# *Innovation in family firms: the role of absorptive capacity and knowledge collaboration*

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# Innovation in Family Firms: The Role of Absorptive Capacity and Knowledge Collaboration

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## ABSTRACT

While prior research suggests that family ownership can significantly facilitate sales and innovation, empirical findings often overlook the nuanced differences in innovation inputs between family and non-family firms. We address this gap by examining the extent to which family firms are able to use absorptive capacity by creating knowledge internally and collaborating with external partners to enhance their innovation. Utilizing micro-level data from 9266 of the most innovative UK firms from 2006 to 2016, we employ a multi-level analysis to examine how different knowledge inputs—such as internal investments in knowledge and external collaborations at the regional and international levels—influence innovation outputs in family and non-family firms. Our findings contribute to the innovation and family business literature by providing a clearer understanding of the innovation dynamics within family firms compared to their non-family counterparts. Additionally, we offer managerial insights and outline policy implications that could foster knowledge transfer in family firms. These recommendations take into account that regional and international knowledge collaboration serves as a boundary condition for family firms to outperform their non-family counterparts.

## 1 | Introduction

A considerable body of family business literature explores the innovation behavior of family firms (FFs) across firm ownership and size (Nieto et al. 2015; De Massis et al. 2013, 2016; Chirico et al. 2020), with more recent studies by Urbinati et al. (2017) and Calabrò et al. (2019). The existing literature depicts family firm innovation as filled with paradoxes and contradictions (Erdogan et al. 2020; Debellis et al. 2021; Rondi et al. 2021), because decision-making in family firms and the factors influencing their innovation behavior differ from non-family firms (Pahnke et al. 2023). Family firms are often perceived as conservative regarding investments in R&D and training for innovation, being more long-term oriented and having a limited resource pool (De Massis et al. 2018). However, their long-term orientation and conservatism enable family firms to mobilize resources for extended periods and prioritize protecting family wealth by adopting risk-averse innovation and growth strategies (Jaskiewicz et al. 2020; Carnes et al. 2022).

Although seminal research on innovation activities in family firms exists (De Massis et al. 2021), it is often assumed that family firms are less innovative than non-family firms and are more likely to rely on internal, family financial resources for innovation. On the other hand, non-family firms engage in open innovation more broadly due to their higher risk-taking and

**Summary**

- This study investigates how family and non-family firms drive innovation by investing in internal knowledge and collaborating with external partners. Drawing on data from over 9200 of the most innovative UK firms (2006–2016), the study reveals that while both types of firms are equally capable of using their internal capacity for innovation (absorptive capacity), family firms can outperform non-family firms when they engage in knowledge collaboration—particularly regionally and internationally.
- Contrary to the common belief that family firms are more risk-averse or inward-looking, the findings show that when family firms form international partnerships, they benefit more than their non-family counterparts in new product creation.
- Collaborations with universities, R&D partners, or international firms help family businesses overcome resource limitations and bring in diverse knowledge that fosters both radical and incremental innovation.
- Managers in family firms should consider investing in both internal innovation capacity and strategic partnerships beyond their immediate networks.
- Policymakers can also support innovation by designing programs that encourage family firms to collaborate both regionally and internationally, including reliance on knowledge spillovers. The research demonstrates that external collaboration is a conduit for family firms aiming to innovate new products and services.

outward-looking behavior (Hoskisson et al. 2017; Audretsch et al. 2021). Non-family firms are more flexible in attracting external partners for financing and collaboration (Guenther et al. 2023). This raises an important research question: How and to what extent do investments in internal knowledge and engagement in open innovation via knowledge collaboration with external partners facilitate innovation outputs in family firms?

Addressing this question is critical to fill significant gaps in the existing literature regarding family firm innovation and boundary conditions enabling family firms to outperform their non-family counterparts. We demonstrate a more nuanced research that specifically addresses the unique characteristics of family businesses, particularly how these firms navigate the complex interplay of traditional business practices and innovation constraints, invest in absorptive capacity, and engage in knowledge sourcing from external partners for innovation. Given the paucity of knowledge on innovation inputs and their relevance to family firm innovation, particularly related to the inward and outward-looking perspectives of family firm innovation (Jaskiewicz et al. 2020; Guenther et al. 2023) and the choice of innovation strategy (Gómez-Mejía et al. 2007; Gómez-Mejia et al. 2011), family firm owners, policymakers, and scholars require a deeper understanding of the diverse inputs associated with innovation strategy and how these inputs shape innovation outputs in both family and non-family firms.

In response to this call in the innovation and family business literature (De Massis et al. 2016, 2018), this study showcases the role of various innovation inputs in family firms, extending prior research on firm innovation in developed economies (Kobarg et al. 2019; Audretsch and Belitski 2024) and linking it to firm ownership (Feranita et al. 2017; De Massis et al. 2018). We use micro-level data on 9266 of the most innovative UK firms that are family and non-family-owned (at least 50% family ownership) between 2006 and 2016 to test our research hypothesis and answer the research question.

Thus, our study makes two contributions to the literature on open innovation in family firms (De Massis et al. 2015, 2018; Magistretti et al. 2019). The first is by theorizing and examining the sources of knowledge (internally and externally) that shape innovation in family and non-family firms. In particular, we describe and evaluate the mechanisms enabling family firms to achieve greater innovation outputs compared to non-family firms, especially when engaging in regional and international collaborations (Magistretti et al. 2019; Calabrò et al. 2019; Baù et al. 2019). Addressing the complexity of family firm innovation, we unpack the contradictions in how family firms should approach innovation based on long-term resource mobilization (Erdogan et al. 2020; Debellis et al. 2021) and investment in both knowledge collaborations and absorptive capacity. The results deepen our understanding of the interplay between internal knowledge creation and external knowledge transfer, helping family firm owners and managers to make informed choices on innovation strategy. By choosing a specific innovation strategy, a firm is subject to different effects on its radical and incremental innovation outputs.

Second, by extending the focus from the drivers of innovation for firms in general to distinguishing between drivers of innovation in family and non-family firms, we extend prior research on the idiosyncrasies of family firm innovation (De Massis et al. 2013, 2015, 2018; Chirico and Salvato 2016) and focus on two innovation strategies: R&D collaboration with external partners and investment in a firm's absorptive capacity (Audretsch and Belitski 2022). Our findings extend the discussion beyond the traditional view of family firms relying heavily on internal resources (see De Massis et al. 2016; Chirico and Salvato 2016; Rondi et al. 2021), as we demonstrate that knowledge collaboration with internal and external partners enhances innovation outputs in family firms to a greater extent than in non-family firms and family firms that do not engage in knowledge collaboration regionally and internationally. This finding helps us bridge the gap in the literature on how family firms integrate open innovation practices with their existing strategies, including developing a firm's absorptive capacity to innovate, a topic that has received limited attention in the family business field.

Our study makes three key statements. First, we demonstrate that family firms have the same level of innovation as non-family firms. Second, both FFs and non-FFs are equally able to utilize their absorptive capacity for innovation outputs. Third, those family firms that are able to create knowledge-based collaborations with at least one external partner regionally and/or internationally, especially beyond national markets and European countries by avoiding close cognitive proximity, will be able to outperform their non-family counterparts in innovation as well as outperform family firms that do not collaborate. Our results hold for both radical and

incremental product innovation in family and non-family firms. Furthermore, we find that knowledge spillovers, investment in R&D internally, and availability of high-skilled workers (Audretsch et al. 2021), innovating new business models (De Massis et al. 2016), and promoting entrepreneurial behavior and orientation (Hornsby et al. 2013).

The next section introduces the theoretical framework and sets out research hypotheses. Section 3 presents data and method. Section 4 presents the results and additional robustness checks. Section 5 discusses the main results, and Section 6 concludes.

## 2 | Theoretical Framework

### 2.1 | Innovation in Family and Non-Family Firms

The debate over whether family firms innovate differently from non-family firms often revolves around how each leverages resources for innovation. While scholars like Casprini et al. (2017), Feranita et al. (2017), and Kotlar et al. (2021) underscore the significance of engagement in external collaborations for innovation for family firms, concerns related to the potential loss of control and the safeguarding of socioemotional wealth (SEW) often deter these firms from engaging deeply in knowledge collaborations (Gómez-Mejía et al. 2007; Gómez-Mejia et al. 2022).

Prior research on innovation in family firms indicated a disparity in innovation levels compared to non-family firms, both in terms of attitudes and outcomes (Erdogan et al. 2020). For instance, Morck and Yeung (2003) demonstrated that Canadian firms controlled by heirs engaged less in research and development compared to benchmark firms of similar age and size within the same industries. These tensions might suggest that family firms are less innovative; however, when examining the broader scope of innovation beyond the confines of R&D investments to include knowledge collaboration with external partners, the distinction between family and non-family firms in terms of innovation outputs becomes negligible.

Resource constraints, often more pronounced in family firms due to their cautious approach toward risky investments and a reluctance to involve external capital investors, theoretically position these firms at a disadvantage in terms of in-house investment in R&D and innovation projects (De Massis et al. 2015, 2018; Kammerlander and van Essen 2017). Yet, this supposed disadvantage is counterbalanced by the unique capability of family firms to build long-term, trust-based relationships with external stakeholders, in particular in local markets within immediate geographical proximity where family businesses could have a historical legacy and strong reputation, for example, Mittelstand in German regions (De Massis et al. 2018). Thereby facilitating knowledge exchanges with local customers and within the local supply chain enables family firms to outperform other non-family firms in innovation inputs and outputs (Miller et al. 2016; Rondi et al. 2021).

This balancing act is evident in how family firms engage with external collaborations for innovation differently (Urbinati et al. 2017; Feranita et al. 2017). While they may initially seem hesitant to collaborate, including family business paradox (Barrett and Moores 2020), the strategic use of their relational and social capital often allows them to effectively manage these collaborations with external partners, as in the case of Luxottica (Gallucci et al. 2016) and Barilla Group (Bernhard 2018), drawing on a broad spectrum of external knowledge and partnerships that compensate for their internal resource limitations or their orientation toward family-asset management (Kano et al. 2021). For instance, family firms are particularly adept at leveraging local networks vis-à-vis national networks that provide them additional competitive advantage to level up their innovation performance with non-family firms (Guenther et al. 2023).

Furthermore, empirical research is often inconclusive, while more recent studies demonstrated that differences in innovation output between family and non-family firms may not be as significant as previously thought (Block et al. 2023). Studies that broaden the definition of innovation to include incremental and user-driven innovations argue that family firms often match or even exceed the innovation outputs of their non-family counterparts when these broader metrics are considered (Moreno-Menéndez and Casillas 2021). This suggests that the traditional metrics of innovation, such as patent counts or R&D expenditure, may not fully capture the innovative capabilities of family firms, which excel in areas like share of new to firm or new to market products and services delivered by a firm and other product-driven innovation measures.

Therefore, the argument that family firms are less innovative than non-family firms requires reevaluation. When considering the full spectrum of innovation activities, including those driven by external collaborations, radical and incremental improvements, family firms might perform on par with, or even better than, non-family firms as they leverage both internal and external resources to drive their innovation strategies. We hypothesize:

**H1.** *Product innovation is not different between family and non-family firms.*

### 2.2 | Internal Knowledge and Innovation in Family Firms

The innovation process necessitates financial and human resources to discover commercially viable new combinations of knowledge. This involves a variety of internal and external knowledge sources (Nieto et al. 2015) which impact the financial and innovation outcomes in both family and non-family firms (Zellweger et al. 2013; De Massis et al. 2018). Internal knowledge creation may influence the strategic decisions of managers to innovate, and also elucidate how firms innovate. This creation occurs through R&D investment, training, and the hiring of highly skilled workers. The principal objective of internal knowledge creation is to increase a firm's absorptive capacity, which plays a crucial role in facilitating innovation within both family and non-family firms by enhancing their ability to understand, assimilate, and apply new knowledge effectively (Audretsch et al. 2024). Investment in internal knowledge is a major source of relative competitive advantage for firms of different ownership (Cohen and Levinthal

1989). Firms that invest in R&D are likely to be more agile and capable of competing in dynamic markets. Based on insights from prior research, including those by Cohen and Levinthal (1989, 1990) regarding the two facets of "R&D," we can draw several connections on how absorptive capacity enables family and non-family firms to increase innovation outputs. It is unlikely that family firms will be distinctly different in achieving higher returns on investment in internal knowledge and recombining external and internal knowledge using absorptive capacity compared to non-family firms. Below, we explain why.

First, regardless of firm ownership, an increase in absorptive capacity means a better ability to recognize the value of new, external knowledge (Kobarg et al. 2019). Indeed, developing absorptive capacity is vital for family firms, which are often criticized for their insular decision-making and traditional business orientation, lack of risk-taking (De Massis et al. 2013, 2016; Guenther et al. 2023), and they require an increase in absorptive capacity to identify and pursue innovative opportunities alongside startups and other incumbent firms, overcoming the traditional boundaries and models of knowledge creation (De Massis et al. 2016; Casprini et al. 2017). Second, once valuable knowledge is recognized, absorptive capacity allows firms to assimilate this knowledge more rapidly and effectively, find important knowledge and technology linkages (Balland et al. 2015). Assimilating new knowledge through training and education, hiring human capital, and investing in R&D internally (Belitski et al. 2020) means integrating new insights with existing knowledge, which is essential for both family and non-family firms. While assimilating external knowledge may challenge the knowledge legacy and traditional modes of innovation of family firms (Casprini et al. 2017), regardless of firm ownership, investment in R&D and human capital may increase the creation of unique knowledge, which then can be patented.

While family firms generally innovate less (Guenther et al. 2023) given the ability-willingness paradox, firms that invest in developing their knowledge internally create a bridge between external innovations and internal capabilities, making it easier to integrate and apply new ideas in-house. Absorptive capacity in firms will change routines and processes aiming at new knowledge creation, which means firms can continually innovate and adapt to changes in the market, and particularly for family firms, this may ensure long-term orientation, ability to innovate in the long term (Carnes et al. 2022).

In addition to R&D investment, cultivating a knowledgeable workforce by hiring STEM and highly skilled workers in areas relevant to the firm's industry can enhance a firm's ability to engage with and benefit from external knowledge (Audretsch and Belitski 2022). In conclusion, investment in internal knowledge will facilitate absorptive capacity in firms of different ownership by enhancing the firm's ability to directly produce and commercialize ideas and by engaging with external knowledge. This capability not only supports the direct application of new ideas but also positions firms to take advantage of broader knowledge spillovers and direct collaborations. We hypothesize:

**H2.** *An increase in firm's absorptive capacity positively affects product innovation, with no difference in the effect between family and non-family firms.*

### 2.3 | Regional Knowledge Collaboration and Firm Innovation

It has been argued that a firm's geographical distance from the source of knowledge constrains innovation activity and limits engagement with external knowledge partners (Balland et al. 2015). Knowledge collaboration on innovation requires a significant exchange of tacit knowledge (Audretsch and Feldman 1996) and trust (Khlystova et al. 2022), suggesting that face-to-face interactions between partners are crucial for knowledge collaboration and firm innovativeness. Prior research argued that external collaborators located outside immediate geographical proximity may be more difficult to trust and sustain communication with (Khlystova et al. 2022), particularly for family firms (FFs) who rely on local partners and trust for knowledge collaboration (De Massis et al. 2018; Guenther et al. 2023).

Regional collaboration on innovation is important for both family and non-family firms to recognize customers' attitudes, values, norms, routines, and expectations; however, the effect of regional collaboration on innovation in family firms is likely to be larger compared to non-family firms. First, family firms aim to create social capital, which depends on face-to-face interactions and their frequency with suppliers, customers, universities, and local government, which influences the way family firms innovate (Baù et al. 2019). Second, similarities in culture and regulation, which can be leveraged through collaboration with customers and suppliers, support FFs in adjusting and adapting their technologies and products to a local market first, before going international (Belitski and Rejeb 2022).

The concepts of cognitive and cultural proximity further explain why knowledge co-creation locally is most attractive for FFs and why they are often the first to exploit it. This refers to the influence of similarities and diversities in organizational culture, norms, and routines in local markets—how actors perceive, interpret, and evaluate knowledge—on effective communication and knowledge transfer within a partnership. A unique cognitive base of different types of domestic economic actors is expected to be substantially similar, as will their role within inter-organizational partnerships (Boschma 2005).

While De Massis et al. (2015) argue that family firms' innovation management tends to be more flexible, a family firm business model can be resistant to change. For example, long-term family goals and values may be associated with community embeddedness and local needs (Baù et al. 2019) and potential conflicts among family members about moving away from a region.

FFs may want to reduce costs by experimenting with innovation and can do so using local markets with a higher level of trust in firms that have been in the region for a long time, and also reduce potential risks related to scaling their production

internationally in unknown cultures of consumption and innovation (Pukall and Calabrò 2014) if they expand to other regions and countries. Finally, according to stewardship theory, governance dimensions of FFs foster pro-organizational behavior that prioritizes new uses for local resources and employees (Carney 2005). Family guardianship, consisting of trustees and councils that are locally embedded, aims at protecting the longer-term viability of the family firm and often pursues regional innovation and governance strategies (Scholes et al. 2021).

To enrich the positioning of the argument, one could examine the case of the Italian family-owned firm, Luxottica, founded in 1961 in the town of Belluno, Italy, a global leader in eyewear manufacturing whose strategic approach to innovation and knowledge collaboration locally provides a showcase of the importance of regional collaboration for innovation before scaling internationally (Gallucci et al. 2016). Here are some facts. Luxottica has long emphasized the importance of local, hands-on interactions in driving its innovation. The region is renowned for its craftsmanship in eyewear, providing Luxottica with a rich pool of local expertise and specialized skills. This proximity to a knowledgeable workforce and a cluster of related businesses has allowed Luxottica to foster strong regional collaborations that are crucial for its innovative processes. Luxottica has strategically collaborated with local universities, technical institutes, and suppliers to stay at the forefront of technological advancements and design innovations in eyewear. These collaborations ensure that Luxottica's products are both technically advanced and culturally relevant, adhering to the esthetic values and norms of its primary regional market. Finally, the cognitive and cultural proximity between Luxottica and its regional partners enhances its ability to effectively communicate and transfer knowledge and adapt its products to enhance local reputation for innovation. We hypothesize:

**H3.** *Collaborating with regional partners has a larger effect on product innovation in family firms compared to non-family firms.*

### 2.4 | International Knowledge Collaboration and Firm Innovation

While localization of knowledge collaboration is important for family firms (Carney 2005; Baù et al. 2019), over time a focus on regional knowledge collaboration may result in a lock-in effect (Boschma 2005; Balland et al. 2015). Exclusive regional contacts could limit the development of a firm's international capabilities and reputation, particularly for firms that directly compete with international companies or aim to export. Therefore, for more radical and new knowledge, family firms (FFs) may need to search for international partners in different geographical markets.

Recent studies on innovative firms in the United States and Europe have demonstrated that firms that develop digital competencies and can adopt digital technologies could sustain and develop international communication and growth (Audretsch and Belitski 2024; Ceipek et al. 2021), with FFs embracing digital business to innovate their business model and international outreach (Soluk et al. 2021).

Collaboration with regional partners is relevant for FFs who can use customers they know as a testing ground for new products and services, before scaling up internationally. In regional and national markets, the competition is less intense, and the protection of intellectual property rights could be better enforced than in the international institutional environment with different intellectual property standards, regulations, and intense competition, leading to positive effects of collaboration, with high relevance for family firms (Chirico et al. 2020).

Unlike local and national markets, which offer knowledge only relevant to specific industries and customers, collaboration internationally may render more niche and rare knowledge, increasing firm innovativeness. In the domestic context, and often limited by local hiring and family contacts, bifurcation bias may kick in (Kano et al. 2021), and to break through with new talent and competition, FFs are pushed for more skillful employees and ideas internationally. First, Kano and Verbeke (2018) demonstrated how FFs might achieve higher innovation outputs compared to non-family firms if they are able to overcome bifurcation bias and learn efficient innovation governance structures internationally. Second, the knowledge received through international collaboration could be immediately applied in the home market given the greater connectedness and trust between local customers and family firms (Guenther et al. 2023), and given the localized entrepreneurial orientation of FFs (Kellermanns et al. 2008). Third, unlike their local competitors, FFs are likely to pay more attention to heterogeneous knowledge sources internationally due to their consistency of business models, uniqueness, and family firm asset specificity (Colombo et al. 2016). Fourth, knowledge received from international partners by FFs will be mainly tacit, needed for radical innovation as FFs employ personal outreach and proximity when pursuing their internationalization strategies (Kano et al. 2021). This focus on socioeconomical wealth and stewardship, in combination with the ability to reach out to international partners, for example using modern-day technologies such as screen sharing and whiteboard options in Zoom telecommunications, will ensure sourcing tacit knowledge internationally (Ceipek et al. 2021; Audretsch et al. 2024), with a very personalized attitude and long-term orientation toward customers and suppliers (De Massis et al. 2018).

To enrich the argument, we illustrate the case of the Barilla Group, an Italian family-owned food company that manufactures various types of pasta and that effectively employs both regional and international knowledge collaboration for innovation (Bernhard 2018). Founded in 1877 in Parma, Italy, Barilla has grown from a small shop that made bread and pasta to a global leader. The company has long benefited from its strong regional ties, sourcing wheat and other ingredients locally and maintaining close relationships with local and national suppliers and customers. These regional collaborations have helped Barilla develop products tailored to local tastes; however, the executive board and shareholders aimed at expanding internationally to overcome the "lock-in" effect described by Boschma (2005). Recognizing the need for more diversified knowledge than local, Barilla began to form partnerships with international food innovators and research institutions, starting a series of health-conscious and sustainable products responding to global

consumer trends. This was the outcome of collaboration with international nutritional experts and food scientists to develop a new line of whole-grain and gluten-free products (Pogutz and Winn 2016). International collaboration for innovation not only diversified their product portfolio but also catered to global customers increasingly concerned with health and dietary restrictions.

Embracing international collaboration, Barilla has utilized digital technologies to overcome geographical barriers and facilitate knowledge exchange with partners across the globe (Audretsch et al. 2024). They have adopted advanced communication tools and platforms for real-time collaboration, which allowed them to tap into the expertise of food technologists globally and implement ideas around the world quickly into manufacturing. We hypothesize:

**H4.** *Collaborating with international partners has a larger effect on product innovation in family firms compared to non-family firms.*

## 3 | Data and Method

### 3.1 | Data and Sample

To test our research hypothesis, we used data collected as part of the Community Innovation Survey (UKIS) conducted biannually by the Office of National Statistics (ONS). UKIS data are gathered through an EU-wide, harmonized survey created in accordance with the guidelines of the third revision of the OECD Oslo Manual (OECD 2005) and widely used in the innovation literature (Belderbos et al. 2004; Audretsch et al. 2021). Unlike prior research, which often focused on cross-sectional data or two-year panel data (Kobarg et al. 2019), we used the 2006–2016 editions of the CIS, which included data from the years between 2006 and 2016. This specific range of data was the most recent one that contained information on the geography of collaboration and various forms of internal knowledge investment and innovation performance data, including both incremental and radical innovation, as well as process innovation, which we required.

To collect the data, the ONS sent questionnaires to at least 26,500 companies biannually starting from 2004. Usable questionnaires were returned from between 7414 and 15,050 companies, depending on the year of the survey, with a response rate between 36% and 57%. To control for potential non-respondent bias, additional companies (the percentage of total is not reported in the survey) were surveyed by phone by the Office of National Statistics.

As we aimed to investigate the influence of internal investment in knowledge and external collaborative innovation activities on incremental and radical innovation output at the firm level, we had to limit our analysis to companies that provided information about their collaborative activities, R&D, the share of employees with a university degree or higher, and their sales of products that are new to the market and to the firm. Data regarding employment, age, and firm ownership were collected and matched from six pooled cross-sectional datasets from the Business Structure Database (BSD), known as the Business Register during 2004–2016. We followed the procedure in data collection and matching.

First, we collected six and matched six consecutive innovation surveys from 2006 to 2016 from the ONS, United Kingdom. Second, we matched the innovation survey with the microdata by year and firm identification number from the BSD—a survey conducted annually by the ONS. The result of the match between the BSD and UKIS resulted in 64,192 firm-year observations. Finally, when deleting firms with missing values for the variable used in our model, our sample was reduced to 13,289 firm-year observations and 9266 firms. All missing values and nonapplicable answers were labeled as missing and, therefore, not included in our sample. Across six surveys, we have 20.01% of observations from the years 2004 to 2006 (2659 firms), 10.91% from 2006 to 2008 (1450 firms), 21.97% from 2008 to 2010 (2919 firms), 14.94% from 2010 to 2012 (1986 firms), 16.24% from 2012 to 2014 (2158 firms) and 15.91% of observations from 2014 to 2016 (2114 firms). Not all firms were observed each year, as the sample of innovative firms is rotating and not repeated.

### 3.2 | Variables

#### 3.2.1 | Dependent Variables

The share of new-to-market products derived from the innovation survey is used as a proxy for innovation output and was rescaled between 0 and 1 for econometric modeling purposes. This variable is widely used in the innovation literature, serving as a proxy for innovation outputs for family firms (Chirico et al. 2020). New product sales reflect the share of new products and services that are new to a firm, its industry, and the market, often perceived as an indicator of innovative behavior (Kobarg et al. 2019).

#### 3.2.2 | Explanatory Variables

We have two sets of explanatory variables to measure the effect of absorptive capacity on innovation (Kobarg et al. 2019; Audretsch et al. 2024) and the extent and geography of knowledge collaboration with external partners. We used "in-house R&D expenditure" (log-transformed) as a measure of the firm's absorptive capacity (Santamaría et al. 2009) and the firm's human capital measured as the share of employees with university degrees and above (e.g., MSc, MBA, PhD, postdoc) in engineering and technology in total full-time employment ("Human capital"). These variables are used to test Hypothesis 2 (H2).

To test Hypotheses 3 and 4 (H3 and H4), we added four explanatory variables for knowledge collaboration on innovation, each equal to one if a firm collaborates on innovation and R&D activities with at least one collaboration partner regionally, nationally, in Europe, or internationally (beyond Europe). The type of collaboration partners could be suppliers of equipment, materials, services, or software; clients or customers; competitors or other businesses in the industry;

consultants; commercial labs or private R&D institutes; universities or other higher education institutions; or government or public research institutes. Zero otherwise (Audretsch and Belitski 2022).

Finally, our key explanatory variable is whether a firm is family-owned. We draw on family business literature and define an FF as partly or wholly controlled and owned by family members. We used 50% family ownership as a cutoff for family ownership criteria (see Guenther et al. 2023). There was an issue with indirect ownership, such as through holding structures and firm cross-holdings, which we should have considered under family ownership. In the United Kingdom, surnames can change after marriage, and we could not track family ownership in such cases. We had about 16% FFs in our sample after applying this cutoff criterion.

#### 3.2.3 | Control Variables

To control how innovation changes with innovation in business models and practices and in family-owned businesses (De Massis et al. 2013, 2018), we used a binary variable equal to one if a firm introduces new business models and practices for organizing procedures (e.g., supply chain management, business re-engineering, knowledge management, lean production, quality management, etc.), and zero otherwise. To explain the differences in innovation behavior between family and non-family firms, we rely on the social–emotional wealth (SEW) theory (Gómez-Mejía et al. 2007; Zellweger et al. 2013). We used "New organizational methods internal," which is a binary variable equal to one if a firm introduces new methods of organizing work responsibilities and decision-making internally (e.g., using a new system of employee responsibilities, teamwork, decentralization, integration or de-integration, education/training, etc.) and zero otherwise; and "New organizational methods external," which is a binary variable equal to one if a firm introduces new methods of organizing external relationships with other firms or public institutions (e.g., first use of alliances, partnerships, outsourcing, or subcontracting, etc.) and zero otherwise. To examine the effect of entrepreneurial behavior and orientation on innovation, drawing on Hornsby et al. (2013), we use an ordinal variable as the extent to which a firm prioritizes the importance of experimentation and innovation related to increasing the range of goods or services and increasing market share in the decision to innovate in goods or services and processes. These self-reported measures are the most commonly utilized in innovation literature and to measure the risk-taking behavior of firms (Gómez-Mejia et al. 2022).

In addition to formal collaboration with external partners, firms might access knowledge as a positive externality via spillovers (Audretsch and Feldman 1996). We include the "knowledge spillover" variable, which is calculated as a sum of scores (0 to 3) of how important to innovation activities was information from conferences, trade fairs, or exhibitions; professional and industry associations; technical, industry, or service standards; and scientific journals and trade/technical publications (rescaled between zero and one). Product innovation is unlikely without improving the processes of how innovation is created. Thus, we use a binary variable "Process innovation," which indicates whether a firm introduces process innovation, and zero otherwise. Process innovations are all new or significantly improved methods; although new to the business, they do not need to be new to the industry. Standard controls include "Firm age" and "Firm employment," both measured as a logarithm of firm age and as a logarithm of firm full-time employees, capturing potential decreasing marginal returns to firm age and size for innovation (Kobarg et al. 2019). We use a binary variable equal to one if a firm invests in internal training for innovation and zero otherwise. We also control for sales abroad as a measure of internationalization with a binary variable "Exporter" and whether a firm is a subsidiary of a multinational or a foreign firm using the variable "Foreign."

Finally, to capture the fixed effects between and within industries, we include 70 industry dummies (SIC code 2 digits) (mining and quarrying is a reference category), albeit they are suppressed to save space. We include 128 region-city fixed effects where firms are located (Aberdeen is a reference category) and six-year fixed effects (2002–2004 period as a reference category). A full list of variables is in Table 1, while the correlation matrix is in Appendix A.

Table 2 illustrates the sample distribution by industry and region during 2004–2016 and provides information on the number of observations.

### 3.3 | Methodology

We used a multilevel mixed-effects logistic model by using a generalized estimation equation, the bounded dependent variable $y_{ijk}$ between [0,1] and a truncated distribution, and the independent variable $x_{ijk}$ such that:

$$y_{ijk} = \beta_0 + \beta_1 x_{ijk} + \beta_2 \tau_{ijk} + \varepsilon_{ijk} \quad (1)$$

where i is the firm level-1, j is the region level-2 and k serves to index the wave survey level-3. The dependent variable $y_{ijk}$—innovation output. The explanatory variables and interactions are in $x_{ijk}$. Other control variables, which represent firm-specific characteristics, as well as city-region, industry and wave fixed-effects described in Table 2 are presented in $\tau_{ijk}$. Finally, $\varepsilon_{ijk}$ is an error term that consists of three components in the hierarchical model:

$$\varepsilon_{ijk} = \gamma_i + \mu_j + t_{k.} + \nu_{ijk} \quad (2)$$

where $\gamma_i$ represents the omitted variables that vary across firms but not over regions and waves, $\mu_{ij.}$ denotes the omitted variables that vary over regions but are constant across firms and time, $t_k$ represents omitted variables which vary across waves, but not across firms and regions, while finally $\nu_{ijk}$ is the error term. Additionally, a multilevel model enables to control for the effect that a city-region and time period shapes firm innovative performance. It also demonstrates that innovative performance is not independent from the influences of time and regional effects. The co-variation between firm innovative performance, sharing the same regional externalities can be expressed by the

**TABLE 1** | Descriptive statistics.

| Label | Description of variables | Survey used | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|---|
| Radical innovation sales | Percentage of sales of products and services that are new to the market and industry in total sales, rescaled from (0%–100%) to (0 to 1) | UKIS | 0.042 | 0.126 | 0 | 1 |
| Incremental innovation sales | Percentage of sales of products and services that are new to the firm, but are not new to market or industry, in total sales, rescaled from (0%–100%) to (0 to 1). This variable is used as part of robustness check | UKIS | 0.049 | 0.122 | 0 | 1 |
| Family firms | Binary variable equal one if firm is owned (at least 50%) by a family, zero otherwise | BSD | 0.159 | 0.365 | 0 | 1 |
| Age | Age of a firm, in logarithms | BSD | 2.670 | 0.739 | 0 | 3.987 |
| Employment | Number of FTEs employees, in logarithms | BSD | 3.965 | 1.446 | 0.693 | 10.778 |
| Innovation training | Binary variable equal one if a firm invests in internal training for innovation, zero otherwise. | UKIS | 0.436 | 0.496 | 0 | 1 |
| New business models | Binary variable equal one if firm introduces new business model and practices for organizing procedures (i.e., supply chain management, business re-engineering, knowledge management, lean production, quality management etc.), zero otherwise | UKIS | 0.238 | 0.426 | 0 | 1 |
| New organizational methods internal | Binary variable equal to one if a firm introduces new methods of organizing work responsibilities and decision-making internally (i.e., use of a new system of employee responsibilities, teamwork, decentralization, integration or de-integration education/training etc.), zero otherwise | UKIS | 0.227 | 0.419 | 0 | 1 |
| New organizational methods external | Binary variable equal to one if a firm introduces new methods of organizing external relationships with other firms or public institutions (i.e., first use of alliances, partnerships, outsourcing, or sub-contracting, etc.), zero otherwise. | UKIS | 0.252 | 0.434 | 0 | 1 |
| Entrepreneurial behavior | How important were increasing range of goods or services and increasing market share in your decision to innovate in goods or services, processes? From 0—not important to 3 very important | UKIS | 1.272 | 1.229 | 0 | 3 |
| Process innovation | Binary variable = 1 if firm introduced any new or significantly improved processes for producing or supplying goods or services, zero otherwise. | UKIS | 0.255 | 0.436 | 0 | 1 |
| R&D investment | Internal Research and Development expenditure (£) in logs | UKIS | 1.298 | 2.162 | 0 | 13.265 |
| Knowledge spillover | Sum of scores (0 to 3) of how important to innovation activities was information from: conferences, trade fairs or exhibitions; professional and industry associations; technical, industry or service standards; scientific journals and trade/technical publications (rescaled between zero and one). | UKIS | 0.289 | 0.275 | 0 | 1 |

(Continues)

**TABLE 1** | (Continued)

| Label | Description of variables | Survey used | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|---|
| Regional collaboration | Binary variable equal one if firm collaborates on innovation with at least one external collaboration partners within the region, zero otherwise | UKIS | 0.146 | 0.353 | 0 | 1 |
| National collaboration | Binary variable equal one if the firm collaborates on innovation with at least one external collaboration partners outside region, but within the country, zero otherwise | UKIS | 0.187 | 0.390 | 0 | 1 |
| Europe collaboration | Binary variable equal one if firm collaborates on innovation with at least one external collaboration partners in European countries, zero otherwise | UKIS | 0.095 | 0.293 | 0 | 1 |
| International collaboration | Binary variable equal one if firm collaborates on innovation with at least one external collaboration partners internationally (outside Europe), zero otherwise | UKIS | 0.080 | 0.269 | 0 | 1 |
| Human capital | The proportion of employees that hold a degree or higher qualification in science and engineering at BA/BSc, MA/PhD, PGCE levels | UKIS | 7.041 | 16.811 | 0 | 100 |
| Exporter | Binary variable equal one if a firm sells its products in foreign markets, 0 otherwise | UKIS | 0.376 | 0.484 | 0 | 1 |
| Foreign | Binary variable equal one if a firm has headquarters abroad (international company, or MNE subsidiary), zero otherwise | BSD | 0.432 | 0.495 | 0 | 1 |

*Note:* Number of observations: 13,289 firm-year observations, controlling for missing values in all variables.
*Source:* Department for Business, Innovation, and Skills, Office for National Statistics, Northern Ireland. Department of Enterprise, Trade and Investment (2018) (hereinafter UKIS-UK Innovation survey). Office for National Statistics (2017) (hereinafter BSD Business Structure Database).

**TABLE 2** | Industrial and regional distribution in a sample.

| Industry distribution | Firms | Share | Regional distribution | Firms | Share |
|---|---|---|---|---|---|
| 1. Mining and quarrying | 118 | 0.89 | North East | 1006 | 7.57 |
| 2. Manufacturing basic | 780 | 5.87 | North West | 977 | 7.35 |
| 3. High-tech manufacturing | 2734 | 20.57 | Yorkshire and the Humber | 1412 | 10.63 |
| 4. Electricity, gas, and water supply | 110 | 0.83 | East Midlands | 1233 | 9.28 |
| 5. Construction | 1417 | 10.66 | West Midlands | 1238 | 9.32 |
| 6. Wholesale, retail trade | 2211 | 16.64 | Eastern | 1089 | 8.19 |
| 7. Transport, storage | 728 | 5.48 | London | 219 | 1.65 |
| 8. Hotels & restaurants | 685 | 5.15 | South East | 1781 | 13.40 |
| 9. ICT | 832 | 6.26 | South West | 1033 | 7.77 |
| 10. Financial intermediation | 356 | 2.68 | Wales | 1096 | 8.25 |
| 11. Real estate and other business activity | 1567 | 11.79 | Scotland | 452 | 3.40 |
| 12. Public admin, defense | 1271 | 9.56 | Northern Ireland | 1753 | 13.19 |
| 13. Education | 153 | 1.15 | **Total** | 13,289 | **100.00** |
| 16. Other community, social activity | 327 | 2.46 | | | |
| **Total** | 13,289 | 100.00 | | | |

*Note:* Number of observations 13,289 after controlling for missing values in all variables.
*Source:* UKIS-UK Innovation survey; BSD Business Structure Database.

intra-class correlation (Goldstein 2011). With this, the between-regions variance contributes to firm innovation outputs in addition to the variance between firms.

## 4 | Results

First, we used a multilevel modeling approach to estimate Equation (1) by utilizing the "xtmixed" command in Stata 18 to estimate mixed-effects Generalized Least Squares (GLS). This model assesses the effect of absorptive capacity and knowledge collaboration in family firms (FFs) versus non-family firms (non-FFs) on product innovation. Mixed-effects GLS is appropriate for our analysis because firms are embedded in the regions where they are located. We began by running the mixed-effects GLS regression on product innovation sales without any independent or control variables in the "empty model" (Models 1, Table 3) to examine the between-group (region) variance.

In Table 3 (specification 2), we add all explanatory and control variables, including the binary family firm variable, while in specifications 3–8, we add interactions between the family firms binary variable and each measure of absorptive capacity (specs. 3–4, Table 3) and knowledge collaboration (specs. 5–8, Table 3). Finally, in specification 9 (Table 3), we include all interactions between family firm and other explanatory variables. We find support for H1, which states no difference between FFs and non-FFs in innovation outputs ($\beta = 0.83$, $p > 0.01$) (Table 3, spec. 2), further extending our understanding of low firm performance. The results do not change when interactions are introduced, as the coefficient for family firms remains insignificant.

Our H2, which states that an increase in a firm's absorptive capacity positively affects product innovation, with no difference in effect between family and non-family firms, is supported. An increase in R&D investment by 1% is associated with a 24 percentage point increase in product innovation (specs. 2–8, Table 3). An increase in human capital by 1% is associated with a one percentage point increase in product innovation (specs. 2–8, Table 3). The interaction coefficients of family firms and human capital ($\beta = 0.99$, $p > 0.10$) and investment in R&D and family firms ($\beta = 1.02$, $p > 0.10$) are insignificant (specs. 3–4, Table 3). This means that the effect of a firm's absorptive capacity on product innovation is independent of firm ownership, so both family and non-family firms can use absorptive capacity to facilitate innovation outputs.

Family firms that collaborate on knowledge with at least one external partner in the region where they are located, compared to family firms that do not collaborate regionally and non-family firms, are likely to increase product innovation by 2.17 times (spec. 5, Table 3), supporting H3. The effect is not significant when family firms collaborate on knowledge with national or European partners. The interaction effect becomes significant again when family firms collaborate with partners outside the United Kingdom and Europe. A family firm that collaborates with at least one international partner on knowledge, compared to non-family firms or family firms that do not collaborate internationally, is likely to increase its product innovation by 2.79 times (spec. 8, Table 3), supporting H4. Compared to national

**TABLE 3** | Main regression results for firm innovation using mixed effects GLS regression model.

| Specification | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
|---|---|---|---|---|---|---|---|---|---|---|
| Dependent variable | | | | | Radical innovation | | | | | Incremental innovation |
| Family firms (H1) | | 0.86 | 0.88 | 0.86 | 0.73* | 0.84 | 0.88 | 0.84* | 0.73** | 0.61*** |
| | | (0.08) | (0.08) | (0.09) | (0.08) | (0.08) | (0.08) | (0.08) | (0.11) | (0.07) |
| Family firms × Human capital (H2) | | | 0.99 | | | | | | 0.99 | 1.00 |
| | | | (0.01) | | | | | | (0.06) | (0.01) |
| Family firms × R&D investment (H2) | | | | 1.02 | | | | | 1.04 | 1.05 |
| | | | | (0.07) | | | | | (0.07) | (0.07) |
| Family firms × Regional collaboration (H3) | | | | | 2.17*** | | | | 2.53*** | 1.69*** |
| | | | | | (0.46) | | | | (0.62) | (0.38) |
| Family firms × National collaboration | | | | | | 1.16 | | | 0.70 | 0.91 |
| | | | | | | (0.26) | | | (0.20) | (0.23) |
| Family firms × Europe collaboration (H4) | | | | | | | 0.81 | | 0.46 | 0.75 |
| | | | | | | | (0.32) | | (0.22) | (0.33) |
| Family firms × Intern. collaboration (H4) | | | | | | | | 2.79** | 3.91** | 4.33** |
| | | | | | | | | (0.05) | (1.23) | (1.53) |
| Age | | 0.93* | 0.94* | 0.94* | 0.93* | 0.94* | 0.94 | 0.94 | 0.93* | 0.95 |
| | | (0.03) | (0.03) | (0.03) | (0.03) | (0.03) | (0.03) | (0.03) | (0.03) | (0.03) |
| Employment | | 0.84*** | 0.85*** | 0.84*** | 0.84*** | 0.84*** | 0.84*** | 0.84*** | 0.84*** | 0.88*** |
| | | (0.02) | (0.03) | (0.03) | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) | (0.01) |
| Innovation training | | 1.36*** | 1.37*** | 1.36*** | 1.36*** | 1.36*** | 1.36*** | 1.36*** | 1.36*** | 1.43*** |
| | | (0.08) | (0.08) | (0.08) | (0.08) | (0.08) | (0.08) | (0.08) | (0.08) | (0.07) |
| New business models | | 1.15** | 1.16** | 1.15** | 1.14** | 1.15** | 1.15** | 1.15** | 1.15** | 1.25** |
| | | (0.07) | (0.07) | (0.07) | (0.07) | (0.08) | (0.08) | (0.08) | (0.07) | (0.07) |
| New organizational methods internal | | 1.00 | 1.00 | 1.01 | 1.01 | 1.01 | 1.00 | 1.01 | 1.01 | 0.94 |
| | | (0.06) | (0.05) | (0.06) | (0.06) | (0.07) | (0.07) | (0.07) | (0.06) | (0.05) |
| New organizational methods external | | 1.24*** | 1.23*** | 1.24** | 1.24** | 1.23** | 1.24*** | 1.23*** | 1.23** | 1.39*** |
| | | (0.08) | (0.08) | (0.08) | (0.08) | (0.08) | (0.08) | (0.08) | (0.08) | (0.08) |
| Entrepreneurial behavior | | 1.91*** | 1.91*** | 1.91*** | 1.90*** | 1.91*** | 1.91*** | 1.91*** | 1.90*** | 2.02*** |
| | | (0.05) | (0.05) | (0.05) | (0.05) | (0.05) | (0.05) | (0.05) | (0.05) | (0.04) |

(Continues)

**TABLE 3** | (Continued)

| Specification | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
|---|---|---|---|---|---|---|---|---|---|---|
| Process innovation | | 1.53*** | 1.53*** | 1.53*** | 1.54*** | 1.53*** | 1.53*** | 1.53*** | 1.54*** | 1.94*** |
| | | (0.09) | (0.08) | (0.08) | (0.08) | (0.09) | (0.09) | (0.09) | (0.09) | (0.10) |
| R&D investment | | 1.24*** | 1.24*** | 1.23*** | 1.24*** | 1.24*** | 1.24*** | 1.24*** | 1.23*** | 1.15*** |
| | | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) |
| Knowledge spillover | | 1.22* | 1.22* | 1.22* | 1.21* | 1.22* | 1.22* | 1.21* | 1.20 | 1.32*** |
| | | (0.14) | (0.14) | (0.15) | (0.15) | (0.14) | (0.14) | (0.14) | (0.15) | (0.15) |
| Regional collaboration | | 1.20** | 1.21** | 1.21** | 1.15* | 1.20* | 1.21** | 1.21** | 1.09* | 1.04 |
| | | (0.09) | (0.08) | (0.09) | (0.09) | (0.09) | (0.09) | (0.09) | (0.08) | (0.08) |
| National collaboration | | 1.36*** | 1.37*** | 1.36*** | 1.36*** | 1.34*** | 1.36*** | 1.36*** | 1.39*** | 1.41*** |
| | | (0.10) | (0.10) | (0.10) | (0.10) | (0.11) | (0.10) | (0.10) | (0.11) | (0.11) |
| Europe collaboration | | 1.09 | 1.09*** | 1.09*** | 1.12 | 1.09 | 1.10 | 1.09 | 1.15 | 0.93 |
| | | (0.11) | (0.11) | (0.11) | (0.11) | (0.11) | (0.11) | (0.11) | (0.12) | (0.09) |
| International collaboration | | 1.13 | 1.13 | 1.13 | 1.15 | 1.14 | 1.13 | 1.10 | 1.09 | 0.85 |
| | | (0.12) | (0.12) | (0.12) | (0.12) | (0.12) | (0.12) | (0.12) | (0.12) | (0.09) |
| Human capital | | 1.01*** | 1.01*** | 1.01** | 1.01** | 1.01** | 1.01** | 1.01** | 1.01** | 0.99*** |
| | | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| Exporter | | 1.66*** | 1.64*** | 1.64*** | 1.64*** | 1.64*** | 1.65*** | 1.64*** | 1.64*** | 1.40*** |
| | | (0.10) | (0.10) | (0.10) | (0.10) | (0.10) | (0.10) | (0.10) | (0.10) | (0.07) |
| Foreign | | 0.96 | 0.95 | 0.95 | 0.94 | 0.95 | 0.95 | 0.95 | 0.94 | 0.95 |
| | | (0.06) | (0.06) | (0.06) | (0.06) | (0.06) | (0.06) | (0.06) | (0.06) | (0.05) |
| Constant | 0.86*** | 0.13*** | 0.14*** | 0.14*** | 0.14*** | 0.14*** | 0.14*** | 0.14*** | 0.14*** | 0.25** |
| | (0.17) | (0.05) | (0.05) | (0.05) | (0.05) | (0.05) | (0.05) | (0.05) | (0.05) | (0.09) |
| Var (year) | 1.81** | 0.79** | 0.78** | 0.78** | 0.78** | 0.78** | 0.78** | 0.78** | 0.78** | 0.89** |
| | (0.87) | (0.46) | (0.46) | (0.46) | (0.46) | (0.46) | (0.46) | (0.46) | (0.46) | (0.47) |
| Var (year-region) | 0.05** | 0.06** | 0.06** | 0.06** | 0.06** | 0.06** | 0.06** | 0.06** | 0.06** | 0.02** |
| | (0.01) | (0.02) | (0.03) | (0.03) | (0.03) | (0.03) | (0.03) | (0.03) | (0.03) | (0.01) |
| Wald $\chi^2$ | 2846.33 | 2142.45 | 2149.13 | 2149.13 | 2150.73 | 2149.64 | 2146.02 | 2147.72 | 2151.43 | 2493.60 |
| Log-likelihood | −7375.52 | −4458.17 | −4457.14 | −4457.43 | −4450.57 | −4456.82 | −4457.88 | −4455.32 | −4446.52 | −5339.89 |
| LR test versus logistic model $\chi^2$ | 2903.88 | 783.41 | 784.00 | 784.50 | 784.50 | 784.60 | 779.70 | 778.10 | 770.50 | 984.29 |

*Note:* Standard errors are robust for heteroscedasticity in parentheses. Industry (2-digit SIC) and year fixed effects are suppressed to save space. Estimation method: Mixed-effects GLM: Radical product innovation regression (spec. 1–9) and incremental product innovation regression (spec. 10) Likelihood ratio test versus logistic model supports use of multi-level mixed-effects generalized linear model and null is rejected. The values of $\chi^2$ are between 2151 and 2846 for radical innovation specifications and 2493 for the incremental innovation specification. Significance level: *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.
*Source:* UKIS-UK innovation survey; BSD Business Structure Database.

and European collaboration (Audretsch and Belitski 2023), collaboration beyond Europe often provides a broader scope and variety of knowledge and market opportunities that can drive more significant innovation, given greater variation in supply and demand. Among these factors is the diverse knowledge that family firms are exposed to and different problem-solving approaches. Many family firms in the United Kingdom are often run by expats from Commonwealth countries outside Europe, where family relationships and knowing someone are particularly important for business models and for creating knowledge networks. Additionally, they gain access to customer mental models and technologies which may not be available in close cognitive proximity or in regional markets. Our results in specification 9 (Table 3), when we pool all interactions together in one regression, support our individual effects findings, making the overall analysis consistent.

Not surprisingly, we found that family firms are neither more nor less innovative than non-family firms; rather, they can leverage external knowledge collaborations to enhance innovation outputs. This extends prior research by Rondi et al. (2021) and Guenther et al. (2023), who demonstrated that family firms are less willing but more able to collaborate, especially within local communities and with customers, and that collaboration is a boundary condition for family firm innovation. Firms that are unwilling or unable to collaborate regionally and internationally will have, on average, 27% less innovation sales (see specs. 5 and 8, Table 3). Our results challenge the traditional notion that family firms are embedded in local communities, are conservative, and might innovate less (De Massis et al. 2018). They extend the argument that family firms with the ability and willingness to pursue a knowledge collaboration strategy might outperform their non-family counterparts (Rondi et al. 2021).

We would like to discuss other determinants of innovation. The introduction of new business models related to establishing practices for organizing procedures (e.g., supply chain management, business re-engineering, etc.) increases product innovation by 1.15 times (specs. 2–8, Table 3). The direct effect of introducing new methods of organization internally for innovation is insignificant, while introducing new methods of organizing external relations increases product innovation by 1.23 times (specs. 2–8, Table 3). Firms that adopt entrepreneurial behavior and orientation increase product innovation by 1.91 times (specs. 2–8, Table 3), supporting Chirico et al. (2020). Exporters to Europe and other international countries have, on average, 64%–65% higher innovation output ($\beta = 1.64$–$1.65$, $p < 0.01$) (specs. 3–8, Table 3). Foreign-owned firms have, on average, the same innovation outputs as domestic firms. Finally, we do not find support for knowledge spillover being a significant predictor of innovation, unlike in Audretsch and Belitski (2022), while we instead find that formal knowledge collaboration enables firms to innovate, which is likely to be associated with further knowledge transfer via spillovers. Firms that collaborate with regional partners have, on average, 18%–19% greater innovation sales than those firms that do not collaborate regionally ($\beta = 0.18$–$0.19$, $p < 0.001$) (specs. 3–8, Table 3). Firms that participate in international conferences, fairs, industry associations, and source knowledge from open sources as a form of spillover have, on average, 22% higher innovation sales ($\beta = 1.22$, $p < 0.01$) (specs. 3–8, Table 3).

### 4.1 | Robustness Check

We estimated Equation (1) with the Tobit data model instead of mixed effect generalized least squares (GLS) estimation to test whether the major results hold and whether our hypotheses are supported. Our dependent variable is a new-to-market product share, which is left censored (some firms have zero innovation sales). The results of Tobit estimation confirm the results in Table 3.

Furthermore, when estimating Equation (1), it was necessary to control for a sample selection bias which could have originated from the fact that we moved from 64,192 observations to 13,289 observations with no missing values. Heckman (1979) procedure is used to test and correct for the selection bias using all available $n$ observations, estimate the probit model of $S_i$ on $Z_i$ and obtain the estimates $\hat{\gamma_h}$. $S_i$ is a selection indicator which captures whether or not innovation output was observed in the initial model of 64,192 observations ($S_i$). $S_i$ indicates we will use the observation in our analysis; $S_i = 0$ means the observation will not be used. Given missing and unreported values of innovation outputs we use less than n (64,192 observations) in our sample, say $n_i$ (13,289 observations). In the selection equation of the Heckman (1979) procedure, our dependent variables $y_i$ are binary, equal one if innovation was reported by a firm (i) (innovation output), zero otherwise. The inverse Mill's ratio $\hat{\lambda}_i = \lambda(z, \hat{\gamma})$ for each $i$ is computed automatically. Using the selected sample, that is, the observations for which $S_i = 1$ we run the regression of

$$y_i \text{ on } x_i \text{ and } \hat{\lambda}_i \tag{3}$$

The equation provides a simple test of selection bias in innovation activity. We use the usual t-statistics on $\hat{\lambda}_i$ as a test of null

**TABLE 4** | Random-effects probit estimates.

| | Innovation active (D = 1) | |
|---|---|---|
| **Two-step Heckman approach** | **Coef.** | **SE** |
| Age | −0.015 | 0.000*** |
| Employment | 0.238 | 0.001*** |
| Human capital | 0.346 | 0.011** |
| R&D external investment | 0.543 | 0.055*** |
| Investment in machinery and other ICT equipment | 1.239 | 0.430** |
| Constant | −1.348 | 0.123*** |
| Sigma u | 1.344 | 0.030 |
| Rho | 0.544 | 0.011 |
| Observations | 64,192 | |
| Industry, wave, and city-region fixed effects | Yes | |
| Wald $\chi^2$ | 1431.39 | |

*Note:* ***, **, and * Significance at the 1%, 5%, and 10% levels, respectively. Industry = Mining; Reference region = Aberdeen; year-wave = 2004–2006.
*Source:* UKIS-UK Innovation survey; BSD Business Structure Database.

hypothesis: $\rho = 0$. In addition to $x_i$, we used two variables in the selection equation such as Buying R&D and investing in knowledge and other ICT equipment (see Table 3). These variables are associated with the propensity to innovate and are used as exclusion criteria. Mills ratio calculated from Table 4 is further included in regression (1) to control for potential selection bias. The coefficient was not statistically significant which means the selection bias was unlikely.

Finally, we estimated Equation (1) using the same method of mixed-effect GLS estimation, with the dependent variable being the percentage of sales from products that are new to the firm but not to the market (incremental innovation) also used in recent family business research (De Massis et al. 2021, 2023). Our H1 and H2 hypotheses, which propose no difference in the effect of product innovation between family and non-family firms, are supported, as is the idea that both family and non-family firms are equally able to benefit from an increase in the firm'ss absorptive capacity for product innovation. The main differences lie in the effects of knowledge collaboration internationally and regionally for family firms (spec. 10, Table 3). The effect size is higher for international knowledge collaboration on incremental innovation in family firms, while the effect size is lower for regional collaboration and incremental innovation in family firms. Our results demonstrate that knowledge spillovers primarily facilitate incremental innovation, contrasting prior research on knowledge spillovers for different innovation outcomes (Audretsch and Belitski 2022). The direct effect of regional collaboration on firm incremental innovation is not significant, while an increase in highly skilled workers reduces product innovation, unlike the effect seen in radical innovation.

## 5 | Discussion

Our study is different from previous research by focusing on innovation in family firms (De Massis et al. 2015, 2023) to examine factors that enable family firms to leverage product innovation through greater engagement in knowledge collaborations within local markets and internationally. Recent studies on innovation in family versus non-family firms (De Massis et al. 2016, 2021) have begun to focus on the resources within the firm and their mobilization for innovation, as well as on the behavioral characteristics that drive this process.

Using extensive secondary data on UK-based firms from 2004 to 2016, we theorized and empirically tested four research hypotheses related to the role of absorptive capacity and knowledge collaboration for radical and incremental innovation outputs in family and non-family firms. Our findings support our research hypotheses and provide further insights into the impact of various knowledge investment and sourcing for knowledge co-creation and commercialization by family and non-family firms. Co-creating innovation with multiple external partners domestically and internationally will require additional changes in the entrepreneurial climate within an organization and experimentation with new business models, markets, and products. This is especially important for family firms, which tend to have a liability of community orientation, reliance on tradition, and a general lack of financial and human resources (De Massis et al. 2021). Cost-sharing and risk-sharing are important drivers of innovation for family firms (Hoskisson et al. 2017), making regional and international knowledge collaboration a boundary condition for increased product innovation, whereas a lack of collaboration can lead to reduced product innovation for family firms.

Family firms (FFs) often face several challenges that limit their capacity for innovation, including a lack of external funding, restricted access to specialized knowledge and technology, and resistance to change due to family traditions and legacy (Jaskiewicz et al. 2020). Their reliance on networks and regional ecosystems (Audretsch and Belitski 2017) means that family firms, which are usually smaller and less specialized, may incur additional costs related to knowledge transfer.

There are several innovation strategies that FFs can employ to overcome these limitations and stimulate innovation. First, FFs may establish formal innovation processes, which include a systematic and structured approach to innovation, such as setting clear goals, identifying opportunities, generating new ideas, validating concepts, and implementing successful innovations. Family firms can also build innovation capabilities by investing in research and development, hiring innovation experts, and fostering a culture of experimentation, risk-taking, and continuous learning (Gómez-Mejia et al. 2022). Collaboration with external partners (Feranita et al. 2017; Audretsch and Belitski 2020), such as universities, research institutions, suppliers, and customers, particularly regionally and internationally, can provide family firms with access to specialized knowledge and technology, as well as local resources and international technology and problem-solving techniques (Colombo et al. 2016).

Second, FFs are more likely to have sustainable growth and often non-commercial goals (Kotlar et al. 2014; De Massis et al. 2016), which may limit their size and employment growth rates and consequently their ability and willingness to engage in collaboration (Guenther et al. 2023). Family firms face the dilemma of choosing between actions that would bring economic gains and those that would protect socioemotional wealth. The regional embeddedness of family firms allows them to benefit from the knowledge and resources of a diversity of external partners, which facilitates resource and knowledge exchange locally and internationally.

Family firms can also benefit from encouraging diversity by engaging with customers and suppliers from different cultures and backgrounds, international clusters, governments, science parks, and universities. By employing these strategies, family firms can overcome innovation limitations and create a culture of innovation and creativity that contributes to their long-term success and sustainability.

## 6 | Conclusion

While family firms may be resistant to change, investing in their absorptive capacity and knowledge collaboration with external partners can be a conduit for product innovation, potentially leading to innovation levels that are comparable to or even exceed those of non-family firms. Greater diversity in knowledge collaborations, both within geographical proximity

and internationally, is crucial and acts as a boundary condition that enhances innovation capabilities in family firms (Debellis et al. 2021; De Massis et al. 2015, 2023).

Based on the literature that emphasizes family firms' ties to communities and regional embeddedness, one might assume that a higher level of cognitive and organizational distance between family firms and external partners would lead to lower innovation. However, this is not the case. Family firms rely on and integrate with regional communities, collaborating with local customers, suppliers, and universities to build long-term relationships and orientation, which helps them survive intergenerationally. Co-creating new knowledge internationally, beyond the geographical boundaries of Europe, introduces "fresh air" into the traditional business models, routines, and networks developed by family firms (Magistretti et al. 2019; De Massis et al. 2015, 2021).

This knowledge collaboration enables the exploration of mechanisms and conditions that can minimize the ability-willingness paradox, adding long-term orientation, trust, and commitment to communities and customers (De Massis et al. 2018).

*Policy implications and generalizability of findings.*

The UK context is particularly relevant for studying innovation in family firms due to several unique market dynamics and policy frameworks that influence innovation activity. The UK market is characterized by a mature market-oriented business environment with well-established industrial sectors and a strong emphasis on innovation and technology development and formal institutions. Additionally, the UK's policy landscape actively supports business innovation through various grants, tax incentives, and support schemes, which are crucial for understanding how family and non-family firms innovate differently (Mazzucato et al. 2020).

The period between 2004 and 2016 is especially significant because it encapsulates a range of economic cycles, including the pre- and post-recession eras and the onset of Brexit negotiations. These events have had profound impacts on business strategies and innovation behaviors in the United Kingdom and other countries. We limit the observation time to the year 2017 onwards to avoid potential bias originating from the Brexit announcement on the strategies of the local and foreign family firms operating within the United Kingdom. Our main explanatory variables capture the shift in innovation strategies, as foreign-owned family firms could be potentially affected.

This study is applicable to other contexts. First, our study's findings on the mobilization of internal resources and engagement in knowledge collaboration externally can be extrapolated to similar mature market economies with strong institutional support for innovation. Countries with similar economic structures and policy environments, such as Canada, Germany, and Australia, may see parallel dynamics in how family firms utilize external collaborations to overcome internal resource limitations. Second, insights into the behavioral characteristics of family firms, such as risk aversion and the reliance on socioemotional wealth, can inform businesses in other regions about balancing traditional family values with the need for innovative practices. This is particularly relevant for family-owned businesses in culturally similar regions where family legacy and control are pivotal to business operations, for example, German Mittelstand (Pahnke et al. 2023). Third, we highlighted the role of entrepreneurial behavior and knowledge collaboration in enhancing innovation output, which provides a template for family firms in emerging markets looking to expand their operational scope and innovate beyond local markets, and evaluate these internationalization strategies. Lessons drawn from the UK's family firms' ability to engage with international partners and leverage global knowledge networks could guide similar strategies in emerging economies as countries progress along the level of economic development and institutional quality (Chowdhury et al. 2019). Finally, the practical implications derived from the UK context about facilitating knowledge transfer and innovation can guide family business owners in other regions to tailor their innovation policies. Understanding the specific needs and behaviors of family firms can lead to more targeted and effective innovation policies that consider the familial context.

Policymakers seeking to internationalize family firms in their regions and countries could develop firm-level incentives to reduce transaction and operational costs. They could also encourage family firms to be more entrepreneurial by fostering an entrepreneurial culture and climate within organizations. This could include fostering organizational innovation by introducing new methods of organizing external relationships with other firms or public institutions (such as alliances, partnerships, outsourcing, or subcontracting). Achieving this may require negotiating bilateral agreements on the mutual recognition of technical standards, R&D collaboration agreements, and joint patenting practices to appropriate the results of international collaboration.

### 6.1 | Practical Implications

Family firm owner-managers who want to increase radical and incremental innovation may begin by focusing on creating absorptive capacity. The goal of investing in internal knowledge through R&D, training, and hiring highly skilled workers is to create and commercialize new products directly. This knowledge should also be used to integrate external knowledge and create greater commercial value with external partners, potentially including cooperation between family firms. For both family and non-family firms, this means converting internal knowledge investments into innovations that can protect and enhance the firm's wealth and facilitate the long-term orientation of family firms.

Family firms looking for potential external innovation partners should understand that changes in business models and experimenting with new partners, new markets, and new product lines facilitate innovation in family firms more than in non-family firms. Managers of small family firms should consider expanding their knowledge collaboration and investment in knowledge internally, rather than relying on a binary strategy, and should establish networks with regional and international partners. Managers in medium and large firms should consider adopting the model used by family firms when collaborating with regional and international customers. More research

is needed to understand "how" family firms can capitalize on their unique family firm characteristics and leverage their close and distant markets located in geographical, technological, and cultural-cognitive proximity (De Massis et al. 2013, 2015; Balland et al. 2015).

### 6.2 | Study Limitations and Future Research

One limitation of this study is that the panel data is unbalanced and does not include the same number of observations for the 2002–2014 period. In the UKIS, firms are asked about their collaboration decisions, their collaboration partner portfolio, and the intensity of collaboration and partner type, rather than geographical proximity. Given that family firms benefit from staying local (De Massis et al. 2016) and from internationalizing, it may be that national institutions (Audretsch et al. 2019) protect family firms while digital technology enables temporal proximity to knowledge networks, helping them overcome a lack of human capital and access external knowledge (Ceipek et al. 2021; Soluk et al. 2021).

Second, the period between 2006 and 2016 is especially significant because it includes economic cycles in the United Kingdom, including the pre- and post-recession eras and the onset of Brexit negotiations. Although the survey is conducted biannually by the Office of National Statistics (ONS) in the United Kingdom, we restricted the observation window to 2017 to avoid potential lingering bias from Brexit's effects on the strategies of both domestic and foreign companies operating in the United Kingdom. As Brexit introduced long-lasting market turbulence and increased environmental uncertainty, it may have reduced the likelihood of radical and incremental innovation and the amount of R&D investment due to market uncertainty and the likelihood of ownership transfer. Our main explanatory variables capture the shift in innovation strategies, as foreign-owned family firms could be potentially affected, and they started ownership change, creating multiple units and using other strategies, which could potentially distort the effect of regional and international collaboration on family firm performance. The period from 2017 to 2022 is an extraordinary period in the United Kingdom that warrants a separate study. In addition, the use of data from 2016 to 2020 was limited due to a low number of responses on innovation sales (dependent variable). Due to the shock, the innovation sales have dropped significantly, which may be related to the onset of Brexit, changes in ownership, market exits, and market uncertainty.

Future research should address these limitations by expanding the data and further investigating the breadth and depth of knowledge collaboration for family and non-family firms. It should also demonstrate that the breadth and depth of knowledge collaboration complements organizational innovation, business model innovation, and entrepreneurial orientation in achieving both innovation and other outcomes (Hornsby et al. 2013), such as productivity, growth, sales, and scaling up, which may differ depending on family ownership.

This study may offer a new research avenue to further understand entrepreneurial behavior and orientation in family firms, investigating innovation outcomes for family firms at different generational and growth stages (young/growth/maturity; first, second, third generation).

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#### Ethics Statement

The authors have read and agreed to the Committee on Publication Ethics (COPE) international standards for authors.

#### Conflicts of Interest

The authors declare no conflicts of interest.

#### Data Availability Statement

Data subject to third-party restrictions. The microdata used in this study are subject to restricted access and were obtained under license from the UK Data Service Secure Lab (https://ukdataservice.ac.uk). Access to these data is limited to accredited researchers and requires approval through the UK Statistics Authority's Research Accreditation Panel. Due to legal and ethical restrictions, the data cannot be shared directly by the authors. Researchers interested in accessing the data must apply through the UK Data Service and meet the necessary accreditation and project approval requirements.

#### References

Audretsch, D. B., and M. Belitski. 2017. "Entrepreneurial Ecosystems in Cities: Establishing the Framework Conditions." *Journal of Technology Transfer* 42, no. 5: 1030–1051.

Audretsch, D. B., and M. Belitski. 2020. "The Limits to Collaboration Across Four of the Most Innovative UK Industries." *British Journal of Management* 31, no. 4: 830–855.

Audretsch, D. B., and M. Belitski. 2022. "The Knowledge Spillover of Innovation." *Industrial and Corporate Change* 31, no. 6: 1329–1357.

Audretsch, D. B., and M. Belitski. 2023. "Evaluating Internal and External Knowledge Sources in Firm Innovation and Productivity: An Industry Perspective." *R&D Management* 53, no. 1: 168–192.

Audretsch, D. B., and M. Belitski. 2024. "Geography of Knowledge Collaboration and Innovation in Schumpeterian Firms." *Regional Studies* 58, no. 4: 821–840.

Audretsch, D. B., M. Belitski, and R. Caiazza. 2021. "Start-Ups, Innovation and Knowledge Spillovers." *Journal of Technology Transfer* 46, no. 6: 1995–2016.

Audretsch, D. B., M. Belitski, and S. Desai. 2019. "National Business Regulations and City Entrepreneurship in Europe: A Multilevel Nested Analysis." *Entrepreneurship Theory and Practice* 43, no. 6: 1148–1165.

Audretsch, D. B., M. Belitski, A. Spadavecchia, and S. A. Zahra. 2024. "The More, the Merrier or the Less Is More? The Role of Firm Capabilities and Industry in the Knowledge Spillover of Innovation." *Technovation* 138: 103115.

Audretsch, D. B., and M. P. Feldman. 1996. "R&D Spillovers and the Geography of Innovation and Production." *American Economic Review* 86, no. 3: 630–640.

Balland, P. A., R. Boschma, and K. Frenken. 2015. "Proximity and Innovation: From Statics to Dynamics." *Regional Studies* 49, no. 6: 907–920.

Barrett, M. A., and K. Moores. 2020. "The What and How of Family Business Paradox: Literature-Inspired Distillations and Directions." *International Small Business Journal* 38, no. 3: 154–183.

Baù, M., F. Chirico, D. Pittino, M. Backman, and J. Klaesson. 2019. "Roots to Grow: Family Firms and Local Embeddedness in Rural and Urban Contexts." *Entrepreneurship Theory and Practice* 43, no. 2: 360–385.

Belderbos, R., M. Carree, and B. Lokshin. 2004. "Cooperative R&D and Firm Performance." *Research Policy* 33, no. 10: 1477–1492.

Belitski, M., R. Caiazza, and Y. Rodionova. 2020. "Investment in Training and Skills for Innovation in Entrepreneurial Start-Ups and Incumbents: Evidence From the United Kingdom." *International Entrepreneurship and Management Journal* 16, no. 2: 617–640.

Belitski, M., and N. Rejeb. 2022. "Does Open Customer Innovation Model Hold for Family Firms?" *Journal of Business Research* 145: 334–346.

Bernhard, F. 2018. "Holding on to Family Values or Adapting to a Changing World—The Case of Barilla." In *Global Business Value Innovations: Building Innovation Capabilities for Business Strategies*, 117–127. Springer International Publishing.

Block, J., C. Hansen, and H. Steinmetz. 2023. "Are Family Firms Doing More Innovation Output With Less Innovation Input? A Replication and Extension." *Entrepreneurship Theory and Practice* 47, no. 4: 1496–1520.

Boschma, R. 2005. "Proximity and Innovation: A Critical Assessment." *Regional Studies* 39, no. 1: 61–74.

Calabrò, A., M. Vecchiarini, J. Gast, G. Campopiano, A. De Massis, and S. Kraus. 2019. "Innovation in Family Firms: A Systematic Literature Review and Guidance for Future Research." *International Journal of Management Reviews* 21, no. 3: 317–355.

Carnes, C. M., M. A. Hitt, D. G. Sirmon, F. Chirico, and D. W. Huh. 2022. "Leveraging Resources for Innovation: The Role of Synchronization." *Journal of Product Innovation Management* 39, no. 2: 160–176.

Carney, M. 2005. "Corporate Governance and Competitive Advantage in Family-Controlled Firms." *Entrepreneurship Theory and Practice* 29, no. 3: 249–265.

Casprini, E., A. De Massis, A. Di Minin, F. Frattini, and A. Piccaluga. 2017. "How Family Firms Execute Open Innovation Strategies: The Loccioni Case." *Journal of Knowledge Management* 21, no. 6: 1459–1485.

Ceipek, R., J. Hautz, A. De Massis, K. Matzler, and L. Ardito. 2021. "Digital Transformation Through Exploratory and Exploitative Internet of Things Innovations: The Impact of Family Management and Technological Diversification." *Journal of Product Innovation Management* 38, no. 1: 142–165.

Chirico, F., G. Criaco, M. Baù, L. Naldi, L. R. Gómez-Mejia, and J. Kotlar. 2020. "To Patent or Not to Patent: That Is the Question. Intellectual Property Protection in Family Firms." *Entrepreneurship Theory and Practice* 44, no. 2: 339–367.

Chirico, F., and C. Salvato. 2016. "Knowledge Internalization and Product Development in Family Firms: When Relational and Affective Factors Matter." *Entrepreneurship Theory and Practice* 40, no. 1: 201–229.

Chowdhury, F., D. B. Audretsch, and M. Belitski. 2019. "Institutions and Entrepreneurship Quality." *Entrepreneurship Theory and Practice* 43, no. 1: 51–81.

Cohen, W. M., and D. A. Levinthal. 1989. "Innovation and Learning: the Two Faces of R & D." *Economic Journal* 99, no. 397: 569–596.

Cohen, W. M., and D. A. Levinthal. 1990. "Absorptive Capacity: A New Perspective on Learning and Innovation." *Administrative Science Quarterly* 35, no. 1: 128–152.

Colombo, M. G., D. J. Cumming, and S. Vismara. 2016. "Governmental Venture Capital for Innovative Young Firms." *Journal of Technology Transfer* 41: 10–24.

De Massis, A., D. Audretsch, L. Uhlaner, and N. Kammerlander. 2018. "Innovation With Limited Resources: Management Lessons From the German Mittelstand." *Journal of Product Innovation Management* 35, no. 1: 125–146.

De Massis, A., A. Di Minin, and F. Frattini. 2015. "Family-Driven Innovation: Resolving the Paradox in Family Firms." *California Management Review* 58, no. 1: 5–19.

De Massis, A., F. Frattini, J. Kotlar, A. M. Petruzzelli, and M. Wright. 2016. "Innovation Through Tradition: Lessons From Innovative Family Businesses and Directions for Future Research." *Academy of Management Perspectives* 30, no. 1: 93–116.

De Massis, A., F. Frattini, and U. Lichtenthaler. 2013. "Research on Technological Innovation in Family Firms: Present Debates and Future Directions." *Family Business Review* 26, no. 1: 10–31.

De Massis, A., J. Kotlar, and L. Manelli. 2021. "Family Firms, Family Boundary Organizations, and the Family-Related Organizational Ecosystem." *Family Business Review* 34, no. 4: 350–364.

De Massis, A., E. Rondi, and P. Rovelli. 2023. "A Methodological Guide to Advance Family Business Innovation Research." In *Field Guide to Family Business Research*, 61–78. Edward Elgar Publishing.

Debellis, F., A. De Massis, A. M. Petruzzelli, F. Frattini, and M. Del Giudice. 2021. "Strategic Agility and International Joint Ventures: The Willingness-Ability Paradox of Family Firms." *Journal of International Management* 27, no. 1: 100739.

Department of Enterprise, Trade and Investment. 2018. *UK Innovation Survey, 1994–2016: Secure Access. [Data Collection]*. 6th ed. UK Data Service. SN: 6699. https://doi.org/10.5255/UKDA-SN-6699-6.

Erdogan, I., E. Rondi, and A. De Massis. 2020. "Managing the Tradition and Innovation Paradox in Family Firms: A Family Imprinting Perspective." *Entrepreneurship Theory and Practice* 44, no. 1: 20–54.

Feranita, F., J. Kotlar, and A. De Massis. 2017. "Innovation Collaboration in Family Firms: Past Research, Current Debates and Agenda for Future Research." *Journal of Family Business Strategy* 8, no. 3: 137–156.

Gallucci, C., R. Santulli, and A. Colombo. 2016. "How Do'family Affairs' Affect Firm's Stock Price? An Application on an Exploratory Case Study." *International Journal of Managerial and Financial Accounting* 8, no. 3–4: 319–333.

Goldstein, H. 2011. *Multilevel Statistical Models*. Vol. 922. John Wiley & Sons.

Gómez-Mejia, L. R., F. Chirico, G. Martin, and M. Baù. 2022. "Best Among the Worst or Worst Among the Best? Socioemotional Wealth and Risk-Performance Returns for Family and Non-Family Firms Under Financial Distress." *Entrepreneurship Theory and Practice* 47: 10422587211057420.

Gómez-Mejia, L. R., C. Cruz, P. Berrone, and J. De Castro. 2011. "The Bind That Ties: Socioemotional Wealth Preservation in Family Firms." *Academy of Management Annals* 5, no. 1: 653–707.

Gómez-Mejía, L. R., K. T. Haynes, M. Núñez-Nickel, K. J. L. Jacobson, and J. Moyano-Fuentes. 2007. "Socioemotional Wealth and Business Risks in Family-Controlled Firms: Evidence From Spanish Olive Oil Mills." *Administrative Science Quarterly* 52, no. 1: 106–137.

Guenther, C., M. Belitski, and N. Rejeb. 2023. "Overcoming the Ability-Willingness Paradox in Small Family Firms' Collaborations." *Small Business Economics* 60, no. 4: 1409–1429.

Heckman, J. 1979. "Sample Selection Bias as a Specification Error." *Econometrica* 47, no. 1: 153–161.

Hornsby, J. S., D. F. Kuratko, D. T. Holt, and W. J. Wales. 2013. "Assessing a Measurement of Organizational Preparedness for Corporate Entrepreneurship." *Journal of Product Innovation Management* 30, no. 5: 937–955.

Hoskisson, R. E., F. Chirico, J. Zyung, and E. Gambeta. 2017. "Managerial Risk Taking: A Multitheoretical Review and Future Research Agenda." *Journal of Management* 43, no. 1: 137–169.

Jaskiewicz, P., D. O. Neubaum, A. De Massis, and D. T. Holt. 2020. "The Adulthood of Family Business Research Through Inbound and Outbound Theorizing." *Family Business Review* 33, no. 1: 10–17.

Kammerlander, N., and M. van Essen. 2017. "Family Firms Are More Innovative Than Other Companies." *Harvard Business Review* 25: 2–5.

Kano, L., and A. Verbeke. 2018. "Family Firm Internationalization: Heritage Assets and the Impact of Bifurcation Bias." *Global Strategy Journal* 8, no. 1: 158–183.

Kano, L., A. Verbeke, and A. Johnston. 2021. "Internationalization Decisions in Family Firms: The Impact of Bifurcation Bias." In *The Palgrave Handbook of Family Firm Internationalization*, 3–35. Springer International Publishing.

Kellermanns, F. W., K. A. Eddleston, T. Barnett, and A. Pearson. 2008. "An Exploratory Study of Family Member Characteristics and Involvement: Effects on Entrepreneurial Behavior in the Family Firm." *Family Business Review* 21, no. 1: 1–14.

Khlystova, O., Y. Kalyuzhnova, and M. Belitski. 2022. "Towards the Regional Aspects of Institutional Trust and Entrepreneurial Ecosystems." *International Journal of Entrepreneurial Behavior and Research*. https://doi.org/10.1108/IJEBR-02-2022-0108.

Kobarg, S., J. Stumpf-Wollersheim, and I. M. Welpe. 2019. "More Is Not Always Better: Effects of Collaboration Breadth and Depth on Radical and Incremental Innovation Performance at the Project Level." *Research Policy* 48, no. 1: 1–10.

Kotlar, J., A. De Massis, F. Frattini, and N. Kammerlander. 2021. "Motivation Gaps and Implementation Traps: The Paradoxical and Time-Varying Effects of Family Ownership on Firm Absorptive Capacity." *Journal of Product Innovation Management* 37, no. 1: 2–25.

Kotlar, J., H. Fang, A. De Massis, and F. Frattini. 2014. "Profitability Goals, Control Goals, and the R&D Investment Decisions of Family and Nonfamily Firms." *Journal of Product Innovation Management* 31: 1128–1145.

Magistretti, S., C. Dell'Era, A. De Massis, and F. Frattini. 2019. "Exploring the Relationship Between Types of Family Involvement and Collaborative Innovation in Design-Intensive Firms: Insights From Two Leading Players in the Furniture Industry." *Industry and Innovation* 26, no. 10: 1121–1151.

Mazzucato, M., R. Kattel, and J. Ryan-Collins. 2020. "Challenge-Driven Innovation Policy: Towards a New Policy Toolkit." *Journal of Industry, Competition and Trade* 20, no. 2: 421–437.

Miller, D., L. Steier, and I. Le Breton–Miller. 2016. "What Can Scholars of Entrepreneurship Learn From Sound Family Businesses?" *Entrepreneurship Theory and Practice* 40, no. 3: 445–455.

Morck, R., and B. Yeung. 2003. "Agency Problems in Large Family Business Groups." *Entrepreneurship Theory and Practice* 27, no. 4: 367–382.

Moreno-Menéndez, A. M., and J. C. Casillas. 2021. "How Do Family Businesses Grow? Differences in Growth Patterns Between Family and Non-Family Firms." *Journal of Family Business Strategy* 12, no. 3: 100420.

Nieto, M. J., L. Santamaria, and Z. Fernandez. 2015. "Understanding the Innovation Behavior of Family Firms." *Journal of Small Business Management* 53, no. 2: 382–399.

OECD. 2005. *The Measurement of Scientific and Technological Activities*. Proposes Guidelines for Collecting and Interpreting Innovation Data.

Office for National Statistics. 2017. *Business Structure Database, 1997–2017: Secure Access. [Data Collection]*. 9th ed. UK Data Service. SN: 6697. https://doi.org/10.5255/UKDA-SN-6697-9.

Pahnke, A., F. Welter, and D. B. Audretsch. 2023. "In the Eye of the Beholder? Differentiating Between SMEs and Mittelstand." *Small Business Economics* 60, no. 2: 729–743.

Pogutz, S., and M. I. Winn. 2016. "Cultivating Ecological Knowledge for Corporate Sustainability: Barilla's Innovative Approach to Sustainable Farming." *Business Strategy and the Environment* 25, no. 6: 435–448.

Pukall, T. J., and A. Calabrò. 2014. "The Internationalization of Family Firms: A Critical Review and Integrative Model." *Family Business Review* 27, no. 2: 103–125.

Rondi, E., A. De Massis, and S. Kraus. 2021. "Servitization Through Open Service Innovation in Family Firms: Exploring the Ability-Willingness Paradox." *Journal of Business Research* 135: 436–444.

Santamaría, L., M. J. Nieto, and A. Barge-Gil. 2009. "Beyond Formal R&D: Taking Advantage of Other Sources of Innovation in Low-and Medium-Technology Industries." *Research Policy* 38, no. 3: 507–517.

Scholes, L., M. Hughes, M. Wright, A. De Massis, and J. Kotlar. 2021. "Family Management and Family Guardianship: Governance Effects on Family Firm Innovation Strategy." *Journal of Family Business Strategy* 12, no. 4: 100389.

Soluk, J., I. Miroshnychenko, N. Kammerlander, and A. De Massis. 2021. "Family Influence and Digital Business Model Innovation: The Enabling Role of Dynamic Capabilities." *Entrepreneurship Theory and Practice* 45, no. 4: 867–905.

Urbinati, A., S. Franzò, A. De Massis, and F. Frattini. 2017. "Innovation in Family Firms: A Review of Prior Studies and a Framework for Future Research." *Revolution of Innovation Management: Internationalization and Business Models* 2: 213–246.

Zellweger, T. M., R. S. Nason, M. Nordqvist, and C. G. Brush. 2013. "Why Do Family Firms Strive for Nonfinancial Goals? An Organizational Identity Perspective." *Entrepreneurship Theory and Practice* 37, no. 2: 229–248.

## Appendix A

### Correlation Matrix

| Variables | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Radical innovation sales | 1 | | | | | | | | | | | | | | | | | | |
| 2. Incremental innovation sales | 0.18* | 1 | | | | | | | | | | | | | | | | | |
| 3. Family firms | 0.03 | 0.02 | 1 | | | | | | | | | | | | | | | | |
| 4. Age | −0.11* | 0.08* | −0.07* | 1 | | | | | | | | | | | | | | | |
| 5. Employment | −0.01 | 0.03* | 0.03* | 0.17* | 1 | | | | | | | | | | | | | | |
| 6. Innovation training | 0.20* | 0.02 | 0.20* | −0.04* | 0.15* | 1 | | | | | | | | | | | | | |
| 7. New business models | 0.18* | −0.08* | 0.20* | −0.04* | 0.13* | 0.26* | 1 | | | | | | | | | | | | |
| 8. New organizational methods internal | 0.12* | 0.04* | 0.13* | −0.01 | 0.16* | 0.27* | 0.40* | 1 | | | | | | | | | | | |
| 9. New organizational methods external | 0.16* | 0.06* | 0.19* | −0.03* | 0.23* | 0.30* | 0.48* | 0.40* | 1 | | | | | | | | | | |
| 10. Entrepreneurial behavior | 0.27* | 0.15* | 0.30* | −0.03* | 0.11* | 0.35* | 0.27* | 0.23* | 0.26* | 1 | | | | | | | | | |
| 11. Process innovation | 0.23* | 0.02 | 0.24* | −0.02* | 0.15* | 0.35* | 0.29* | 0.27* | 0.28* | 0.37* | 1 | | | | | | | | |
| 12. R&D investment | 0.33* | 0.12* | 0.25* | 0.01 | 0.27* | 0.36* | 0.26* | 0.22* | 0.31* | 0.39* | 0.34* | 1 | | | | | | | |
| 13. Knowledge spillover | 0.20* | 0.34* | 0.21* | 0.01 | 0.19* | 0.43* | 0.27* | 0.27* | 0.31* | 0.49* | 0.31* | 0.39* | 1 | | | | | | |
| 14. Regional collaboration | 0.18* | 0.28* | 0.14* | −0.03 | 0.04* | 0.21* | 0.19* | 0.19* | 0.17* | 0.26* | 0.26* | 0.24* | 0.26* | 1 | | | | | |
| 15. National collaboration | 0.25* | 0.15* | 0.21* | −0.01 | 0.13* | 0.27* | 0.27* | 0.23* | 0.25* | 0.35* | 0.33* | 0.41* | 0.34* | 0.50* | 1 | | | | |
| 16. Europe collaboration | 0.24* | 0.03* | 0.15* | 0.01 | 0.14* | 0.20* | 0.18* | 0.17* | 0.20* | 0.26* | 0.25* | 0.39* | 0.26* | 0.38* | 0.56* | 1 | | | |
| 17. International collaboration | 0.25* | 0.06* | 0.16* | 0.01 | 0.13* | 0.17* | 0.167* | 0.14* | 0.19* | 0.23* | 0.23* | 0.40* | 0.23* | 0.33* | 0.47* | 0.57* | 1 | | |
| 18. Human capital | 0.28* | 0.14* | 0.11* | −0.10* | −0.01 | 0.17* | 0.14* | 0.11* | 0.16* | 0.16* | 0.16* | 0.36* | 0.24* | 0.13* | 0.22* | 0.24* | 0.27* | 1 | |
| 19. Exporter | 0.18* | −0.01 | 0.14* | 0.07* | 0.17* | 0.18* | 0.16* | 0.12* | 0.19* | 0.20* | 0.19* | 0.41* | 0.28* | 0.12* | 0.25* | 0.31* | 0.29* | 0.25* | 1 |
| 20. Foreign | −0.01 | −0.01 | 0.02 | 0.22* | 0.50* | 0.09* | 0.07* | 0.05* | 0.17* | 0.08* | 0.08* | 0.20* | 0.17* | −0.02 | 0.07* | 0.11* | 0.09* | 0.04* | 0.20* |

*Note:* Significance level: *$p < 0.05$.
*Source:* UKIS-UK Innovation survey; BSD, business structure database.