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Open innovation in family-owned firms

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Abstract

This paper investigates the impact of family ownership on firms' adoption of open innovation strategies. Using data from the VIII UniCredit survey on medium-sized enterprises, we find that family ownership is positively and significantly associated with the adoption of open innovation models by firms. The propensity to engage in open innovation by family firms is particularly pronounced in firms involved in product innovation and in collaborations with suppliers. The paper also delves into the inherent characteristics of family owners, emphasizing that the positive association between family ownership and open innovation is largely driven by their long-term perspective and relational abilities.

Keywords: open innovation; family firms; product innovation; process innovation; relational capital.
JEL codes: O36; G32; D22.

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1 Introduction

Family firms are central in the economic landscape, significantly influencing both the number and distribution of businesses and contributing substantially to gross domestic product and employment. Their relevance is particularly pronounced in Italy, where over 85% of all businesses are family-owned, highlighting the critical role they play in the country's economy (The Economist, 2015; Murro and Peruzzi, 2019; AIDAF, 2022). In light of this considerable contribution, the relationship between family ownership and firms' orientation towards innovation has garnered considerable attention from researchers (Munari et al., 2010; Minetti et al., 2015a; Cucculelli and Peruzzi, 2020). Technological innovation is universally recognized as a pivotal driver of firm performance and productivity, fostering market penetration, and sustaining market leadership (Tellis et al., 2009; OECD, 2010). Over recent decades, the paradigm of innovation has undergone a profound change. The conventional model, which emphasized conducting core R&D activities exclusively within the boundaries of the firm, has increasingly been seen as less crucial. Contemporary innovation frameworks propose a more inclusive approach, advocating for firms to expand beyond their internal boundaries and leverage external sources of knowledge (Chesbrough, 2003; Berchicci, 2013).

In this evolving landscape, the aim of this paper is to investigate whether, and under what conditions, family-owned firms are more inclined to adopt open innovation strategies over traditional closed innovation models, when compared to non-family-owned businesses. Theoretically, the impact of family ownership on firms' adoption of open innovation is a priori ambiguous. On the one hand, family firms may adopt a cautious approach to open innovation, driven by a desire to control and preserve traditional values. Their preference for maintaining the status quo and minimizing external influence might result in reluctance to engage with external partners for innovation. On the other hand, the pronounced risk aversion characteristic of family owners, combined with the long-term perspective inherent in family businesses, may render them more receptive to the sustainable benefits of open innovation. Such firms might perceive open innovation as a strategic avenue to access new ideas, resources, and markets while distributing costs and risks. Additionally, the relational dynamics and trust-based culture prevalent in family businesses can lead to stronger, more effective collaborations with external partners in open innovation projects. In fact, the ability of family owners in building relationships could be instrumental in reducing the transaction costs typically associated with open innovation initiatives.

To explore the relationship between family ownership and the adoption of open innovation strategies by firms, we use data from the VIII UniCredit survey on medium-sized enterprises, conducted by the Italian banking group UniCredit in 2011 on a sample of 1,408 Italian firms. The unique advantage of this dataset is the provision of detailed measures of innovation activities based on firms' responses to the survey. This feature of the dataset is particularly

invaluable in the context of open innovation, as it enables the delineation of specific traits of these strategies, including the nature of the innovations introduced, the types of collaborative partners involved, and their geographic locations. Additionally, the survey offers a wealth of information on a broad range of firm characteristics, which are widely recognized as key factors influencing the propensity to engage in open innovation initiatives.

The estimation results reveal a positive and significant association between family ownership and firms' adoption of open innovation strategies. After addressing concerns of endogeneity, we find that family-owned businesses are 10% more inclined to engage in collaborative innovation rather than adhere to closed innovation models, compared to firms with different ownership structures. In addition, our analysis highlights that the interplay between family ownership and firms' adoption of open innovation strategies varies with specific characteristics of the innovation introduced and the choice of collaboration partners. In particular, firms involved in product innovation exhibit a greater probability to adopt open innovation strategies if they are family-owned. Conversely, family ownership does not significantly influence the inclination towards open innovation in the case of process innovators. Remarkably, family owned firms are found to be 9.3% more likely to collaborate for innovation with suppliers compared to their non-family-owned counterparts. The study then delves into the underlying mechanisms that shape the influence of family ownership on open innovation adoption by firms, particularly focusing on the role played by family firms' long-termism, relational abilities, and conservatism. Consistently with the theory, our results reveal that the positive relationship between family ownership and open innovation engagement by firms is driven by the long-term perspective and relational abilities inherent in family owners.

This paper contributes to two main strands of the existing literature. First, it extends the research on family ownership and technological innovation, aligning with the works of Munari et al. (2010), Minetti et al. (2015), and Cucculelli and Peruzzi (2020), who explore the effects of ownership structures on firms' technological innovation in various contexts. Building on these studies, our research delves into the contemporary paradigm of innovation, that is the open innovation model, and investigates the unique influence of family ownership in embracing this approach. The existing literature on the adoption of open innovation stratgies by family-owned firms, to be discussed in Section 3.2, remains relatively limited, primarily relying on case study analyses (see, e.g., Casprini et al., 2017; Magistretti et al., 2019; Munoz-Bullon et al., 2020). This paper seeks to fill this gap in the literature, providing a more comprehensive understanding of the phenomenon. To this end, we investigate the association between family ownership and open innovation, exploring various innovation types (both product and process) and assessing the impact of different open innovation partners. In addition, this study delves into the mechanisms influencing family firms' engagement in open innovation, specifically focusing on the role played by family firms' long-termism, relational abilities, and conservatism. Second, this paper contributes to the broader literature on the

determinants of open innovation adoption by firms (Cassiman and Veugelers, 2002; Fritsch and Lukas, 2001; Brockman et al., 2018; Wyrwich et al., 2023). By considering the factors previously identified as affecting firms' engagement in open innovation strategies, our study unveils the significant role that firm ownership structure, particularly family ownership, plays in this context.

The paper is organized as follows. Section 2 presents the institutional background, setting the context for our study. Section 3 reviews the existing literature on open innovation and the impact of family ownership, offering a theoretical foundation for our research. Section 4 details the dataset and outlines the empirical strategy employed in our analysis. Section 5 discusses the main findings, providing preliminary insights into the channels of influence. Section 6 delves deeper into the mechanisms that drive the relationship between family ownership and firms' adoption of open innovation strategies. Section 7 concludes.

2 Institutional background

Italy offers an ideal setting for investigating the relationship between family ownership and the adoption of open innovation strategies. Family firms play a crucial role in the Italian economy, both in terms of their numerical impact and their contribution to GDP and employment. In particular, Italy has approximately 784,000 family businesses, which represent more than 85% of all enterprises and around 70% of total employment. This percentage is similar to that of other major European economies, such as France (80%), Germany (90%), and Spain (83%). However, what sets the Italian context apart is that family firms are less reliant on external managers: 66% of Italian family businesses are managed by family members, compared to 26% in France and only 10% in the United Kingdom (AIDAF, 2022).

Regarding the innovativeness of Italian firms, Italy is characterized by a relatively low R&D intensity. In 2010, R&D spending of Italian enterprises relative to GDP was 1.2%, compared to 2.3% in OECD countries and 1.9% in the European Union (World Bank, 2010). According to the EU Community Innovation Survey (CIS), 51.9% of Italian firms with at least ten employees undertook innovation activities in 2010-2012, with 35.5% of all businesses focusing on product and process innovations (ISTAT, 2014). Large enterprises were the most active, with 69.2% undertaking innovation activities, followed by medium and small enterprises (54.8% and 32.7%, respectively). The data also reveal that few innovators chose to collaborate with other enterprises or institutions, with suppliers being the primary cooperation partners (12.5% of all product and process innovators).

3 Related literature and hypotheses framing

3.1 Open innovation

Open innovation has been described as a collaborative approach to innovation that involves the integration of external knowledge and expertise into a firm's innovative processes (Chesbrough, 2003; 2006; Brockman et al., 2018). This concept has gained significant attention in recent years, as its managerial implications have become more evident. As a result, scholarly interest in open innovation has increased considerably, with researchers seeking to understand the reasons for the shift from closed to open innovation models.

A useful theory for explaining the benefits of open innovation is the resource-based view (Grant, 1996; Audretsch and Belitski, 2023). According to this theory, innovation collaboration is a way to access resources and reduce monetary risks associated with innovation activities in uncertain technological environments. In particular, open innovation allows firms to maximize value through the combination of partners' resources that may not be available within the firm and the exploitation of complementarities. These resources can include physical technological infrastructures, technological knowledge, and fundraising channels (Kobarg et al., 2019; Stadler et al., 2022). Additionally, from an organizational learning perspective, innovation collaboration allows firms to exchange experiences and competencies and to acquire skills associated with the innovation process and organization (Argote and Miron-Spektor, 2011). Open innovation strategies are also linked to the management of supply chains (Obradovic et al., 2021; Zhang et al., 2023). Collaborating with suppliers and customers is found to be crucial for business success, as customers can provide complementary knowledge, help strike the right balance between performance and price, offer insights into customers' behavior, and increase the likelihood that the innovation will be accepted and adopted by other firms within the same customer community. Moreover, innovation collaborations with suppliers can lead to downsizing, which reduces operational costs, improves efficiency, and enhances firms' competitive position.

Although open innovation provides firms with the opportunity to collaborate and integrate external knowledge into their innovation processes, there are potential costs associated with this approach (Murro and Peruzzi, 2022a). The transaction cost economics perspective highlights the substantial transaction costs associated with integrating external knowledge, such as the investment of time and money in searching and selecting suitable innovation partners, as well as the coordination, management, and control of their activities. Furthermore, firms that shift from internal to open innovation models must undergo a significant reorganization, which results in additional costs. In addition to transaction costs, innovation collaboration also involves opportunity costs, as firms must weigh the benefits and risks of openness to external partners. While collaborating with external partners can increase the knowledge base and access complementary resources, firms may also face the risk of reduced appropri-

ability of the innovation's returns and the potential disclosure of relevant information about the innovation project. This risk may be compounded by the possibility of critical knowledge leakage about the firm's innovation efforts to its competitors. Therefore, firms must carefully consider the costs and benefits of open innovation before engaging in collaborative activities.

Empirically, some studies have investigated the factors influencing firms' decisions to engage in open innovation. Cassiman and Veugelers (2002), for a sample of Belgian manufacturing firms, find a significant impact of external information flows on firms' decision to cooperate for innovation. Fritsch and Lukas (2001) reveal a positive association between firm size and open innovation strategies. Negassi (2004) confirms that innovation collaboration increases with firm size and R&D intensity, but not with market shares. De Faria et al. (2010), using data from the Portuguese Community Innovation Survey, show that firms from high-tech industries are more likely to cooperate for innovation. Brockman et al. (2018), by analyzing co-owned patents across 21 countries, find evidence that higher levels of societal trust are associated with greater open innovation. The significant role of trust is also confirmed by Wyrwich et al. (2023) who suggest that founders are less likely to engage in open innovation if their experiences engender a generalized lack of trust.

This paper aims to contribute to this body of literature by examining the impact of family ownership on the decision to invest in open innovation strategies. Below, we present the current evidence on the relationship between family ownership and technological innovation, as well as the hypothesis to be tested empirically.

3.2 Family firms and technological innovation

Investments in innovation differ substantially from those in tangible assets across multiple dimensions (Minetti et al., 2015a). First, innovations involve high levels of information asymmetry, as they are difficult to understand for third parties and few interim signals, such as cash flows, are available on their final outcome (Rajan and Zingales, 2001). Second, innovations require expertise and technological knowledge, are long-term oriented and characterized by high risk and uncertain results (Hall, 2005; Schivardi and Schneider, 2008). Third, innovations are risky also because they have low salvage value, as the assets are often intangible or specific to the firm (Cucculelli and Peruzzi, 2020). All these traits make innovation investments heavily dependent on the specific incentives and characteristics of the firms' owners, especially in the case of family-owned businesses.

From a theoretical point of view, the impact of family owners on innovation activities is ambiguous. On the one hand, families have a long-term investment horizon as they maintain permanent ties with the companies and aim to transfer their ownership down the generations (Sraer and Thesmar, 2007; Caselli and Gennaioli, 2013). Moreover, they usually benefit from patient capital, i.e., financial capital that is invested for long periods without the threat

of liquidation (Sirmon and Hitt, 2003). This leads family owners to have higher incentives to ensure that the company invests in technological innovation. On the other hand, family ownership can expose firms to other problems and agency costs that may negatively influence investment decisions, especially those concerning innovation (Morck and Yeung, 2003; Munari et al., 2010). A major issue that can characterize family-owned firms is related to risk aversion, since families typically invest a significant amount of their own wealth in the company. To protect the existing business's cash flows, family owned firms may be unwilling to invest in innovation and to engage in "creative destruction". In addition, family owned businesses are often conservative and favor investment decisions that reinforce the status quo (Minetti et al., 2015a). Related to this, distorsions can also arise due to family owners' fear of losing control over their business. Their preference to transmit managerial positions to inefficient descendants, rather than considering the recruitment of highly skilled professional managers, can result in a shortage of the essential expertise required for investing in technological innovation (Bertrand and Schoar, 2006; Bertrand et al., 2008).

Also from an empirical standpoint, the relationship between family ownership and technological innovation remains unclear. Chen and Hsu (2009), for a sample of Taiwanese firms, reveal a negative correlation between family ownership and R&D investment. This finding is confirmed by Munari et al. (2010), who report that increased family shareholding is inversely related to R&D expenditure. Similar conclusions are drawn by Muñoz-Bullón and Sanchez-Bueno (2011) for a sample of Canadian listed corporations, and by Anderson et al. (2012). The latter demonstrate that family firms devote less capital to long-term investments compared to firms with more dispersed ownership structures. In addition, when breaking down long-term investments into R&D and capital expenditure, family firms display a preference for investing in physical assets over the riskier R&D projects. Block (2012) presents diversified findings in his analysis of R&D spending within U.S. family and founder-owned firms. His study suggests that while family ownership tends to reduce R&D intensity, ownership by individual founders generally exerts a positive influence. For a sample of Taiwanese firms, Chi (2023) provides evidence that controlling ownership by family group negatively impacts innovation, suggesting that agency costs, primarily due to excess control rights, outweigh the benefits of social capital associated with family groups. Other studies have revealed a favorable impact of family ownership on R&D investments and innovation. For instance, Schmid et al. (2014), utilizing a biannual survey of listed German firms, observe that R&D intensity is higher in family-managed firms, with the influence of family control through voting rights being negative but mostly insignificant. Similarly, Minetti et al. (2015a), for a sample of small and medium-sized Italian manufacturing firms, show that firms owned by families are significantly more inclined to introduce both product and process innovations. Soluk et al. (2021), for a sample of German firms, highlights that family influence positively affects digital business model innovation. Cucculelli and Peruzzi (2020) further extend these findings by

showing that, particularly during the maturity phase of the industry life-cycle, family firms are more inclined to adopt riskier product innovations, suggesting a strategic shift in their approach to innovation in response to evolving industry dynamics.

Regarding the impact of family ownership on open innovation initiatives, the current literature is somewhat limited and primarily based on case study analysis. For instance, Casprini et al. (2017), explore how family firms manage internal and external knowledge flows through a detailed case study of an Italian family firm. Their research shows that the unique capabilities of a family firm can effectively address critical barriers in acquiring and transferring knowledge within the framework of open innovation strategies. Similarly, Magistretti et al. (2019) analyze two design-intensive firms and provide evidence on how family involvement in control and management shapes collaboration with external designers in the process of product innovation. Munoz-Bullon et al. (2020) investigate the effect of combining internal and external R&D activities on the innovation performance of a large sample of Spanish firms, spanning from 1990 to 2016. Their findings reveal that family-owned businesses can better exploit the benefits of engaging in both internal and external R&D simultaneously, which results in a notable enhancement of their innovation performance. More closely aligned with our paper, Belitski and Rejeb (2022) explore the propensity of family firms to employ the open customer innovation model and the comparative advantages of collaboration with customers for both family and non-family firms. Their study, based on the use of longitudinal data from UK firms between 2002 and 2014, reveals that while both family and non-family firms engage in open innovation with customers, family firms derive greater benefits from such collaborations, particularly in domestic markets. Guenther et al. (2023) extend this analysis to include spatial proximity as a key factor influencing family firms' decision to collaborate with customers. They find that smaller family firms are more inclined to collaborate with geographically proximate customers, thereby achieving a greater innovation premium compared to non-family firms.

This paper seeks to add to this strand of literature by investigating whether, and under what conditions, family-owned firms are more inclined to adopt open innovation strategies compared to non-family-owned businesses. Specifically, we aim to build upon previous research by exploring various types of innovation (both product and process) and considering a range of open innovation partners. In addition, this study examines the mechanisms driving the impact of family ownership on open innovation adoption by firms, focusing on the role played by family firms' long-termism, relational abilities, and conservatism.

3.3 Testable hypotheses

Based on the theories and empirical evidence presented above, we expect an ambiguous effect of family ownership on the adoption of open innovation strategies by firms. On the one hand,

family firms, often characterized by a strong sense of tradition and continuity, might exhibit a cautious approach towards open innovation due to concerns about control and preserving family legacy (Bertrand and Schoar, 2006; Minetti et al., 2015a). Their preference for maintaining the status quo and minimizing external influence could lead to a reluctance in engaging in innovation with external partners. On the other hand, the heightened risk aversion typical of family owners, usually leading to less innovation, may encourage these firms to pursue open innovative activities as it allows sharing of risks and costs with other parties. Similarly, the long-term perspective inherent in family businesses might make them more receptive to the sustainable benefits of open innovation (Sraer and Thesmar, 2007; Bennedsen et al., 2015). Acknowledging the necessity to remain competitive and adaptive in a fast-changing business environment, family firms might view open innovation as a strategic avenue to access new ideas, resources, technologies, and markets. This approach could be particularly pertinent for those seeking to maintain their core values while embracing continuous innovation. Moreover, the relational dynamics and trust-based culture common in family businesses could foster stronger, more effective collaborations with external partners in open innovation projects (Bunkanwanicha et al., 2013; Luo et al., 2014). More specifically, the ability of family owners in building relationships could be instrumental in reducing the transaction costs associated with open innovation initiatives.[1]

Consistently with these arguments, we propose the following hypothesis to be tested empirically:

Hypothesis: The influence of family ownership on the adoption of open innovation strategies by firms is a priori ambiguous. Family firms' preference for preserving tradition and control may hinder the engagement with external partners in open innovation. However, their risk aversion and long-term orientation, combined with a culture of strong relational dynamics, could conversely motivate these firms to adopt open innovation practices as a strategic means to mitigate risks, access new resources, and sustain competitiveness.

4 Data and method

4.1 Data sources

To perform our empirical investigation, we draw information from the VIII UniCredit survey on medium-sized enterprises, carried out by the Italian banking group UniCredit in 2011.[2]

[1] Numerous studies have shown that family businesses invest substantial resources in nurturing interpersonal relationships and building networks of business contacts, which are found to influence firm survival and performance (Sirmon and Hitt, 2003; Salvato and Melin, 2008; Zahra, 2010; Bennedsen et al., 2015; Cucculelli et al., 2019).

[2] The survey was conducted by a major Italian institute of statistics (Doxa, the Italian branch of the Gallup International association) on behalf of UniCredit. The respondents were given comprehensive instructions on

The survey gathers data on a sample of 1,408 Italian firms that are UniCredit customers, and it provides information for the year 2010. The firms were selected using a stratified sampling method in order to ensure the representativeness of the sample at the industry and province levels. The survey provides detailed information on various aspects, such as (a) firms' ownership and governance structure; (b) investments in product and process innovation; (c) firms' financial structure and relationships with the banking system; (d) extent of internationalization and export; (e) organizational structure and number of employees. To all the surveyed firms, we also attached balance-sheet information provided by the Centrale dei Bilanci database. The distinctiveness of our dataset lies in the provision of innovation activity measures that are based on firms' survey responses, rather than indirectly inferred from balance-sheet statements. This approach is particularly useful in the context of open innovation, enabling us to capture specific traits of these strategies, such as the types of open innovation partners and their geographic locations. Despite these positive elements, the use of self-reported data from firms may raise concerns about the accuracy of reported innovation propensity. In our context, several factors mitigate this risk. First, Italian privacy legislation (Law 675/1996) prohibits the use of personal data for purposes other than those specified in the survey. Interviewers clearly communicated to respondent firms that their information would be used only for compiling statistical analyses and understanding business perspectives, reducing the likelihood of firms misreporting information to enhance their market reputation. Additionally, considerable effort was made to ensure that survey questions were clear and easily understandable, thereby minimizing potential measurement errors. It's also important to note that any pure measurement error in the dependent variable would likely not bias our results unless it was systematically related to one or more of the explanatory variables.

Table 1 provides a detailed description of all the variables employed in the empirical analysis. Table 2 presents summary statistics for all firms, by firm ownership and open innovation strategies. On average, the surveyed firms have been in business for 31 years and have slightly over 62 employees. The majority of firms are located in the North of Italy (71.95%), while 16.48% operate in the Center, and 11.58% in the South of the country.

4.2 Measurement

Open innovation The comprehensive information provided by the UniCredit survey allows us to directly measure open innovation strategies. To construct our primary dependent variable, we rely on a specific survey question that asks: "*Who is the main partner with whom the firm has cooperation agreements on technological innovation activities? (i) research centers/universities; (ii) customers or clients; (iii) suppliers; (iv) firms belonging to the same business group; (v) competitors; (vi) trade associations; (vii) the firm has no cooperation*

how to interpret the questionnaire, and particular attention was devoted to ensure that the questions were intelligible and that measurement errors were minimized.

agreements on technological innovation activities". Similar to Tether (2002), we classify firms that answered (i)-(vi) as adopting open innovation strategies. Since the question on cooperation agreements was only directed to firms that introduced a product or process innovation within the previous three years, our analysis only includes innovative firms. As reported in Table 1, 61.07% of the firms identified as innovative businesses claimed to adopt an open innovation strategy by collaborating on technological innovation activities with external partners. Suppliers and customers are the most commonly engaged cooperation partners, representing 20.36% and 17.83% of innovating firms, respectively. However, significant proportions of companies also collaborate with research centers and universities (10.67%) and firms belonging to the same business group (6.92%).[3] Figures 1(a) and 1(b) draw the distribution of firms engaged in innovation agreements and family-owned businesses across Italian provinces. The figures indicate that firms relying on open innovation strategies are not clustered in a few provinces but are rather homogeneously distributed in the Italian territory.

Family firms In order to identify family-owned firms, we rely on the following question from the UniCredit survey: "*Is your firm controlled by an individual or a family-owned entity?*". Consistent with the considerable presence of family businesses in Italy, in our sample 63.35% of firms are family-owned, as reported in Table 1. The data also provide insights on the alignment between ownership and management. Specifically, the UniCredit survey asks firms about the CEO's familial relationship with the company's owners: "*Is the CEO of your firm external to the family that owns it?*". In our sample, 44.13% of firms have family CEOs, indicating that among family-owned firms, 70.99% are also family run.[4]

Control variables To correctly estimate the impact of family ownership on the adoption of open innovation strategies and mitigate the omitted variables bias associated with the cross-sectional structure of our dataset, we control for a broad set of potential confounding effects. Consistent with the literature on open innovation, we control for firm age (*Age*, expressed in logarithm) and size (*Size*, measured by the number of employees, also expressed in logarithm). On the one hand, there is evidence showing that large firms may be more inclined to engage in collaborative innovation as they possess greater absorptive capacity, which allows them to better identify, absorb and utilize external knowledge in an open innovation regime (Dahlander and Gann, 2010). On the other hand, there are studies indicating that younger and smaller firms may experience more significant resource constraints. As suggested by the resource-based view of open innovation, this may lead to a greater demand for open innovation and a faster adjustment speed in the decision-making process (Chesbrough, 2010; Brockman

[3] See Table A1.

[4] We will exploit the information about family CEOs in Section 6 when discussing the mechanisms influencing the relationship between family ownership and open innovation adoption.

et al., 2018). To capture this phenomenon, we add two other measures of firms' internal knowledge: the proportion of graduate employees (*Graduates*) and the amount of intangible assets (*Intangibles*). Firms with few graduates and investments in intangibles may lack the human and technological resources required to perform closed innovation activities, and may be more likely to collaborate with innovative partners (Maietta, 2015). Then, we include two proxies of profitability and growth opportunities: the firm's return on investments (*ROI*), and the sales growth rate (*Sales growth*). To capture regional factors that may influence a firm's adoption of open innovation strategies, we also add two province-specific controls. First, we control for the level of judicial inefficiency (*Judicial inefficiency*), measured by the number of civil suits pending (Jappelli et al., 2005). Second, following Brockman et al. (2018), we include the level of provincial trust (*Trust*), measured with voter turnout using data for the European elections of 1979, 1984, 1989, 1994 and 1999, and six referenda (Guiso et al., 2004). Finally, we saturate the empirical model with a comprehensive array of fixed effects: geographical dummies (at the NUTS-2 level), based on the region where the firm is located, and sector dummies according to the two-digit NACE classification.

4.3 Empirical model

The aim of this paper is to investigate whether family ownership influences the adoption of open innovation strategies over closed innovation models. The probability that firm i cooperates with external partners on technological innovation can be written as:

$$P(Open\ innovation_i = 1) = \Phi(\alpha_1 + FF_i\beta_1 + Z_i\gamma_1) \tag{1}$$

where Φ represents the standard normal cdf; FF_i denotes our measure of family ownership (*Family firm*); Z_i is the vector of exogenous covariates described above, as well as controls for variations across industries and geographical areas. Since our dependent variable is a binary variable taking values zero and one, we estimate Equation (1) by maximum likelihood probit regressions.[5]

One might be concerned that family ownership may be endogenous. First, some omitted variables could be correlated with firm ownership and also affect its adoption of open innovation strategies. Second, there could be a possibility of reverse causality. To mitigate the first concern, in our empirical specification we control for a broad range of variables that may influence the firm's decision to collaborate on technological innovation, including firm-specific factors, industry and region fixed-effects. Furthermore, given that Italy has a low capital market development and inactive markets for corporate control, family ownership tends to be very persistent overtime, thus relieving worries of reverse causality (Franks et al., 2012; Bird and Wennberg, 2014). Despite these efforts, to mitigate endogeneity concerns, we also com-

[5]In all the regressions, standard errors are heteroskedasticity robust, clustered at the firm level.

plement probit estimates with an instrumental variables approach. As both open innovation and family ownership are binary variables, we estimate a bivariate probit model that includes Equation (1) and the following probit equation for firms' ownership structure:

$$P(FF_i = 1) = \Phi(IV_i\delta_1 + Z_i\lambda_1) \tag{2}$$

where IV_i represents our set of instruments, and Z_i is the vector of exogenous covariates and controls for differences across regions and industries included in Equation (1).[6] Consistent with previous studies on firm ownership (Laeven and Levine, 2007; Faccio et al., 2011; Amit et al., 2015; Fang et al., 2021), we include the following instruments: the share of family-owned firms in the same province of firm i (*Share FF*), and the share of total assets of all the other family-owned firms in the same region of firm i (*Share FF assets*).

In order to be valid, our instruments must be correlated with family ownership while not being correlated with unobservable variables that could also be associated with the adoption of open innovation strategies. Regarding the first point, our instruments are likely to capture local factors that influence the probability of a firm being family owned (Chang et al., 2008). With respect to the second issue, we have strong reasons to believe that the provincial share of family-owned firms and the regional share of their assets affect firms' adoption of open innovation only through the family firm variable, ensuring the non-correlation between our instruments and the firms' decision to rely on open innovation. This is partially confirmed by the correlation coefficients between the two instrumental variables (*Share FF* and *Share FF assets*, respectively) and the dependent variable, as reported in Table 3, which are 0.040 and 0.005.[7]

5 Main results

This section presents the baseline findings (5.1) and discusses some preliminary insights into the underlying mechanisms (5.2).

5.1 Family firms and open innovation strategies

The estimation results on the relationship between family ownership and open innovation strategies are presented in Table 4. Panel A reports the baseline findings obtained from the

[6] Equations (1) and (2) constitute a recursive bivariate probit model. The effect of family ownership on the adoption of open innovation strategies can be identified under the assumption that the instruments IV_i are excluded from Equation (1). Although FF_i enters Equation (1) as an endogenous variable, Equations (1) and (2) can be estimated using a standard bivariate probit software (Greene, 2002).

[7] We cannot entirely rule out the possibility that certain unobserved local characteristics correlate with both the presence and size of family-owned firms, and their adoption of open innovation initiatives. To address these concerns, as presented in Section 4.2, we will incorporate various province-level controls in all our regressions.

non-instrumented probit and instrumented bivariate probit models. Panel B shows the results for a set of robustness tests.

Panel A column (1) reports the marginal effects from the non-instrumented probit estimation, while column (2) presents the marginal effects from the instrumented bivariate probit regression as specified in Equations (1) and (2). After controlling for a large set of firm characteristics, province variables, and industry and region fixed effects, we find that family firms are significantly and positively associated with the adoption of open innovation strategies, instead of closed innovation models. The marginal effects for the variable *Family firm* are 0.062 and 0.101 (both statistically significant at 90%) for the non-instrumented and instrumented models, respectively. These figures imply that a family-owned firm is 10.1 percentage points more likely to collaborate for innovation than a firm characterized by a different ownership structure. In line with our hypothesis, we interpret these findings as suggesting that the long-term orientation, risk aversion, and relational capital inherent in family firms outweigh their conservatism. This balance of characteristics ultimately encourages these businesses to invest in open innovation strategies, instead of focus on closed innovation models.

The bottom of column (2) shows the marginal effects of the instruments from the probit equation of family ownership (Equation 1).[8] We find that both coefficients are positive and statistically significant at conventional levels. Hence, consistently with our expectations, the higher the share of family firms in the province and the greater their size in terms of total assets, the larger the probability of firms being family-owned. The Kleibergen-Paap Wald F-statistic from the first stage, equal to 84.05, suggests that we do not face an issue of weak instruments.[9] The marginal effects for the control variables align with the evidence provided by previous studies. More specifically, consistently with the resource-based view, larger and more profitable firms, as well as those with higher investments in intangible assets, are less likely to rely on open innovation, thereby favoring closed innovation models (Tether, 2002; Maietta, 2015). In contrast, variables such as firm age, the proportion of graduate employees, and the rate of sales growth do not show a significant association with the probability of firms engaging in open innovation initiatives. Finally, consistent with previous studies, our analysis reveals a positive and significant relationship between the level of trust at the provincial level and the adoption of open innovation by firms (Brockman et al., 2018).

In Panel B, we conduct a series of robustness checks to further address potential omitted variable issues. In columns (3) and (4), we aim to control more comprehensively for region-sector explanatory factors. To achieve this, we re-estimate the non-instrumented probit and the instrumented bivariate probit models, incorporating an alternative set of fixed effects,

[8] To save space, the coefficients on firm controls and province variables are not reported.

[9] In spite of that, it is important to stress here that the literature on weak instruments is less developed with regard to diagnostics for non-linear IV models. Thus, the often used cutoff values for the first-stage F-statistic are derived using a linear model under the assumption that the model is homoskedastic (Stock and Yogo, 2005).

specifically the interaction between region and industry dummies. The marginal effects reported in the table are consistent with our baseline results, indicating that family ownership is significantly and positively correlated with the adoption of open innovation in both models. Specifically, the marginal effects are 0.083 in the non-instrumented model and 0.103 in the instrumented model (both statistically significant at 90%). This suggests that being family-owned is associated with a 10.3 percentage points increase in the likelihood of a firm employing open innovation strategies. Again, the significance of our instrumental variables (*Share FF* and *Share FF assets*), combined with the value of the F-statistic (97.74), reinforces the validity of our instruments In column (5), we further address endogeneity concerns by implementing a propensity score matching (PSM) approach (Fang et al., 2014; Murro and Peruzzi, 2019; 2022b). To apply this method, we initially divide our sample of innovative firms into two categories: family-owned and non-family-owned businesses. We then match firms from these groups to ensure that the resulting subsamples are as comparable as possible in terms of variables that might be correlated with the adoption of open innovation strategies. More specifically, we estimate a probit model using *Family firm* as the dependent variable, and incorporate all the firm-specific controls from our baseline estimations. This approach involves setting a tolerance level for the maximum propensity score distance (caliper) between the treatment and control groups; we set this caliper at 0.0005.[10] After forming the treatment and control groups, we finalize the process by rerunning our baseline regression as specified in Equation (1). The estimation results align closely with those of the baseline regressions discussed earlier.

5.2 Heterogeneous effects

The relationship between family ownership and firms' adoption of open innovation strategies may vary depending on certain characteristics of the innovation being introduced and the choice of partners for collaboration. Therefore, in this section, we delve further into these aspects by distinguishing between product and process innovators (Table 5) and examining the different partners involved in the innovation agreements (Table 6).

Product and process innovators Using the data from the UniCredit survey, Table 5 classifies the surveyed firms as either product or process innovators.[11] Panel A presents the results for the impact of family ownership on the adoption of open innovation strategies

[10] Figure A1 illustrates the kernel density of the estimated propensity scores for the treated and control groups both before and after the matching process. The graph indicates that matching significantly improves the degree of similarity between the two subsamples in terms of the covariates used for the matching strategy. This confirms that the PSM procedure effectively reduces the likelihood that omitted variable bias, rather than credit rationing, is driving our results.

[11] The survey asks: "*In the last three years, did the firm introduce product innovations?*" and "*In the last three years, did the firm introduce process innovations?*".

for the subsample of firms engaged in product innovation. Similarly, Panel B reports these estimates for the subsample of firms engaged in process innovation. The results reported in column (1) indicate that firms engaging in product innovation are more likely to rely on open innovation strategies when family-owned. The marginal effect is 0.168 (statistically significant at 90%), which implies that firms introducing product innovations being family-owned are 16.8 percentage points more likely to collaborate with external partners on these innovations, when compared to non-family-owned firms. The UniCredit survey also allows us to distinguish between firms introducing completely new products and businesses focusing focusing on improvements to existing products. Hence, in Panel A, columns (2) and (3), we examine the types of product innovation introduced. For both subsamples we detect a positive and statistically significant relationship between family ownership and the adoption of open innovation by firms. More specifically, as indicated by the marginal effects, family-owned firms are 20.7 percentage points more likely to engage in innovation collaborations compared to non-family-owned businesses when introducing new products, and 16.6 percentage points more likely when focusing on improvements to existing products. For process innovators, the marginal effect shown in column (4) indicates that family ownership does not significantly influence the adoption of open innovation strategies in this subsample. This result remains nearly consistent across different areas of process innovations such as production, logistics, maintenance, and IT. Specifically, for firms introducing process innovations in production and logistics (columns 5 and 6), we observe a positive, though not statistically significant, relationship between family ownership and open innovation. Conversely, for process innovators focusing on maintenance systems (column 7), a positive and statistically significant impact of family ownership on innovation collaboration is detected. Family-owned process innovators focusing on maintenance systems are 29 percentage points more likely to engage in open innovation compared to their non-family-owned counterparts involved in the same type of process innovation.

Open innovation partners Firms can engage in cooperative agreements for innovation with various types of partners. As shown in Table A1, in our sample, suppliers and customers are the most common partners for such collaborations. However, a significant proportion of companies also engage with research centers and universities, and firms within the same business group. We propose that family ownership may influence firms' motivations to collaborate with different types of partners. Therefore, in Table 6, we examine whether the impact of family ownership on the adoption of open innovation varies based on the type of innovation collaborator. Based on the information provided by the survey, in this table, we refine our dependent variable to focus specifically on the innovation partners engaged by the sample firms. The estimation results reveal that family ownership positively influences firms' tendency to rely on open innovation with suppliers (column 3). Family-owned firms are 9.3

percentage points more likely to collaborate for innovation with suppliers, when compared to non-family-owned firms. By contrast, family ownership does not show a significant association with innovation agreements with other types of partners. This result highlights the relevance of suppliers as open innovation partners for family-owned firms. This is consistent with the transaction cost economics perspective, as collaborating with suppliers can reduce search and coordination costs, thereby enhancing innovation performance. In addition, the relational abilities inherent in family owners can be particularly valuable and leveraged in their interactions with suppliers, facilitating collaboration for innovation purposes.[12] Heterogeneous effects in terms of open innovation partners are also disclosed in Table A2, when examining their geographical localization. Family ownership is positively and significantly associated with the adoption of open innovation strategies when the innovation partners are located in the same region. Conversely, a negative, though not statistically significant, effect is observed when firms engage in open innovation with partners located in the same country or abroad.

6 Mechanisms

The relationship between family ownership and firms' adoption of open innovation strategies can be explained by the theories discussed in Section 3. On one hand, family firms may cautiously approach open innovation to control and preserve their legacy. On the other hand, their risk aversion and long-term orientation might drive them to embrace open innovation, sharing risks and accessing new ideas, resources, and markets, thereby aligning with their need to remain competitive. Moreover, the inherent relational abilities and trust-based culture of family businesses can enhance collaborations in open innovation, thereby reducing transaction costs. In what follows, we investigate the relevance of these mechanisms in our context by analyzing whether the impact of family ownership on firms' adoption of open innovation strategies varies depending on firms' long-termism (Section 6.1), relational abilities (Section 6.2), and conservatism (Section 6.3).

6.1 Long-termism

Measuring firm long-termism presents a challenge as our dataset does not include a direct proxy for the length of firms' horizon. The literature consistently indicates that older firms are more likely to survive and, consequently, tend to have a longer-term horizon (Minetti et al., 2015b). In Table 7, we split the sample based on firm age. Column (1) considers the subsample of firms older than 16 years (the 25th percentile of the distribution). Column (2) focuses on firms older than 27 years (the median value of the distribution). Column (3)

[12] The mechanism of relational capital will be further discussed in Section 6.2.)

examines the sample of firms older than 39 years (the 75th percentile of the distribution). The results indicate that family ownership positively influences the adoption of open innovation strategies in older firms, specifically those with over 39 years of operation. With a marginal effect of 0.416 (statistically significant at 90%), the data suggest that older family-owned firms are 41.6 percentage points more likely to engage in open innovation compared to non-family-owned businesses. Therefore, consistently with our hypothesis, the observed positive effect of family ownership on open innovation may be attributed to the long-term perspective of family owners, making them more receptive to the sustainable benefits of open innovation.

6.2 Relational capital

As suggested by the literature, the network of relationships established over time by family firms plays a crucial role in successful business operations. By investing substantial resources in nurturing interpersonal relationships, family firms can secure public resources and enhance their economic performance (Salvato and Melin, 2008; Bunkanwanicha et al., 2013). Previous studies have shown that relational abilities in family-owned firms are particularly strong when family founders and CEOs are at the helm. Therefore, in Table 8, column (1), we conduct our baseline regression using the *Family CEO* variable instead of the *Family firm* dummy. *Family CEO* is a dummy variable set equal to one if the firm is both family-owned and family-run, and zero otherwise. The marginal effect presented in the table is 0.067 (statistically significant at 95%). This suggests that having a family CEO is associated with a 6.7 percentage points increase in the likelihood of a firm employing open innovation strategies. In column (2), we further examine the role played by family managers by running our regression on the subsample of family-owned firms. The marginal effect is again positive and statistically significant, indicating that among family businesses, those that are family-run are 51.9 percentage points more likely to engage in open innovation strategies compared to family-owned firms that are not family-run. Among the various relationships family firms may invest in, those with their lenders can be particularly beneficial. Therefore, as a measure of relational abilities, in columns (3) and (4), we classify firms based on the length of their lending relationships. In column (3), we focus on firms with short-term banking relationships (< 15 years); in column (4), we examine firms with long-term banking relationships (> 15 years). This latter subsample is expected to include firms with greater relational abilities. The marginal effects reported in the table indicate that family ownership positively influences the adoption of open innovation only in the subsample of firms with long-term banking relationships. More specifically, family-owned firms with extended relationships with their banks are 23.7 percentage points more likely to engage in open innovation compared to non-family-owned businesses. Overall, the findings in Table 8 confirm our hypothesis and suggest that family ownership plays a significant role in determining firms' adoption of open innovation strategies, especially

for those firms characterized by greater relational abilities.

6.3 Conservatism

A characteristic that may hinder family firms from engaging in open innovation strategies is their conservative tendency to uphold tradition and positioning. In Table 9, we investigate this mechanism by dividing the sample according to two dimensions indirectly related to firms' conservatism. More specifically, in columns (1) and (2), we categorize firms based on whether they have changed their main production sector in the last three years (either by maintaining their position in the previous sector or by completely abandoning it). In columns (3) and (4), we differentiate between firms that have avoided collaborations (not related to innovation activities) with other businesses to preserve their autonomy and those without such concerns. Thus, in columns (1) and (3), we analyze firms that are more conservative, while in columns (2) and (4), we focus on businesses that are less oriented towards tradition. The estimation results support our hypothesis. As indicated by the marginal effects in the table, family ownership has a positive impact on the adoption of open innovation strategies in the subsamples of firms that are less conservative. Conversely, in the subsample of more conservative businesses, family ownership is negatively and significantly correlated with the likelihood of firms engaging in open innovation (column 3).

7 Conclusions

This paper has examined the influence of family ownership on firms' adoption of open innovation strategies. By leveraging the rich data from the VIII UniCredit survey on medium-sized enterprises, the study has shed light on the engagement in open innovation activities by family-owned firms. The findings reveal that family ownership is positively and significantly associated with the adoption of open innovation strategies. In particular, we find that family-owned businesses are 10% more inclined to engage in collaborative innovation rather than adhere to closed innovation models, compared to firms with different ownership structures. The propensity to engage in open innovation by family businesses is particularly pronounced in firms involved in product innovation and in collaborations with suppliers, underlining the distinct innovation dynamics within family-owned businesses. In exploring the basis of the association between family ownership and open innovation, the paper delves into the inherent characteristics of family-owned firms and how these traits influence the firms' approach towards open innovation. The results are consistent with the theoretical expectations, highlighting that the positive link between family ownership and open innovation is largely driven by the long-term perspective and relational abilities of family owners.

In providing this evidence, the paper contributes to enriching the dialogue in two main

strands of literature. First, it extends the research on family ownership and technological innovation, by concentrating on the contemporary innovation paradigm represented by open innovation models. Second, the study enhances the broader understanding of the determinants of open innovation adoption by firms, unraveling the significant impact of firm ownership structure.

Our results carry significant implications for management. First, family-owned firms should recognize the benefits of adopting open innovation strategies, especially in production innovation, as a means to enhance competitiveness and market position. It is crucial for family management to promote a culture that supports open innovation by emphasizing the importance of external collaboration, knowledge sharing, and sustained strategic partnerships. Most importantly, family owners should capitalize on their unique strengths, such as long-term orientation and relational abilities, to facilitate open innovation. They should strategically use their relational networks and trust-based culture to reduce transaction costs and enhance the efficacy of collaborative innovation projects. This approach is particularly pertinent in their interactions with suppliers, as suggested by our results. These considerations also hold substantial relevance for policy formulation. Recognizing their pivotal role in the economic landscape, policymakers should create frameworks and incentives that promote the engagement of family-owned firms in open innovation. Policies should aim to foster networks and ecosystems that encourage collaboration among family and non-family-owned firms, suppliers, research centers, and other potential innovation partners. Finally, in designing policies related to innovation, policymakers should consider the distinctive attributes of family businesses, such as their long-term perspective and relational abilities.

Despite offering valuable insights into the relationship between family ownership and open innovation, this paper is not exempt from limitations. First, while the persistence over time of family ownership is acknowledged, the cross-sectional nature of our dataset limits our ability to track temporal changes in firms' engagement with open innovation initiatives. Second, despite the richness of our dataset, more detailed information on firms' ownership structures would enrich the analysis. Comprehensive data on aspects such as ownership concentration, the presence of minority shareholders, and CEO tenure, and the breadth of firms' networks would provide a more nuanced understanding of the benefits and costs of innovation collaborations in firms with different ownership and governance structures. Recognizing these limitations is important as it can open avenues for future research.

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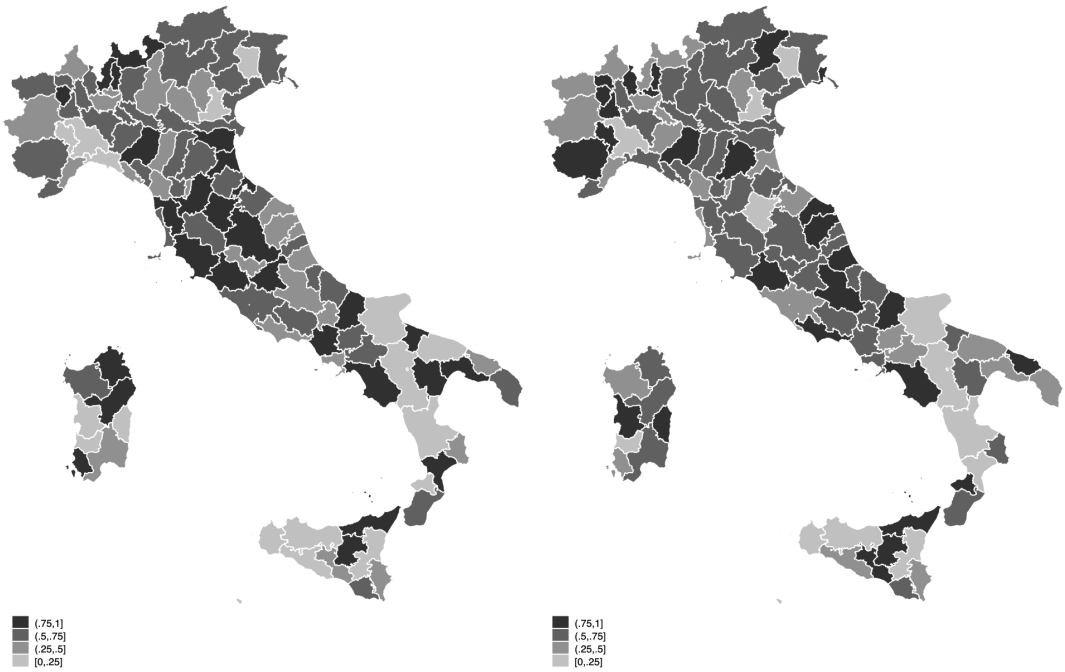
Tables and Figures

Figure 1
Family-owned firms and open innovation adoption across Italian provinces (NUTS-3)



(a) Open innovation (b) Family-owned firms

Notes: The figures show the percentage of family-owned firms and open innovation adoption for the firms in our sample.

Table 1
Variable definitions

Variable	Description
Dependent variable:	
Open innovation	Dummy variable equal to one if the firm cooperates with external partners on technological innovation, and zero otherwise.
Independent variable:	
Family firm	Dummy variable equal to one if the firm is family owned, and zero otherwise.
Control variables:	
Age	Number of years since inception.
Size	Number of employees in the year of the survey.
Graduates	Number of graduate employees over the total number of employees.
Intangibles	Intangible assets.
ROI	Return on investments.
Sales growth	Growth rate of sales.
Judicial inefficiency	Number of civil suits pending in the province, scaled by the population.
Trust	Voter turnout using data for the European elections of 1979, 1984, 1989, 1994 and 1999, and six referenda.
Instrumental variables:	
Share FF	Share of family firms in the province.
Share FF assets	Share of family firms' assets in the region (computed excluding firm i).
Other variables:	
Family CEO	Dummy variable equal to one if the firm is run by a family member, and zero otherwise.
Geographical areas:	
North	Dummy variable equal to one if the firm is located in the North of Italy, and zero otherwise.
Center	Dummy variable equal to one if the firm is located in the Center of Italy, and zero otherwise.
South	Dummy variable equal to one if the firm is located in the South of Italy, and zero otherwise.

Table 2
Summary statistics and univariate tests

	All firms			Open innovation strategies					Family ownership				
	Mean	Std. Dev.	Obs.	Open innovation=1		Open innovation=0		t-test	Family firm=1		Family firm=0		t-test
				Mean	Obs.	Mean	Obs.		Mean	Obs.	Mean	Obs.	
Dependent variable:													
Open innovation	0.611	0.488	1228						0.627	789	0.581	439	-1.593
Independent variable:													
Family firm	0.634	0.482	1408	0.660	750	0.615	478	-1.593					
Control variables:													
Age	31.19	22.70	1315	30.61	708	32.27	446	1.168	31.90	859	29.85	456	-1.563
Size	62.91	80.97	1340	66.54	718	66.07	455	-0.095	59.61	870	69.01	470	1.920
Graduates	0.781	0.414	1278	0.819	684	0.773	432	-1.824	0.781	837	0.780	441	-0.054
Intangibles	0.030	0.056	1331	0.030	714	0.032	448	0.476	0.030	845	0.031	486	0.248
ROI	0.044	0.085	1331	0.038	714	0.051	448	2.538	0.045	845	0.042	486	-0.631
Sales growth	-0.057	0.513	1184	-0.065	639	-0.053	401	0.363	-0.042	753	-0.085	431	-1.536
Judicial inefficiency	0.517	0.535	1369	0.540	730	0.469	463	-2.402	0.532	867	0.491	502	-1.419
Trust	0.838	0.068	1353	0.838	720	0.839	461	0.090	0.836	853	0.840	500	0.960
Geographical areas:													
North	0.719	0.449	1408	0.695	750	0.759	478	2.509	0.722	892	0.715	516	-0.275
Center	0.165	0.371	1408	0.179	750	0.136	478	-2.030	0.154	892	0.184	516	1.459
South	0.116	0.320	1408	0.127	750	0.105	478	-1.190	0.124	892	0.101	516	-1.370

Notes: The table reports summary statistics and univariate tests for the main variables used in the regressions. Definitions for all variables can be found in Table 1.

Table 3
Correlation matrix

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1)	Open innovation	1.000											
(2)	Family firm	0.051	1.000										
(3)	Age (log)	-0.053	0.051	1.000									
(4)	Size (log)	-0.045	-0.008	0.120	1.000								
(5)	Graduates	0.040	0.032	-0.013	0.227	1.000							
(6)	Intangibles	-0.040	0.001	-0.111	0.066	0.025	1.000						
(7)	ROI	-0.097	0.005	-0.028	-0.116	0.020	0.005	1.000					
(8)	Sales growth	-0.015	0.029	-0.200	-0.045	0.059	0.026	0.093	1.000				
(9)	Judicial inefficiency	0.098	0.049	-0.094	-0.017	0.072	0.019	0.005	0.067	1.000			
(10)	Trust	-0.027	-0.009	0.074	0.082	-0.025	-0.016	0.020	-0.077	-0.561	1.000		
(11)	Share FF	0.040	0.262	0.045	-0.017	0.046	-0.031	-0.004	-0.006	0.145	-0.099	1.000	
(12)	Share FF assets	0.005	0.382	0.079	0.029	0.035	-0.047	0.064	-0.008	0.030	-0.088	0.177	1.000

Table 4
Open innovation in family-owned firms

	Panel A: Baseline results		Panel B: Robustness checks		
			Industry × Region dummies		Propensity score matching
	Probit	Bivariate Probit	Probit	Bivariate Probit	Probit
Dependent variable	Open innovation		Open innovation		Open innovation
	(1)	(2)	(3)	(4)	(5)
Family firm	0.062*	0.101*	0.083*	0.103*	0.106***
	(0.035)	(0.064)	(0.043)	(0.061)	(0.040)
Age (log)	-0.017	-0.012	-0.008	0.001	0.034
	(0.027)	(0.028)	(0.034)	(0.028)	(0.039)
Size (log)	-0.031	-0.035*	-0.059**	-0.054***	-0.047*
	(0.021)	(0.019)	(0.026)	(0.020)	(0.028)
Graduates	0.025	0.016	0.002	0.014	0.070
	(0.048)	(0.035)	(0.052)	(0.035)	(0.075)
Intangibles	-0.533*	-0.062	-0.622	-0.030	-0.946*
	(0.295)	(0.324)	(0.426)	(0.360)	(0.514)
ROI	-0.685***	-0.523**	-0.895***	-0.568***	-1.008***
	(0.262)	(0.209)	(0.306)	(0.212)	(0.347)
Sales growth	-0.021	0.002	-0.006	0.022	0.167
	(0.035)	(0.028)	(0.041)	(0.028)	(0.116)
Judicial inefficiency	0.014	0.049	0.127	0.118*	-0.082
	(0.133)	(0.121)	(0.085)	(0.068)	(0.173)
Trust	0.526	0.506*	0.802**	0.830**	1.012**
	(0.383)	(0.288)	(0.390)	(0.345)	(0.514)
Instrumental variables:					
Share FF		0.728***		0.755****	
		(0.110)		(0.186)	
Share FF assets		0.841***		1.117***	
		(0.313)		(0.307)	
Region dummies	Yes	Yes	No	No	Yes
Industry dummies	Yes	Yes	No	No	Yes
Region × Industry dummies	No	No	Yes	Yes	No
F-instruments		84.05		97.74	
Overid. test (p-value)		0.882		0.105	
Observations	825	858	667	858	264

Notes: This table presents the marginal effects from the probit and bivariate probit regressions. Three, two and one star (*) mean, respectively, a 99, 95 and 90 percent level of significance. Standard errors, clustered at the provincial level, are shown in parentheses. Definitions for all variables can be found in Table 1.

Table 5
Heterogeneous effects: Product and process innovators

Dependent variable	Panel A: Product innovators			Panel B: Process innovators				
	Open innovation			Open innovation				
	All	New product	Improved product	All	Production	Logistics	Maintenance	IT
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Family firm	0.168*	0.207**	0.166*	0.105	0.142	0.251	0.290***	-0.004
	(0.089)	(0.100)	(0.087)	(0.075)	(0.149)	(0.315)	(0.044)	(0.065)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Instrumental variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	716	532	674	742	537	338	287	479

Notes:This table presents the marginal effects from the bivariate probit regressions. In Panel A, we focus on the subsample of product innovators: column (1) includes all product innovators, column (2) is dedicated to firms introducing new products, and column (3) to those improving existing products. In Panel B, we shift to the subsample of process innovators: column (4) includes all process innovators, column (5) focuses on firms innovating production processes, column (6) on firms innovating logistics processes, column (7) on those innovating maintenance processes, and column (8) on firms innovating IT processes. Three, two and one star (*) mean, respectively, a 99, 95 and 90 percent level of significance. Standard errors, clustered at the provincial level, are shown in parentheses. Definitions for all variables can be found in Table 1.

Table 6
Heterogeneous effects: Open innovation partners

Dependent variable	Research centers / Universities	Customers and clients	Suppliers	Firms of the same business group	Competitors and Trade associations
	Open innovation	Open innovation	Open innovation	Open innovation	Open innovation
	(1)	(2)	(3)	(4)	(5)
Family firm	-0.002	-0.017	0.093***	-0.010	0.001
	(0.016)	(0.055)	(0.022)	(0.012)	(0.003)
Control variables	Yes	Yes	Yes	Yes	Yes
Instrumental variables	Yes	Yes	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes
Observations	858	858	858	858	858

Notes:This table presents the marginal effects from the bivariate probit regressions. The dependent variable Open innovation is defined based on the firm's main innovation partner: in column (1), it is equal to one for partnerships with research centers or universities, and zero otherwise; in column (2), it denotes partnerships with customers or clients; in column (3), with suppliers; in column (4), with firms from the same business group; in column (5) with competitors and trade associations. In each case, the variable is set to one for the specified partnership type and zero otherwise. Three, two and one star (*) mean, respectively, a 99, 95 and 90 percent level of significance. Standard errors, clustered at the provincial level, are shown in parentheses. Definitions for all variables can be found in Table 1.

Table 7
Mechanisms: Long-termism

Dependent variable	Age > 16 years Open innovation (1)	Age > 27 years Open innovation (2)	Age > 39 years Open innovation (3)
Family firm	0.111 (0.101)	0.280 (0.275)	0.416*** (0.068)
Control variables	Yes	Yes	Yes
Instrumental variables	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes
Observations	649	441	205

Notes:This table presents the marginal effects from the bivariate probit regressions. Column (1) examines the subsample of firms older than 16 years (representing the 25th percentile of the distribution); column (2) focuses on firms older than 27 years (the median of the distribution); and column (3) considers firms older than 39 years (the 75th percentile). Three, two and one star (*) mean, respectively, a 99, 95 and 90 percent level of significance. Standard errors, clustered at the provincial level, are shown in parentheses. Definitions for all variables can be found in Table 1.

Table 8
Mechanisms: Relational capital

Dependent variable	Family CEO Open innovation (1)	Family CEO (subsample FF) Open innovation (2)	Bank relationships < 15 years Open innovation (3)	Bank relationships > 15 years Open innovation (4)
Family CEO	0.067** (0.029)	0.519*** (0.023)		
Family firm			0.175 (0.191)	0.237* (0.136)
Control variables	Yes	Yes	Yes	Yes
Instrumental variables	Yes	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Observations	842	556	405	453

Notes:This table presents the marginal effects from the bivariate probit regressions. Column (2) focuses on the subsample of family-owned firms. Columns (3) and (4) categorize firms based on the length of their banking relationships: firms with relationships shorter than 15 years are in column (3), and those with relationships longer than 15 years are in column (4). Three, two and one star (*) mean, respectively, a 99, 95 and 90 percent level of significance. Standard errors, clustered at the provincial level, are shown in parentheses. Definitions for all variables can be found in Table 1.

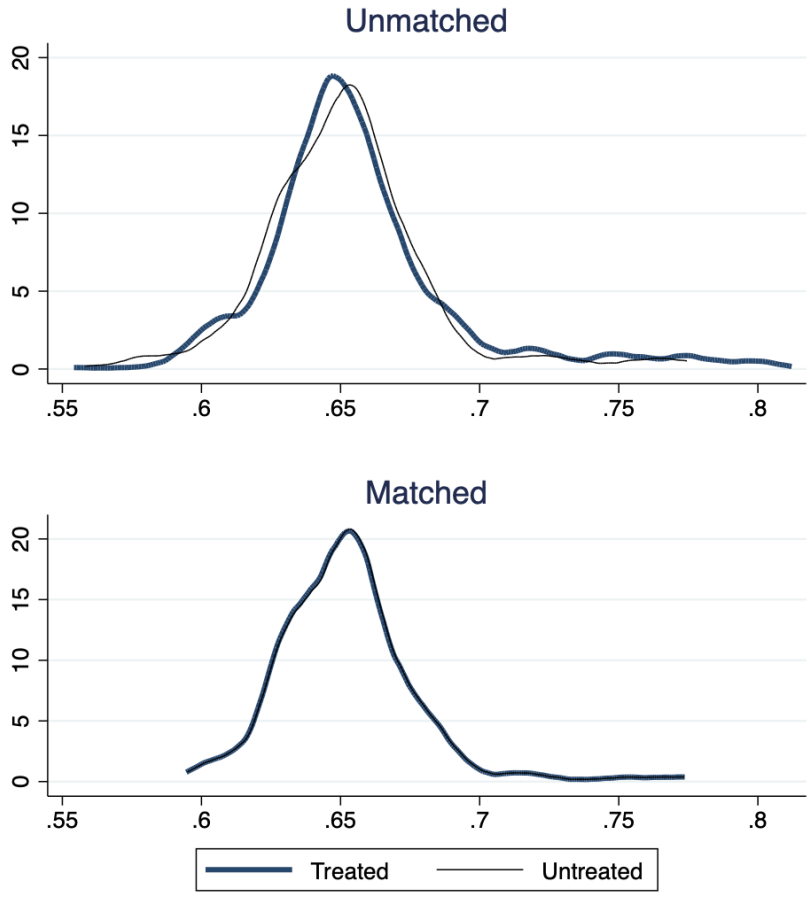
Table 9
Mechanisms: Conservatism

	Δ in production sector = 0	Δ in production sector = 1	Control preservation = 1	Control preservation = 0
Dependent variable	Open innovation	Open innovation	Open innovation	Open innovation
	(1)	(2)	(3)	(4)
Family firm	0.062	0.137**	-0.189*	0.232***
	(0.078)	(0.059)	(0.099)	(0.087)
Control variables	Yes	Yes	Yes	Yes
Instrumental variables	Yes	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Observations	710	148	413	445

Notes: This table presents the marginal effects from the bivariate probit regressions. Firms are categorized based on their level of conservatism, with high conservatism in columns (1) and (3), and low conservatism in columns (2) and (4). In particular, column (1) includes firms that have changed their main production sector in the last three years, either by maintaining their position in the previous sector or by abandoning it; column (2) focuses on firms that have not changed their sector of activity; column (3) examines firms that aim to preserve their control in terms of decision-making autonomy, while column (4) considers those firms that are not focused on preserving control. Three, two and one star (*) mean, respectively, a 99, 95 and 90 percent level of significance. Standard errors, clustered at the provincial level, are shown in parentheses. Definitions for all variables can be found in Table 1.

Appendix

Figure A1
Balancing test for the propensity score matching (PSM)



Notes: This figure reports the performance of the balancing test between family (treated group) and non-family (control group) owned firms for the sample before and after matching.

Table A1
Main partner of open innovation strategies

	Observations	%
Research centers/Universities	131	10.67
Customers or clients	219	17.83
Suppliers	250	20.36
Firms belonging to the same business group	85	6.92
Competitors	17	1.38
Trade associations	48	3.91

Table A2
Geographical localization of open innovation partners

	Same region	Italy	Abroad
Dependent variable	Open innovation	Open innovation	Open innovation
	(1)	(2)	(3)
Family firm	0.127***	-0.043	-0.006
	(0.035)	(0.065)	(0.019)
Control variables	Yes	Yes	Yes
Instrumental variables	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes
Observations	858	858	858

Notes: This table presents marginal effects from the bivariate probit model. In column (1), the dependent variable Open innovation is set to one if the firm's main innovation partner is located within the same province or region, and zero otherwise. In column (2), it is set to one if the firm's main innovation partner is located within Italy, and zero otherwise. In column (3), Open innovation is set to one for partners located abroad, and zero otherwise. Three, two and one star (*) mean, respectively, a 99, 95 and 90 percent level of significance. Standard errors, clustered at the provincial level, are shown in parentheses. Definitions for all variables can be found in Table 1.