Technology Acquisition in Family and Non-Family Firms: A Longitudinal Analysis of Spanish Manufacturing Firms

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ABSTRACT

Technology acquisition from external sources has been identified as a critical competence for sustained success in innovation, and research has paid a good deal of attention to studying its advantages, drawbacks, determinants and outcomes. Traditionally, research has modeled the choice to acquire technology from outside a firm's boundaries as the result of a trade-off between the benefits of external acquisition (e.g., higher return on investment, lower costs, increased flexibility, access to specialized skill sets and creativity) and its drawbacks (e.g., opening the market to new entrants, risk of imitation of core competencies and reduced value appropriability). Yet, this view does not capture the behavioral considerations that may potentially encourage or discourage managers from sourcing technology outside the firm's boundaries. This behavioral aspect is especially important if one wants to understand the conduct in external technology acquisition of family firms, that are found to favor strategic actions that preserve the controlling families' control and authority over business, even at the cost of giving up potential economic benefits. Thus, external technology acquisition is likely to be interpreted differently in family and non-family firms. Despite its importance, how the involvement of a controlling family affects decisions in technology and innovation management and, specifically, external technology acquisition, is an overlooked topic in extant research and requires further theoretical and empirical examination. This study attempts to fill these gaps by extending the tenets of the behavioral agency model and prior research pointing to particularistic decision making in family firms to uncover the behavioral drivers of external technology acquisition in family and non-family firms.

Theory is developed that relates performance risk, family management and the contingent effect of the degree of technology protection on external technology acquisition, and the hypotheses are tested with longitudinal data on 1,540 private Spanish manufacturing firms. The analyses show that managers are more likely to acquire technology from external sources through R&D contracting when firm performance falls below managers' aspirations. Family firms are generally more reluctant to acquire external technology, and the effect of negative aspiration performance gaps becomes less relevant as family management is higher, which is attributed to family managers' attempts to avoid losing control over the trajectory that technology follows over time. However, family firms become more favorable to consider the adoption of an open approach to technology development when some protection mechanisms (specifically, the filing of patents on the firm proprietary technologies) increase the managers' perceptions of control over the technology trajectory.

As such, this study makes a contribution to the understanding of the behavioral factors driving external technology acquisition, and it offers important insights regarding technology strategy in family firms.

Introduction

Technology acquisition from external sources has been identified as a critical competence for sustained success in product and process innovation. As a result of the growth of technology complexity, the shortening of product life cycles and the escalation of technology development costs, firms have increasingly sourced technology from outside their boundaries in the attempt to reduce development time and costs, share risks and access expertise not available in house (e.g., Calantone and Stanko, 2007). Although external technology acquisition has been a critical component of firm's technology strategy since the 1980s (Chatterji, 1996), the recent debate around open and collaborative innovation paradigms indicates that it still ranks very high on the agenda of R&D and product managers (Dahlander and Gann, 2010; Lichtenthaler, 2011).

As a consequence of this growing practical interest towards external technology acquisition, innovation scholars have put considerable effort in studying its determinants and benefits (e.g., see Swan and Allred, 2003). However, the risks and drawbacks of external technology acquisition have received comparatively minor attention (Lichtenthaler, 2011), which leads some scholars to consider it as a controversial decision in technology strategy (Almirall and Casadesus-Masanell, 2010; Boudreau, 2010). Prior research has shown that the uncertainty, information asymmetries and agency relationships engendered by technology acquisition from external parties require appropriability regimes that allow the firms to capture the economic benefits of their innovation efforts (Pisano, 1990; West, 2003). Most recent research has emphasized that openness to external technology sources also raises concerns regarding the firms' ability to control the development trajectories that technology follows over time (Almirall and Casadesus-Masanell, 2010; Zirpoli and Becker, 2011). Thus, sourcing external technology emerges as a decision that, on the one hand, allows to potentially improve innovation performance (yet at the expense of higher uncertainty regarding the distribution of potential results) and, on the other, leads managers to operate in domains where they have less control than they have within their organizations. However, there is a gap regarding how managers assess positive and negative factors in choosing whether to acquire external technology or not, in spite of raising calls for research on those internal processes, including behavioral aspects, that

may be relevant for understanding potential barriers to technology acquisition from external sources (Lichtenthaler, 2011).

A behavioral perspective is particularly important when assessing the conduct in external technology acquisition of family firms, which are defined as those firms whose decision making is driven by the family vision for how the firm will benefit the family across generations (Chua, Chrisman, and Sharma, 1999). Indeed, the family is an additional group of stakeholders in organizations that has the power and authority to impose on the firm the pursuit of family goals in addition to its economic goals (Chrisman et al., 2012). These goals derive from the controlling families' willingness to protect their accumulated endowment of socioemotional wealth, and are reported to entail different cognitive logics for decisions affecting risk and control (Gomez-Mejia et al., 2007; Gomez-Mejia, Makri, and Larraza-Kintana, 2010).

How the involvement of a controlling family affects decisions in technology and innovation management and, specifically, external technology acquisition, is an overlooked topic in extant research (Cassia, De Massis, and Pizzurno, 2012; De Massis, Frattini, and Lichtenthaler, forthcoming-a; De Massis et al., forthcoming-b). This gap needs to be filled first because family firms are very common in all world economies and provide a significant contribution to economic growth and employment (La Porta et al., 1999). Family firms are, e.g., reported to generate 64% of GDP and employ 62% of the total workforce in U.S. (Astrachan and Shanker, 2003), suggesting that innovation issues in family firms are of great interest to policy in order to foster economic development. Second, the cumulating evidence that strategic decisions in family firms reflect a broader array of economic and non-economic considerations than in non-family firms (Chrisman and Patel, 2012; Gomez-Mejia et al., 2007) suggests that family involvement may significantly affect the characteristics of the technological innovation process in family firms. Finally, external technology acquisition is likely to be especially useful for family firms to achieve success in product and process innovation. Studies applying the behavioral agency model showed that the goal of preserving socioemotional wealth for the family inevitably leads to the adoption of a more conservative attitude that entails aversion to risk, implying inferior and greatly volatile R&D investments to develop innovations (Gomez-Mejia et al., 2007; Chen and Hsu, 2009; Chrisman and Patel, 2012). But family firms need technological know-how as well as non-family firms to provide new products to the marketplace, because profits and

competitiveness come as a by-product of these activities (Christensen et al., 2004). Complementing their internal knowledge base with externally sourced technology seems thus an excellent compromise to improve innovation ability for family firms that typically underplay internal R&D investments.

This article attempts to fill these gaps by developing and testing behavioral agency hypotheses for external technology acquisition of family and non-family firms. The greater uncertainty due to the simultaneous presence of positive and negative effects, and the possibility for dissimilar managers' cognitive frameworks to influence the decision to source technology from outside, make the behavioral agency model (BAM) an appropriate framework to understand the factors driving firms' decision to acquire external technology. From the BAM perspective, the decision to undertake risky activities such as to initiate searches for alternative routines and opportunities or, as proposed in this article, to open the boundaries of technology search by acquiring external technology is more likely to occur when a firm is dissatisfied with the status quo, namely when its performance falls below the target or aspiration level (Bromiley, 1991; Wiseman and Gomez-Mejia, 1998). However, the reference point varies consistently with the managers' cognition. Some managers' decisions are strictly guided by economic performance and risk evaluations, while others may also be driven by consideration of other, socioemotional, outcomes.

The managers' cognitive assessment of uncertain decisions is a fundamental issue in BAM (Wiseman and Gomez-Mejia, 1998), and its consideration has already enriched the understanding of disparate management processes, among which the extent of internal R&D efforts (Chrisman and Patel, 2012). Recently, Gomez-Mejia et al. (2010) suggested that family firm managers' desire to retain control may affect technology strategy, favoring choices that maintain them adjacent to their existing technology platforms as opposed to venturing into new technology trajectories. However, no endeavor has been hitherto made to extend BAM to other aspects of a firm's innovation and technology strategy, and whether managers' cognition also influences a firm's conduct in technology sourcing is a question that remains unanswered.

The empirical analysis is conducted using a longitudinal dataset comprising 4,903 time-series cross-sectional observations, consisting of 1,540 Spanish companies operating in twenty

manufacturing industries over the period 2000-2006. The case of manufacturing firms is particularly interesting because products become rapidly obsolete and require innovation (Tushman and Anderson, 1986), and external technology acquisition is particularly suitable in contexts where products may embrace elements or subsystems developed by other players (Almirall and Casadesus-Masanell, 2010). It thus provides an opportunity to examine how performance risk, family involvement in top management, as well as technology protection mechanisms may affect the way firms adjust their technology boundaries in the wake of internal and external disruptions.

The remainder of the article is organized as follows. The second and third sections give the theoretical underpinnings of our study and develop hypotheses. The fourth section describes the methodology and the fifth section reports the findings of the regression model. Discussion of these findings and their implications, identification of avenues for future research and conclusions follow.

Behavioral Foundations of External Technology Acquisition

Acquisition of technology from external sources (e.g., clients, suppliers, competitors, universities or research centers) can take several forms, ranging from mergers, acquisitions and joint ventures, to non-equity alliances, in-licensing and R&D contracting (Van de Vrande, Lemmens, and Vanhaverbeke, 2006). Whereas equity modes for external technology acquisition are characterized by a strong commitment from the parties involved, a low degree of reversibility, and a strong control over the outcome of the technology acquisition process, non-equity alliances such as in-licensing and R&D contracting require less commitment and are reversible, but ensure lower control to the parties involved in the development and outcome of the acquisition process (Chiesa and Manzini, 1998). The focus of this article is on R&D contracting, which entails externalizing R&D activities to a third party on the basis of a detailed contractual agreement and acquiring the technological knowledge resulting from the external organization's R&D effort (Howells, Gagliardi, and Malik, 2008). The reasons for this focus are twofold. First, acquiring technology through R&D contracts represents an externally directed strategic action that drastically reduces the focal firm's control over technology development and does not ensure

sharing of risk among parties. This makes it particularly appropriate for exploring the impact of family goals on technology strategy in that preserving the family's control and authority is a primary source of non-economic benefits to family agents, causing idiosyncratic preferences of family firms toward risk (Gomez-Mejia et al., 2007). Second, R&D contracting is very common in practice (Howells et al., 2008) but, despite this, it has received limited attention from innovation management research as a contractual form for external technology acquisition (Van de Vrande et al., 2009) compared, e.g., to in-licensing.

To understand the decision to acquire technology from outside a firm's boundaries, prior research has mainly adopted a perspective based on transaction cost theory (Tidd and Trewhella, 1997; Williamson, 1998). The tactical view proposed by the transaction cost perspective underlines the relative costs of developing internally vis-a-vis buying a technology. The decision to source a technology from outside is therefore the result of a trade-off between the benefits of external acquisition, e.g., higher return on investment, lower costs, increased flexibility, access to specialized skill sets and creativity, and its drawbacks, e.g., opening the market to new entrants, risk of imitation of core competencies and reduced value appropriability (Calantone and Stanko, 2007; West, 2003).

What is neglected by this perspective is the role of performance feedbacks and managerial cognition in affecting the way the decision to acquire technology is framed. Research adopting a transaction cost perspective assumes that whenever rivals are precluded the opportunity to appropriate the focal firm's know-how and profit from it, e.g., because of the presence of a strong appropriability regime, managers will frame the choice of acquiring external technology as positive, emphasizing the benefits of such decision. However, recent contributions (Almirall and Casadesus-Masanell, 2010; Zirpoli and Becker, 2011) show that leaving other firms develop parts of the final product involves ceding to the partners the autonomy to make choices that will affect the characteristics of future products. As technological innovations progress following path-dependent trajectories (Dosi, 1982), contracting the development of new technology outside the firm's boundaries is likely to reduce the focal firm's control over the long term technological trajectory of new products, meaning that the firm may be forced in the future to operate under constraints to organizational actions that could have been avoided in case of internal technology

development (Almirall and Casadesus-Masanell, 2010; Pfeffer and Salanik, 1978). As family managers are reported to seek non-economic utilities from being able to influence the type of goods produced by the firm (Demsetz and Lehn, 1985), and to consequently frame strategic decisions differently from managers of non-family firms, limiting the analysis of external technology acquisition to economic considerations may result into inaccurate theory predictions. On the contrary, behavioral aspects such as performance feedbacks and managerial cognition have the potential to refine current understanding of the determinants of external technology acquisition and to provide important insights as to how managers actually evaluate benefits and drawbacks relative to this innovation practice.

Behavioral considerations are especially crucial in family firms, where managers may be firmly reluctant to allow new actors from outside the family circle acquire the capacity to exert some influence and control over the strategic direction of the firm, as they can see this as a loss of socioemotional wealth (Gomez-Mejia et al., 2010). To understand the potential differences between family and non-family firms, a thorough consideration of the distinctive managerial cognitions in family firms and of their effect on the decision to externally acquire technology is needed.

Managerial Decisions in Family Firms

There is cumulating evidence that family involvement in businesses leads to distinctive objectives and sets of assumptions for managers about the way organizations should work, and these cognitive frameworks influence the family firm managers' behavioral processes. Past research indicates that family firms follow particularistic goals such as keeping authority and control in the hands of the family, behaving altruistically with other family members, fulfilling the family members' sense of belonging, affection, and intimacy, and growing the prestige and reputation of the family (Schulze, Lubatkin, and Dino, 2003; Gomez-Mejia et al., 2007; Chrisman et al., 2012). These non-economic, family-centered goals create utilities that are important to family firm managers because they create socioemotional wealth for the family (Gomez-Mejia et al., 2007).

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The idea that family firms' managers have different cognitions drives research on this ubiquitous form of business organization. The perspective adopted by family business research is the one of the dominant coalition in the firm influencing its internal processes (Cyert and March, 1963), which lays the foundations for asserting that administrative decision-making reflects the managers' background, experience, knowledge and values (Hambrick and Mason, 1984). These ideas are wholly incorporated into BAM, which is a model of organizational behavior and risk taking that extends the traditional normative models of rational choice (Wiseman and Gomez-Mejia, 1998). According to BAM, a decision maker's risk preferences change with the framing of problems. Problems are framed as either positive or negative using a reference point to compare anticipated outcomes from available options, and the manner a choice is perceived by managers may thus affect their decisions (Wiseman and Gomez-Mejia, 1998).

Extending these tenets, recent studies have emphasized the importance of non-economic, family-centered goals (Chrisman et al., 2012) that influence managerial cognition and concur to explain the decisions of managers in family firms (Gomez-Mejia et al., 2007). If managers in family firms are driven by a desire to preserve socioemotional wealth, this is likely to be reflected in their firms' behaviors in the form of a preference toward organizational structures and actions that reduce risk and facilitate managerial control. For example, BAM has been used to show that family involvement causes a set of behaviors, including a higher executive entrenchment and lower compensation risk (Gomez-Mejia, Larraza-Kintana, and Makri, 2003), the choice to embrace higher business risk in order to avoid losing control through the adherence to a producers' cooperative association (Gomez-Mejia et al., 2007), and a reluctance toward diversification when this means diluting family control (Gomez-Mejia et al., 2010).

Most recently, Chrisman and Patel (2012) applied the BAM perspective to explore the differences between family and non-family firms in terms of R&D investments. Their findings provide a firm theoretical rationale to prior empirical evidence of lower investments in R&D by family firms (e.g., Block, 2012; Chen and Hsu, 2009). The idea that loss-averse family firms are reluctant to internalize risky innovative activities in order to avoid threats to their socioemotional wealth is interesting because this implies that finding alternative technology strategies such as acquiring technological knowledge through R&D contracting may be a promising way for these

firms to provide new products to the marketplace. However, very little is known about the impact of the unique behavioral traits of family firms on decisions concerning external technology acquisition.

In the next section, drawing upon the BAM perspective, a set of hypotheses is developed, that explore the possible effects of performance risk, family involvement in top management, and technology protection mechanisms on the managerial processes underlying the acquisition of external technology.

Theoretical Development and Hypotheses

Performance Risk and External Technology Acquisition

Contrary to the traditional normative models of rational choice, BAM suggests that managers avoid decisions that they associate to threats to their wealth, even if this choice entails higher business risk. It follows that when deviations of performance outcomes below the aspiration level are observed, the target for comparison being either the firm's past performance or the performance of other firms (Lant, 1992), managers perceive a threat in the form of a potential loss to their accumulated endowment and react by undertaking risky activities, such as searching for alternative routines, opportunities or technologies (Bromiley, 1991; Wiseman and Gomez-Mejia, 1998). While past research has considered several types of risky activities, this article focuses on the decision to acquire technology from outside the firm's boundaries. It is here argued that external technology acquisition entails a degree of hazard because it has the potential to raise organizational performance but it also entails high levels of risk and uncertainty associated with the outcome of R&D contracting, it exposes the focal firm to moral hazard problems, and it leads managers to operate in domains where they have less control than they have within their firms (Howells et al., 2008). Taken together, the application of BAM to external technology acquisition suggests that:

> *H1: External technology acquisition is positively related to the gap between aspirations and performance (either in terms of a) discrepancy from a historical*

performance target, or of b) discrepancy from performance of referent firms), so
that the former increases as organizational performance negatively diverges from
the aspiration level.

Family Management and External Technology Acquisition

Past research has shown that controlling families are primarily concerned with the possibility to lose their socioemotional wealth, and they are thus reluctant toward the dilution of their discretionary power over the firms' strategic decisions (Gomez-Mejia et al., 2007). Differently put, owners and managers in family firms hold different cognition of what is a crucial loss than those in non-family firms since preserving discretionary power is more salient to them than meeting a performance target. Since BAM proposes that decision makers are loss-averse, meaning that they are more sensitive to losing wealth than to increasing wealth (Wiseman and Gomez-Mejia, 1998), these differences in managerial cognition between family and non-family firms are expected by BAM to produce distinctive behaviors. In particular, rather than considering accumulated endowments like salary, promotions, titles and professional prestige, managers in family firms are likely to frame relinquishing their socioemotional wealth as a crucial loss and are thereby likely to accept threats to the firm's financial wellbeing (e.g., lower innovativeness, declining performance) in order to prevent that loss.

As discussed, the external acquisition of technology leads firms to cede discretionary power over innovation activities to external parties and lose some control over the trajectory of future product developments. In the eyes of family managers this can be seen as a barrier to the accomplishment of non-economic, family-centered goals and thus corrode the foundations of socioemotional wealth the family derives from being in control. Specifically, external technology acquisition is likely to entail greater complexity in product innovation (Grimpe and Kaiser, 2010) and would thus force family firms – that typically suffer disadvantages in terms of specialized human resources (e.g., Schulze et al., 2003) – to hire external managers, ceding to non-family managers some control over decision-making processes. Moreover, by contracting out the development of new technology to be implemented in the firm's products, the firm devolves

substantial resources without any guarantee of returns, and the firm may need in the future some know-how from the technology partner, which it may not be able to gain elsewhere, allowing the external actor to gain some control over the focal firm's resources and diminishing the focal firm's power (Almirall and Casadesus-Masanell, 2010; Pfeffer and Salanik, 1978). For these reasons, losing control over the new products development trajectory may be seen by family managers as a loss of the family's ability to exercise unconstrained authority, influence, and power over all aspects of the business (Schulze et al., 2003) and a threat to the authority foundation of socioemotional wealth (Gomez-Mejia et al., 2010). Besides authority, acquiring external technology also impairs the identity foundation of socioemotional wealth for the controlling family. Indeed, family firms tend to internally define their products and prefer them remaining within the firm boundaries because the family closely identifies with those products (Donnelley, 1964). Such association of the family name with the firm products reflects the willingness of the family to have its name recognized and respected within the community (Dunn, 1996), and can be lost when allowing other parties to take control over the new product development.

In view of the foregoing, managers in family firms are expected to hold different cognitions regarding the decision to acquire external technology from those held by managers in non-family firms. In spite of its potential benefits, family firm managers are likely to avoid such decision in order to preserve the authority and identity foundations of socioemotional wealth for the family. Thus, it is proposed that:

> *H2: There is a negative relationship between external technology acquisition and*
> *family management.*

Organizations are likely to become more inclined to search for alternative opportunities and routines when faced with deviations of performance outcomes below the aspiration level (Bromiley, 1991; Wiseman and Gomez-Mejia, 1998). According to BAM, the reference point for such organizational actions is typically based on economic returns - as previously hypothesised - either in terms of the firm's past performance or the average performance of other firms in the same industry (Lant, 1992).

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However, in family firms, family goals and economic goals interact in setting the organizational strategic actions (Chrisman and Patel, 2012; Gomez-Mejia et al., 2007). As discussed above, engaging in technology sourcing may represent a threat to the authority and identity foundations of socioemotional wealth for the controlling family. As a consequence, whereas non-family managers may perceive below-aspiration level performance as a potential loss to their wealth, and respond by acquiring external know-how in order to recover innovativeness, managers in family firms are likely to set the loss of socioemotional wealth as their primary concern, and avoid external technology acquisition even in face of negative performance feedbacks. In other words, consistent with the idea that family firms are more willing to tolerate below-target performance as a condition of retaining control of the firm (Gomez-Mejia et al., 2007), avoiding actions that threat the preservation of socioemotional wealth for the controlling family can be expected to be more salient to family firm managers than meeting a performance target. For these reasons, it is hypothesized that:

> *H3: Family management moderates the relationship between external technology acquisition and the gap between aspirations and performance (either in terms of a) discrepancy from a historical performance target, or b) discrepancy from performance of referent firms), so that the relationship is weaker among family than non-family firms.*

Control Beliefs: The Contingent Role of Technology Protection

The model proposed in this article has hitherto assumed that family firms generally avoid external technology acquisition because it entails loss of socioemotional wealth for the controlling family. However, contingency theories of strategic decisions (Baird and Thomas, 1985) posit that managerial evaluation of different strategies is also affected by the competitive settings of the business. Incorporating contingency factors into the model will help isolate the effects of family firm managers' cognitive differences regarding the decision to acquire external technology and will provide higher external validity to the above arguments, moving from

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universalistic predictions toward a contingency view of strategic decisions in family firms. In addition, it allows relaxing the assumptions that family-centered goals are always divergent from the firms' economic goals, and exploring the conditions under which family firms can undertake risky competitive actions without obstructing the controlling families' socioemotional utilities. One specific factor that characterizes the competitive setting in which the decision to acquire external technology is made and may affect family firms' negative propensity toward this choice is the degree of protection of the focal firm's proprietary technologies ensured by intellectual property rights (IPRs). The existence of effective mechanisms to protect proprietary technology is an important contingency when analyzing technology acquisition, because such mechanisms increase the managers' perceptions of their ability to appropriate economic rents from technology development and to preserve control over the trajectory that technology follows over time (Cohen, Nelson, and Walsh, 2000; Gambardella, Giuri, and Luzzi, 2007). Research on deliberate decision making suggests that beliefs about the presence of factors that may facilitate or impede performance of a behavior and the perceived power of these factors constitute the control beliefs of a decision maker (Ajzen, 2002). Similarly, research in strategy has shown that top executives who believe they can control the outcomes of their decisions tend to pursue more aggressive strategies (Miller, Kets de Vries, and Toulouse, 1982).

Following this line of reasoning, if lower external technology acquisition in family firms is to be attributed to different cognition of managers, meaning that the crucial loss for family firms managers is represented by the loss of control over the trajectory of future products development rather than poor performance, it is reasonable to expect that family firms' reluctance toward the adoption of an open approach to innovation is likely to deaden when some protection mechanisms are put in place that preserve such control. These mechanisms may be seen as a defense against the uncertainty associated to loss of control over technology, increasing managers' perception about the family firm's power in the relationship with external actors, and reducing the family firm managers' cognition of risks associated with loss of socioemotional wealth. It follows that:

H4: Technology protection moderates the relationship between external technology acquisition and family management so that the relationship is weaker when family firms' technology is protected by intellectual property rights.

Figure 1 provides a synthetic representation of the conceptual framework developed in this section.
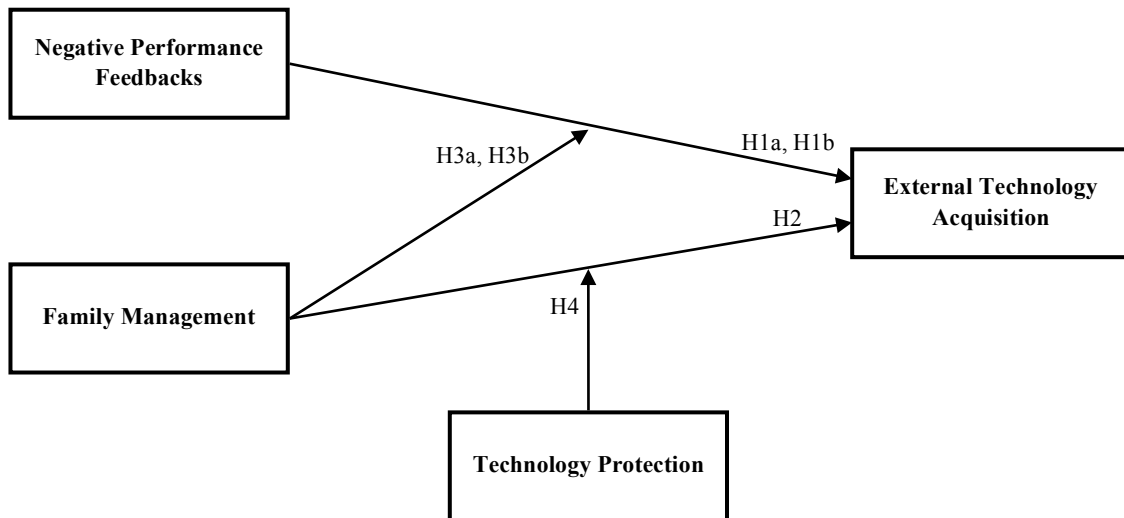
Figure 1. Conceptual framework and hypotheses

Methods

Sample

The hypotheses developed in this article are tested on a representative sample of Spanish firms from the database Encuesta Sobre Estrategias Empresariales (Survey on Business Strategies, ESEE), produced by a public institution financed by the Spanish Ministry of Industry. The ESEE was designed with the aim of ensuring the representativeness of Spanish manufacturing firms. For this purpose, all companies with more than 200 employees were surveyed (and approximately 70% completed the survey), and smaller companies with more than 10 employees were selected on the basis of a stratified sampling. The focus on manufacturing industries is considered appropriate in the context of external technology acquisition because in such

industries firms' products typically embrace elements or subsystems developed by other players (Almirall and Casadesus-Masanell, 2010). Moreover, the unbalanced feature of this dataset implies that the firms can enter and exit from the survey in the same way the companies appear and disappear in the economy. For this reason, this sample is apt to observe sufficient degrees of performance and business risk. Restricting the sample of companies to observations in the same time period would affect the randomness of the sample, and there would be a much lower probability of firms facing declining performance to be included. Furthermore, the typically high degree of obsolescence of manufacturing firms' products makes these firms particularly inclined to rely on innovation (Tushman and Anderson, 1986). Indeed, this database has already been used in previous innovation studies (e.g., Alonso-Borrego and Forcadell, 2010). In total, the sample used in this article includes 4,903 time-series cross-sectional observations, consisting of 1,540 companies operating in twenty different manufacturing industries over the period 2000-2006.

Dependent Variable

External technology acquisition. Although there are different forms through which firms can acquire external technology, for the reasons discussed in the previous section, this study focuses on R&D contracting, that captures the total expenses made by a firm to buy R&D services from other organizations such as competitors, suppliers, universities, public research organizations (Van de Vrande et al., 2009). This variable is calculated as the ratio of external expenses for R&D to sales in year t.

Independent Variables

Negative performance feedbacks. Performance is here assessed using ROA, defined as the net operating income divided by total assets. The measurement of performance using ROA is widely supported in the literature, particularly for manufacturing firms. Moreover, ROA is a performance indicator very susceptible to the influence of managers, and has been used in previous studies applying BAM to innovation decisions (Chrisman and Patel, 2012). Following prior research (Chrisman and Patel, 2012), a continuous censored variable is constructed to

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measure each of the two types of gaps between aspirations and performance, namely discrepancy from a historical performance and from performance of referent firms. This reflects the assumption that, as negative discrepancies between the firm's performance and either its historical performance or the performance of competitors widen, decision makers are more likely to perceive gaps between current performance and aspirations (Iyer and Miller, 2008). The first gap measure, *historical performance gap*, refers to the magnitude of performance shortfalls between periods and was measured by comparing a firm's performance in time t-1 and its performance in time t-2. A score of zero means that the target was achieved. The second gap measure, *referent-target performance gap*, consists of a comparison of the focal firm's performance in time t-1 with the performance of other firms in the sector in time t-2, based on the average ROA of firms in the relevant two-digit NACE industry. Both variables were measured by their absolute value, meaning that the resulting magnitude of positive scores indicates the extent to which the firm falls below the performance target of either past performance or referent firms' performance in a particular year.

Family management. Family firms are defined as firms with a particularistic vision of business and goals resulting from the presence of a controlling family (Chua et al., 1999). A direct measure of family vision and goals is not available in the ESEE database. This is a common problem to which prior research has typically obviated by assuming that family vision and goals are highly correlated to the extent of family involvement in the firm (e.g., Gomez-Mejia et al., 2010). This assumption has also received empirical validation (e.g., Chrisman et al., 2012; Chrisman and Patel, 2012), so this study adopts an objective measure of family influence. For all those firms that are family owned the ESEE database reports the number of owners and owner's relatives who occupy top managerial positions. Based on this information, a continuous variable counting the number of family members in top managerial positions in time t, is built to measure family management (e.g., Cruz et al., 2010).

Technology protection. Patents are key legal mechanisms to protect proprietary technology and to exclude rivals from using company's own inventions (e.g., Levin et al., 1987). Strong and dependable patents increase the innovator's ability to appropriate economic rents from its technology by, e.g., facilitating the proof of patent infringements (Lanjouw, 1998), making it

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harder for other companies to invent around the patent (Gambardella et al., 2007) and by raising the defenses against the competitive aspects of external relationships (Katila et al., 2008). Managers increasingly rate patents as an effective means of protecting some parts of the firm's product invention against rivals' divergent interests, which is supported by the strong growth in international patenting since the late 1980s (Athreye and Cantwell, 2007). The ESEE database reports the number of international patents a company registers in each year, but no information is available regarding the total stock – and quality – of patents held by each firm. Consistently with prior research (e.g., Rothaermel and Deeds, 2004), a raw count of patents is used as a reasonable proxy of the quality of protection mechanisms put in place by a firm. Therefore, technology protection is measured as the difference between the number of patents registered in time t-1 and those registered in time t-2. This variable takes positive values if a firm has increased the protection of its internal technological know-how and has presumably amplified the control beliefs held by managers.

Control Variables

In order to rule out possible alternative explanations to those formally hypothesized, the model includes the following six control variables lagged at t-1 that could potentially affect the dependent variable. Firm *age* is measured as the number of years between the foundation of the firm and the observation year. Firm *size* is measured as logged annual sales. *Internal R&D intensity* is measured as the ratio of a firm's internal R&D expenditures to sales and acts a proxy of absorptive capacity because sourcing decisions may be influenced by the firm's ability to absorb new capabilities (Cohen and Levinthal, 1990). *Return on assets* accounts for the overall firm efficiency. *Debt* is measured as the total liabilities provided by third parties adjusted by sales. Finally, *equity* is measured as the sum of equity capital, reserves and results pending application, less the interim dividend paid during the year, adjusted by sales.

Data Analysis

The descriptive statistics and correlations for the variables are reported in Table 1. As the assumption for normal distribution could not be met in the ordinary least squares (OLS)

regression model, the panel-EGLS (estimated generalized least squares) estimator was used. The independent variables were centered around the mean before calculating the interaction terms in order to avoid problems of multicollinearity among the variables in the regression equation (Cohen, 2003). The variance inflation factor after each regression was calculated to see whether results were subject to the threat of multicollinearity. Values were within acceptable limits, indicating that estimations were free of any significant multicollinearity bias. The Hausman test suggests that fixed effect GLS panel model is more appropriate than random effect (Chi-Square=30.761, $p<0.01$). In addition, redundant fixed effect test indicates that the fixed effect of periodic dimension needs to be controlled (F-Statistic=2.141, $p<0.001$). As such, two-way fixed effect GLS panel regression is used as the tool of our primary analysis. White's (1980) cross sectional correction of covariance is used to control for heteroscedasticity and serial correlation.

Table 1. Descriptive Statistics and Correlations (N = 4,903)

Variable	Mean	S.D.	1	2	3	4	5	6
1. External technology acquisition (%)	0.15	0.80	1.00					
2. Historical performance gap	2.26	10.68	-0.02	1.00				
3. Referent-target performance gap	10.17	85.90	-0.01	0.02	1.00			
4. Family management	0.59	0.91	-0.05	0.03	0.04	1.00		
5. Technology protection mechanisms	-0.04	3.15	0.00	0.00	0.00	0.01	1.00	
6. Age	26.91	21.10	0.07	-0.04	-0.04	-0.08	-0.02	1.00
7. Size (log total asset)	13.86	2.53	0.15	-0.19	0.03	-0.24	-0.01	0.37
8. Internal R&D intensity (%)	0.17	0.87	0.25	-0.02	-0.02	-0.03	-0.02	0.08
9. Return on assets	3.26	15.32	-0.02	-0.14	-0.04	0.04	0.00	-0.01
10. Liabilities	1.18	2.88	-0.01	0.20	0.05	0.02	0.00	-0.09
11. Equity	0.75	0.88	-0.01	0.19	-0.02	0.03	0.00	0.01

Variable	7	8	9	10	11
7. Size (log total asset)	1.00				
8. Internal R&D intensity (%)	0.17	1.00			
9. Return on assets	-0.15	-0.03	1.00		
10. Liabilities	-0.22	-0.01	0.11	1.00	
11. Equity	-0.23	-0.01	0.24	0.40	1.00

Correlations $\geq |.05|$ are significant at $p<.001$.

Results

Table 2 reports the results of the regression model used to test the hypotheses. Estimated coefficients are standardized. Hypotheses 1a and 1b propose that firms use external technology acquisition when their performance falls below the aspiration level. The effect of historical performance gap is not significant, so that hypothesis 1a is not supported, but external technology acquisition is significantly higher at $p<.001$ when performance fell below the referents firms' performance, strongly supporting hypothesis 1b. The results also show a significant negative effect at $p<.01$ of family management on external technology acquisition. Thus, hypothesis 2 is supported.
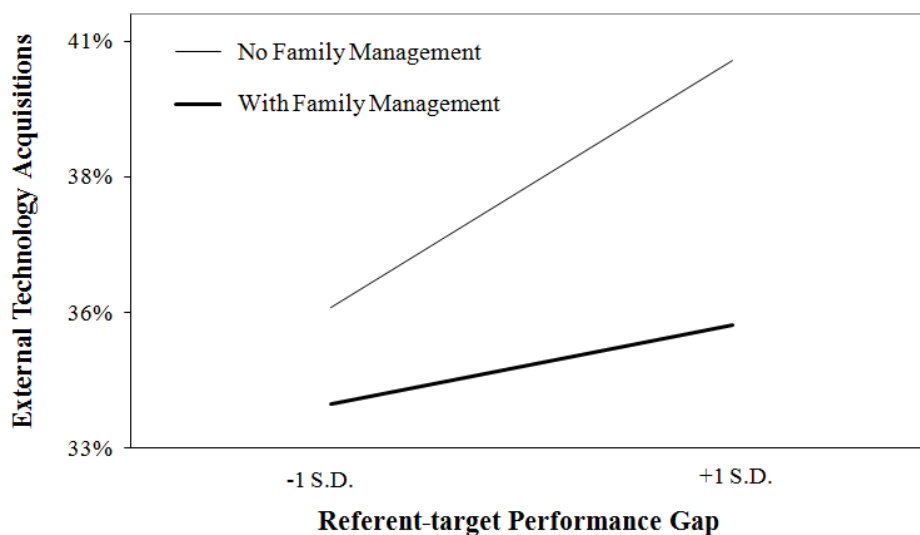
Table 2. Effects of Performance Risk, Family Management, and Technology Protection on External Technology Acquisition

Variable	External Technology Acquisition	Industry-Adjusted External Technology Acquisition
1. Referent-target performance gap	0.009***	0.030***
	(0.000)	(0.000)
2. Historical performance gap	-0.003	-0.002
	(0.000)	(0.000)
3. Family management	-0.025**	-0.023*
	(0.008)	(0.010)
4. Technology protection mechanisms	-0.001	0.000
	(0.004)	(0.004)
5. Family management × Referent-target performance gap	-0.016**	-0.017**
	(0.000)	(0.000)
6. Family management × Historical performance gap	0.001	-0.003
	(0.000)	(0.000)
7. Family management × Technology protection mechanisms	0.009**	0.007*
	(0.003)	(0.003)
8. Internal R&D intensity	0.136**	0.136***
	(0.037)	(0.027)
9. Age	-0.044***	-0.037***
	(0.000)	(0.000)
10. Size (log asset)	-0.009	-0.022
	(0.068)	(0.071)
11. Return on assets	0.001	0.002
	(0.000)	(0.001)
12. Liabilities	0.022	0.025*
	(0.003)	(0.003)

13. Equity	-0.027†	-0.028
	(0.028)	(0.027)
Observations	4,903	4,903
Adjusted R^2	0.266	0.233
F-Statistics	2.141***	1.957***

† p < .10; * p < .05; ** p < .01; *** p < .001. Standardized coefficients are reported.

The moderation effects predicted in hypotheses 3a, 3b, and 4 were tested including the corresponding interaction terms in the regression model. Hypotheses 3a and 3b propose that family management moderates the negative relationship between external technology acquisition and negative performance feedbacks. The results show that the moderating effect of family management on the relationship of external technology acquisition is not significant for historical performance gap, so hypothesis 3a is not supported. However, the relationship is significant at p<.01 for referent-target performance gaps. As hypothesized, the coefficient of the interaction term is negative, suggesting that family management reduces the strength of the relationships, thus confirming hypothesis 3b. To facilitate interpretation, the relationship between external technology acquisition and referent-target performance gap for firms with and without family management has been plotted in Figure 2. Consistently with prediction, this figure clearly shows much lower elasticity of external technology acquisition to below-target performance for family versus non-family firms.

Figure 2. Effects of Performance Risk on External Technology Acquisition

Hypothesis 4 proposes that the negative relationship between external technology acquisition and family management is moderated by technology protection, so that the relationship is weaker when the firms' proprietary technologies are protected through patents. Results in Table 2 show that technology protection does not affect directly external technology acquisition, but it affects at significance level of $p < .01$ the relationship between external technology acquisition and family management. This brings support to hypothesis 4. These relationships are drawn in Figure 3 to facilitate interpretation. As represented in Figure 3, the negative line plotted for the family management variable in the case of no technology protection mechanisms becomes flat when such mechanisms are put in place. As a post hoc test, given α error probability equals to 0.01, the analysis is found to have enough power (power: $1 - \beta$ error probability=1.000) to capture the variance of external R&D acquisition (Faul et al., 2007).
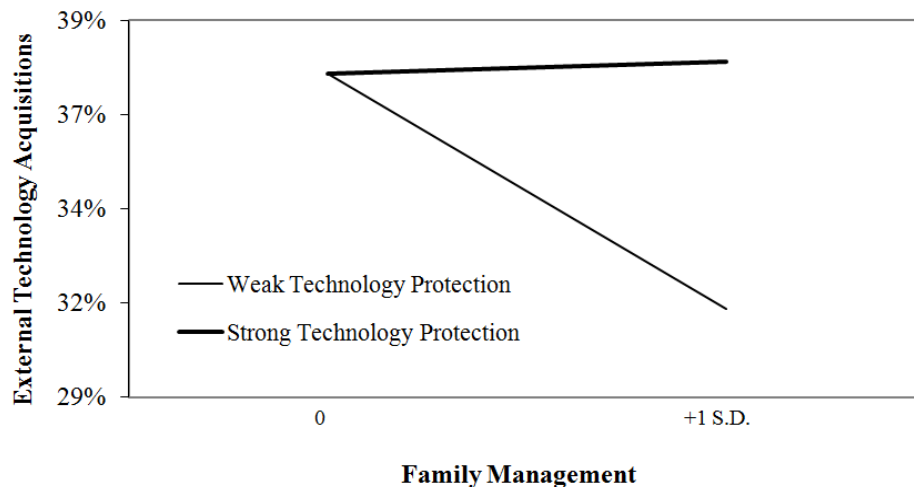
Figure 3. Effects of Family Management on External Technology Acquisition by Technology Protection

Notes: Without Technology Protection is controlled as 0. Strong Technology Protection is controlled by +1 standard deviation from the mean. The vertical scale is based on mean and unstandardized estimated coefficients of all other variables in fixed effect panel regression; insignificant coefficients are controlled as zero.

Additional Analyses

Although the sample includes only manufacturing firms, and family firms are reported to be quite distributed among all industrial sectors (Anderson and Reeb, 2003), additional analyses have been conducted in order to assess the possibility of artifactual results in Table 2 due to aggregating these firms across different manufacturing industry sectors. Table 3 shows the sample distribution of companies by two-digit industry and by family business status (based on the presence of at least two family members in top management). The analysis reveals that family involvement is a common feature of firms belonging to a broad array of industries in our sample, the average being 36.8% of all firms. However, the ratio of family firms ranges between a minimum of 14.8% in the motor vehicles industry and 60.92% in the furniture industry, indicating that controlling for industry affiliation may be important for our empirical analysis.

Table 3. Distribution of Firms by Industry and Family Status*

Industry	All firms	Family firms	Non-family firms	Family firms ratio
Agricultural and industrial machinery	391	131	260	33.5%
Beverage	67	13	54	19.4%
chemicals	328	52	276	15.9%
Electrical machinery and apparatus	308	92	216	29.9%
Ferrous and nonferrous	173	34	139	19.7%
Food and snuff	462	165	297	35.7%
Furniture industry	238	145	93	60.9%
Leather and footwear	134	70	64	52.2%
Meat	123	59	64	48.0%
metal products	495	215	280	43.4%
Motor vehicles	240	33	207	13.8%
Non-metallic mineral products	337	118	219	35.0%
Office machines, data processing, and	66	29	37	43.9%
Other manufacturing	113	49	64	43.4%
Other transport	108	16	92	14.8%
Paper	170	42	128	24.7%
Publishing and printing	241	98	143	40.7%
Rubber and plastic	294	116	178	39.5%
Textiles and clothing	474	253	221	53.4%
Timber	141	75	66	53.2%
Total	4903	1805	3098	36.8%

* Observations refer to firms' yearly attributes; family firms are defined as those firms where two or more members of a controlling family are actively involved in the top management.

To ensure the robustness of the results, the full regression in Table 2 is run again, while adjusting external technology acquisition by industry level. Specifically, the industry influences

are controlled by subtracting to each firm's external expenses in R&D to sales in year t the median industry level of external R&D intensity in the same year. The results, reported in the second column of Table 2, were consistent with our primary analysis, although some coefficients' significance was slightly altered: the coefficient for family management in Table 2 changed from -0.025 to -0.023, significant at $p \leq 0.05$; internal R&D intensity became more significant at $p \leq 0.01$; the coefficients for liabilities and equity ratios changed into significant at $p \leq 0.05$ and insignificant, respectively; finally, the interaction between family management and technology protection in Table 2 changed from 0.009 to 0.007, now significant at $p \leq 0.05$. Taken as a whole, the R^2 of the model changed from 26.6% to 23.3% and all results of post-hoc analyses were confirmed. Thus, the adoption of an alternative measure of technology acquisition that takes into account potential influences of firms' industry affiliations yielded the same pattern of results.

Discussion

Prior research has approached the decision to acquire external technology based on a transaction cost perspective and therefore as a purely economic matter, modeling it as a trade-off between the benefits and drawbacks of technology sourcing. This article extends these tenets by adopting a BAM perspective to investigate how behavioral considerations of performance risk and different managerial cognition frameworks affect external technology acquisition.

The findings show that managers are more likely to acquire technology from external parties through R&D contracting when firm performance falls below the aspiration level. Also, family firms are found to be more reluctant to acquire external technology vis-a-vis non-family firms, and the influence of negative aspiration performance gaps becomes less relevant as family management is higher. This effect is attributed to family firm managers' attempts to avoid losing control over the trajectory that technology follows over time. However, this general tendency is mitigated by an important factor, technology protection: family firms become more favorable to consider the adoption of an open approach to innovation when patents on proprietary technologies increase the managers' perceptions of control over the technology trajectory. As such, this study makes a contribution to the understanding of the factors driving external technology acquisition as well as to the understanding of managerial decisions in family firms.

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First, the theoretical and empirical analyses of this article suggest a new way for approaching decisions regarding external technology acquisition. The application of BAM shows that managers' willingness to acquire technology from outside the firm's boundaries changes with the framing of problems on the basis of the available options to prevent losses to accumulated endowment (Wiseman and Gomez-Mejia, 1998). When managers observe deviations of performance outcomes below the aspiration level they become more likely to explore external technology in order to speed up innovativeness and identify new business opportunities. Further, the findings reveal that referent-target aspirations matter most when considering the choice to acquire external technology, whereas historical target-performance gaps are found to be not significant. Whereas prior research (e.g., Chrisman and Patel, 2012; Gomez-Mejia et al., 2007) posited that internal and external reference targets are likewise incorporated by managers in their consideration of risky decisions, the results of this study may signal that self-reflection is not a relevant reference dimension for externally oriented organizational actions such as the acquisition of external technology. Rather, the evidence provided here can be interpreted as a preliminary indication that a loss of competitive advantage relative to the industry is the primary reference when it comes to externally oriented actions: managers who see a decline in their assets' profitability react proactively in order to recover their competitive positioning by, for example, sourcing new technological assets from external organizations. In sum, this study contributes to research regarding the decision to adopt open innovation by shedding light on the behavioral processes that are relevant for understanding the decision to acquire external technology (Lichtenthaler, 2011), and it calls for further research aimed at better understanding the differential effect of internal and external reference dimensions on different types of organizational actions.

Second, by considering the different assumptions for managers in family and non-family firms and focusing on the effects of the family firms' propensity to preserve socioemotional wealth for the family (Gomez-Mejia et al., 2007), this article uncovers some barriers to open innovation that were not considered in prior research (Lichtenthaler, 2011). Although acquiring external technology may be seen as a way to quickly develop new products, the reluctance to cede control over the technological trajectory of new products to external actors drives family firms' aversion

to this practice. Prior research has focused on the technical and economic implications of sharing control over the innovation trajectory with external parties (Dosi, 1982; Almirall and Casadesus-Masanell, 2010), but it is here shown that family firms may prefer to adopt a strategy that preserves the firm's discretion over technology decisions in the long term, because ceding such control represents a threat to both the authority and identity foundations of socioemotional wealth (Gomez-Mejia et al., 2010).

More broadly, this article provides a complementary perspective to the prevailing view that transaction costs drive managers' decision to embrace external technology acquisition. In addition to economic considerations, managers use external technology acquisition as a response to declining performance, but when the preservation of socioemotional wealth becomes a priority, as it happens in family firms, the firm is less likely to acquire external technology even if this means accepting below target performance. From a practical point of view, this encourages R&D and product managers to make explicit the reasons underlying their decisions to acquire a technology or develop it internally, although they do not entirely respond to an economic logic. This will help them verify the correctness of their perceptions regarding benefits and drawbacks of acquiring a specific technology, to reduce potential biases engendered by performance feedbacks, and therefore improve their decision making process.

In addition to extending the behavioral perspective to the field of technology strategy, this study has theoretical and practical implications for strategic management in family firms. The emphasis on the family as a controlling interest and its influences on technology strategy has empirical relevance because family control is the predominant form of governance around the world (La Porta et al., 1999) and family firms are widespread across all industrial sectors (Anderson and Reeb, 2003). Not only the findings of this article extend the understanding of the risk taking behaviors of family firms (Gómez-Mejía et al., 2007; Chrisman and Patel, 2012) to the arena of technology strategy, but they also introduce the idea that the pursuance of socioemotional wealth by the part of controlling families is contingent on the internal conditions of the firm. In particular, it is here shown that managers can pursue family goals and undertake risky activities at the same time when some protection mechanisms are in place that increase the firm's ability to preserve socioemotional wealth. If the firm owns proprietary rights over its

technologies, managers' perception about the family firm's power in the relationship with external actors increases and they become more favorable to consider the acquisition of external technology. This finding has strong implications for both theory and practice, because it challenges the idea that the willingness to preserve socioemotional wealth is an uncontrollable force and introduces the possibility that family firm managers actively take actions to secure their particularistic interest, thus becoming able to undertake risky activities while continuing to preserve socioemotional wealth for the family. As such, these results bring support to the idea that family-centered goals and the firm's economic goals are not necessarily divergent (Chrisman and Patel, 2012) and add to previous research by identifying technology protection as a practical mechanism that makes these goals compatible rather than conflicting in the decision to open the firm's technology boundaries. Future research is needed to discover further mechanisms and contingency factors aside technology protection that allow family firms to keep their particularistic goals safe without damaging their ability to conduct aggressive and risky competitive strategies.

Limitations and Future Research Directions

Aside from its contributions, this study has several limitations, which not only represent the boundaries of its insights but also provide opportunities for future research. First, research using other sampling frames than Spanish manufacturing firms is needed to extend the validity of the findings to publicly traded firms and firms outside Spain. Also, by considering only Spanish firms it was not possible to observe the effect of different national patent regimes on the extent of external technology acquisition. Taking a cross-country perspective in future studies will allow to assess the relative importance of low appropriability and loss of control on the technology trajectory as barriers to inbound open innovation.

Second, this study relies on secondary data sources and, similarly to recent studies (Gomez-Mejia et al., 2010; Chrisman and Patel, 2012), the pursuance of family goals to obtain socioemotional wealth was proxied by family ownership and management. Based on prior research, it is here assumed that family goals and socioemotional wealth go hand in hand with family involvement (Chrisman et al., 2012). However, this study shows that despite similar

configurations of family involvement, family firms may differ in the level of family goals they pursue and the importance they attach to the preservation and growth of socioemotional wealth. Thus, research is needed to measure family goals and further extend the understanding of the link between family involvement and family goals, consistently with a more heterogeneous view of family firms (Chrisman and Patel, 2012; De Massis et al., forthcoming-c).

Third, the analysis shows that family firms' reluctance towards external technology acquisition is lower when technology protection mechanisms are put in place. These results, while providing novel insights into the conditions under which family-centered goals can be pursued jointly with the economic goals of the firm, only catch one of the possible factors that might affect the interplay between family and economic goals. Further research is warranted to uncover all other factors, both internal and external, that may potentially determine the compatibility or hierarchy among the two classes of goals that coexist in family firms. For instance, extending the BAM to consider further contingency factors such as the product life-cycle, competition, or institutional pressures, has the potential to significantly improve the understanding of the interplay between family and economic goals in family firms, and consequently to enhance the predictive power of empirical models.

Finally, this article focuses on a specific form through which external technology can be acquired, i.e., R&D contracting. Future research is thus needed to extend the findings to other governance forms such as in-licensing or joint-ventures.

In conclusion, this article provides a novel perspective, based on the behavioral agency model, to explain firms' decisions to acquire external technology. The results show that behavioral factors, overlooked in prior research, are important in explaining family and non-family firms' decisions regarding the boundaries of technology development activities. While this study brings new perspectives to research on technology and innovation management and extends prior knowledge about the distinctiveness of family firms, more research is needed to better understand the behavioral processes driving strategic decisions in technological innovation among family firms and in comparison with non-family firms.

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