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# On external knowledge sources and innovation performance: Family versus non-family firms

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ABSTRACT

External knowledge has been found to be vital in generating innovation. However, little is known about the conditions under which firms can benefit from utilizing specific external knowledge sources. Using the knowledge-based view as our theoretical underpinning, we empirically examine how the usage of knowledge gained from market- and science-based sources influences innovation performance differently between family and non-family firms. An analysis using panel data drawn from Belgian firms supports our hypothesis that the relationship between the use of knowledge gained from suppliers and customers and innovation outcomes is weaker for family firms than for non-family firms, while the relationship between the use of knowledge gained from universities and research institutes and innovation outcomes is stronger for family firms. This study extends the literature by revealing the role firm type (i.e., family versus non-family) plays in moderating the relationship between the use of knowledge obtained from distinct external sources and innovation performance.

## 1. Introduction

Innovation has always been critical for companies seeking to develop and maintain a competitive advantage and/or gain entry into new markets (Becheikh et al., 2006). According to a widely shared definition, innovation is the commercialization of invention (Massa and Testa, 2008; Schumpeter, 1942). Innovation has long been perceived as knowledge-intensive (Kanter, 1988); thus, it is sometimes described as new knowledge incorporated in products and services (Afuah, 1998). Our study focuses on innovation performance, which is defined as the sale of new or significantly improved products (goods or services) (Dziallas and Blind, 2019). A large body of literature has built on the knowledge-based view (Grant, 1996a, 1996b) to explore the drivers of innovation output and suggests that new product creativity is related primarily to firms' ability to manage and create knowledge. Following this approach, innovation scholars have highlighted the crucial role of external knowledge in achieving innovation (Ahuja and Katila, 2001; Laursen and Salter, 2006; Un et al., 2010). To provide more fine-grained results, an increasing number of studies are examining the distinct impacts of various external knowledge sources—such as customers, suppliers, universities, and research institutions—on innovation performance (Chen et al., 2016; De Zubielqui et al., 2016). While some studies find that specific external sources have a positive impact on innovation outputs (Amara and Landry, 2005; Díez-Vial and Montoro-Sánchez, 2016), others find no relationship, or even a negative relationship (Knudsen, 2007; Lhuillery and Pfister, 2009; Lööf and Heshmati, 2002).

These mixed findings underline the necessity of exploring the conditions under which firms can benefit from utilizing specific external knowledge sources to generate innovations. Research on these contingencies is scarce (West and Bogers, 2014). Recent studies show that firm-related factors such as innovation competencies, innovation orientation, size, and age may be important moderators in the relationship between specific knowledge sources and innovation outcomes (Kobarg et al., 2018; Yu and Lee, 2017). While these findings are important, we suggest that firm type—specifically, the distinction between family firms (FFs) and non-family firms (non-FFs)—is a crucial but overlooked moderating factor. Investigating how firm type impacts the relationship between the use of knowledge gained from specific external sources and innovation performance is important given the international ubiquity of FFs (La Porta et al., 1999) and the increasing evidence that the antecedents of innovation differ between FFs and

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non-FFs because of family involvement in the business (Calabrò et al., 2019).

Therefore, this study empirically examines how knowledge usage from distinct external sources, defined as the extent to which a firm uses knowledge obtained from specific external sources (Bapuji et al., 2011)—in our case, market-based sources (customers and suppliers) and science-based sources (universities, government and public research institutes)—influences innovation outcomes differently between FFs and non-FFs. Market-based knowledge differs fundamentally from science-based knowledge (Du et al., 2014), which motivates us to investigate their distinctive impacts on innovation performance under the condition of firm type. While market-based knowledge comprises information about the latest market trends and needs, much cutting-edge scientific knowledge flows from universities and research institutes (De Zubielqui et al., 2016; Gesing et al., 2015; Nieto and Santamaría, 2007). Additionally, knowledge transfer between firms and scientific organizations implies higher risk and uncertainty (Caloghirou et al., 2003) because of the divergences between science and industry, particularly in terms of research objectives, incentives, and structures (Veugelers and Cassiman, 2005).

The knowledge-based view (KBV) emphasizes not only the influence of knowledge creation on innovation but also relational networks and interaction rules and directives as enabling mechanisms of that relationship (Grant, 1996a, 1996b). Although the KBV (Grant, 1996b, 2013) acknowledges the important role of external knowledge, the KBV focuses on knowledge integration within organizational boundaries and does not elaborate on the enabling conditions by which external knowledge is integrated into the firm to generate innovation. Therefore, we draw on the tie-strength (Granovetter, 1973) and formalization literature (Chen et al., 2013) to deepen our understanding of the important KBV mechanisms behind relational networks and interaction rules and directives to theoretically argue that firm type (FFs versus non-FFs) has a moderating effect on the relationship between knowledge usage from external sources and innovation performance. The central tenet of the tie-strength literature is that the strength of the ties between social actors can influence the novelty of the knowledge they accumulate, with strong ties often resulting in redundant knowledge stock and weak ties leading to more novel knowledge (Granovetter, 1973). Additionally, formalization—denoting the codified rules and procedures governing interactions among innovation partners (Chen et al., 2013; Du et al., 2014)—can affect the relationship between specific knowledge sources and innovation outputs (Du et al., 2014; Gesing et al., 2015). Since FFs typically differ from their non-FF counterparts in the extent to which they formalize their interactions with external partners (Casprini et al., 2017; De Massis et al., 2015) and the extent to which they form ties with external partners (Arregle et al., 2007; Huybrechts et al., 2011; Miller and Le Breton-Miller, 2005), we expect FFs and non-FFs to exert different effects on the relationship between knowledge usage from distinct external sources and innovation performance.

Our study contributes to the innovation literature by revealing how an underexplored firm-type variable (i.e., FFs versus non-FFs) moderates the relationship between knowledge usage from specific external sources and innovation outputs. Knowing what types of firms benefit more from the use of knowledge drawn from particular external sources is important given the critical role outside knowledge plays in engendering innovation and the substantial cost of external knowledge search (Laursen and Salter, 2006), which often requires significant investments in critical search capabilities and can incur high transaction costs (Christensen et al., 2005).

Our study also contributes to the literature on family businesses. While studies have examined the role of external knowledge in family firm innovation (De Massis et al., 2018; Lambrechts et al., 2017), the research has examined only the impact of aggregated external knowledge inflows (e.g., Akram et al., 2021; Serrano-Bedia et al., 2016), and has not distinguished between market- and science-based actors. Our study delineates the impact of knowledge inflows from specific external sources, such as market- and science-based sources, on innovation performance in FFs and non-FFs and identifies which knowledge inflow sources FFs can convert into innovation outcomes more or less effectively than non-FFs. We thereby address a recent call in the family business literature for more fine-grained studies into the types of knowledge that FFs should possess, acquire, or seek in order to enhance their innovation performance (Hu and Hughes, 2020).

## 2. Literature review and hypothesis development

This study uses the KBV (Grant, 1996a, 1996b) as its theoretical underpinning, since the KBV highlights not only the influence of knowledge creation on innovation but also relational networks and interaction rules and directives serving as enabling mechanisms of that relationship. The KBV of the firm posits that organizations are knowledge-bearing entities and that the fundamental function of the firm is to integrate and use knowledge (Conner and Prahalad, 1996; Grant, 1996b). Researchers have proposed the KBV of firm innovation (Quintane et al., 2011), since the literature has long perceived innovation as knowledge-intensive (Kanter, 1988), and knowledge has been recognized as an essential organizational attribute for fostering innovation (Dougherty, 1992). The KBV discusses the role of relational networks in knowledge access and organizational characteristics such as interaction rules and directives in knowledge integration (Grant, 1996a, 1996b). However, the KBV focuses on internal organizational mechanisms despite acknowledging that knowledge can reside beyond organizational boundaries. Hence, when examining the role of the networks in the integration of external knowledge to increase innovation performance, the subsequent literature has complemented the KBV with Granovetter's (1973) concept of "tie strength" (e.g., Zheng et al., 2011). Scholars have also investigated the impact of formalized inter-firm collaboration on the conversion of external knowledge into innovation (Du et al., 2014; Gesing et al., 2015). We build on this formalization literature to deepen the KBV's understanding of the roles played by interaction rules and directives. Despite the burgeoning literature on these topics, the firm type issue has been largely overlooked. Since FFs and non-FFs differ in both the relational strength they form with external parties and in the degree of the formalization of their interaction with innovation partners, we argue that a thorough examination of firm type as a contingency factor will enrich the literature. In short, the KBV of firm innovation, together with its attention to relational networks and interaction rules and directives, provides strong theoretical guidance for our examination of the differences between FFs and non-FFs in their conversion of distinct sources of external knowledge into innovation outputs.

Using the KBV (Grant, 1996a, 1996b) as a theoretical underpinning, we first discuss how the usage of knowledge obtained from customers, suppliers, universities, and government and public research institutes ("research institutes" hereafter) impacts innovation outputs. We then delve into the tie-strength and formalization literature to examine the differences between FFs and non-FFs in the way their usage of knowledge obtained from market-based sources (suppliers and customers) and science-based sources (universities and research institutes) impacts innovation outcomes.

### 2.1. Knowledge usage from specific external sources and innovation performance

Scholars have proposed a number of potential drivers of innovation performance, given their critical role in long-term business success. The KBV, which has become prominent in this literature (Ganter and Hecker, 2013), suggests that competitive advantages are related primarily to resources and capabilities based on knowledge (Conner and Prahalad, 1996; Grant, 1996b). According to this approach, companies achieve value by managing their knowledge efficiently while producing new knowledge or creative combinations of existing knowledge, expressed as

new goods or services (Ebbers and Wijnberg, 2009). The KBV of the firm distinguishes between the internal creation of knowledge and knowledge acquisition, which is the search, identification, and integration of external knowledge (Grant, 1996a, 1996b). Our study focuses on external knowledge acquisition, based on the research finding that many of the knowledge sources necessary for triggering innovations—such as customers, suppliers, and universities—reside outside the firm (Ahuja and Katila, 2001; Un et al., 2010).

We investigate four sources of external knowledge: suppliers, customers, universities, and research institutes. The roles of these sources in innovation performance have been discussed in the innovation literature (Becheikh et al., 2006; Kolluru and Mukhopadhaya, 2017); however, the findings are mixed, and few studies have attempted to determine the conditions that facilitate or hamper the utilization of specific knowledge sources. Following the literature (e.g., Danneels, 2002; Du et al., 2014), we classify these external sources into two types—market-based sources (customers and suppliers) and science-based sources (universities and research institutes)—which differ in the types of innovation information and inherent risks they carry.

Market-based knowledge comprises information obtained from actors closely linked to the market. Research suggests that obtaining knowledge from suppliers and customers is beneficial to innovation performance. Accessing resources (e.g., capabilities, ideas, knowledge) from suppliers can improve firms' ability to differentiate products in the market and derive a competitive advantage (Van Echtelt et al., 2008; Von Hippel, 1988). Suppliers—especially providers of equipment, materials, and components—are considered important for technology and knowledge transfer, as they enable firms to introduce more innovations (Laursen and Salter, 2006; Kaufmann and Tödtling, 2001). The early involvement of suppliers in new product development is found to mitigate the negative impact of technological uncertainty (Petersen et al., 2003; Ragatz et al., 2002), an inherent feature of the innovation process (Freeman and Soete, 1997).

Customers are often seen as sources of new ideas for product innovation (Von Hippel, 1988, 2005). Customers regularly modify their machines, equipment, and software to better satisfy their needs (Von Hippel, 2005). Hence, firms may benefit from their customers' ideas and inventions by conducting proactive market research or producing products based on customers' designs and evaluating what may be learned from general product development (van de Vrande et al., 2009). Additionally, customers can provide solicited information on new/-evolving needs and post-launch improvements (Rothwell, 1994). Thus, knowledge gained from customers enables firms to target the right market segments and make appropriate strategic decisions in their product variant development plans and marketing activities (Su et al., 2006) thereby reducing the risk of innovation failure.

On the other hand, researchers suggest that knowledge sourced from market-based actors is not always conducive to higher innovation performance. During the knowledge exchange process, suppliers can misappropriate the information and use it for themselves, to the detriment of the firms (Baiman and Rajan, 2002). Customers are sometimes unable to articulate their needs for advanced technology-based products or to conceptualize ideas beyond the realm of their own experiences (Knudsen, 2007). Nonetheless, a sizable number of empirical studies have affirmed the crucial role of supplier knowledge in innovation success (Kaufmann and Tödtling, 2001; Un et al., 2010) as well as customer knowledge (Chatterji and Fabrizio, 2014; Ragatz et al., 2002; Souder et al., 1997).

In addition, the *extent* to which firms use knowledge obtained from customers and suppliers (i.e., market-based knowledge sources) can also influence innovation performance (Laursen and Salter, 2006). Innovation requires a large amount of knowledge and carries a high level of uncertainty; hence, firms need to draw heavily from these key sources to extract valuable knowledge and reduce uncertainties. Empirical studies have found a positive relationship between the extent to which firms utilize knowledge drawn from key sources, such as customers and suppliers, and innovation performance (Ebersberger et al., 2012; Laursen and Salter, 2006).

In summary, given the mounting evidence that the usage of knowledge obtained from market-based sources has a positive impact on innovation outputs, we hypothesize the following:

**Hypothesis 1.** The more firms use knowledge from customers and suppliers, the higher their innovation performance.

Universities and research institutes are often acknowledged as sources of new scientific and technological knowledge (Lundvall, 1992; Nelson, 1993). When acquiring knowledge from science-based sources, firms can access tacit scientific knowledge as well as (unpublished) codified knowledge, allowing them to rapidly build on the latest research findings (Fabrizio, 2009). Moreover, science-based sources provide an understanding of the underlying fundamental properties generating the observed outcome—thus, knowledge of why it happened rather than simply what happened (Fleming and Sorenson, 2004). Such knowledge benefits the search for innovation by enabling a rough prediction of the expected interactions between coupled components, thus allowing firms to focus their search in the most likely areas of opportunity and exclude search areas that would have proved futile (Fleming and Sorenson, 2004). Accordingly, an innovation search guided by more scientific knowledge enables inventors to discover the most useful configurations (Fabrizio, 2009). Knowledge obtained from these science-based sources has been found useful for fostering product innovations that may open up entirely new markets or market segments (Belderbos et al., 2004a; Tether, 2002). A firm that chooses not to acquire technological knowledge from universities and research institutes may fall behind, reducing its chances of creating a breakthrough product (Spencer, 2003). On the other hand, extant findings also suggest that knowledge gained from science organizations tends to be used for basic, precompetitive research (Arora and Gambardella, 1990; Lewis, 1990), which might not be useful for immediate application in the industry (Cohen and Levinthal, 1990; Cohen et al., 2002). However, universities and research institutes are gradually turning their attention to industry demands (Santoro and Chakrabarti, 1999; Nieto and Santamaría, 2007) because of government incentives and funding pressure (Gibbons et al., 2010; Tether, 2002). A number of studies have reported a positive relationship between acquiring knowledge from universities and research institutes and innovation outcomes in both high- and low-technology industries (Amara and Landry, 2005; Belderbos et al., 2004b; Santoro et al., 2017). In line with these studies, we propose the following:

**Hypothesis 2.** The more firms use knowledge from universities and research institutes, the higher their innovation performance.

### *2.2. Distinct impacts on innovation performance of knowledge usage from different external sources between FFs and non-FFs*

We build upon the tie-strength and formalization perspectives to understand how these diverse types of knowledge sources have differential impacts on innovation performance between FFs and non-FFs. We first describe the key premises of the tie-strength and formalization literature, and then explain their applications to FFs and non-FFs.

#### *2.2.1. The tie-strength perspective*

The tie-strength literature examines the nature of relationships and their effect on information sharing between individuals (Brown and Reingen, 1987; Burt, 1987; Granovetter, 1973) in both intra-organizational (Hansen, 1999; Krackhardt, 1992) and inter-organizational settings (Bertrand-Cloodt et al., 2011; Chung et al., 2000; Koka and Prescott, 2002; Rindfleisch and Moorman, 2001; Uzzi, 1999). This literature is therefore well-suited for deepening our understanding of the network relationship mechanism of the KBV. The tie-strength literature classifies relationships in terms of strong and weak ties. Tie strength is usually measured as the degree of emotional

closeness and/or frequency of the interactions between social actors (Ghoshal et al., 1994; Hansen, 1999; Marsden and Campbell, 1984; Reagans and McEvily, 2003). The main feature of tie strength is the effect of the relational bonds among social actors on information-sharing activities (Granovetter, 1973; Uzzi, 1999). In his pioneering study, Granovetter (1973) demonstrated that information about employment opportunities was more likely to be acquired from acquaintances (i.e., weak ties) than from family members (i.e., strong ties), suggesting that weak ties enable more access to novel information than do strong ties, which tend to recycle familiar information. In line with this finding, subsequent management-related studies have found a positive relationship between strong ties and knowledge similarity (Expósito-Langa and Molina-Morales, 2010), as well as a positive association between weak ties and novel information (Ahuja, 2000; Levin and Cross, 2004). Research on high-tech start-ups finds that strong ties reduce the likelihood of obtaining valuable information on market needs or technical knowledge (Presutti et al., 2007). Bonner and Walker (2004) also show that the newer the product being developed, the less positive is the relationship between strong ties and new product advantage.

According to the tie-strength literature, the more emotionally involved two individuals are, the more time and effort they are willing to expend on behalf of each other, including in knowledge transfer (Reagans and McEvily, 2003). Repeated interactions can lead exchange partners to become more alike and develop similar knowledge stocks (Coleman, 1988). Strong ties have been found to constrain firms in their search for new heterogeneous information (Mitsuhashi, 2003). Since innovation is considered new knowledge incorporated in products and services (Afuah, 1998), possessing a similar knowledge stock will hamper new knowledge creation (McFadyen and Cannella, 2004) and thus innovation performance. Moreover, individuals with strong ties often identify with one another or identify themselves in terms of their group membership (Bolino et al., 2002), which may limit their openness to alternative methodologies, generating forms of "collective blindness" (Nahapiet and Ghoshal, 1998, p. 245). Indeed, strong ties have been found to limit an organization's market view and stymie experimentation (Danneels, 2003; Uzzi, 1997).

On the other hand, weak ties are more likely to be a source of diverse, non-redundant information (Granovetter, 1973; Powell and Smith-Doerr, 1994). According to McPherson et al. (2001), weak ties tend to exist between dissimilar ties and thus offer access to diverse pools of new information and knowledge. Obtaining access to new and heterogeneous sources of knowledge can foster novel combinations (Nooteboom, 2000). Empirical evidence produced through innovation management research supports this notion. For example, Perry-Smith (2006) observed a positive correlation between weak ties and individual-level creativity. Modest (versus high) communication frequency between new product development teams, a manifestation of weak ties, was found to produce the most creative solutions to complex problems (Leenders et al., 2007). Dai et al. (2018) find that weak ties enhance firms' influence on dominant design, the key technological features of a new technology or product.

#### 2.2.2. Formalization perspective

We define "formalization" as a firm's use of formally explicated and codified rules and procedures, rather than informal ones, in its interactions with innovation partners (Chen et al., 2013; Du et al., 2014). Specifically, formalization refers to a firm's interactions with partners that are routinized, planned, and structured, rather than unplanned, fleeting, and ad hoc (Chen et al., 2013), or that are characterized by regular monitoring and adherence to strict upfront planning, rather than informal collaborations based on trust and other self-reinforcing mechanisms (Du et al., 2014). The concept of "formalization" is thus well-suited as a way to deepen the KBV's understanding of the role interaction rules and directives play in the integration of external knowledge to generate innovation. Although formalization provides some degree of structure and order during the knowledge-sourcing process, thereby reducing ambiguity and the potential for partner opportunism, these rules can also stifle new ideas and creativity (Damanpour, 1991). Therefore, the literature shows that the decision on whether to manage the knowledge-sourcing process with external parties formally or informally depends on such factors as the sources of knowledge involved (Du et al., 2014; Gesing et al., 2015). Specifically, researchers find that high levels of formalization enhance the relationship between market-based partnerships and the financial performance of innovation projects. The underlying reason is that firms may have a competitive relationship with some suppliers (Schultze et al., 2007) and may thus require measures to protect innovation projects from unwanted knowledge spillovers while sourcing external knowledge. A more formal management of innovation projects during knowledge exchange with suppliers can minimize the cost and performance losses arising from such hazards (Du et al., 2014; Gesing et al., 2015). Additionally, even if ideas from customers would score high on novelty and customer benefits, they are found to score low on feasibility relative to professional sources (Poetz and Schreier, 2012). Therefore, a more formal collaboration approach enhances the chances that new idea development will take place according to plan and that unfeasible suggestions from customers will be filtered out (Du et al., 2014).

By contrast, innovation projects with science-based partners have been reported to correlate with better new product performance when they are managed informally (Apa et al., 2021; Du et al., 2014). Firms usually approach universities and research institutes to obtain fundamentally new knowledge and technologies from basic research or to develop a better understanding of the technical feasibility of particular applications of technology research (Cockburn and Henderson, 1998). This process is usually characterized by uncertainty, during which experimentation and serendipitous discoveries play critical roles (Du et al., 2014). A high degree of formal management over this process may stifle experimentation with new technologies and reduce the possibility of serendipity. Moreover, unlike market-based partners, universities and research institutions have fewer incentives to act opportunistically as they do not directly compete with industrial firms in the marketplace and typically lack required complementary assets to commercialize intellectual property from joint research. Thus, there are less concerns about unwanted knowledge spill-overs and formalization may be less needed for science-based partnerships (Du et al., 2014; Gesing et al., 2015).

#### 2.2.3. Differential impacts of knowledge usage from customers and suppliers on innovation performance between FFs and non-FFs

Based on the extant FF research, we will first discuss why the tie between FFs and suppliers and customers is stronger than that between non-FFs and suppliers and customers. From the tie-strength perspective, we explain why the impact of knowledge usage from suppliers and customers on innovation performance differs between FFs and non-FFs. In a similar vein, we explicate the differences between FFs and non-FFs in the extent to which they formalize their interactions with innovation partners, and apply this formalization perspective to elaborate the moderating effect of firm type on the relationship between the usage of knowledge obtained from suppliers and customers and innovation outcomes.

Family firms have long been known to develop relationships with customers and suppliers that are deeper and more enduring than those developed by non-FFs (Miller and Le Breton-Miller, 2005; Miller et al., 2008). Family business owners seek to maintain the long-term soundness of their business and build social capital for later generations; thus, they are found to move from a transactional link with suppliers and customers toward strong and lasting relationships (Arregle et al., 2007; Huybrechts et al., 2011; James, 2006; Lyman, 1991; Miller and Le Breton-Miller, 2003). Empirical research shows that FFs are likely to have relationships with customers and suppliers that are stronger than those of non-FFs (Miller et al., 2008, 2009). The strength of the relationships between FFs and their customers and suppliers has been

expressed in terms of frequent contacts, personal friendships, prolonged relations through generations, and unconditional support during difficult times (Uhlaner et al., 2004). Hence, based on the definition of "tie strength" (i.e., closeness and/or interaction frequency), the tie between FFs and their suppliers and customers can be deemed to be stronger than that between non-FFs and their suppliers and customers. Consequently, the information FFs choose to utilize from these sources for their innovation activities tends to be less novel and less likely to be turned into innovation outputs than the information used by non-FFs. Contrariwise, non-FFs that choose to use information from these sources can benefit more than FFs; this information will be more novel because weak ties can result in diverse, non-redundant knowledge stocks, and the relationships non-FFs have with their customers and suppliers tend to be weaker than the relationships FFs have with theirs.

Furthermore, regarding the formalization of interactions with innovation partners, FFs have been found to rely on informal knowledge transfer and use unstructured methods in their innovation coordination, unlike non-FFs (Casprini et al., 2017; De Massis et al., 2015). Due to the high concentration of ownership and management in FFs, the owner-managers possess a high degree of organizational authority, giving them the managerial discretion required to avoid formalized rules and procedures that would limit their decision-making power (De Massis et al., 2015). As a result, FF owner-managers can "analyze their investment decisions on the back of an envelope or utilize heuristic methods or a mental calculus rather than a careful and exact accounting calculation", "pursue opportunities that can only be rationalized by particularistic or intuitive [and thus informal] criteria", and avoid normative frameworks such as consulting and deferring to alliance partners, which may impede their capacity to seize unlegitimized opportunities[1] (Carney, 2005, pp. 259, 260). Furthermore, "extensive formalization indicates a lack of trust and blunts the value of social relationships" (Sundaramurthy and Lewis, 2003, p. 405). Thus, high levels of formalization and trust are often deemed substitutes for governing interactions with innovation partners. Since FFs' relationships with external stakeholders are often embedded with high degrees of trust (Corbetta and Salvato, 2004; Granovetter, 1985; Miller and Le Breton-Miller, 2005), a high degree of formalization is less likely to be widely used in FFs than in non-FFs. Overall, FFs' tendency to establish long-term and trust-based relationships with external partners provides them leeway to engage in non-formalized screening and explore risky opportunities (Muñoz-Bullón et al., 2019). Indeed, research on inter-firm collaboration between FFs shows that trust embedded in collaboration eliminates the need for formalized contracts (Hatak and Hyslop, 2015). Given the necessity of formally managing interactions with market-based partners (Du et al., 2014; Gesing et al., 2015), FFs are less likely to achieve innovations than non-FFs when using knowledge from market-based actors.

Overall, FFs' strong relationships with customers and suppliers reduce their ability to obtain new ideas from these sources, thereby attenuating the relationship between knowledge usage from market-based actors and innovation performance. Furthermore, the less formalized way in which FFs manage innovation collaboration with external partners relative to non-FFs poses an additional barrier for them, as they generate innovations through the specific nature of market-based knowledge resources, which usually requires a more formalized approach to managing the knowledge-acquisition process. Thus, we hypothesize the following:

**Hypothesis 3.** The relationship between knowledge usage from customers and suppliers and innovation performance is weaker for FFs than for non-FFs.

#### 2.2.4. Impact on innovation performance between FFs and non-FFs of knowledge usage from universities and research institutes

We apply the definition of "tie strength" to determine why ties with universities and research institutes are weaker than are those with customers and suppliers in both FFs and non-FFs. From a tie-strength perspective, both FFs and non-FFs should be able to acquire more new knowledge from this source. However, we argue by building on the formalization perspective that the lower levels of formalization in FFs relative to non-FFs should allow FFs to unlock the full potential of their science-based sources to generate innovation.

Although there is substantial evidence of a positive relationship between knowledge obtained from scientific sources (universities and research institutes) and innovation outcomes, knowledge transfer between firms and scientific organizations implies high risk and uncertainty (Caloghirou et al., 2003; Vavakova, 1995) because of the divergent research objectives, intellectual property rights management methods, incentives, and structures involved (Jensen and Thursby, 2001; Veugelers and Cassiman, 2005). First, fundamental research traditionally conducted by science-based organizations and the applied research executed in companies may generate scientific or technological distance, which hampers efficient knowledge sharing (Lhuillery and Pfister, 2009). Second, regarding the management of intellectual property rights, science organizations typically share research results with colleagues and the general public as soon as possible, but companies tend to keep new knowledge and technology secret until they have been patented (Hall et al., 2003; Nelson, 2001). Third, regarding incentives and structures, scientific organizations often base tenure and promotions on publications and grants rather than on technology transfer, and their organizational structure is seen as more cumbersome and less flexible than firm structures are (Crow and Bozeman, 1989, 1998; Siegel et al., 2003). For these reasons, innovation projects conducted in collaboration with universities or research institutes are subject to more difficulties, delays, and failure than are collaborations with suppliers and customers (Hall et al., 2003; Lhuillery and Pfister, 2009).[2] Given the higher risk incurred in projects with universities and research institutes and their smaller role in firms' daily operations, both FFs and non-FFs will be less likely to contact science sources frequently and will be less emotionally involved with them than they are with suppliers and customers. Hence, FFs and non-FFs will both have weaker ties with universities and research institutes than with suppliers and customers. Accordingly, from a tie-strength perspective, both FFs and non-FFs should be able to acquire more novel knowledge from this knowledge source.

In addition, firms must also employ appropriate formalization mechanisms to unlock the full potential from specified external sources to acquire novel information. As mentioned, FFs tend to be less formalized than non-FFs in managing knowledge-sourcing activities, and a lower level of formalization is more beneficial for innovation performance when it comes to knowledge usage from science-based sources. Thus, from the formalization perspective, FFs are more likely to generate innovations than are non-FFs when using knowledge gained from universities and research institutes.

In sum, both FFs and non-FFs can acquire novel information when utilizing knowledge from universities and research institutes because of the weak nature of these relationships. However, because FFs are less

[1] Products and technologies possess legitimacy when they are "taken for granted" as the appropriate form or method, but new markets and emerging product niches lack this legitimacy because they are unfamiliar and not well-understood by sceptical resource providers (Aldrich and Fiol, 1994).

[2] Belgium, from which our sample is drawn, was found to provide a high number of government support systems for science–industry cooperation (Seppo et al., 2014). However, the extent to which government incentives can bridge the above-discussed obstacles and lead to fruitful collaboration results is unclear. As the empirical evidence on how government support impacts cooperation with science-based actors is mixed (Veugelers and Cassiman, 2005), we consider these sources more risky than other sources (i.e., market-based actors).

formalized in their interactions with external partners, they are able to use the knowledge gained from universities and research institutes more efficiently than non-FFs are. Hence, we hypothesize the following:

**Hypothesis 4.** The relationship between knowledge usage from universities and research institutes and innovation performance is stronger for FFs than for non-FFs.

Fig. 1 below presents the study's conceptual model, depicting the relationship between knowledge inflows from market- and science-based sources, firm type (FFs versus non-FFs), and innovation performance.

## 3. Data and methods

### 3.1. Sample

We use data drawn from three sources: the Flemish Community Innovation Survey (CIS), Bel-first, and company websites. The CIS is an official survey conducted by several EU member states by the European Commission and Eurostat. The Flemish CIS is a stratified (according to sector and size class) random sample that complies with the guidelines and definitions set out in the Oslo Manual (OECD, 2005) for surveys on innovation activities and covers both production and service firms. We construct a panel dataset using the CIS surveys conducted in 2009, 2011, and 2013, because our variables of interest are available only for these waves. The questionnaire for survey wave *t* collected firms' business data for year *t-1*. For example, the 2009 survey wave collected business data for 2008.

In line with previous studies (e.g., Kobarg et al., 2019), we limit our analysis to companies from the manufacturing sector to ensure a strict focus on product innovation in this sector and to curb the effects of varying sectoral business structures and regulatory frameworks. Furthermore, "innovation in service-oriented sectors can differ substantially from innovation in many manufacturing-oriented sectors. It is often less formally organized, more incremental in nature and less technological" (OECD, 2005, p. 11). Therefore, we examine innovation performance by focusing on the manufacturing industry. After excluding missing observations and outliers, we obtain an unbalanced panel dataset comprising 186 firms and 228 firm-year observations.[3]

Data on firm size, firm age, and past performance are obtained from Bel-first, a financial database provided by Bureau van Dijk, which contains detailed financial information (annual financial accounts) on Belgian companies. The CIS is used to extract the remaining variables, with the exception of the family firm variable, which we construct using data taken from the CIS and company websites.

### 3.2. Dependent variables

We measure innovation performance as the sales share of new or significantly improved products (goods or services). This proxy provides direct information on the performance success of commercializing inventions; thus, it is often employed in innovation studies (e.g., Amara and Landry, 2005; Dziallas and Blind, 2019; Un et al., 2010).

### 3.3. Independent variables

Consistent with prior studies, we construct the family firm variable based on ownership (Barth et al., 2005; Ben-Amar et al., 2013; Broekaert et al., 2016) or whether the firm perceives itself as a family business (Astrachan et al., 2002; Zellweger et al., 2010). Specifically, a business is considered a FF when (1) a shareholder (single or family) owns at least 50% of the company's shares or when (2) it has an individual or family ownership below 50% but perceives itself as a family business during the study period, as indicated on its website.[4] If neither of these conditions is met, the business is classified as a non-FF. Following this operationalization, approximately 49% of the sample is identified as FF.

The CIS asked respondents to rate the extent to which they used each knowledge source for innovation activity on a scale from 0 to 3 ("not used," "low," "medium," or "high," in that order). Following the literature, we operationalize knowledge usage, or the extent to which firms use knowledge from external sources, by summing the scores for the related sources (Kang and Kang, 2014; Poot et al., 2009). Therefore, knowledge usage from suppliers and customers has a value from 0 to 6, measuring the extent to which firms use information or knowledge from suppliers and customers for innovation activities. Similarly, knowledge usage from universities and research institutes has a value from 0 to 6, measuring the extent to which firms use information or knowledge gained from universities and research institutes for innovation activities.

### 3.4. Control variables

*Firm size.* Large companies might resist innovation activities because of their bureaucratic structure (Sathe, 2003), while small firms might outperform larger incumbent firms in creativity, speed, and flexibility, especially when new technologies emerge (Bower and Christensen, 1995). On the other hand, because of their greater resources, large firms are more likely to successfully commercialize their inventions (Ettlie and Rubenstein, 1987). Thus, firm size is controlled for by taking the natural logarithm of (1+ number of employees) in the firm.

*Firm age.* Young firms are often highly innovative (Gassmann and Keupp, 2007), and older firms may have entrenchment issues (Muñoz-Bullón et al., 2019). Therefore, we control for firm age by calculating the difference between the year of the respective panel wave and the firm's founding year.

*Group.* A firm belonging to a group is expected to achieve more innovations because it can benefit from knowledge spillovers and internal access to finance (Köhler et al., 2012; Veugelers and Cassiman, 2004). Hence, we control for business group membership using a binary variable indicating whether a firm belongs to a business group.

*Past performance.* Strong past performance may generate future organizational slack, which can be used to explore new alternatives (Cyert and March 1963; Daniel et al., 2004). We measure this construct using return on equity (ROE) in the previous wave (Tanriverdi and Venkatraman, 2005).

*Research and development intensity.* This measure is widely used to capture absorptive capacity (Cohen and Levinthal, 1990; Tsai, 2001), a crucial firm ability to "recognize the value of new, external information, assimilate it, and apply it to commercial ends" (Cohen and Levinthal, 1990, p. 128). Hence, we include a measure of research and development (R&D) intensity, expressed as the ratio of R&D expenditure to firm sales. Since the distribution of this variable is highly skewed, we take the natural logarithm (1 + R&D intensity) prior to further analysis.

*Industry.* A firm's innovation behavior is closely associated with its industry (Audretsch, 1997; Malerba et al., 1997). The industry captures various technological dimensions (e.g., technological opportunity, appropriability regimes) and dynamic aspects (e.g., cumulativeness, or the emergence of dominant designs and technology life cycle) (Breschi

[3] The Flemish CIS is run on a voluntary basis, thereby the response rates were around 40%–60%, lower than the 90% and above in countries where the surveys are mandatory. Our sample size is on par with the sizes of samples used in previous studies that used the same data source (e.g., Aerts and Schmidt, 2008), and is thus considered normal.

[4] Studies suggest that family ownership in a listed firm lower than 50% can entail a significant family influence on the organization and its decision making (Villalonga and Amit, 2006). Because our sample contains both non-listed and listed firms, we investigate listed firms with family ownership levels below 50%. All of these firms also declared themselves FFs on their website during the study period, leading us to characterize them as FFs in our sample.

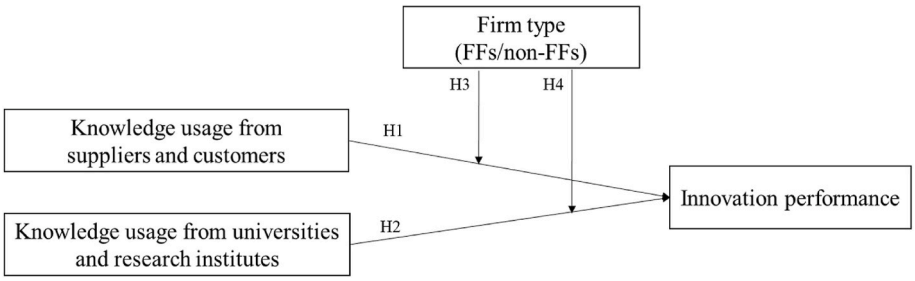


**Fig. 1.** Conceptual model.

et al., 2000; Teece, 1986). Following Eurostat's guidelines, we use the companies' main NACE code to classify industries into four categories: high-tech, medium-high-tech, medium-low-tech, and low-tech. Overall, 18%, 46%, 28%, and 8% of the sample firms fall into these categories, respectively.

### 3.5. Econometric estimation: lagged-variable random-effects Tobit model

The dependent variable has two peculiar features. The first is the percentage of sales from innovation outputs, which ranges from 0 to 100. Second, since many firms reported no sales from innovations, about one-third of the observations have a value equal to zero for the dependent variable (72 left-censored observations in the dependent variable). For these two reasons, scholars suggest that it is appropriate to use the Tobit estimation model (Gujarati 1995). Essentially, the Tobit model considers the fact that the underlying distribution of the model's error term is censored. The Tobit model is estimated by the maximum likelihood method, which yields consistent estimators for the model parameters, while generalized least squares (particularly ordinary least squares) would result in biased (asymptotically inconsistent) estimation (Greene, 1981). Therefore, the Tobit model is commonly used in innovation studies (Becheikh et al., 2006) that employ a similar dependent variable (e.g., Bourke and Roper, 2016; Laursen and Salter, 2006; Leiponen and Helfat, 2010).

We estimate random-effects Tobit models for the following reasons. First, in short panels, the likelihood estimator for fixed effects Tobit is inconsistent due to the incidental parameters problem (Cameron and Trivedi, 2005). Hence, given our research design, random effects estimation is preferred over fixed effects estimation. Second, the likelihood-ratio test comparing random effects with the pooled Tobit model suggests that the between-panel variance is highly significant. This supports the choice of longitudinal over cross-sectional analyses.

Since time lags often occur between the implementation of innovation strategies and outcomes, we estimate a lagged variable model in which the independent and control variables are all lagged by one panel wave (i.e., by two years), which corresponds to the survey's two-year implementation lag. This two-year lag between innovation outcomes and knowledge sources is appropriate for the types of innovations that occur in manufacturing industries (Leiponen and Helfat, 2010). In general, it also adheres to the finding that "the total lag associated with the innovation process varies between 1.17 and 2.62 years" (Goel, 1999, pp. 54, 55). The model is estimated such that the firm's share of sales from products new to the market or to the firm observed in panel wave *t* is regressed on the use of external knowledge sources, firm type (FFs versus non-FFs), and the control variables observed in panel wave *t−2* (i.e., the wave collected two years prior to the wave collected in year *t*). Such lagged-variable models have been shown to possess superior predictive validity, particularly when innovative outcomes are measured (Laursen and Salter, 2006). Furthermore, this approach allows us to mitigate concerns about common method bias because the temporal precedence of the predictor variables is firmly established before the outcomes are observed (Podsakoff et al., 2003).

## 4. Findings

### 4.1. Descriptive statistics and results of hypothesis testing

Table 1 provides descriptive statistics and correlations for all variables, except for those reflecting industry and time. On average, the respondents attributed 16.80% of their turnover to innovation outputs. Firms tend to use information and knowledge obtained from customers and suppliers to a greater extent than those obtained from universities and research institutes, which corroborates our earlier notion that firms may find it difficult to utilize knowledge from science-based sources because of the divergence between science and industry. Table 1 shows that innovation performance is positively associated with knowledge usage from suppliers and customers, while no significant relationship is observed between innovation outputs and the usage of knowledge gained from universities and research institutes. The latter result points to contradictory findings in the innovation literature about the impact of science sources on innovation performance and suggests that firms may differ in their ability to effectively convert knowledge from these sources into innovation outcomes. The FFs in our sample also display lower innovation performance than their non-FF counterparts.

Table 2 presents the estimation results for the random-effects Tobit models. The models are constructed gradually by entering only the control and dummy variables for industry in the baseline model and then adding independent variables and interaction effects step by step. Hypotheses 1 and 2 predict the positive impact on innovation performance of knowledge usage from suppliers and customers and from universities and research institutes, respectively. As shown in Model 2, Hypothesis 1 receives support at the 1% level, while Hypothesis 2 is not supported. Hypotheses 3 and 4 postulate that the usage of different knowledge types impacts on innovation outputs differently between FFs and non-FFs. Both hypotheses receive support at the 5% level, as shown in Model 3. These findings confirm our notion that the relationship between knowledge usage from suppliers and customers and innovation outcomes is weaker for FFs than for non-FFs, whereas the relationship between knowledge usage from universities and research institutes and innovation outcomes is stronger for FFs than for non-FFs. Additionally, the estimation results for the control variables suggest that innovation performance is higher for firms with greater R&D investment ($p < .05$), in line with the literature.

Fig. 2 compares innovation outputs between FFs and non-FFs via the usage of knowledge gained from suppliers and customers. In line with Hypothesis 3, whereas non-FFs experience a steady rise in innovation performance as their usage of knowledge obtained from suppliers and customers increases, FFs witness only a marginal increase. Moreover, non-FFs achieve higher innovation performance than FFs with high levels of knowledge usage from suppliers and customers.

Fig. 3 compares innovation outputs between FFs and non-FFs via the usage of knowledge gained from universities and research institutes. In line with Hypothesis 4, the more FFs use knowledge from universities and research institutes, the higher their innovation performance. By contrast, increased usage of this knowledge does not increase innovation outcomes for non-FFs, and even decreases them.

**Table 1**
Descriptive statistics and correlations.

| Variable | Mean | SD | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Innovation performance | 16.80 | 23.87 | 1 | | | | | | | | |
| 2. Firm type (FF/non-FF) | 0.49 | 0.50 | −0.13* | 1 | | | | | | | |
| 3. Knowledge usage from suppliers & customers | 4.02 | 1.29 | 0.17** | 0.10 | 1 | | | | | | |
| 4. Knowledge usage from universities & research institutes | 2.03 | 1.68 | 0.09 | −0.01 | 0.13* | 1 | | | | | |
| 5. R&D intensity[a] | 0.06 | 0.09 | 0.26** | −0.13* | 0.08 | 0.17* | 1 | | | | |
| 6. Past performance (ROE) | 13.83 | 44.64 | −0.13 | 0.03 | −0.10 | 0.11 | −0.12 | 1 | | | |
| 7. Group | 0.66 | 0.48 | 0.05 | −0.46** | −0.03 | 0.08 | 0.11 | −0.09 | 1 | | |
| 8. Firm size[a] | 4.53 | 1.49 | −0.03 | −0.34** | 0.05 | 0.30** | 0.02 | −0.08 | 0.46** | 1 | |
| 9. Firm age | 29.08 | 20.05 | −0.02 | 0.03 | 0.04 | 0.11 | −0.01 | 0.10 | 0.05 | 0.37** | 1 |

Notes. n = 228.
*p ≤ .05 **p ≤ .01.
[a] Log-transformed variables.

**Table 2**
Estimation results for dependent variable Innovation performance.

| | Model 1 (baseline) | Model 2 | Model 3 |
|---|---|---|---|
| R&D intensity | 75.635** (26.260) | 60.229* (25.63) | 60.456* (25.250) |
| Past performance (ROE) | −0.060 (0.050) | −0.062 (0.049) | −0.061 (0.048) |
| Group | 0.652 (5.875) | −1.658 (6.013) | −1.069 (5.879) |
| Firm size | −0.744 (1.978) | −2.849 (2.046) | −2.145 (2.034) |
| Firm age | 0.036 (0.132) | 0.054 (0.127) | 0.095 (0.126) |
| Industry controls | | | |
| Medium-low tech | −1.970 (9.777) | −4.304 (9.521) | −5.391 (9.364) |
| Medium-high tech | 8.920 (9.462) | 7.109 (9.304) | 6.721 (9.142) |
| High tech | 10.949 (10.550) | 6.034 (10.36) | 5.824 (10.197) |
| | | | |
| Family firm status | | −11.96* (5.217) | 7.171 (15.319) |
| Knowledge usage from customers and suppliers | | 5.217** (1.731) | 8.285*** (2.307) |
| Knowledge usage from universities and research institutes | | 2.132 (1.411) | −0.728 (1.899) |
| | | | |
| Family firm status* Knowledge usage from customers-suppliers | | | −7.376* (3.406) |
| Family firm status* Knowledge usage from universities-research institutes | | | 5.784* (2.676) |
| | | | |
| Log-likelihood | −783.144 | −775.230 | −771.028 |
| Wald chi-square | 30.57*** (9) | 46.57*** (12) | 55.36*** (14) |
| Rho (S.E.) | 0.472 (0.153) | 0.426 (0.156) | 0.421 (0.158) |

Notes.
n = 228. Left-censored observations: 72. Right-censored observations: 7.
*p ≤ .05; **p ≤ .01; ***p ≤ .001, constant included.
The industry category "Low tech" serves as the baseline category.
Rho is the proportion of the total variance contributed by the panel-level variance component.

### *4.2. Robustness tests and alternative specifications*

We perform several additional tests to ensure the robustness of our findings. The panel Tobit likelihood function is calculated using the Gauss–Hermite quadrature. For the first robustness check, the reported results are found to be insensitive to the quadrature parameters and the number of integration points. Next, a re-estimation of all of the models above with the bootstrapped version of Tobit shows that the signs and significance levels of all the main and moderation effects remain the same. This result alleviates concerns about heteroscedasticity.

Since we cannot compare the fixed and random effects models because of the inconsistency of the fixed effects estimator in short panels, we re-estimate all models with an alternative method: Generalized Estimating Equation (GEE) model (Liang and Zeger, 1986). GEE enables us to relate a response variable that follows a non-normal distribution to a predictor variable in a linear term via a proper family distribution and link function. Given that the dependent variable is the sales share of new or significantly improved products (goods or services), we use a binomial distribution and a logit link function, which are usually employed to model a dependent variable with proportional or fractional values (Papke and Wooldridge, 1996). The results of the GEE models turn out to be similar to those of Tobit models, bolstering our confidence in the robustness of the findings.

Moreover, we estimate the specifications of alternative models. First, several researchers argue that the increasing use of external sources is curvilinearly (inverted U-shaped) related to innovative performance (Berchicci, 2013; Laursen and Salter, 2006). To control for this possibility, we test alternative model specifications in which the usage of external knowledge is entered into a curvilinear specification. We find no support for curvilinear relationships.

Several studies suggest that the use of strong and weak ties can be complementary: Weak ties can be used to access novel knowledge and strong ties to recognize and validate newly acquired knowledge (Gilsing and Duysters, 2008; Rost, 2011). Hence, we test the significance of the interaction terms between the usage of knowledge from suppliers and customers and the usage of knowledge gained from universities and research institutes while controlling for firm type (FFs versus non-FFs). The interaction terms are not statistically significant. These results suggest the absence of potential interactions between knowledge sourcing from strong and weak ties.

Since FFs are often inclined to develop strong ties with their customers and suppliers, a relationship between FFs and the knowledge usage from customers and suppliers may be assumed. Therefore, we empirically test if this is the case. The Spearman's correlation test is not significant, suggesting no correlation between firm type (FFs versus non-FFs) and the use of knowledge gained from customers and suppliers. The

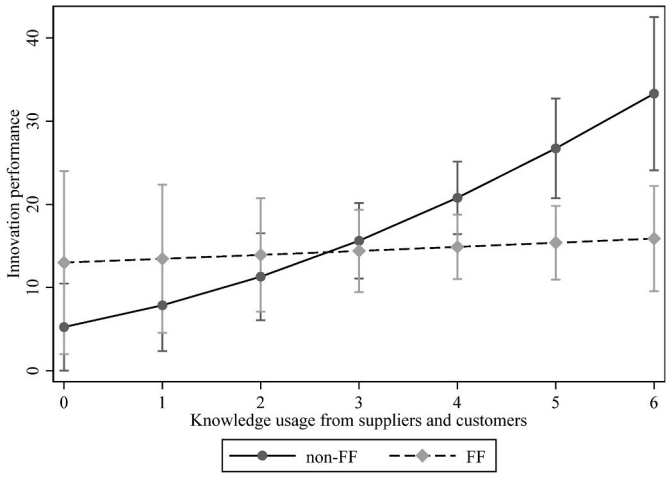


**Fig. 2.** Knowledge usage from suppliers and customers and innovation performance for FFs versus non-FFs.

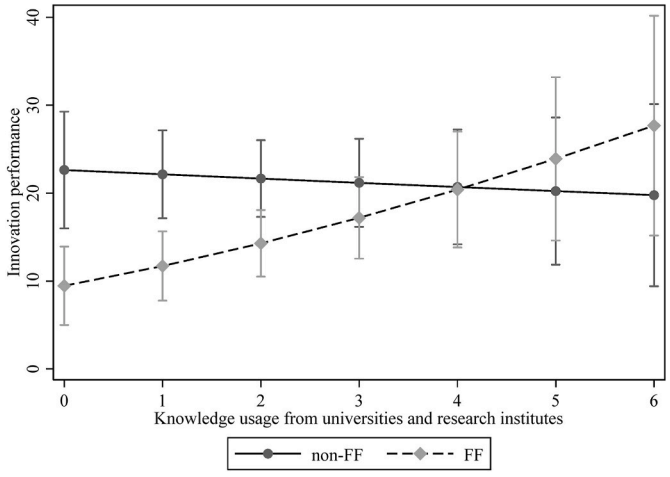


**Fig. 3.** Knowledge usage from universities and research institutes and innovation performance for FFs versus non-FFs.

Mann–Whitney *U* test is not significant, indicating no difference between FFs and non-FFs regarding the distribution of their knowledge usage from customers and suppliers. Similar results have been documented in other studies (e.g., Classen et al., 2012). These results suggest that given the distinct types of knowledge that market-based and science-based sources provide, FFs (as well as non-FFs) may search for knowledge from the source that can complement their needs and not always confine their search to the type of partners they often have strong ties with. This logic is in line with the literature that firms engage in open innovation to tap into complementary external resources needed for innovation (Chesbrough, 2003; Feranita et al., 2017). Overall, these tests bolster our choice of moderation models.

Next, we test the assumption that there is a mediation relationship in our data, wherein the usage of knowledge gained from customers and suppliers mediates the relationship between firm type and innovation performance. The results show that firm type is not significantly related to the mediator (usage of knowledge gained from customers and suppliers). The average causal mediation effect is also not significant. Additionally, in Hypothesis 4, we argue that FFs and non-FFs have weaker ties with universities and research institutes than with suppliers and customers. Hence, we assume that FFs and non-FFs do not differ in their usage of knowledge obtained from universities and research institutes. We empirically test this assumption with our dataset using the same steps as those used above and obtain similar results. These tests reinforce our choice of moderation models.

Although we have used lagged-variable models to mitigate concerns about reversed causality whereby more innovative firms may be more likely to source knowledge externally, there may exist unobserved factors that drive the firm's choice to use knowledge gained from customers and suppliers or universities and research institutes, and simultaneously influence innovation performance. To test whether our results are affected by this potential endogeneity, we use an instrumental variable (IV) approach to Tobit regression (Love et al., 2011). Following the literature (e.g., Abramovsky et al., 2009; Love et al., 2011; Nieto and Santamaría, 2010; Singh et al., 2016), we use market expansion goals and ex ante average employee costs as two IVs for knowledge usage from customers and suppliers, and ex ante firm performance and the receipt of public funding as two IVs for knowledge usage from universities and research institutes. These instruments are extracted from Bel-first and the CIS.

The market expansion goal is measured as the extent to which the goal of increasing market share is important to the firm. A higher emphasis on this goal will lead to a greater use of knowledge gained from market-based sources (Stephan et al., 2019). Additionally, strategic firm goals provide decision-making criteria and direction for a firm's actions, and will only subsequently and indirectly influence performance (Baum et al., 1998); thus, without appropriate strategies, the market expansion goal is less likely to have a direct influence on innovation outcomes. Ex ante average employee costs are measured as the average employee costs in the previous period. Firms tend to search for external knowledge when they lack internal resources, such as qualified personnel (Paananen, 2012). Hence, a high level of internal human resources can reduce the need to use information from customers and suppliers. Furthermore, there is an ongoing debate over whether the level of human resource can generate higher innovation outputs with several studies observing no direct effects (Woschke et al., 2017). Our data support this theoretical rationale, as neither market expansion goals nor ex ante average employee costs are statistically correlated with innovation performance.

The ex ante firm performance is measured as the average return on assets in the period before a firm's decision to use knowledge from universities and research institutes (Singh et al., 2016).[5] The rationale behind this instrument is that the lower the past performance, the greater the extent to which the firm will approach universities and research institutes for new knowledge or technology (Cassiman and Valentini, 2016). Due to the significant time gap between ex ante firm performance and innovation outcomes in our study, this instrument is unlikely to have a significant impact on firm innovation output. The last IV captures whether the firm received any kind of public financial support for innovation activities from local or national sources (Abramovsky et al., 2009). Government-supported firms have a higher probability of collaborating with universities/government labs than do firms without government support (Beck et al., 2016), due to the increase in R&D support via government funding (Miotti and Sachwald, 2003). Furthermore, the receipt of public support is less likely to have a direct effect on innovation performance, as the literature offers mixed arguments and findings concerning its direct impact on innovation output and is increasingly pointing to moderators and mediators as factors determining the effectiveness of these funds (Albors-Garrigos and Barrera, 2011). Our data confirm these theoretical rationales, as neither ex ante firm performance nor the receipt of public funding is statistically correlated with innovation performance.

Although we use four potential IVs, we cannot guarantee that they fulfil the strict exclusion restriction (i.e., they are valid). Therefore, we first test the validity of the instruments using the Hansen J-statistic

[5] This instrument is different from past performance in the control variable set, which is measured as return on equity in the period before the innovation outcome and in the same period as knowledge usage from external sources.

overidentification test (p = .83) and cannot reject the null hypothesis that our IVs are valid. However, the Hansen J-test assumes that at least one of the instruments is valid. Therefore, we also execute a Kinky Least Squares (KLS) exclusion restriction test (Kiviet, 2020), which enables an instrument-free inference. The KLS exclusion restriction test shows that we cannot reject the null hypothesis that the instruments are validly excluded in the main model at the 5% significance level for endogeneity correlations in the interval [−1, 0.216] for "market expansion goal", for endogeneity correlations in the interval [−1, 0.252] for "receipt of public funding", and for all endogeneity correlations for "ex ante average employee costs" and "ex ante firm performance". The results of these tests support the premise that our instruments are valid. [6]

Next, we estimate the IV models for Tobit. In the first-stage regression, market expansion goals and ex ante average employee costs are both significantly associated with knowledge usage from customers and suppliers, and the signs of the estimated coefficients are also in line with the literature. Similarly, ex ante firm performance and the receipt of public funding are significantly correlated with knowledge usage from universities and research institutes with the expected signs. The F-statistic associated with our instruments in the first-stage regression for the usage of knowledge gained from customers and suppliers and from universities and research institutes are 18.96 and 32.14 respectively, well above the conventional threshold (F ≥ 10). Hence, any concerns regarding weak instruments are alleviated. In the second-stage regressions, the impact of the predicted knowledge usage from universities and research institutes on innovation performance and the impact of the predicted knowledge usage from customers and suppliers on innovation performance are consistent with the results of the Tobit models reported above. The Wald test for the exogeneity of the instrumented variables is not significant (p = .32). We cannot reject the null hypothesis of no endogeneity. Therefore, regular Tobit model estimates are preferred. Overall, these tests suggest that our findings are not driven by endogeneity.[7]

## 5. Discussion and conclusions

This study investigates innovation performance in FFs and non-FFs from a knowledge perspective. Building on the KBV (Conner and Prahalad, 1996; Grant, 1996b) and the innovation literature, we hypothesized that the more firms use knowledge gained from market- or science-based actors, the higher their innovation performance will be. Our data support the hypothesis on market-based sources, but not on science-based sources. The latter result is consistent with the literature's finding that industry representatives typically view science-based sources as important for innovation performance but also as difficult to extract knowledge from, as well as unpredictable due to the divergent research objectives, intellectual property rights management methods, incentives, and structures involved (Caloghirou et al., 2003). Hence, not all firms can reap significant benefits from these science sources.

Regarding the moderating effect of firm type, the results show that the relationship between knowledge usage from customers and suppliers and innovation outputs is weaker in FFs than in non-FFs. This result is in line with our theoretical argument on tie strength and formalization. Specifically, the strong relationships that FFs tend to build with customers and suppliers reduce FFs' ability to obtain new ideas when utilizing knowledge from these sources, thereby attenuating the relationship between the knowledge usage from market-based actors and innovation performance relative to non-FFs. In addition, this relationship is further weakened by the lower degree of formalization in the way FFs often manage their innovation collaborations with external partners relative to non-FFs, which is detrimental to the use of these knowledge sources.

By contrast, our findings show that the association between knowledge usage from universities and research institutes and innovation outputs is stronger in FFs than in non-FFs. Science-based sources tend to have weak ties with both FFs and non-FFs. Hence, utilizing knowledge from these sources helps both types of firms access novel knowledge. However, the low levels of formalization often found in FFs are beneficial when utilizing knowledge from science-based sources, enabling FFs to achieve a higher innovation performance. These findings have several important theoretical and practical implications.

### 5.1. Theoretical contributions

Since the KBV (Grant, 1996a,b) emphasizes not only the influence of knowledge on innovation but also the mechanisms and conditions that facilitate this process, it draws our attention to relational strength and formalization as crucial factors supporting new knowledge acquisition, prompting us to reveal firm type—particularly the FF/non-FF distinction—as an important yet underexplored contingency. We thus highlight the continued role of the KBV as a strong theoretical guide for uncovering more fine-grained results, especially when investigating the factors that support the conversion of knowledge into innovation outcomes.

The KBV (Grant, 1996b, 2013) acknowledges the role of external knowledge but does not elaborate extensively on the conditions that enable the integration of external knowledge into the firm to generate innovation. Theorizing on knowledge acquisition, Grant (2013) discussed the importance of relational networks and interaction rules and directives. We deepen our understanding of these mechanisms by building on the tie-strength and formalization literature to show theoretically how differences in the strengths of ties with network partners and in the degrees to which interactions with external partners are formalized determine how external knowledge impacts innovation performance. This integration of the tie-strength and formalization perspectives complements the KBV to create a more comprehensive framework.

We also contribute to the contingency perspective by identifying firm type as a critical firm-related factor that influences how knowledge usage from specific external sources impacts innovation performance. Innovation scholars have largely agreed on the significance of external knowledge sourcing, measured as the sum of all outside sources, but the findings regarding the impact of specific knowledge sources on innovation performance are mixed. In line with the growing literature, we show that exploring the moderating role of firm-related factors can open a path toward a more refined framework that can reconcile the literature's contradictory results.

This study also adds to the family business literature in several ways. First, we show the potential application of the KBV as a theoretical underpinning by which to advance research on innovation performance and collaborative innovation in family businesses, since the use of the KBV in these fields is still limited (Calabrò et al., 2019). Second, family business scholars have long recognized the role of external knowledge in producing innovations, but external knowledge inflows are often measured as the aggregation of all external sources. We pinpoint the nuances across external knowledge sources originating from the

[6] To correct for the potential endogeneity problem of interaction terms, we use the technique suggested by Wooldridge (2010, pp. 267–268). The instruments still turn out valid, and the Wald test for exogeneity is not significant. Therefore, we cannot reject the null hypothesis of no endogeneity for the moderating terms. However, our IVs turn out to be weak for the interaction terms; thus, the IV estimator should not be used to replace the standard estimator (i.e., Tobit model) (Larcker and Rusticus, 2010). Even though we cannot find adequate instruments for the interaction terms, literature shows that the interaction terms are much less affected by endogeneity than the main effects, i.e., knowledge usage from market-based sources and knowledge usage from science-based sources (Benito et al., 2016; Bun and Harison, 2019; Vanacker et al., 2019), which alleviates our concern about the potential endogeneity in the interaction effects.

[7] The results of all the robustness tests described in this section are available on request.

differences in the levels of relational strength that FFs tend to have with diverse sources and the different levels of formalization required to successfully acquire knowledge from distinct sources. Therefore, we highlight the necessity of examining the heterogeneity of external knowledge sources to discover more fine-grained results, especially in the context of family business innovation. Third, we show that the strong community-like relationships FFs maintain with their customers and suppliers work as a double-edged sword: On the one hand, they can be a source of social capital that helps FFs to sustain their business, as has often been documented (Ahrens et al., 2019; Long, 2011); on the other hand, an overreliance on these sources can lead to unfavorable results, such as dependencies (Miller and Le Breton-Miller, 2005), homogeneous thinking, and reduced innovation ability (Chirico and Salvato, 2016). Our findings empirically highlight the downside of strong relational ties with external partners in FFs by drawing attention to their negative effects on innovation performance. Finally, our results extend the discussion on FF formalization. Prior research tends to focus on the low internal formalization of FFs and its benefits for adopting discontinuous technologies (König et al., 2013). Our findings suggest that FFs' orientation for low formalization when sourcing external knowledge may not always be beneficial for innovation performance. The decision on whether to manage the interactions informally depends very much on the source of the knowledge: When it originates from universities and research institutes, there is a positive effect; when it originates from customers and suppliers, there seems not to be a positive effect.

### 5.2. Implications for practice

Regarding innovation activities, managers should be aware of how the strength of relational ties can affect the novelty of their knowledge. Our research suggests that FFs and non-FFs can increase their innovation performance by leveraging the knowledge obtained from external sources with which they tend to have weak ties and thus accumulate more novel knowledge. On the other hand, although long, enduring relationships with customers and suppliers can lead to competitive advantages for FFs, thus helping them to achieve high financial performance, a strong tie may constrain their search for novel information. Hence, FFs should be careful when using these knowledge sources in innovation activities. Furthermore, our study echoes the previous research finding that different knowledge sources require a different formalization approach to unlock their full potential for engendering innovation (Du et al., 2014; Gesing et al., 2015). Therefore, both FFs and non-FFs should consider the types of knowledge they source from and apply the appropriate formalization mechanisms to make the most of them.

Moreover, our findings can inform the practices of government agencies and business consultants involved in family business development. Their support for knowledge mobilization is crucial because of the potential divergences between science and industry. Some FFs might avoid risky projects to preserve family control and wealth (Hiebl, 2013) and might refrain from acquiring knowledge from science-based sources despite their greater ability to do so. Given the positive relationship between knowledge usage from universities and research institutes and innovation outcomes among FFs, government agencies should introduce programs and incentives designed to bridge the distance between science and industry. Business consultants should also help FFs discover opportunities to leverage knowledge from universities and research institutes to increase innovation performance without harming the family's objectives.

### 5.3. Limitations and future research directions

This study has several limitations. First, our results are based on an analysis of manufacturing firms in the Flemish part of Belgium. Belgium is an innovation-driven economy (Bauweraerts and Colot, 2017) and has a high-performing science base (Veugelers and Cassiman, 2005). The country has many government support systems for science–industry collaboration; however, the federal–regional political system in Belgium is highly complex, which deters the development of a consistent policy for promoting industry–science links (Polt et al., 2001). These country-specific factors may affect the outcomes of innovation based on knowledge obtained from science-based sources. Future studies could expand the research scope to investigate whether our findings still hold in other contexts. Second, as we use secondary data, we lack information about family involvement in management teams and boards of directors, which would have enabled a more fine-grained investigation of the family's influence. However, the literature shows that FF managers (both family members and non-family members) integrate their own interests into their decision-making processes (Vandekerkhof et al., 2018) because they tend to be selected based on whether they share the family's values and meet their expectations (Gomez-Mejia et al., 2011). However, additional information about actual family and founder involvement in management could advance our understanding of innovation behaviors in FFs (Block, 2012). Finally, the Flemish CIS is part of the European CIS, which is conducted biennially. Hence, it is impossible for us to test other time-lag possibilities, such as a one-year or three-year lag. Future research could try to apply other time-lag possibilities to enhance the robustness of the findings.

Our findings also point to future research questions. First, if innovation projects with science-based actors entail uncertainty due to the divergence between science and industry, it would be interesting to explore the micro-mechanisms of how FFs manage to overcome these barriers and successfully utilize knowledge obtained from scientific sources to generate innovations. The findings would contribute to the family business literature, which has called for more research on collaborative innovation in FFs (Calabrò et al., 2019). A few studies have identified the mechanisms by which FFs manage organizational issues, such as conflicting goals and the fear of losing control in collaborative innovations with external partners (Lambrechts et al., 2017), and have examined how FFs manage internal and external knowledge flows in open innovation (Casprini et al., 2017). Nevertheless, little is known about how FFs cope with a specific source of external knowledge to engender innovation. Since our study highlights the heterogeneity of external knowledge—specifically, its conversion into innovation outputs in FFs and non-FFs—our findings imply that different strategies may be necessary to acquire information drawn from different external sources. Therefore, given their unique strengths and weaknesses, a deep dive into how FFs can access and successfully implement knowledge obtained from universities and research institutes throughout the innovation process will yield deeper insights for academia and practitioners. Second, while we could not find empirical evidence for this claim, one could wonder whether FFs could be biased towards an increased knowledge usage from customers and suppliers because of their generally strong ties with these partners. That is, even though the relationship between knowledge usage from customers and suppliers and innovation performance is weak for FFs, frequent interactions with these types of partners might tempt FFs to rely on these partners' knowledge for new projects even though innovative opportunities lie elsewhere. Future research could investigate under which circumstances these biases exist and how FFs can overcome them to align their knowledge usage with their needs. Third, there might be multiple steps in the process of acquiring external knowledge and converting it into innovation output (Zahra and George, 2002). Our theorization focuses on how tie strength with external parties and formalization level in governing interactions among innovation partners affect the obtaining of novel knowledge, since new knowledge acquisition is linked to new product development and overall plays an imperative role in this process (Yli-Renko et al., 2001). Yet, we acknowledge that the formalization aspect can assist the knowledge conversion process beyond the acquisition stage depending on the extent innovation partners are involved in the innovation process of the focal firms. Hence, future studies could conduct a more in-depth analysis to enrich our understanding of formalization across different stages of the

knowledge conversion process. Lastly, from a macro perspective, scholars could examine the specific national or regional incentives that facilitate firms' access to scientific sources. As mentioned, Belgium provides support systems for science–industry cooperation (Seppo et al., 2014). Future research could delve deeper into the effectiveness of these systems and investigate the extent to which these incentives actually encourage FFs and/or non-FFs to reach out to science-based sources and successfully convert the acquired knowledge into innovation outcomes.

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