Received: 7 June 2021 | Revised: 31 August 2023 | Accepted: 3 November 2023

DOI: 10.1002/smj.3570

RESEARCH ARTICLE

SMS | Strategic Management Journal WILEY

To commercialize inside or outside of the firm: Behavioral considerations in patent exploitation by family firms

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Funding information
The Italian Ministry of Education, University and Research (MIUR), Grant/Award Number: B41J12000160008

Abstract

Research Summary: This article examines the relationship between family ownership and patent use strategy using primary data from a patent survey, as well as patent and firm-level data from secondary sources. The findings reveal that family firms are less likely than non-family firms to license their patents and more likely to internally commercialize them. We show that the decision of family firms to license less does not depend on lower patent quality or inefficient patent use. Instead, it arises from their preference for patent uses that allow them to exert greater control over the value they can derive from their innovations. We also show that family firms commercialize more patents because they leverage their managerial discretion to explore and seize emerging internal patent commercialization opportunities.

Managerial Summary: Whether the desire of families in family firms to maintain control over the company and strategic resources negatively impacts their economic performance has important governance implications. Within the context of patent commercialization, in line with this desire for control, our study highlights the preference of family firms to prioritize internal commercialization over licensing. To offset their underlicensing tendency, family firms internally commercialize more patents by being

nimble to identify and capitalize on emerging commercialization opportunities. This enables them to align their control ambitions with patent commercialization efficiency, akin to nonfamily firms.

KEYWORDS

family firms, family ownership, innovation, patent commercialization, patent licensing

1 | INTRODUCTION

Family ownership has significant effects on firms' strategic decisions and performance—such as growth, diversification, divestiture, internationalization, market value, and profit stability (e.g. Feldman et al., 2016; La Porta et al., 1999; Miller & Breton-Miller, 2005; Villalonga & Amit, 2020). However, to date, we have a limited understanding of the choice of family firms to exploit innovations internally or externally. This is surprising in that not only is innovation a key source of the competitive advantage of firms, but several studies have also shown that the ability to appropriate value from innovations depends critically on the strategic choice to exploit innovations through internal commercialization or licensing (e.g., Arora & Ceccagnoli, 2006; Arora & Gambardella, 2010; Teece, 2006). While the innovation literature offers extensive considerations on the effects of competition, access to complementary assets, or the profit-dissipation implied by licensing on the internal or external exploitation of innovations (e.g., Arora & Ceccagnoli, 2006; Fosfuri, 2006), there are practically no studies on how family firms cope with this issue.

A key feature of family firms is that they assign non-economic values to their assets. This prompts them to exert greater control on them and more generally behavioral factors affect their strategies. Nonetheless, we do not have a good understanding of the behavioral explanations that affect the strategies of commercial exploitation of innovations associated with ownership type (Chirico et al., 2020; James et al., 2013). The lack of research that brings these two streams of literature—family ownership and commercial exploitation of innovation—can be attributed to two factors. First, the two streams of research remain independent as separate fields of study and hence they talk less to each other. Second, there is a lack of granular data on the uses of innovations. This article tries to fill this gap theoretically and empirically.

Studying how family ownership influences the commercial exploitation of innovations is important for several reasons. First, the literature has not directly tested whether the non-economic values that family firms place on the control of their assets impose tradeoffs on economic values such as firm growth. Previous studies have documented the propensity of family firms to underinvest in M&A, internationalization, diversification, but without considering other strategic choices that may have similar outcomes, this does not answer the question of tradeoffs. Our empirical setting is ideal to disentangle this theoretical puzzle as it provides information on all the uses of innovation: licensing, internal commercialization, and non-use of innovations for commercial purposes. Our study of the commercial exploitation of innovation is then a test-bed for the potentially broader problem of the attitude of family firms toward internal or external exploitation of their assets. Second, to the extent that family firms are pervasive organizational types and innovations are key to the competitiveness of firms, it is important to study the influence of family ownership on the use of these key strategic resources. We then

explain how and why behavioral factors are a key driver of the differences in the commercial exploitation of innovations by family and non-family firms. Third, because our empirical setting is innovation, a phenomenon with social and private benefits, we draw implications for the family firms' approach to technology exploitation and the development of technology markets.

We employ unique patent survey data collected from inventors in 20 European countries, Israel, Japan, and the United States (Patval2). We combine this survey data with patent characteristics data from PATSTAT, and ownership and other firm characteristic data from Orbis. We tested our hypotheses with a sample of 471 family and non-family firms and 2759 patents. The results suggest that family firms are more reluctant to license their patents than non-family firms and they commercialize their patents internally more than non-family firms. Further analyses reveal that the choice to license fewer patents by family firms is due to their preference to maintain control over their technologies.

The article makes several contributions to the innovation and family firm literature. To the innovation literature, it demonstrates that the decision to exploit patents is not only driven by economic considerations, as established by the literature (Arora & Ceccagnoli, 2006; Ziedonis, 2004), but also by behavioral factors that affect the commercialization strategy of the controlling owner of the firm. We bring new insight to the innovation literature by showing the importance of the type of controlling owner as a predictor of the commercial exploitation of innovations. Second, the article sheds light on how a preference for internal commercial exploitation of innovations by family firms affects markets for technology by reducing the supply of patents and consequently limiting technology spillover and specialization (Arora et al., 2004). To the family firm literature, our study provides evidence that family firms' interest to nurture non-economic values does not necessarily lead to a suboptimal economic outcome at the firm level. It provides evidence that to protect their non-economic values, family firms engender their unrestrained decision-making power to explore and seize different routes of resource exploitation to internally exploit their innovations. Finally, we show that family firms' preference to use their patents internally rather than externally has positive implications for the scaling up and growth of family firms. We elaborate on all these points in the contribution and conclusion section.

The article is organized as follows. In the theory and hypotheses section, we discuss the theoretical background of family firm governance and patent exploitation and move on to developing hypotheses. In the data and method section, we describe our data and variables and explain our empirical strategy. In the result and discussion section, we test hypotheses and present additional results (a) to empirically probe the mechanisms that drive the commercialization strategy of family firms, and (b) to rule out alternative explanations. This is followed by a contribution and conclusion section.

2 | THEORY AND HYPOTHESES

2.1 | Family governance and strategic choices: A prospect theory approach

In the canonical theory of modern corporations, agency problem arises from the *divergence of goals* between the principal (shareholders) and agents (managers) and the difference in their propensity to *risk-taking* (Jensen & Meckling, 1976). According to this theory, because managers are less diversified than shareholders, their goal favors strategies that diversify risk and they tend to be risk-averse in evaluating decisions (Eisenhardt, 1989; Jensen & Meckling, 1976).

This divergence in *goals* and *risk-taking* propensity is not limited to shareholders and managers, it also exists between diversified and undiversified shareholders (Carpenter & Sanders, 2004; Cruz et al., 2010; Eisenhardt, 1989). A typical case of this is family-controlled firms in which the *goals* and *risk-taking* appetite of controlling families are different from minority shareholders (Cruz et al., 2010; La Porta et al., 1999). The agency problem is that family firms reflect the interest and risk-taking appetite of controlling families. The *divergence in goals* stems mainly from family firms' interest to nurture non-economic values of controlling families in addition to or at the expense of improving economic values. This contrasts with the goals of minority shareholders who care more about enhancing economic values with little to no interest in non-economic values (Gomez-Mejía et al., 2007; Villalonga & Amit, 2020). Non-economic values refer to (a) families' close emotional ties and identification with the firm, and the desire to ensure the continuity of this tie through succession, (b) unique interest to maintain independence and privacy, and (c) rare managerial discretion and influence of families over the business (Berrone et al., 2012; Gomez-Mejia et al., 2016; Miller & Le Breton-Miller, 2021).

Unlike the goal divergence argument of agency theory, the literature has challenged the risk-aversion argument of agents in general, and of controlling families in family firms (Lim et al., 2010; Martin et al., 2013; Wiseman & Gomez-Mejia, 1998). Recent advances in the field propose that the posture of controlling families in family firms is more aligned with prospect theory than agency theory (Chrisman & Patel, 2012; Lim et al., 2010; Pepper & Gore, 2015; Wiseman & Gomez-Mejia, 1998). In agency theory, controlling families and agents alike are considered to be risk-averse regardless of whether they are maximizing gains or minimizing losses (Demsetz, 1983; Gomez-Mejia et al., 2010; Jensen & Meckling, 1976). In contrast, prospect theory proposes that agents follow different rules in gain and loss contexts such that (a) they are risk-takers in the context of loss, (b) they are risk-averse in the context of gain, (c) their choice is based on changes from the current reference point and not from the overall value, and (d) problem framing can change their reference point and risk-taking posture (Kahneman & Tversky, 1979; Wiseman & Gomez-Mejia, 1998). This theory predicts the decision-making behavior of agencies, both in family and non-family firms. What is unique about family firms in comparison to non-family firms is what constitutes losses and gains. What might be a gain decision context for non-family firms could turn into a loss context for family firms if the decision leads to economic gains at the expense of non-economic values (Gomez-Mejía et al., 2007). This uniquely affects family firms' reference point (gain or loss) and their risk-taking attitude (loss-averse or risk-taking) when they make strategic choices.

Leveraging this theoretical insight under the umbrella of behavioral agency theory, the literature on family firms has provided a lot of new insights into the role of non-economic values in influencing the strategic choices of family firms in areas such as M&A, internationalization, divestiture, recruitment, and so on. What is still relatively less understood is whether this change in risk-taking attitude, driven by their desire to nurture their non-economic values, imposes a trade-off on economic gains and whether family firms employ specific strategies to circumvent this trade-off. This article contributes to addressing these questions.

2.2 | Factors influencing patent utilization strategies

Innovation and its outputs, like patents, are the founding blocks of competitive advantages (Grant, 1996; Teece, 2007). They are the bases for keeping capabilities dynamic via ensuring sustained experimentation, improving absorptive capacity, and granting monopolistic rent

(Leone & Reichstein, 2012; Moreira et al., 2020; Teece, 2007; Ziedonis, 2004). Patents allow owners to gain monopolistic rent for a limited time set by patent laws by providing exclusive rights to exploit their inventions by themselves or through licensing (Gans et al., 2008). Firms use patents to pursue their profit interest directly or indirectly. Directly, they benefit from commercializing new products or processes by embedding the technology, or by licensing patents in technology markets. Indirectly, firms use their patents to prevent rivals from inventing around and fencing them (offensive blocking) and to protect themselves from infringement suits (defensive blocking) (Cohen et al., 2000; Torrisi et al., 2016).

The literature proposes that firms' choice of patent uses depends on the complexity of the technology, the availability of complementary resources, and the extent of competition in the technology domain (Cohen et al., 2000; James et al., 2013; Lanjouw & Schankerman, 2001). The use of patents in complex technology classes such as semiconductors, biotechnology, and digital platforms is different from their use in discrete technology classes such as pharmaceuticals (Hall & Ziedonis, 2007; Teece, 2006). Patenting in complex technology classes serves primarily as a tool to defend against holdups and infringement suits that might block the use of own technology for product commercialization (Ziedonis, 2004).

Similarly, ownership of complementary assets is an important determinant of the decision to license or internally commercialize technologies (Teece, 2006). Complementary assets refer to generic or specialized manufacturing, marketing, distribution networks, and aftersales services relevant to the technology-embedded product to be produced, promoted, and distributed. The presence of these assets gives a competitive edge for in-house commercialization by increasing the quality and reliability of the product and reducing the cost of production (Arora & Ceccagnoli, 2006; Arora & Gambardella, 2010; Teece, 2006).

Moreover, the presence of competition in the technology domain increases both licensing and commercialization of patents (Moreira et al., 2020; Torrisi et al., 2016). Licensing decisions are also influenced by the focal firms' market share in the product market and the extent of competition in the technology domain. As such firms' decision to license their patents is determined by the net again from royalty fees of licensing less revenue that dissipates due to competition from the licensees (Fosfuri, 2006).

2.3 | Patent utilization strategies in family firms: Commercializing inside or outside of the firm

As we alluded to earlier, the non-economic value that controlling families aim to protect and nurture in family firms comprises emotional bond and its generational continuity, secrecy from scrutiny, and exceptional managerial discretion and influence over the business (Berrone et al., 2012; Gomez-Mejia et al., 2016; Miller & Le Breton-Miller, 2021). Controlling families can drive utilities from each of these independently and jointly. Moreover, these dimensions are intertwined with each other and with the economic values of the firm. For example, the desire to maintain ties with the firm and ensure its continuity with the next generation could influence family firms' time horizon for returns on investments (Anderson et al., 2012; Berrone & Gomez-Mejia, 2009; Miller & Breton-Miller, 2005). Similarly, secrecy from scrutiny and rare managerial discretion over the business are fundamental to keeping current and future family ties to the firm. In turn, these two non-economic values are outcomes of a family's strong control over the business.

For this reason, controlling families exhibit a strong taste for control and they put in place various governance mechanisms in excess of their ownership through pyramid structures, dual-

class shares, and over-representation in the board and management of the firm (Gomez-Mejia et al., 2016; Villalonga & Amit, 2020). They also safeguard their privacy by staying as private firms to avoid stock market scrutiny and new capital diluting their controlling ownership (La Porta et al., 1999; Villalonga & Amit, 2020).

This suggests that family firms' interest to protect and nurture non-economic values influences their risk-taking posture toward alternative strategic choices. The behavioral agency theory suggests that both family and nonfamily firms tend to show risk-averse behavior when evaluating prospective decisions in situations where their current status quo represents gains. Conversely, these firms tend to exhibit risk-taking tendencies when assessing prospective actions in cases where their current status quo is characterized by losses (Chrisman & Patel, 2012; Gomez-Mejía et al., 2007; Lim et al., 2010). While losses and gains are related to economic outcomes for non-family firms, in the case of family firms they encompass non-economic values. This leads family firms to adopt a distinct risk posture toward the same strategic choices compared with non-family firms.

In the context of technology commercialization, exploiting patents internally or externally affects the degree of control and the associated non-economic value that firms appropriate from controlling their technology. Given that the focal technology is in their hands at the time of evaluating commercialization alternatives, this is a status quo condition that implies that family firms take a risk-averse posture toward licensing as it generates a loss of control over their patent by creating dependence on the licensees' actions in several ways.

First, external commercialization subjects the licensor to rely on the licensee for the financial success of their technology. Revenue goals from licensing are tied to the total revenue that the licensee generates from using this technology (Kotha et al., 2018; Wang et al., 2013). Once agreed, the licensor has to rely on the licensee's commitment, and capability to leverage complementary assets to exploit the technology (Arora & Ceccagnoli, 2006; Fosfuri, 2006). If the licensee fails to leverage the required resources to successfully exploit the focal firm's technology, the licensor loses revenue, and it has limited control to turn this around with respect to in-house commercialization.

Second, licensing limits the licensors' control over the trajectory of the technology (Leone & Reichstein, 2012; Moreira et al., 2020). Licensees could recombine the licensed invention in ways that licensors do not anticipate (Gurgula, 2017). As such, recombination opportunities and spillover effects of licensing to the licensee can at times be consequential in eroding the competitive positions of the licensor both in the technology and product markets (Laursen et al., 2010, 2017; Leone & Reichstein, 2012).

Third, licensing agreements cover a set of conditions such as exclusive or non-exclusive use of the patent by the licensee, licensing scope (product and geography in which the technology can be exploited), and financial compensation to the licensor (Leute, 2010; Somaya et al., 2011). The realization of this contract depends on both parties' mutual commitment to abide by it. A potential failure of the licensee to abide by the licensing agreement and subsequent litigation costs is a risk that licensors experience when they opt for commercializing their technology externally rather than internally (Duplat et al., 2018; Somaya, 2003).

Overall, licensing forces family firms to depend on the licensee for the financial success of their patent and the realization of the contract. It also increases the risk of losing control over the technological trajectory of their innovation. Ceding control over the financial and technological returns of their strategic resource is a non-economic value that family firms want to protect and nurture. This decision context evokes the risk aversion posture of family firms. Therefore, we hypothesize the following.

Hypothesis 1. All else equal, family firms are less likely to license their patents than non-family firms.

Hypothesis H1 implies that, from an economic point of view, family firms will be less efficient, on average, in exploiting their inventions because of their non-economic constraint on one strategic choice, licensing. They can offset this economic inefficiency only if they are more efficient in exploiting their technology internally—that is, their rate of internal exploitation is higher than non-family firms. Otherwise, they appropriate a lower total (economic and non-economic) value of their technology because of the lower economic component (Anderson et al., 2012; Berrone et al., 2012; Feldman et al., 2016).

The idea is that firms choose between licensing, internal commercialization, and non-use of a given patent depending on the relative expected gains of these alternative options (where non-use is a deferred decision to use the patent). In assessing these gains, family firms consider both economic and non-economic returns. If they feel that licensing induces loss of control, and they care about it, they will end up licensing patents only if they exhibit a sufficiently higher expected economic return than the best of the other two options, to outweigh the fear of losing control. As a result, family firms will hold more patents that can be used for internal commercialization than ideal from an economic point of view. If, on average, opportunities for economic exploitation of patents do not differ between family and non-family firms, family firms will face a lower average expected return from non-licensed patents because they hold patents that are relatively more efficient to license than to exploit internally. According to behavioral theory, this implies that family firms perceive a greater economic loss in this condition. They then take more risk than non-family firms in their internal commercialization strategies and try to commercialize patents in non-standard ways or in less familiar domains compared with what non-family firms do. In addition, the greater control that family firms exercise facilitates nimbleness. It enables them to redirect, reorganize, and repurpose more clearly and more quickly actions toward newer and more risky internal commercialization activities.

To summarize, we expect family firms to commercially exploit their patents internally more than non-family firms for two reasons.

First, in line with family firms' desire to protect and nurture non-economic value, internal commercialization grants more control over the technological and financial returns of innovation. The financial proceeds that they earn from exploiting their technology depend on their production, marketing, and distribution capabilities, unlike licensing where this is entrusted to the licensee. Internal commercialization allows them to have control over the scalability of production and distribution as well as over maintaining and developing their competitiveness in the technology domain (Laursen et al., 2017).

Second, the control mechanisms families put in place beyond and above their direct ownership, such as their involvement in the management, enable them to take bold decisions (Miller & Le Breton-Miller, 2021; Villalonga et al., 2015). Controlling families are better positioned to spur their discretion to influence the management to explore possibilities of internal commercial exploitation as they eschew licensing their inventions. They become nimble to search and seize internal commercialization opportunities prompted by their risk-taking behavior and the need to compensate for their under-licensing. This might include reallocating internal resources to assess the feasibility of exploiting their inventions within the firm by actively searching and seizing opportunities that are not anticipated ex-ante.

Therefore, we expect that as family firms shun licensing for fear of losing control over the technological trajectory and financial proceedings, they aggressively explore and seize internal commercial exploitation opportunities by leveraging their decision-making discretion. Their

nimbleness to explore more possibilities for internal commercialization of their patents then offsets the lower overall patent use due to under-licensing. We hypothesize the following.

> **Hypothesis 2.** All else equal, family firms are more likely to commercialize their patents internally than non-family firms.

3 | DATA AND METHOD

3.1 | Data

We tested our hypotheses by combining survey data about patent use strategies, patent characteristics data from PATSTAT, and ownership and other firm characteristic data from Orbis. We collected the survey data (Patval2) from a sample of inventors located in 20 European countries, Japan, and the United States. To conduct the survey, we first collected all applications to the EPO with priority dates between 2003 and 2005. From these applications, we randomly chose respondents among the inventors listed in each patent. This sampling procedure produced 124,134 unique patent/inventor combinations. We conducted the survey between 2009 and 2011 in Europe, Israel, Japan, and the United States. The survey produced 23,044 usable responses. Respondents returned 11,307 letters due to wrong addresses, and 12 errors occurred due to mistakes when inventors filled out the questionnaire. Excluding the letters sent to the wrong addresses, the response rate is 20%.

Inventors may not be directly involved in the decision of how to exploit patents. However, they are the best available source of information about their own patents because managers are not so directly related to individual patents, and inventors know about the uses and values of their patents because their reward systems are often linked to them, and in general, they have natural interests and information about what happens to their inventions (Harhoff & Hoisl, 2007; Torrisi et al., 2016). For example, Gambardella et al. (2008) compared the distribution of responses to the patent value question by inventors and managers in this survey and found similar distributions with a slight overestimation of patent values by inventors.

We combined this survey data with patent characteristic data from PATSTAT, and ownership and firm characteristic data from Orbis for all publicly listed companies that are included in the patent survey data. We obtained 2966 patents owned by 501 companies with relevant firm-level data.

3.2 | Measurement

A. | Dependent variables

The survey asked inventors about the status of the patent at the time of the survey, that is, whether the patent was commercially exploited internally or externally. From these questions, we defined our two variables as follows.

> *Licensed patent*: The variable takes value 1 if the patent was licensed or sold and 0 otherwise.
> *Commercialized patent*: The variable takes value 1 if the patent was internally commercialized and 0 otherwise.

B. | Explanatory variables

Family firms

This dummy variable takes value 1 if at least 10% of the firm is owned by a family or a private person and zero otherwise. It is common to use 10% as a cutoff point to identify family ownership, especially among listed companies (e.g., La Porta et al., 1999; Villalonga & Amit, 2020). For robustness check, we also used (a) at least 5% and 15% family ownership as cutoff points, and (b) another dummy variable of whether a family is represented in the management (board) and has at least a 5% ownership (coded as 1 or zero otherwise).

C. | Control variables

Since our prediction is on family firms' preference to license or internally commercialize their patents, we included an array of control variables at the patent, firm, technology, and country level.

Patent level controls

These variables are indicators of the technological or economic value of the inventions, which affects the likelihood of the commercial exploitation of patents. We constructed them from bibliometric data (PATSTAT) as well as from the survey data. Based on the literature, we controlled for patent characteristics using seven variables related to the value of patents. They are (A) Research time: The number of man-months to generate the invention represented by 9 classes indexed from 1 to 9, from no R&D time (1) to 72 man-months or more (9). We created a dummy variable that takes value 1 if the invention time is more than or equal to 13 man-months (above the median) and zero otherwise. (B) The economic value of the patent. We used a survey question that asks inventors to rate the economic value of the focal patent by comparing it with other patents in their industry, top 10%, top 25%, and top 50%. We used a dummy variable that takes value 1 if the focal patent's economic value is rated as top 50% in the industry and zero otherwise. (C) Patent citation. We controlled for Patent XY forward citation to the focal patent. We used the log of the total of X or Y patent citations made to the focal invention over the last 5 years since the publication of the search report, (log (citation +1)). We made this adjustment to handle cases of patents with zero citations in our dataset. The more X and Y forward citations a focal patent receives, the higher its strategic importance in the technology space and its economic values (Czarnitzki et al., 2011; Grimpe & Hussinger, 2014).[1] (D) Patent status: a dummy variable that takes value 1 if a patent is granted to the focal invention and zero otherwise. (E) Patent family size: It is the number of patents granted in various countries to protect a single invention. It is a proxy for the patent owner's expectation of opportunities to use the patent in different markets, and hence the value of the patent. (F) We also included dummies for the Patent Priority year because previous studies show that information disclosure about the invention, that is, patent publication, affects the likelihood of technologies traded in the market (Gans et al., 2008; Hegde & Luo, 2018). (G) Number of claims reported in the patent

[1]Patent examiners classify citations to prior art into various categories according to their significance. If prior art is classified as X or Y citation, it means that the prior art is highly relevant to the invention. These citations imply that either taken alone (X-type references) or in combination with other references (Y-type references), they can impede the novelty of the invention and the likelihood of receiving a patent.

document (log-transformed). The number of claims defines the scope of patent protection; a wider scope provides a potentially greater economic value compared with a narrow scope (Marco et al., 2019). (H) Moreover, we included a variable that captures the availability of complementary assets that contributes to the internal commercial exploitation of patents (Ceccagnoli et al., 2010; Teece, 2006). We used a variable in the survey that ranges from 1 (completely disagree) to 5 (completely agree) depending on the extent to which respondents agree with the statement that the organization has complementary resources to make the invention a success. The variable is a dummy that takes value 1 if respondents agree or completely agree (4 or 5) and zero otherwise.

Firm-level controls

At the firm level, we included firm size and age that influence internal versus external patent exploitation (Motohashi, 2008; Torrisi et al., 2016; Walsh et al., 2016). We controlled for firm size by the number of employees of the firm (log-transformed) and firm age by the number of years since the year of incorporation (log-transformed).

Technology class and country-level control variables

Technology characteristics, the strength of intellectual property rights, and competition in the technology domain influence how firms choose to exploit their patents (Gurgula, 2017; James et al., 2013; Moreira et al., 2020). Therefore, we controlled for technology competition using a survey question that asks inventors if they were aware of one or more parties competing for the patent. We categorized competition as equal to 1 if one or more parties were competing for the patent, and zero otherwise. Then, we included dummies for technology classes to control for technical characteristics such as complex vs discrete technology that influences patent uses. Finally, we included country dummies for applicant firms to parse out country-level effects including the strength of IPR on patent uses (Pitkethly, 2001; Zhao, 2006).

3.3 | Methods

Our dependent variables, internal commercialization, and licensing, are choice variables. To isolate the causal link between family ownership and these two types of patent uses, we need to rule out confounding factors. Following previous work (e.g., Feldman et al., 2016, 2019), we created matched samples of firms with and without family ownership using the Coarsened Exact Matching technique (CEM).

CEM is preferable to alternative matching procedures such as propensity score matching (PSM) because of its reliability in creating a balance between the treatment and control groups (Iacus et al., 2012). This method allows us to isolate the differences in covariates between family and non-family firms, and help to mitigate the effect of nonrandom selection on internal commercialization and licensing decisions. We proceeded in two steps: identify relevant covariates to create a balance between treated and control groups and match the two groups by those covariates, technology class, and country. To identify important covariates, we predicted the propensity to be a family-owned firm (treated group) on all the patent and firm-level variables that we identified in the variable definition section. We present the results in column 1 of Table S1a of the Appendix. Of these covariates, we found that patents in the top 50% in the industry, the log of patent claims, the log of firm age, competition, and whether

a patent is granted are significantly related to family ownership. That is, they cause sample imbalance between treated (family firms) and control groups while the other covariates do not.

After identifying these covariates, we matched the dummy variables exactly (i.e., the patent is in the top 50% in the industry, whether the patent was granted, and competition) and used coarsened matching for patent claims and firm age. We coarsened these two continuous variables into four categories set by the CEM-Stata routine. Then, we matched within 3-technology classes, electronics and instruments, chemical and process engineering, mechanical and constructions, and within country. In this way, we match family and non-family firms based on these relevant covariates and lose fewer observations than if we matched the two types of firms with all the covariates regardless of their effect on the sample balance. After the matching, we re-run the same regression model using family ownership as the dependent variable, and as regressors firm and patent characteristics to check the sample balance. We show results in Table S1a, column 2, in the Appendix. They show that we do not have a significant sample imbalance. The coefficient estimates of the log of the number of claims, log of firm age, and patent in the top 50% in the industry are not significant anymore. The effect of patent grant is substantially reduced, but not completely eliminated. Since this variable is not matched with CEM, where we could have the flexibility to change the degree of coarseness, it is an exact matching and there is no further step we can take to eliminate this effect completely. Overall, family, and non-family firms are alike in the observable firm and patent characteristics with the matched sample. With this process, some treated groups (family firms) end up having more than one control group, and we used cem_weights to account for it in the regressions. With the CEM, our sample reduced from 501 firms and 2966 observations to 471 firms and 2759 observations. We tested our hypotheses on this matched sample.

Another methodological issue is that we measure the key explanatory variable, family ownership, at the firm level, while we measure the main dependent variables at the patent level. We then cluster robust standard errors by firm-id to account for multiple observations at the firm level for each patent.

A. | Estimation

Since our dependent variables are binary, we used a Limited Dependent Variable model, that is, logistics regression, to test our hypotheses. We also show the results of linear probability model estimates to interpret the coefficients more easily.

4 | RESULTS AND DISCUSSION

Table 1 presents the summary statistics. Twelve percent of the patents in our dataset are licensed or sold and 67% are commercialized, while the remaining 21% are unused. A third of the patents are owned by family firms.

We formally tested our Hypotheses as shown in Table 2. The first two columns test Hypothesis 1 and the other two test Hypothesis 2. As columns 1a and 1b show, the probability of licensing of family firms is 3.5 percentage points smaller than non-family firms, which corresponds to 29% of the unconditional probability of licensing in the sample. Similarly, columns 2a and 2b

TABLE 1 Summary statistics.

Variables	*N*	Mean	SD	10th	50th	90th
Patent licensed	2426	0.12	0.32	0	0	1
Patent commercialized within the firm	2523	0.67	0.47	0	1	1
Research time for serendipitous patents	2757	0.01	0.09	0	0	0
Deviation from planned internal commercialization	2460	−0.11	0.59	−1	0	1
Deviation from planned licensing	2291	−0.27	0.54	−1	0	0
Family firms	2759	0.32	0.47	0	0	1
Complementary assets	2759	0.65	0.48	0	1	1
Research time	2759	0.25	0.43	0	0	1
Patent XY citation in the last 5 years (log)	2759	0.30	0.49	0	0	1.09
Patent family size	2759	27.45	15.04	7	33	41
Patent in the top 50% in the industry	2759	0.62	0.49	0	1	1
No. of patent claims (log)	2759	2.67	0.51	2.08	2.64	3.30
Firm-size (log)	2759	10.60	1.88	8.08	10.97	12.95
Competition	2759	0.32	0.47	0	0	1
Firm Age (log)	2759	3.94	1.08	2.20	4.40	5.06
Priority_year_2003	2759	3.13	0.46	0	0	1
Priority_year_2004	2759	0.38	0.49	0	0	1
Priority_year_2005	2759	0.31	0.46	0	0	1
Patent Granted	2759	0.41	0.49	0	0	1
Language future-time reference	2746	0.31	0.46	0	0	1
Cultural-long-term orientation	2746	0.57	0.49	0	1	1

show that the probability of internal commercialization of family firms is 6.3 percentage points higher than non-family firms, which corresponds to 9% of the unconditional probability of internal commercialization in the sample.

Patents in the top 50% in the industry, patent family size, and competition in technology increase patent licensing. Access to complementary assets and patent quality (being in the top 50% in the industry) increase the likelihood of commercializing inventions internally. Other measures of patent quality, patent XY citation, number of claims made in the patent, and whether the patent is granted do not have any effect on licensing or commercialization. These results remain qualitatively the same when we change the definition of family ownership by decreasing the ownership cutoff point to 5% or increasing it to 15%. We observe similar results when we measure family ownership using a dummy variable of whether the family is represented in the (management) board and has at least a 5% ownership. We present these results in Table S2a in the Appendix.

These findings are in line with the literature on family firms' behavior about control over strategic resources and nurturing non-economic values of control. They corroborate our hypotheses that their strategic choices are informed by this penchant for control, while remaining agile to overcome the potential tradeoff that this preference may impose on them.

TABLE 2 Licensing vs commercializing patents by ownership type.

Dependent variable	Patent licensed		Patent commercialized internally	
	(1a)	(1b)	(2a)	(2b)
Model	Logit	Linear prob	Logit	Linear prob
Family firm	−0.403 (0.200)	−0.035 (0.017)	0.303 (0.133)	0.063 (0.027)
Complementary assets	−0.153 (0.190)	−0.017 (0.018)	0.328 (0.129)	0.070 (0.028)
Research time	0.351 (0.215)	0.036 (0.023)	−0.183 (0.145)	−0.039 (0.032)
Patent XY citation in the last 5 years (log)	0.023 (0.203)	0.005 (0.021)	0.082 (0.112)	0.017 (0.023)
Patent family size	0.016 (0.007)	0.001 (0.001)	−0.003 (0.005)	−0.001 (0.001)
The patent in the top 50% of the industry	0.567 (0.195)	0.048 (0.016)	0.282 (0.115)	0.060 (0.025)
No. of patent claims (log)	0.153 (0.191)	0.017 (0.018)	0.039 (0.150)	0.008 (0.032)
Number of employees (log)	−0.058 (0.055)	−0.006 (0.006)	−0.073 (0.036)	−0.015 (0.007)
Competition	0.359 (0.188)	0.038 (0.020)	−0.065 (0.130)	−0.014 (0.028)
Firmage (log)	−0.080 (0.084)	−0.007 (0.008)	0.117 (0.061)	0.024 (0.013)
Patent granted	−0.150 (0.175)	−0.012 (0.016)	0.079 (0.137)	0.015 (0.029)
Constant	−3.313 (0.926)	0.026 (0.090)	1.181 (0.624)	0.748 (0.126)
Observations	2426	2426	2523	2523
R^2		.066		.054

Note: Robust standard errors clustered by company-id in parentheses. Dummies for technology classes, priority year for patent application, and country dummies are included in all the regressions.

4.1 | Mechanisms and alternative explanations

To substantiate our claims, we conduct further analyses. We study the mechanisms that could explain the family firms' tendency to license less and internally commercialize more patents. More specifically we aim to corroborate our theory that *family firms' preference to control and nurture their non-economic values explains their patent commercialization strategy*. To this end, we empirically (a) examine the mechanisms that lead family firms to successfully commercialize more patents internally, (b) rule out alternative explanations related to the potential inefficiency of family firms to license their technology, (c) examine if family firms encounter a trade-off in the type of innovations they license or commercialize internally, and (d) rule out the possibility that this result is driven by family firms' long-term orientation.

A. How do family firms succeed in internally commercializing more patents?
The literature suggests that controlling families have more discretion to influence strategic decisions in ways that fit their interests (Luo & Chung, 2005; Miller & Le Breton-Miller, 2021). In line with it, we argued in the hypothesis development section that family firms' nimbleness, that is, their ability to actively search for in-house commercialization opportunities, drives the positive relationship between family ownership and internal patent commercialization. We tested this mechanism in two ways.
The first one is the extent to which family firms deviate from their intended patent use in

favor of internal commercialization more than non-family firms. The intuition is that if internal commercial exploitation is a preference of family firms, they should leverage their influence on the management of the firm to look for opportunities for internal commercial exploitation by deviating from planned patent uses. To test this, we use a set of survey questions and construct two variables: (1) Deviation in favor of internal commercialization, and (2) Deviation in favor of licensing. The survey asked inventors, in separate questions, if internal commercial exploitation or licensing was the primary reason for patenting their inventions at the time of patent filing. Out of five options we marked internal commercialization or licensing as the primary reason if the inventors ticked one of the top two responses ("agree" or "completely agree"). This is our measure of planned patent use. Ex-post, firms may internally commercialize or license their patents inline or differently from their intended patent uses. Deviation in favor of internal commercialization is the difference between the actual patent uses less intended internal commercialization. It takes three values −1 (patent internal commercialization was intended but the patent was licensed), 0 (executed as planned), and 1 (licensing was intended but the patent was internally commercialized). We followed the same logic to create a variable for deviation in favor of licensing.

The descriptive statistics in Table 1 show that both family and non-family firms deviate from their planned patent uses. Deviation is much bigger on the licensing front (27%) than internal commercialization (11%). We run regressions using these deviations from intended internal commercialization or licensing and show results in Table 3 columns 1 and 2 using ordered logistic regressions. Results show that family firms deviate from intended internal commercialization by 20.2 more percentage points than non-family, while there is no difference in licensing decisions. Deviation from planned patent uses in favor of internal commercialization is not a general tendency of family firms to deviate from their plans for technology exploitation, but it is specific to internal commercialization. Since deviation from planned uses requires some form of flexibility to change actions and operations compared with plans, we take this result as evidence that family firms are nimble to exploit opportunities to commercialize their patents internally.

Second, we examined whether family firms systematically experiment with serendipitous inventions for internal commercialization. The intuition is that serendipitous inventions are fortuitous in that firms have never thought of these inventions before, and they discover them in "very crude and nascent" conditions (Murayama et al., 2015). They need resources such as research time to further develop and evaluate their technical and commercial relevance. The greater tendency of family firms to commercialize their inventions internally could encourage them to spend more resources than non-family firms on internally commercialized serendipitous inventions. To test this, we examine if family firms invest more research time on serendipitous patents and especially on internally commercialized serendipitous patents. We coded inventions as serendipitous when the inventors claim that the focal invention has come from a pure inspiration that is not related to their job. We show regression results in Table 3 columns 3–5. Column 3 shows that family firms are more likely to spend extra research time on serendipitous patents regardless of the type of use. The subsample analyses in columns 4 and 5 show that this result holds if the serendipitous patent is internally commercialized (column 4), but not if it is licensed (column 5). Family firms experiment with serendipitous innovations for internal commercialization more than non-family firms, but not for licensing.

We interpret these two results—that is, deviating from planned patent uses in favor of

TABLE 3 Family firms' active search for internal commercialization opportunities.

Dependent variables	Dev. from planned int. commercialization	Dev. from planned licensing	Research time for serendipitous patents		
	(1)	(2)	(3)	(4)	(5)
				A subsample of internally commercialized patents	A subsample of licensed patents
Model est.	**Ordered logit**	**Ordered logit**	**Linear prob**	**Linear prob**	**Linear prob**
Family firm	0.202 (0.109)	−0.010 (0.125)	0.007 (0.003)	0.013 (0.005)	0.014 (0.015)
Complementary assets	−0.038 (0.153)	−0.314 (0.199)	0.003 (0.003)	0.002 (0.003)	0.023 (0.021)
Research time	−0.372 (0.155)	0.177 (0.151)			
Patent XY citation in the last 5 years (log)	0.203 (0.122)	0.160 (0.181)	−0.004 (0.003)	−0.004 (0.003)	−0.025 (0.022)
Patent family size	−0.007 (0.004)	0.008 (0.005)	0.000 (0.000)	−0.000 (0.000)	0.000 (0.001)
The patent in the top 50% in the industry	−0.229 (0.154)	−0.386 (0.109)	0.011 (0.002)	0.007 (0.003)	−0.004 (0.008)
No. of patent claims (log)	−0.127 (0.122)	−0.093 (0.119)	−0.009 (0.004)	−0.008 (0.004)	−0.019 (0.013)
Patent granted	0.231 (0.139)	−0.240 (0.125)	−0.008 (0.004)	−0.006 (0.005)	−0.026 (0.029)
Constant			0.011 (0.019)	−0.000 (0.008)	0.204 (0.115)
Constant cut1	−1.652 (0.605)	−1.859 (0.583)			
Constant cut2	1.614 (0.605)	2.112 (0.576)			
Observations	2460	2291	2757	1678	288
R^2			.022	.026	.244

Note: Robust standard errors clustered by company-id in parentheses. Controls for firm size (log of no. of employees), firm age (log), and dummies for competition, technology classes, priority year for the patent application, and country are included in all the regressions.

internal commercialization and spending more research time on internally commercialized serendipitous patents—as indications of family firms' agility to search and pursue emerging opportunities to exploit their patents internally more than non-family firms. This agility to harness internal commercialization opportunities is a capability that enables them to overcome the negative consequence of their idiosyncratic desire to maintain control over their technology.

B. Does inefficiency explain the lower propensity of licensing by family firms?

We proposed that the desire to control their technologies drives family firms' lower propensity to license. However, the same empirical pattern can emerge for other reasons. Therefore, we do not know whether more internal commercialization compensates for under-licensing. For example, a higher proportion of unused patents by family firms (neither licensed nor internally commercialized), with respect to non-family firms, may depend on fear of losing control or mere inefficiency in licensing inventions. Similarly, even if the proportion of unused patents is the same as non-family firms, the quality of unused patents by family firms can be higher than unused patents of non-family firms. If either or both are true, family firms' tendency to license less could mirror their inefficiency to utilize their patents in the market for technology, and therefore that they are inefficient in their overall patent exploitation.

To rule out this explanation we compare the difference in the proportion of unused patents by family and non-family firms. We run a regression where the dependent variable is a dummy that takes value 1 if the patent is unused and zero otherwise. The results are in Table 4, columns 1a and 1b. The coefficients of family firms are negative, but not significantly different from their non-family counterparts. Family firms' tendency not to license as much as non-family firms does not reduce the overall rate of commercial exploitation of their technologies.

Then, to see if unused patents of family and non-family firms are different in quality, we run a range of regressions with several dependent variables that proxy for patent quality: patent citations (log), patent family size, patent in the top 50% in the industry, and whether the patent is granted. Our main independent variable is the interaction term of unused patents and being a family firm. If the patent quality of unused patents of family firms is higher, we expect to observe a positive and significant coefficient of this interaction term in at least some or all the regressions in Table 4, columns 2–6. The results show the absence of a significant difference in the patent quality of unused patents of family and non-family firms—that is, we do not find any inefficiency of family firms in technology exploitation according to the proportion and quality of unused patents.

We also studied if lower patent licensing is related to family firms' disadvantage in matching markets. Some studies suggest that family firms are informationally opaque, and their resources are harder to value by transacting partners (Anderson et al., 2009; Chirico et al., 2011). If the lower licensing of family patents is caused by the information opaqueness of patents owned by family firms, we expect a decline in the difference between family and non-family firms' propensity to license among the sample of innovation with patent grants than those without grants. A patent grant is an important milestone in indicating the value of the invention as it is an approval by the third party regarding the novelty and industrial applicability of the invention (Farre-Mensa et al., 2020; Gans et al., 2008; Hsu & Ziedonis, 2013). We examined this claim by dividing our data into two subsamples of patent applications that are granted by the patent office and those that are not granted (rejected, under examination, or withdrawn). We show the results in Table 5 (column 1 is for a

TABLE 4 Family ownership and the quality of unused patents.

	Unused patents		Patent citation	Patent family	Patent in the top 50%	No. of patent claims (log)	Invention is patented
	(1a)	(1b)	(2)	(3)	(4)	(5)	(6)
Dependent variables	**Logit**	**Linear pro.**	**OLS**	**OLS**	**Logit**	**OLS**	**Logit**
Unused patent			−0.033 (0.028)	−0.538 (1.557)	−0.664 (0.214)	−0.040 (0.043)	−0.081 (0.204)
Family firm	−0.122 (0.150)	−0.018 (0.023)	0.018 (0.030)	0.265 (1.456)	0.099 (0.119)	0.023 (0.035)	0.249 (0.122)
			(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Unused patent #family firm			−0.032 (0.053)	−1.058 (2.087)	0.168 (0.286)	0.070 (0.061)	0.187 (0.306)
Complementary assets	−0.322 (0.155)	−0.052 (0.026)	0.021 (0.022)	−0.129 (0.758)	0.232 (0.124)	−0.015 (0.026)	0.179 (0.108)
Research time	0.051 (0.177)	0.008 (0.028)	0.009 (0.031)	2.240 (0.924)	0.171 (0.167)	0.136 (0.032)	−0.344 (0.152)
Patent family size	−0.005 (0.007)	−0.001 (0.001)	0.003 (0.001)		0.005 (0.004)	0.001 (0.001)	0.020 (0.005)
The patent in the top 50% in the industry	−0.631 (0.157)	−0.099 (0.027)	0.061 (0.024)	0.832 (0.676)		−0.003 (0.023)	−0.099 (0.127)
No. of patent claims (log)	−0.098 (0.155)	−0.014 (0.024)	0.100 (0.019)	1.085 (0.932)	−0.015 (0.106)		−0.315 (0.110)
Patent granted	−0.036 (0.156)	−0.004 (0.025)	−0.030 (0.021)	3.253 (0.841)	−0.090 (0.128)	−0.069 (0.024)	
Patent XY citation in the last 5 years (log)	−0.220 (0.133)	−0.033 (0.019)		2.902 (0.737)	0.328 (0.131)	0.110 (0.022)	−0.147 (0.106)
Constant	−1.586 (0.766)	0.210 (0.104)	−0.037 (0.155)	22.325 (5.647)	2.016 (0.646)	2.784 (0.142)	−0.028 (0.646)
Observations	2461	2461	2461	2461	2461	2461	2461
R^2		.070	.089	.243		.182	

Note: Robust standard errors clustered by company-id in parentheses. Controls for firm size (log of no. of employees), firm age (log), and dummies for competition, technology classes, priority year for patent application, and country are included in all the regressions.

subsample of innovations with patent grants and column 2 is for those without patent grants). We observe a negative relationship between family firms and licensing in the sample of granted patents and a slightly less pronounced negative effect in the sample of non-granted patents, with a relatively larger *p*-value. According to this finding, information opaqueness is unlikely to be the reason for less licensing by family firms.

The results in Tables 4 and 5 indicate that family firms are not less efficient in their overall commercial exploitation of their technologies both in quantity and quality, and their under-licensing is not related to inefficiency in technology markets.

C. Is there a pecking order in the quality of patents family firms license (commercialize)?

A related question is whether family firms are following a pecking order for internal and external commercialization of patents. If family firms pick high-quality inventions to commercialize internally, the lower quality of licensed patents—rather than their desire for control—may then explain the lower licensing outcome. To test this, we run a set of regressions in which the dependent variables are measures of patent quality and our main independent variables are the interaction terms of the type of patent use and being a family firm. We show the results in Table 6. In columns 1–5, our main explanatory variable is the interaction term of internal commercialization and family firm (Patent_commercialized within#family). In columns 6–10, our main explanatory variable is the interaction term of licensed patents and family firms (Patent licensed#family). Our main explanatory variables, that is,

TABLE 5 Licensing by family firms in the subsample of granted and non-granted patents.

Dependent variable	**Licensed patent**			
	Subsample of patent applications with patent grants		**Subsample of patent application without patent grants**	
	(1)	**(2)**	**(3)**	**(4)**
Models	**Logit**	**Linear prob.**	**Logit**	**Linear prob.**
Family firm	−0.507 (0.285)	−0.040 (0.020)	−0.305 (0.280)	−0.031 (0.025)
Complementary assets	−0.527 (0.385)	−0.045 (0.032)	0.132 (0.253)	0.006 (0.026)
Research time	0.278 (0.391)	0.022 (0.036)	0.472 (0.273)	0.050 (0.031)
Patent XY citation in the last 5 years (log)	0.266 (0.327)	0.029 (0.037)	−0.136 (0.211)	−0.010 (0.024)
Patent family size	0.034 (0.012)	0.003 (0.001)	0.006 (0.009)	0.000 (0.001)
The patent in the top 50% in the industry	0.527 (0.299)	0.041 (0.022)	0.533 (0.271)	0.046 (0.023)
No. of patent claims (log)	0.019 (0.377)	0.004 (0.031)	0.176 (0.214)	0.019 (0.021)
No. of employees (log)	0.030 (0.113)	0.003 (0.008)	−0.106 (0.064)	−0.011 (0.008)
Competition	−0.087 (0.360)	−0.006 (0.030)	0.696 (0.214)	0.075 (0.025)
Firm age (log)	−0.157 (0.129)	−0.012 (0.011)	−0.044 (0.121)	−0.004 (0.011)
Constant	−3.243 (1.864)	−0.105 (0.140)	−2.713 (1.013)	0.097 (0.118)
Observations	962	997	1429	1429
R^2		.096		.082

Note: Robust standard errors clustered by company-id in parentheses. Controls for technology classes, priority year for the patent application, and country dummies are included in all the regressions.

patent_commercialized within#family in columns 1–5 and patent licensed#family in columns 6–10, are not strongly related to any of the measures of patent quality. The quality of internally commercialized or licensed patents by family firms is not different from patents of non-family firms undergoing a similar use. Therefore, family firms are not making a tradeoff or setting a pecking order on the quality of inventions when they choose to commercialize more and license less.

The results and discussion in points B and C imply that family firms' lower licensing is neither related to choosing poor quality patents for the technology markets nor to inefficiency in commercially exploiting their technologies. It is likely to be related to the claim that under-licensing depends on family firms' desire to control their technologies.

D. Is lower patent licensing of family firms driven by their long-term orientation?

The literature argued that family firms value investments with long-term returns more than other firms (Anderson et al., 2012; Miller & Breton-Miller, 2005). This is partly due to family ties to the firm and their intention to pass it on to the next generation. Therefore, family firms' predisposition toward internal exploitation of their inventions could be the result of their long-term orientation. If this was the case, we would expect to see the internal exploitation of inventions by family firms to be stronger in countries with a culture of long-term orientation than in other countries. Based on existing literature, we measured countries' long-term orientation using two measures: The future-time reference of the language of the country and Hofstede's cultural measure of long-term orientation.

Future-time reference of the language of the country: The linguistic structure of future-time reference (FTR) refers to the idea that languages that require speakers to grammatically distinguish the timing of events affect intertemporal choices. A language that grammatically separates the future and the present generates the feeling of being more distant from the future and makes commitments with long-term outcomes more difficult—that is, languages with strong future time reference relate to short-term orientation. The literature used this measure to examine the commitment of corporations to CSR and individuals on health, saving, and other factors (see, e.g., Chen, 2013; Liang et al., 2018). We then measured FTR with a dummy variable equal to 1 if the official language of a country has a strong future time reference, and zero otherwise. We used the categorization of languages developed by Chen (2013) which covers all countries in our data for this analysis.

Cultural long-term orientation: This cultural dimension indicates the time orientation of societies. Countries with a long-term orientation encourage thrift and investments with long-term returns. The literature used this measure extensively to capture long-term orientation (e.g., Bearden, 2006; Nevins et al., 2007). We used the data from Hofstede's cultural measure of long-term orientation.[2] We created a dummy variable that takes value 1 if a country's long-term orientation is higher than the median score, and zero otherwise. We estimated our main regressions using licensing or internal commercialization as dependent variables on the independent variables, the direct effects and interaction of family ownership with long-term orientation (the inverse of Strong Future time reference), or with Hofstede's measure of long-term orientation, and all the controls. A strong future time reference is the opposite of long-term orientation, and the results should be interpreted as such. If long-term orientation is the underlying driver, we expect the interaction effect of family ownership and long-term orientation to be significant. We present the results in Table 7.

[2]https://geerthofstede.com/research-and-vsm/dimension-data-matrix/.

TABLE 6 A comparison of the quality of licensed and commercialized patents by ownership type.

	Patent citation	Patent family	Patent in the top 50%	No. of claims (log)	Invention is patented	Patent citation	Patent family	Patent in the top 50%	No. of claims (log)	Invention is patented
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dependent variables	**OLS**	**OLS**	**Logit**	**OLS**	**Logit**	**OLS**	**OLS**	**Logit**	**OLS**	**Logit**
Patent_commercialized within	0.009 (0.027)	−0.769 (1.150)	0.296 (0.149)	0.016 (0.042)	0.106 (0.175)					
Family firm	−0.007 (0.040)	−0.516 (1.606)	0.157 (0.206)	0.061 (0.052)	0.360 (0.238)	0.006 (0.029)	0.100 (1.346)	0.171 (0.114)	0.047 (0.033)	0.318 (0.128)
Patent_commercialized within#family	0.025 (0.047)	0.789 (1.668)	−0.053 (0.232)	−0.027 (0.061)	−0.095 (0.253)					
Complementary Assets	0.023 (0.023)	−0.217 (0.790)	0.261 (0.122)	−0.019 (0.026)	0.167 (0.106)	0.019 (0.024)	−0.425 (0.746)	0.245 (0.128)	−0.017 (0.028)	0.181 (0.114)
Research Time	0.005 (0.031)	2.336 (0.904)	0.188 (0.161)	0.140 (0.032)	−0.332 (0.151)	0.010 (0.033)	2.059 (0.957)	0.175 (0.161)	0.135 (0.032)	−0.280 (0.149)
Patent family size	0.003 (0.001)		0.006 (0.004)	0.001 (0.001)	0.021 (0.005)	0.004 (0.001)		0.006 (0.004)	0.001 (0.001)	0.020 (0.006)
The patent in the top 50% in the industry	0.062 (0.025)	0.918 (0.640)		−0.000 (0.024)	−0.142 (0.132)	0.065 (0.025)	0.995 (0.680)		−0.008 (0.023)	−0.088 (0.132)
No. of patent claims (log)	0.102 (0.019)	1.068 (0.992)	−0.003 (0.109)		−0.313 (0.112)	0.106 (0.020)	0.817 (0.821)	−0.033 (0.105)		−0.279 (0.110)
patent granted	−0.034 (0.020)	3.355 (0.895)	−0.132 (0.133)	−0.069 (0.025)		−0.024 (0.024)	3.208 (0.903)	−0.076 (0.133)	−0.062 (0.024)	
Patent XY citation in the last 5 years (log)		2.631 (0.748)	0.331 (0.134)	0.111 (0.022)	−0.166 (0.103)		2.935 (0.681)	0.345 (0.134)	0.117 (0.023)	−0.119 (0.117)
Patent licensed						0.005 (0.058)	2.295 (1.389)	0.568 (0.235)	0.065 (0.055)	−0.096 (0.211)
Patent licensed#family firm						0.027 (0.081)	0.408 (1.817)	0.043 (0.412)	−0.097 (0.075)	−0.255 (0.362)
Constant	−0.042 (0.159)	23.071 (6.145)	1.795 (0.642)	2.776 (0.140)	−0.114 (0.618)	−0.048 (0.163)	21.782 (5.512)	2.017 (0.643)	2.809 (0.141)	−0.310 (0.654)
Observations	2523	2523	2523	2523	2523	2426	2426	2426	2426	2426
R^2	.085	.242		.192		.091	.246		.184	

Note: Robust standard errors clustered by company id in parentheses. Controls for firm size (log of no. of employees) firm age (log), and dummies for competition, technology classes, priority year for patent application, and country are included in all the regressions.

TABLE 7 The role of long-term orientation of internal and external commercialization of patents by family firms.

	Licensed		Commercialized_within		Licensed		Commercialize_within	
Dependent variables	**(1a)**	**(1b)**	**(2a)**	**(2b)**	**(3a)**	**(3b)**	**(4a)**	**(4b)**
Model	**Logit**	**Linear_prob**	**Logit**	**Linear_prob**	**Logit**	**Linear_prob**	**Logit**	**Linear_prob**
Family firm	−0.191 (0.264)	−0.019 (0.027)	0.322 (0.190)	0.074 (0.043)	−0.512 (0.234)	−0.045 (0.019)	0.296 (0.148)	0.059 (0.029)
Familyfirm#Longterm_orientation	−0.447 (0.363)	−0.029 (0.034)	−0.026 (0.261)	−0.017 (0.055)				
LongTerm_orientation	−0.077 (0.244)	−0.007 (0.026)	0.521 (0.191)	0.115 (0.043)				
Complementary assets	−0.156 (0.187)	−0.017 (0.019)	0.335 (0.127)	0.072 (0.028)	−0.163 (0.187)	−0.018 (0.019)	0.334 (0.129)	0.072 (0.028)
Research Time	0.315 (0.199)	0.033 (0.022)	−0.206 (0.148)	−0.044 (0.033)	0.319 (0.202)	0.035 (0.022)	−0.188 (0.147)	−0.040 (0.032)
Patent XY citation in the last 5 years (log)	0.035 (0.196)	0.007 (0.021)	0.091 (0.114)	0.019 (0.024)	0.015 (0.201)	0.005 (0.021)	0.082 (0.113)	0.018 (0.024)
Patent family size	0.016 (0.007)	0.001 (0.001)	−0.002 (0.005)	−0.000 (0.001)	0.017 (0.007)	0.001 (0.001)	−0.004 (0.005)	−0.001 (0.001)
The patent in the top 50% in the industry	0.521 (0.197)	0.045 (0.016)	0.263 (0.114)	0.056 (0.025)	0.531 (0.194)	0.046 (0.016)	0.283 (0.116)	0.060 (0.025)
No. of patent claims (log)	0.172 (0.192)	0.018 (0.019)	0.041 (0.149)	0.008 (0.032)	0.195 (0.197)	0.021 (0.019)	0.038 (0.148)	0.008 (0.032)
Competition	0.328 (0.182)	0.033 (0.020)	−0.094 (0.131)	−0.021 (0.029)	0.370 (0.181)	0.038 (0.020)	−0.092 (0.131)	−0.020 (0.029)
Patent granted	−0.124 (0.184)	−0.013 (0.016)	0.059 (0.138)	0.011 (0.029)	−0.125 (0.182)	−0.013 (0.016)	0.078 (0.136)	0.016 (0.029)
Familyfirm#Future_Time_Reference					0.314 (0.356)	0.030 (0.034)	0.082 (0.260)	0.029 (0.059)
Language FutureTime_Reference					−0.137 (0.261)	−0.020 (0.028)	−0.506 (0.198)	−0.114 (0.046)
Constant	−2.868 (0.789)	0.068 (0.081)	0.549 (0.581)	0.623 (0.122)	−2.915 (0.779)	0.067 (0.080)	0.833 (0.578)	0.689 (0.121)
Observations	2413	2413	2510	2510	2413	2413	2510	2510
R^2		.054		.051		.054		.049

Note: Robust standard errors clustered by company-id in parentheses. Controls for firm size (log of no. of employees), firm age (log), and dummies for competition, technology classes, and priority year for patent application are included in all the regressions.

First, the main effect of long-term orientation in both measures (Language Future Time_Reference and Hofstede's Long-term orientation) contributes to an increase in the internal exploitation of patents but does not have any effect on licensing. This validates the measurement of the key construct, long-term orientation. The interaction effect of long-term orientation and family ownership does not significantly determine the choice of patent exploitation. Moreover, the main effect of family ownership on both licensing and internal commercialization remains significant after the inclusion of the interaction effects except in columns 1a and 1b for licensing. Even in this case, the joint effect of (family ownership) + (family ownership long-term orientation) remains significant. This set of results indicates that family firms' tendency to license less and internally commercialize their patents more than their non-family firms is unlikely to be driven by their long-term orientation.

E. Other additional analysis:

We also tested two alternative explanations for internal commercialization. The first alternative explanation is related to family firms' propensity to limit their debt which may affect their liquidity and likelihood of internal commercialization. We checked this by including the debt-to-equity ratio in our main model. Please see the result in Table S3a in the Appendix. We observe that the debt-to-equity ratio increases internal commercialization, but it does not have any effect on licensing. More importantly, the hypothesized relationships remain significant with the inclusion of this control. The second alternative explanation relates to the propensity of family firms to generate exploitative inventions and patents that can be easily commercialized internally. To test this, we created a variable, exploratory patent, that captures the technological distance of the focal patent to the patent stock of the firm. Details of this measure and results are in S4 and Table S4a in the Appendix. After controlling for this variable, we still observe the effect of family ownership on licensing and internal commercialization. Finally, as we explained in the data section, our analyses are based on patents of publicly listed companies, which may introduce some baise to our results. We addressed this concern by testing our hypotheses while controlling for sample selection and found results qualitatively similar to those presented in the original model. For further details, please refer to section S5 & Table S5a in the Appendix. Overall, our results and the mechanisms we proposed are robust to several tests for alternative explanations.

5 | CONTRIBUTIONS AND CONCLUSION

This study examined whether family firms forgo economic values to nurture non-economic values or shun some strategies and pursue others without making tradeoffs. To answer this question, we chose a setting in which we can examine all the strategic options for exploiting intellectual properties (licensing, internal commercialization, and non-use) by family versus non-family firms. Results suggest that family firms prioritize strategies that protect their non-economic values (maintaining control) and shun others (licensing) that threaten these values. Because they leverage their discretion to explore alternative ways of using their strategic resources, their interest to maintain control does not seem to impose trade-offs on their economic returns. Our contribution to the literature is bringing a third dimension to the conversation. Using this finding in the context of technology commercialization, we highlight the

relevance of testing the validity of assumptions related to trade-offs that family firms bear to balance economic and non-economic values. Besides, our findings prompt us to study mechanisms that could lead to over or underperformance, or performance parity, between family and non-family firms. We draw four implications from these findings.

Our first contribution is to the patent and innovation literature. Governance has not received much traction in the innovation literature as much as it has in other strategy literatures such as internationalization, M&A, divestiture, or political influence (Berrone & Gomez-Mejia, 2009; Birhanu & Wezel, 2022; Feldman et al., 2016). Our finding contributes to this literature by introducing a new antecedent that determines the internal versus external commercial exploitation of intellectual properties by showing that the commercial exploitation strategy of inventions is not only driven by economic considerations (Arora & Ceccagnoli, 2006; Fosfuri, 2006; Teece, 2006) but also it is influenced by idiosyncratic preference toward ensuring control over intellectual properties. Family ownership shapes whether patents are exploited within or outside the boundary of the firm.

Second, we shed light on how the idiosyncratic choice of family firms to internally exploit their patents affects the development of technology markets (Arora et al., 2004). The development of a technology market enhances the private and public benefits of innovation by giving access to other technologies, creating the opportunity to trade intellectual properties, and opening the possibility of recombining knowledge and enhance rate and quality of innovation (Arora & Gambardella, 2010; Chatterji & Fabrizio, 2016). The reluctance of family firms to transact their technology affects the development of the market for technology by reducing the number of patents available for trading. This might limit specialization in upstream innovation and downstream commercialization, especially in countries where family firms account for a significant share of firms in an economy.

Third, under the umbrella of behavioral agency theory, the family business literature has provided a lot of new insights on how strategic decisions, along with a broad range of business activities, drive non-economic benefits, and indicate the trade-offs that this may impose on economic gains and the growth of firms (Berrone et al., 2012; Gomez-Mejía et al., 2007). In the context of technology commercialization, we show that family firms' interest to preserve non-economic values does not lead to sub-optimal economic outcomes at the firm level. The mechanism by which they circumvent sub-optimal economic outcomes is engendering their unrestrained decision-making power to explore and seize different routes of resource exploitation.

Fourth, family firms' preference to maintain control over their firms for financial and non-financial reasons limits the growth of family firms by limiting their internationalization, the decision to go public, and the undertaking of mergers and acquisitions (Arregle et al., 2017; Caprio et al., 2011; Villalonga & Amit, 2020). Our study shows that for the same number of patents, family firms are more likely to scale up than non-family firms because they have a strong preference to exploit their patents internally. This gives some insight into how the same behavioral tendency that deters external growth of family firms through internationalization, and M&A, could lead instead to the growth of family firms internally.

ACKNOWLEDGMENTS

We are grateful to Editor Sendil Ethiraj and two anonymous reviewers for their feedback and suggestions during the review process. We thank Mario Daniele Amore, Bocconi University, for reading the earlier version of the manuscript and offering us helpful comments, and Marco Corsino, University of Bologna, for his comments on the empirical analysis and construction of some key variables. We also thank the participants at the 2021 Strategic Management Society,

seminar participants at STORM research center, emlyon Business School, and David Eccles School of Business for their valuable inputs. Finally, we acknowledge the European Commission [Contract FP7-SSH-2007-1-grant agreement No. 217299] and the Italian Ministry of Education, University and Research [Project#2010H37KAW and CUP B41J12000160008] for supporting the creation of the patent dataset. All errors are ours.

DATA AVAILABILITY STATEMENT

Data available on request due to privacy/ethical restrictions.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Birhanu, A. G., & Gambardella, A. (2023). To commercialize inside or outside of the firm: Behavioral considerations in patent exploitation by family firms. *Strategic Management Journal*, 1–27. https://doi.org/10.1002/smj.3570