvement and the market relevance of firms' innovations. Two arguments support this view. First, external board social capital can enhance "the timing, relevance, and quality of information" available to the firm (De Carolis and Saparito, 2006, p. 44). Firms with high family involvement and their members enjoy increased levels of trust, which encourages partners to share more knowledge in earlier stages, putting board members into a prime spot to receive and process cutting-edge information early on in the innovation process (Thomke, 2003). Additionally, partners will invest more time and resources in relationships with firms with high family involvement, as they expect to benefit from long-lasting relationships and reciprocity with family members that are typically rooted in the long-term orientation and personalism of the family (Deephouse and Jaskiewicz, 2013; Lude and Prügl, 2019). This situation enhances

board members' knowledge of technologies and current trends, and thus, enables them to dedicate the right resources to product development processes that create relevant innovations.

Second, board members in firms with high family involvement are likely to engage in exchanges with trustworthy and competent external parties, as well as more generally encourage greater openness with regard to innovation than firms with low family involvement (Shi et al., 2015). We expect that if board members pursue open innovation practices (e.g., Bogers et al., 2017) for a longer period with good experiences and successful innovation stories, this openness will transfer to the core values of the families and their businesses. This shift in the culture may encourage a new identity of openness and innovation, which will, in turn, affect the identity of all family members, and their employees, too, contributing to an entrepreneurial spirit that fosters greater freedom to pursue innovation projects with great market relevance. Hence, we hypothesize:

H4b: External board social capital amplifies the positive relationship between family involvement and the relative market relevance of innovations.

Figure 1 illustrates our research model.

Methodology

Sample and Data

To test our hypotheses, we base our analysis on firms that have been continuous members of the U.S. S&P 500 index between 2006 and 2013. The S&P 500 is a frequently used data set in research on family firms (Dyer and Whetten, 2006; Randolph, Wang, and Memili, 2018; Short, Payne, Brigham, Lumpkin, and Broberg, 2009) and innovation (Block, 2012; Latham and Braun, 2010), as it covers 70% to 80% of total U.S. equity market capitalization (S&P Indices, 2019). We exclude banks, as their research activities are largely not based on patents, and public utility firms, as government regulation can affect their investment choices (Anderson, Duru, and Reeb, 2012; Lee, 2006).

To create a comprehensive data set, we aggregated data from four different sources including (1) Compustat North America for financial statement data, (2) patent data that were gathered using the Questel Orbit Intelligence database and web scrapers, (3) manually collected data on family involvement and board characteristics from proxy statements (SEC Form DEF 14 A) and company websites, and (4) manually collected and coded product announcements from PR Newswire and BusinessWire via the Nexis database. Since we analyze two different dependent variables, we created two subsamples. First, our sample to analyze the number of inventions (as expressed by the number of patents) comprises 2064 firm-year observations for 258 firms between 2006 and 2013, as well as 1.85 million patents. Second, our sample on the relevance of innovations (i.e., customer novelty of product announcements) includes 744 firm-year observations for 124 manufacturing firms from 2008 to 2013, as well as 1774 product announcements.

Dependent Variables

There is still not a generally accepted single indicator to measure the performance of innovation efforts.
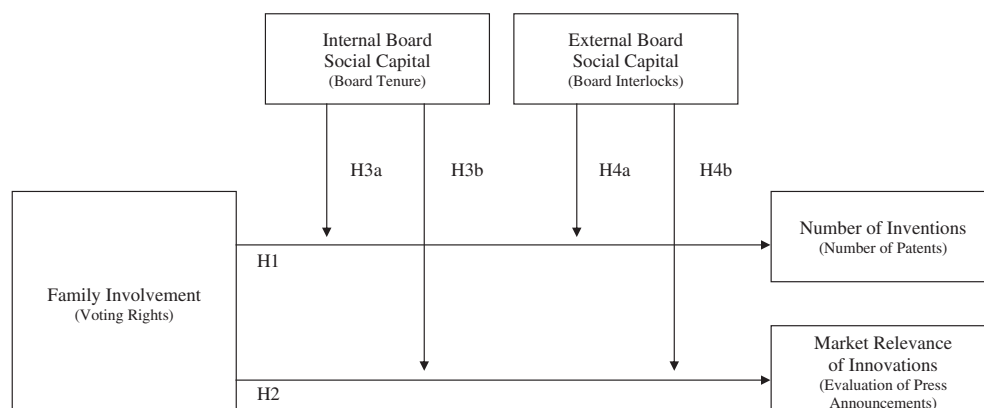

Figure 1. Conceptual Model

Previous studies using secondary data have focused on patent counts and new product announcements (e.g., Artz et al., 2010). We also use these two measures as our dependent variables in our analyses to obtain a comprehensive view.

Number of inventions. In line with previous studies on outcomes of innovation in family firms (Block et al., 2013; Liu, Chen, and Wang, 2017; Memili, Fang, and Welsh, 2015) and innovation more generally (Artz et al., 2010), we measure *number of inventions* as the number of patents, that is, the total number of successful patent applications of a firm in a given year. The advantages of this measure include the external validation of the technological novelty (Chin, Chen, Kleinman, and Lee, 2009) and the economic significance derived from the property rights that patents confer (Ahuja and Lampert, 2001).

We use a multistep approach to collect patent data. First, we identify subsidiaries of our sample companies to map all patents correctly to the selected S&P 500 members. We then collect patent count and citation data for the years 2006 to 2017 in the Questel Orbit Intelligence database. This database comprises global patent information from more than 60 patent-issuing authorities (Questel, 2019). Organizations' subsidiaries are cross-checked with the Orbit data and Google Patents to ensure broad coverage of inventions. To control for truncation issues, we follow the guidelines by Hall, Jaffe, and Trajtenberg (2005), resulting in the inclusion of 1.85 million patents in our study.

Market relevance of innovations. To move beyond the sheer number of inventions toward an indicator for the relative relevance of innovations for the market, we additionally analyze new product announcements. These announcements offer two main advantages as a measure of innovativeness. First, the rich information typically provided in press announcements makes it possible to distinguish among different degrees of innovativeness. Second, because companies view these new product announcements as an important means of communication, they publish them regularly (Carroll and McCombs, 2003; Kennedy, 2008; Zavyalova, Pfarrer, Reger, and Shapiro, 2012).

We collected the product announcement data from PR Newswire and BusinessWire through Nexis. These newswire services have been widely used in research on innovation activities (Chandy and Tellis, 2000; Sood and Tellis, 2009). We additionally cross-checked the announcements with company website information to ensure accuracy. We focused our product announcement analysis on manufacturing firms with standard industrial classification (SIC) codes from 2000 to 3999 to ascertain that firms have managerial control over product design and production and to increase consistency among the announcements (Konchitchki and O'Leary, 2011). Subsidiaries were identified via the 10-K company filings and included in the search.

To classify the collected announcements, we rely on the approach of Chandy and Tellis (2000) to assess if announced products also reflect innovations from a market perspective. Listing the new products that a firm introduced in a given year, we had three experts rate each product. The experts all have master's degrees in management or engineering as well as work experience in the innovation field. The experts independently rate the products on a 9-point Likert scale for their customer benefits from a market perspective, following Chandy and Tellis (2000, p. 6): "For superiority in user benefits relative to the previous product generation, they rated each innovation on a scale ranging from 1 (not at all higher) to 9 (substantially higher)." We only employ Chandy and Tellis's (2000) customer benefit scale and not their technology scale, since we already cover the technology perspective in our patent count variable.

We took several actions to ensure interrater reliability. We clearly defined the different levels of the newness of customer benefits and provided our experts with illustrative examples. We ensured that the experts had access to consistent information on customer benefits and markets in the coding process. The use of a preceding product generation as the point of reference lowers the subjectivity of the ratings. The results demonstrate sufficient interrater reliability, with r_{wg} coefficients consistently larger than .70 (Burke, Finkelstein, and Dusig, 1999). We assign a product announcement as a market-relevant innovation when the average of the three experts' ratings is a minimum of five on the 9-point scale (Chandy and Tellis, 2000). We finally measure relative *market relevance of innovations* as the number of market-relevant new product announcements scaled by the number of total collected product announcements in a given year. This ratio can take values from zero to one, with one theoretically representing a firm announcing only products that are innovative from a customer perspective.

Independent Variables

Family involvement. Our central independent variable is *family involvement*. In a two-step approach, we first identified family firms and then measured the degree of influence the family can exert over the business through their voting rights. Following Anderson and Reeb (2004), we identified family firms through fractional equity ownership and/or board membership in the firm. Data on fractional equity ownership and board presence was hand-collected from proxy statements and enriched with data from company websites. We identified 29% of the patent sample and 28% of the product announcement sample as coming from family firms in 2008, which is in line with previous studies (Anderson and Reeb, 2004; Lee, 2006). We collected and included data on family firm characteristics for each year from 2006 to 2013, even though the figure shows only a small variation over the panel years.

To capture the degree of influence the family can exert on the business, we collected detailed information on the percentage of family-controlled voting rights for the firms identified in step one. The main reason there is a difference between fractional ownership and voting rights is the fact that certain special shares are assigned extra votes (Miller and Le Breton–Miller, 2011, p. 1060). An example of a public company that uses this system is Google (Alphabet Inc.), whose cofounders, Larry Page and Sergey Brin, are among several insiders who own so-called "Class B" stock, which has 10 votes per share. This system is particularly prevalent in family firms. Villalonga and Amit (2009) analyzed 515 large listed U.S. corporations between 1994 and 2000 and found that in family firms, family members own an average of 15.3% of the shares but control 18.8% of the voting rights. We focus on voting rights as an indicator of family involvement. We also include non-family firms where family involvement equals zero to reflect the depth of family involvement in managerial decision-making across firms in general.[1] Our *family involvement* measure captures the share of family voting rights in relation to overall voting rights.

Internal board social capital. We operationalize *internal board social capital* through the average tenure of board members. Longer average tenures of

board members lead to an increase in the board's co-working experience, which allows them to "develop a collectively owned 'bonding' form of social capital" (Barroso-Castro et al., 2016, p. 14). This bonding enables them to arrive at a mutual strategic understanding and reduces goal conflict (Kor, 2003).

We employ the average tenure of board members instead of the shared tenure. Even though these two measures are highly interrelated (correlation .67), we believe that the average tenure is better suited to capture the wealth of longer tenures in relation to innovation activities. The shared tenure model ignores long-term board members' experience that does not have pairwise overlaps with other current board members. We argue that this experience is also valuable, as it represents an important connecting mechanism between the board and the rest of the firm—long-term board members are especially important to transfer knowledge between upper and lower organization levels. Much of the knowledge that supports innovation is tacit, and the transfer of this knowledge is supported through long-standing relationships (Seidler-de Alwis and Hartmann, 2008). We collect data on each board member and year from proxy statements and company websites and calculate the average tenure for the board as a whole.

External board social capital. We measure *external board social capital* through the number of external ties of board members in the form of board interlocks. An interlock, as noted above, occurs "when a person affiliated with one organization sits on the board of directors of another organization" (Mizruchi, 1996, p. 271). Board interlocks have been used in various studies to measure external board social capital (Barroso-Castro et al., 2016; Haynes and Hillman, 2010; Lester and Cannella, 2006; Tian, Haleblian, and Rajagopalan, 2011). We count connections only to listed companies, as the size, importance, and nature of unlisted companies are, in many cases, not transparent, and the data on interlocks is fragmentary.

Control Variables

We employ several control variables in this study. Important "raw material or stimuli" for the R&D process (Brown and Svenson, 1988, p. 30), and major influences on the R&D output, are the financial resources deployed in the form of R&D

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[1]When focusing the sample on family firms only, the negative relationship between family involvement and number of inventions ($p < .01$) as well as the positive relationship between family involvement and the relative relevance of innovations ($p < .05$) prevail.

expenses (Block et al., 2013). We scale R&D expenses by sales and replace missing values with zero to measure *R&D intensity* (Bansal, Joseph, Ma, and Wintoki, 2016). Firm size is likely to influence both the governance practices (Bammens, Voordeckers, and Van Gils, 2008) and the innovation outcomes of firms (Katila, 2002). We control for it using the natural logarithm of total sales for our *sales* variable. In addition, we control for the financial performance of the firm using the return on assets (*ROA*), as it potentially influences the board's attitude toward innovation projects, especially risky ones. We include *capital expenditures* because they can be seen as another target for investment besides R&D, especially for family firms, which prefer a lower level of idiosyncratic risk (Anderson et al., 2012). To account for a potential orientation toward expansion that affects innovation behavior, we include *sales growth* as the average change of sales over the last two fiscal years (Cannella, Jones, and Withers, 2015). At the board level, we control for *board size*, measured as the number of directors (Zattoni et al., 2015). In our regressions using coded press announcements, we also control for the total *number of product announcements*. We also include year effects to capture (unobserved) shocks that are time-varying (Papies, Ebbes, and Van Heerde, 2017).

Analysis

Our first dependent variable, the *number of inventions* (i.e., number of patents) is a nonnegative count variable. Verbeek (2017) advises applying negative binomial panel regression models when such count data are overdispersed. Overdispersion is present when the sample variance of the dependent variable is larger than its mean, which is true for our patent-count variable, and corresponds to overdispersion in patent data of prior studies (Block et al., 2013). In line with Block et al. (2013), the Bayesian information criterion (BIC) is used to choose between model types, and it indicates that negative binomial panel models are more appropriate for our data than Poisson regressions. We, therefore, estimate count data models using negative binomial panel regressions (Alcácer, Gittelman, and Sampat, 2009; Liang, Li, Yang, Lin, and Zheng, 2013). A Hausman test suggests that a fixed-effects negative binomial panel estimation is more appropriate when using the number of patents as a dependent variable (vs. a random-effects estimation; Hausman, 1978),

which is in line with prior work (Wadhwa, Phelps, and Kotha, 2016).

Our second dependent variable, relative relevance of innovations, is a proportion bounded between zero and one [0,1]. We thus use fractional logit estimations with robust standard errors (SEs) that employ a logit transformation implemented via a generalized linear model and ensure that predicted values stay in the unit interval (Papke and Wooldridge, 1996). "Fractional logits cannot accommodate fixed effects," as per Hochberg, Ljungqvist, and Lu (2010, p. 844). We control for omitted factors relating to industry and time (effects are not reported to conserve space).

Results

Descriptive Statistics and Correlations

Tables 1 and 2 show the descriptive statistics and correlations among the variables of our study. There are correlations naturally higher than .5 between sales and capital expenditures as well as between external board social capital and board size. The results do not substantially change regarding direction and significance when the regressions are repeated without one of the variables of the relating pairs. The other correlations are lower than |.5|. We computed individual and average variance inflation factors (VIF). The highest individual VIF in our patent sample is 1.75, while the mean VIF is 1.30. For our product announcement sample, the values are 1.92 and 1.36, respectively. The individual VIF values do not indicate that the SEs are inflated (Lindner, Puck, and Verbeke, 2020).

Results from Regression Analyses

Table 3 presents the results of our fixed-effects negative binomial panel regressions with the number of inventions, that is, number of patents, as a dependent variable. Model 0 in Table 3 contains only control variables. Model 1 shows the estimation of the main effect, family involvement, in relation to the number of patents. Model 2 and Model 3 add the interaction terms of internal and external board social capital. Finally, Model 4 shows the full model. In H1, we expected that family involvement would negatively relate to the number of patents. Models 1 to 4 support this reasoning, since family involvement is indeed negatively associated with the number of successful patent applications (Model 1, $\beta = -.13$, $p < .01$).

Table 1. Descriptive Statistics: Patent Sample (*N* = 2064)

	Mean	SD	1	2	3	4	5	6	7	8	9	10
1. Number of inventions	897.01	2205.81	1.00									
2. Family involvement	.06	.16	−.06**	1.00								
3. Internal board social capital	8.45	2.96	−.02	−.00	1.00							
4. External board social capital	46.25	17.63	.23***	.03	−.15***	1.00						
5. R&D intensity	.04	.08	.26***	−.04†	−.02	.03	1.00					
6. Sales	9.47	1.10	.31***	−.03	−.12***	.40***	−.24***	1.00				
7. Capital expenditures	1652.54	3318.32	.18***	−.05*	−.09***	.23***	−.14***	.52***	1.00			
8. ROA	.12	.07	.06***	.03	.16***	−.05*	.07***	−.03	−.07**	1.00		
9. Sales growth	.16	.31	.04*	−.02	−.04†	−.01	.14***	.04†	.02	.20***	1.00	
10. Board size	10.91	2.76	.12***	.01	−.08***	.58***	−.09***	.28***	.13***	−.03	−.05*	1.00

Notes. Table displays pairwise correlation coefficients.
***p < .001; **p < .01; *p < .05; †p < .10.

Table 2. Descriptive Statistics: Product Announcement Sample (*N* = 744)

	Mean	SD	1	2	3	4	5	6	7	8	9	10	11
1. Market relevance of innovations	.02	.12	1.00										
2. New product announcements	2.38	3.54	.03	1.00									
3. Family involvement	.06	.17	.13***	.10**	1.00								
4. Internal board social capital	8.60	2.70	−.01	.16***	.07*	1.00							
5. External board social capital	45.22	16.33	−.02	.07†	−.09**	−.07*	1.00						
6. R&D intensity	.06	.08	−.01	.13***	−.09**	−.02	.10**	1.00					
7. Sales	9.40	1.11	−.01	.09*	−.13***	−.20***	.37***	−.20***	1.00				
8. Capital expenditures	1218.28	3591.47	−.03	−.01	−.07*	−.13***	.20***	−.09*	.54***	1.00			
9. ROA	.13	.07	.06†	−.04	.04	.11**	−.08*	.03	−.12***	.02	1.00		
10. Sales growth	.12	.29	.03	.05	−.05	−.05	−.03	.17***	.07*	.03	.22***	1.00	
11. Board size	10.71	2.90	.03	−.04	.03	−.05	.62***	−.08*	.24***	.06	−.05	−.07*	1.00

Notes. Table displays pairwise correlation coefficients.
***p < .001; **p < .01; *p < .05; †p < .10.

We hypothesized that internal board social capital (H3a) and external board social capital (H4a) would act as contingencies that attenuate the negative relationship between family involvement and number of inventions. Model 2 in Table 3 indicates that the positive interaction between family involvement and internal board social capital is marginally significant (Model 2, $\beta = .03$, $p < .10$). The full Model 4 provides support for H3a (Model 4, $\beta = .03$, $p < .05$). Table 3 also shows that the coefficient of the interaction between

family involvement and external board social capital is positive and significant in Models 3 and 4 (Model 3, $\beta = .07$, $p < .01$; Model 4, $\beta = .08$, $p < .001$). This finding confirms H4a. Figures 2 and 3 show the interaction plots of these interaction effects at high levels (i.e., one standard deviation above the mean) and low levels (i.e., one standard deviation below the mean). While the slopes for internal board social capital are statistically different from zero for low levels ($p < .01$) and high levels ($p < .10$), the slopes for external board social

Table 3. Fixed-Effects Negative Binomial Panel Regressions (Number of Inventions)

Variable	Number of Inventions				
	(0)	(1)	(2)	(3)	(4)
R&D intensity	.04**	.04**	.04**	.03*	.04**
Sales	.25***	.26***	.25***	.24***	.28***
Capital expenditures	.02	.02	.02	.03	.02
ROA	.04*	.03*	.03*	−.00	.03
Sales growth	.00	.00	.00	.05	.01
Board size	−.01	−.01	−.01	−.01	.00
Family involvement		−.13**	−.11**	−.13**	−.10*
Internal board social capital			.01		.01
Internal board social capital × family involvement			.03†		.03*
External board social capital				.01	−.01
External board social capital × family involvement				.07**	.08***
Wald chi-squared	437***	448***	447***	525***	462***
N^a	1992	1992	1992	1992	1992
Log likelihood	−8464.98	−8459.83	−8458.05	−8490.20	−8451.20

Notes. Standardized regression coefficients are reported for non-dummy variables.
[a]N denotes the number of observations used in the model estimations after dropping observations without patents. Number of observations with zero patents: 72.
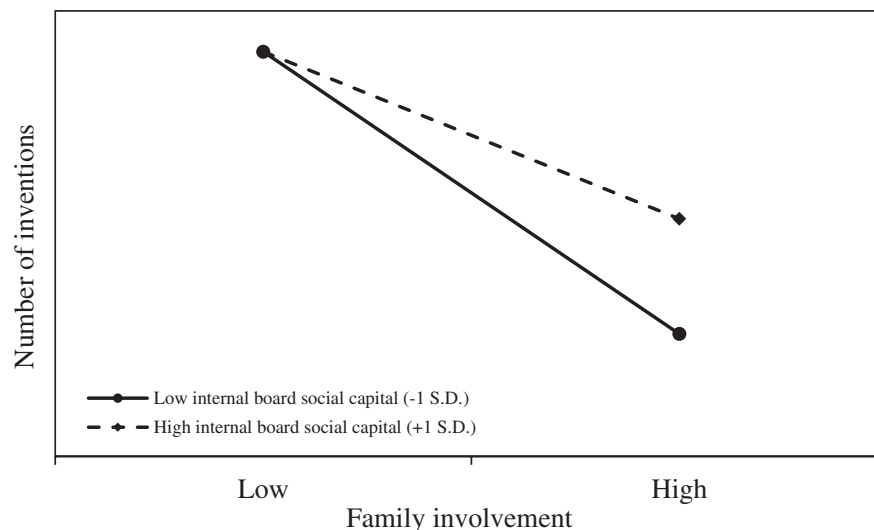***$p < .001$; **$p < .01$; *$p < .05$; †$p < .10$.

Figure 2. The Moderating Effect of Internal Board Social Capital on the Relationship Between Family Involvement and Number of Inventions

capital are only statistically different from zero for low levels ($p < .001$), not for high levels ($p > .10$). The plots indicate that the negative association between family involvement and the number of inventions is stronger when board social capital levels are low.

Table 4 presents the results of our fractional logit estimations with the relative market relevance of innovations as our dependent variable to assess H2, H3b, and H4b. Model 0 in Table 4 shows a controls-only regression. Model 1 tests the main effect of family involvement on the relative market relevance of innovations. Model 2 and Model 3 estimate the interaction effects of internal and external board social capital with family involvement. Model 4 is a full model comprising both interactions. In H2, we expected a positive relationship between family involvement and the relative market relevance of innovations. Models 1 to 4 in Table 4 support H2, as the coefficient of family involvement is positive and significant (Model 1, $\beta = .35$, $p < .001$). Regarding H3b and H4b, our results in Models 2 to 4 provide no evidence supporting our hypotheses that internal
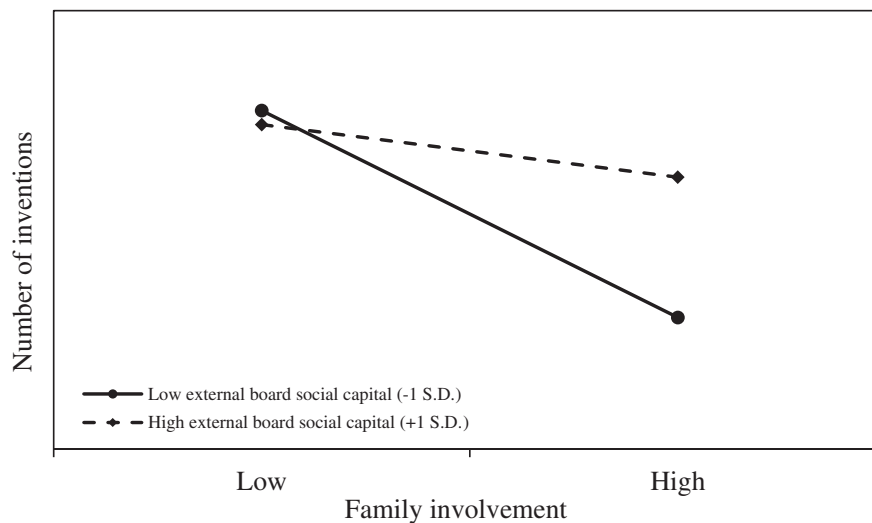

Figure 3. The Moderating Effect of External Board Social Capital on the Relationship Between Family Involvement and Number of Inventions

Table 4. Fractional Logistic Regressions (Relative Market Relevance of Innovations)

Variable	Market Relevance of Innovations				
	(0)	(1)	(2)	(3)	(4)
R&D intensity	−.04	.05	.04	.10	.09
Sales	−.01	.13	.10	.21	.18
Capital expenditures	−.35	−.35	−.34	−.33	−.33
ROA	.28*	.28*	.30*	.28*	.30*
Sales growth	.01	.00	−.00	−.01	−.02
Board size	.19	.16	.16	.27	.27
Number of product announcements	.16†	.09	.11	.10	.12
Family involvement		.35***	.36***	.37***	.37***
Internal board social capital			−.16		−.16
Internal board social capital × family involvement			.06		.05
External board social capital				−.37	−.37
External board social capital × family involvement				.14	.14
Wald chi-squared	40***	56***	57***	55***	56***
Nᵃ	744	744	744	744	744
Log pseudo-likelihood	−81.06	−79.11	−78.97	−78.56	−78.43

Notes. Standardized regression coefficients are reported for non-dummy variables.
ᵃN denotes the number of observations used in the model.
***$p < .001$; **$p < .01$; *$p < .05$; †$p < .10$.

and external board social capital amplifies the positive link between family involvement and the relative market relevance of innovations. The related interaction terms are statistically insignificant. Thus, we find no support for H3b and H4b.

Additional Analyses

We performed several tests in addition to our main models. Successful patent applications are a well-established invention indicator, but they mainly summarize the number of technological inventions. They may suffer from strategic motives such as protective patenting, which inflates the number of patents and lowers the validity of patent counts (Artz et al., 2010; Blind, Cremers, and Mueller, 2009; Jell, Henkel, and Wallin, 2017). To ensure that our patent-based analysis captures the relevance of firms' inventions, we reestimated our models using patent citations as a dependent variable. Patent citations constitute a measure of technological importance (Tang, Li, and Yang, 2015) and economic value (Alcácer et al., 2009; Harhoff, Narin, Scherer, and Vopel, 1999), and are, therefore, also an indicator for technological inventions that are considered relevant by researchers.

Table 5 presents the results of fixed-effects negative binomial panel regression analyses with the number of patent citations as a dependent variable. It shows a negative and significant coefficient for family involvement (Model 1, $\beta = -.17$, $p < .001$), which provides additional evidence for a similar relation as in H1. While we do not detect a significant interaction effect regarding internal board social capital, external board social capital significantly moderates the relationship between family involvement and patent citations (Model 3, $\beta = .15$, $p < .001$), attenuating this negative main relationship.

Beyond that, we conducted additional tests, which, to conserve space, are not tabulated. First, the natural strong link between R&D expenses and patenting activity may bias our findings. Without controlling for R&D intensity, we reestimated our regressions, explaining the number of patents. The results remain stable regarding direction and significance and corroborate our initial findings. Second, following Wadhwa et al. (2016), we rerun our fixed-effects negative binomial panel models as random-effects negative binomial panel models. The results remain fully robust. Third, as executive directors can be busy with their internal, day-to-day tasks, and are, therefore, potentially less important for external knowledge sourcing (Blanco-Alcántara, Díez-Esteban, and Romero-Merino, 2019; Liu and Paul, 2015), we excluded them from our external board social capital estimations and reestimated our main models. Our results are again fully robust. Fourth, one could also argue that family involvement needs time to materialize in innovation. When repeating the main models

Table 5. **Fixed-Effects Negative Binomial Panel Regressions (Patent Citations)**

Variable	Number of Patent Citations				
	(0)	(1)	(2)	(3)	(4)
R&D intensity	.13***	.12***	.12***	.11***	.11***
Sales	.53***	.52***	.52***	.53***	.53***
Capital expenditures	.01	.02	.02	.04†	.03
ROA	.02	.02	.02	.00	.00
Sales growth	−.01	−.01	−.02	−.02	−.02
Board size	−.00	−.00	−.00	−.02	−.02
Family involvement		−.17***	−.19***	−.17***	−.17***
Internal board social capital			−.03		−.03
Internal board social capital × family involvement			−.03		.01
External board social capital				.07*	.07*
External board social capital × family involvement				.15***	.15***
Wald chi-squared	1304***	1319***	1327***	1359***	1364***
N^a	1952	1952	1952	1952	1952
Log likelihood	−11,505.96	−11,493.64	−11,491.84	−11,470.48	−11,469.40

Notes. Standardized regression coefficients are reported for non-dummy variables.
[a]N denotes the number of observations used in the model estimations after dropping observations without patent citations. Number of observations with zero patent citations: 112.
***$p < .001$; **$p < .01$; *$p < .05$; †$p < .10$.

with one-year lagged independent variables, we find that the results remain consistent regarding direction and significance. Finally, we checked for a three-way interaction effect among family involvement, internal board social capital, and external board social capital.[2] While there is no significant effect on relative market relevance of innovations, we find a significant and positive three-way interaction effect relating to the number of inventions ($\beta = .03$, $p < .05$). Interaction plots indicate that the combination of high levels of both external and internal board social capital relates to an especially large number of inventions in situations of high family involvement.

Discussion

Summary of Results

Scholars have engaged in a lively discussion about the inputs and outcomes of family firm innovation, emphasizing the ambiguous link between the two (e.g., Duran et al., 2016; De Massis, Di Minin, et al., 2015; Rondi et al., 2019). Contributing to this discussion, we set out to explain how the involvement of family members in the business influences the outcomes of innovation efforts. In particular, we explored the relationship between family involvement and (1) the number of firm inventions as well as (2) the relative market relevance of the firm's innovations. In light of the important role that board members play in managerial decision-making (Zattoni et al., 2015), we discussed their internal and external social capital (Barroso-Castro et al., 2016), and argued that both act as critical contingencies that moderate the link between family involvement and innovation outcomes.

In line with our first hypothesis, we find that strong family involvement is negatively associated with the number of inventions. One explanation for this finding could be that family members fear losing control over their firm's operations (Chrisman et al., 2015; Chua et al., 1999) and fear the technological and financial failure which could come from pursuing too many misconceived R&D projects, and which would threaten their socioemotional wealth (Gomez-Mejia et al., 2011). With this in mind, they may use their influence on the firm to avoid pursuing too many simultaneous R&D projects, which will, in turn, reduce the number of inventions. As for our second hypothesis, our results

confirm the positive link between the depth of family involvement and the relative market relevance of innovations. Strongly involved family members may use their superior firm knowledge, market expertise, and strong customer relationships (Block, 2012; Rondi et al., 2019; Sirmon and Hitt, 2003) to fully support each of the comparatively few innovation projects and make sure that they are tailored to market needs.

As for our hypotheses on the moderating role of board members' internal and external social capital, our findings are mixed. They confirm our theorizing that both internal and external board social capital attenuate the negative link between family involvement and the number of inventions. Strong internal bonds of board members may lead to collective cohesion and collective goals (Adler and Kwon, 2002), which likely result in effective decision-making through the pooling of complementary skills and knowledge (e.g., Kor and Sundaramurthy, 2009). The strong internal bonds may reduce the fear of the uncertainty that can come from investments in R&D, diverting family members from using their influence against R&D projects. Our results indicate that low levels of external social capital increase the strength of the negative relationship between family involvement and inventions. External board social capital provides board members with the necessary knowledge about new ideas and trends (Gassmann et al., 2010) and valuable routines (Duran et al., 2016), as well as access to innovation-related information (Shropshire, 2010; Zona et al., 2018). In the absence of strong external ties, family members may perceive higher uncertainty and their objections against pursuing several R&D projects at the same time may be more pronounced.

As for our hypotheses on the moderating influence of internal and external board social capital on the link between family involvement and relative market relevance of innovations, we could not confirm our theorizing, as the two interaction terms were statistically insignificant. An explanation with regard to internal board social capital could be that strong family involvement in managerial decision-making is more important than collective cohesion and collective goals. Some board members might be able to use their superior knowledge about the firm, market, and customer (Block, 2012; Rondi et al., 2019; Sirmon and Hitt, 2003) independently of their fellow board members to make effective decisions on their most valuable innovation projects and allocate the right amount of resources to them. As for external

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[2]We thank an anonymous reviewer for this suggestion.

board social capital, a potential explanation for our non-finding could be that the relationship might not follow a logic of "the more the better." While some external knowledge is highly beneficial to innovation processes (Stanko et al., 2017), too much of it may even be distracting and detrimental for customer-focused innovation processes.

Beyond testing our hypotheses, our additional analyses show that there is indeed a significant three-way interaction among family involvement, internal board social capital, and external board social capital that is associated with the number of inventions. Our findings suggest that high external board social capital attenuates the negative effect of family involvement on the number of inventions if the internal board social capital is low. However, if both external board social capital and internal board social capital are high, the influence of strong family involvement on the number of inventions becomes positive. This indicates that the effect of both types of social capital is, at least with regard to the number of inventions, complementary.

Theoretical Implications

Our study yields several important implications for the literature on family firm innovation, socioemotional wealth, and board social capital. We enrich the discussion on family firm innovation by providing empirical evidence that the influence of families on the innovation process indeed follows a "doing more with less" pattern (Duran et al., 2016, p. 1224). We corroborate this notion by distinguishing between family members' impact on technological and market outcomes of R&D. Family involvement has important and opposite consequences for inventions and innovations, two essential outcomes of R&D processes. This differentiation is crucial, as prior work from the family firm literature mixes technological inventions with market-based innovations (Duran et al., 2016), though the two are known to have different impacts on commercial success (Artz et al., 2010).

We also add to the discussion on whether ownership control or board membership is the critical feature that distinguishes family firm and non-family firm innovation processes and outcomes (Chrisman et al., 2012). We show that both ownership control and board membership are pivotal elements and that they interact with each other. While we support prior literature arguing that family voting rights are a decisive factor for control (Villalonga and Amit, 2009),

we also reveal how voting rights interact with board influence. Family involvement through voting rights shapes innovation behavior, as it transfers the families' values, beliefs, and knowledge to the family business (Sorenson et al., 2009). Internal and external board social ties act as boundary conditions for the influence of family involvement on technological inventions. We also identify board members' internal and external social capital as contingencies for the link between the family's actions and the outcomes of innovation.

While we draw on the concept of socioemotional wealth to explain heterogeneity in family-induced innovation patterns, we also work toward a more complete picture that integrates critical boundary conditions of family firm innovation on the board level. Introducing board social capital into the relationship between family involvement and innovation increases our understanding of how one of the central governing bodies concretely shapes R&D strategy. Through this, we also strengthen the theoretical link between socioemotional wealth and unique organizational innovation profiles. Family members' socioemotional wealth considerations influence the outcomes of R&D in different ways, as our results show when comparing the low number of family firm inventions and the relatively high market relevance of family firm innovations.

Finally, we build upon Barroso-Castro et al.'s (2016) notion of differentiating between internal and external social resources on the board level, and we transfer this view to the domain of the family firm. It seems that collective cohesiveness and collective goals—elements that arise from firm tenure; from the family's values; and from external impulses in the form of ideas, trends, and practices—pave the way for successful technological invention in firms with high family involvement. This observation is in line with prior findings that the boardroom's social capital can be a driver for strategic change (Haynes and Hillman, 2010), and concretizes this view by illuminating its influence on tangible innovation outcomes.

Managerial Implications

Beyond its implications for theory, this study also offers insights for practice. Family members with voting rights can benefit from our results, as we point out their tendency to pursue fewer technological inventions than board members in non-family firms. This may help them to identify biases in decision-making

that lead to this behavior and seek advice for a neutral view on technological trajectories. This tendency is also not necessarily an insurmountable obstacle for the firm's technological R&D output. When it conflicts with an invention-focused strategy, family members and family firm managers who seek to counteract this influence can appoint a technology-friendly board. Appointing board members with strong internal bonds as well as high-quality external networks can help to contain adverse effects of family influence.

From a market perspective, our results help family members to argue in favor of their control in shareholder discussions. Family members' influence can lead to efficient innovation processes that result in products that are comparatively relevant to the market. This conclusion strengthens the notion that family control helps organizations to pursue long-term competitive advantage instead of short-term goals. Non-family shareholders in family firms can see from our research that providing knowledgeable family members with the opportunity and the power to influence and change innovation processes can help shape a market-friendly innovation agenda.

Furthermore, our study identifies internal board social capital and external board social capital as two important boundary conditions for the negative link between family involvement and the number of inventions. While both attenuate this link independently from each other, our additional analyses indicate that the presence of both high internal board social capital and high external board social capital actually turns this negative effect around. Hence, managers of family firms that are used to dealing with strong involvement of the family in decision-making and still seek to enhance the patenting activities of their firm can benefit from composing a board of directors with strong internal and external board social capital. They can achieve this through nominating directors with strong personal ties to other firms and board interlocks while maintaining continuity among the members of the board to strengthen their common understandings and beliefs as well as enhancing the effectiveness of their decision-making.

Limitations and Future Research

Though it enjoys the advantages of employing multiple data sources, our study has some limitations that open up promising avenues for further research.

First, our R&D outcome measures are only proxies for inventions and innovations, and cannot capture all outputs. Some novel technologies may not be patented, but still, be inventions. Some firms with market-relevant innovations may not report them through press announcements. Thus, future researchers might survey R&D and marketing managers in family firms on the relationships among family involvement, invention strategy, and market-relevant innovations. In addition, our board-based measure of external social capital neglects social interlocks outside of boards. Enriching board-based data with additional data from managerial networks and social career platforms will likely enable future researchers to find additional insights on the relevance of social capital for innovation in family firms and beyond.

By using a sample from the U.S. S&P 500 index, we cover the majority of equity market capitalization in the largest capital market in the world, but we are geographically limiting ourselves to the United States and capturing only listed companies. We encourage future researchers to test the generalizability of our findings in other countries with different cultural and economic environments. Also, studies focusing on private companies could yield additional insights. Differences in size and governance mechanisms might lead to different outcomes regarding the impact of social capital.

Finally, our additional analyses show a significant three-way interaction among family involvement, internal board social capital, and external board social capital when analyzing patent counts. This indicates that the two types of board social capital not only independently influence R&D activities in firms with high family involvement, but also jointly determine the effectiveness of these activities. While an in-depth examination of the joint moderating effect of internal board social capital and external board social capital lies beyond the scope of this paper, we encourage future researchers to take up our initial findings and further examine the effect of the interplay of these two types of board social capital on innovation activities in family firms.

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