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Combining Internal and External R&D: The Effects on Innovation Performance in Family and Non-Family Firms

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Abstract

We examine the effect of combining internal and external R&D loci on innovation performance in family and non-family firms. Our longitudinal analysis of 27,438 firm-year observations of Spanish manufacturing firms from 1990 to 2016 shows that family firms can better exploit the benefits of simultaneously engaging in internal and external R&D activities, leading to a positive effect on innovation performance. Moreover, the relationship between combined internal and external R&D and innovation performance in family firms is contingent upon firm economic performance. By pointing to the importance of taking into account the combination of internal and external R&D loci to foster innovation in family firms, we challenge current family business innovation research.

Keywords: external R&D, family firm, innovation performance, internal R&D

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Introduction

The debate on the implications of internalizing innovation activities and outsourcing technology acquisition is ongoing, and the literature on this issue is full of countervailing theoretical arguments and mixed empirical evidence (e.g., Hagedoorn & Wang, 2012; Vega-Jurado, Gutiérrez-Gracia, & Fernández-de-Lucio, 2009). Extant research has built a compelling case for the complementarity between internal and external innovation activities, as the capacity to absorb knowledge from external loci is assumed to be a function of the firm's prior knowledge predominantly stemming from internal R&D (Cassiman & Veugelers, 2006; Cohen & Levinthal, 1989; Zahra & George, 2002). However, further work is needed to understand if and how firms can generate such complementarity from combining internal and external R&D[1].

In this study, our first research question focuses on whether and why family firms (FFs) may behave differently from non-family firms (non-FFs) in reaping innovation rewards from *combined R&D*, i.e., simultaneously engaging in internal and external R&D activities. We posit that in pursuing distinctive goals, the unique set of resources that FFs bundle and leverage will shape the outcome of their innovation activities (Carnes & Ireland, 2013).

The trade-off between affective endowment and financial concerns in FFs often differs from non-FFs (Carney, 2005; Yu, Lumpkin, Sorenson, & Brigham, 2011). FFs are typically motivated by, and committed to, the preservation of their affective endowment (Berrone, Cruz, & Gomez-Mejia, 2012), aiming to meet the goals of both the family and the business systems (Gomez-Mejia, Haynes, Nuñez-Nickel, Jacobson, & Moyano-Fuentes, 2007; Zellweger, Chrisman, Chua & Steier, 2019). The non-financial aspects that meet the family's affective needs are the pivotal reference point in these businesses. Strategic choices in FFs will

[1] With the term 'external R&D' we refer to the firm sourcing innovation from outside parties via contractual agreements (i.e., R&D contracting).

therefore tend to reflect the family's desire to accomplish family-centered noneconomic goals apart from economic utilities (Berrone et al., 2012; Gomez-Mejia et al., 2007), and this holds particularly for their resource deployment and management (Sirmon & Hitt, 2003). As a result, how FFs shape their innovation outcomes based on their distinctive propensity to assimilate and transform external resources, combine them with internal ones, and exploit their available resource stock (Carnes & Ireland, 2013; Sirmon & Hitt, 2003) potentially differs from non-FFs when undertaking both internal and external R&D.

We also address another important research question: Is an FF's advantage in exploiting combined R&D stronger in situations of below-par performance? As mentioned, noneconomic goals are expected to be a primary focus in FFs (Berrone et al., 2012; Kotlar & De Massis, 2013). Nevertheless, the priority of family-centered noneconomic goals reduces when economic conditions threaten FF survival, and thus the long-term benefits for the family (Gomez-Mejia, Patel, & Zellweger, 2018). As FFs facing negative economic prospects are expected to develop a more explorative attitude in making critical decisions regarding external R&D (Patel & Chrisman, 2014), we posit that FFs will be better at transforming the combined internal and external R&D loci into innovation performance compared to situations of high performance relative to the aspiration level.

To examine these research questions, we first rely on the resource-based view (RBV), given that FFs need to pay attention to resource management to transform external resources, combine them with internal resources, and exploit the bundle of tangible and intangible assets (e.g., Carnes & Ireland, 2013; Chrisman, Chua, & Zahra, 2003; Eddleston, Kellermanns, & Sarathy, 2008; Sirmon & Hitt, 2003). Understanding how resources may be drivers of superior innovation outcomes in FFs compared to non-FFs is of particular interest for practice and academic research (Carnes & Ireland, 2013; De Massis, Frattini, & Lichtenthaler, 2013). Assuming that firms in an industry or group are heterogeneous in terms of their resources (Peteraf, 1993), a key determinant of sustained competitive advantage (Wernerfelt, 1984) is holding resources that are valuable, rare, inimitable, and irreplaceable (Barney, 1991).

Second, based on the behavioral theory of the firm (Cyert & March, 1963), we explore how the effect of a combined R&D strategy on innovation performance in FFs might be contingent upon performance aspirations. According to this perspective, the behavior of a firm's dominant coalition affects its decision-making process (Cyert & March, 1963), playing a role in strategic decisions such as those concerning innovation (Classen, Van Gils, Bammens, & Carree, 2012; Kotlar, De Massis, Frattini, Bianchi, & Fang, 2013). Under this framework, we suggest that when FFs underperform, family decision-makers are more likely to sacrifice their affective endowment to ensure the firm's future financial wealth (Chrisman and Patel, 2012; Gomez-Mejia et al., 2018). We therefore posit that negative performance gaps threatening the firm's survival lead the dominant coalition to place more emphasis on economic over family-centered noneconomic goals, resulting in the pursuit of innovation benefits from combining internal and external R&D loci.

This paper contributes to the literature in at least two ways. First, despite the ever-greater focus on understanding technological innovation in FFs (e.g., Chrisman & Patel, 2012; De Massis, Frattini, Kotlar, Petruzzelli, & Wright, 2016; De Massis, Audretsch, Uhlaner, & Kammerlander, 2018a; De Massis, Ding, Kotlar, & Wu, 2018b; Duran, Kammerlander, Van Essen, & Zellweger, 2016; Filser, De Massis, Gast, Kraus, & Niemand, 2018), the means with which FFs can facilitate innovation performance have received less attention (e.g., Calabrò, Vecchiarini, Gast, Campopiano, De Massis, & Kraus, 2018; De Massis et al., 2013). FFs are particularly efficient in turning innovation inputs into outputs (Duran et al., 2016; Matzler, Veider, Hautz, & Stadler, 2015). External R&D is deemed a critical competence for sustained innovation success, and hence the need to explore the extent to which complementing the internal knowledge base of FFs with externally sourced technology improves their innovation performance over non-FFs. Our analysis therefore contributes to family business literature by analyzing the relative influence of different R&D loci on innovation performance in FFs versus non-FFs. In particular, we provide new insights on resource deployment and leverage, helping explain why FFs are far more efficient at turning combined internal and external innovation inputs into innovation outcomes.

Second, previous studies have drawn on the behavioral framework to address firm strategy formulation (i.e., R&D investment) (Chrisman & Patel, 2012). Our findings advance this research stream by exploring the outcome of strategic choices (i.e., the output of R&D investments) under adverse firm conditions. To our best knowledge, no attention has thus far been paid to understanding whether certain contingences (i.e., performance-aspiration gaps) affect the impact that a combined R&D locus has on innovation performance. In this regard, prior research stresses that under a negative performance-aspiration gap, family decision-makers' behavior becomes more aligned with financial utilities, and the divergence between maintaining current family-centered noneconomic goals and pursuing prospective financial concerns is therefore likely to be mitigated (e.g., Gomez-Mejia et al., 2018). We argue that family decision-makers will exhibit a higher propensity to prioritize financial over family-centered noneconomic goals when the FF performs below aspiration levels (Gomez-Mejia et al., 2018), with positive consequences on innovation performance from combined R&D.

Theoretical Background and Hypotheses Development

Family Firms and Innovation Performance: State of the Art

Before analyzing the relationship between FFs' internal and external R&D loci and innovation performance, we address a number of distinctive traits of FFs that may affect the transformation of innovation inputs into good innovation performance (for a systematic literature review on innovation in FFs, see for example, Calabrò et al., 2018).

First, FFs are characterized by the family's emotional commitment to the firm. The duality of affective and business relationships allows family members to work with initiative and devotion (Miller, Wright, Le Breton-Miller, & Scholes, 2015). This creates a deep and shared understanding of how things are done in the firm. As a result, the workforce in FFs possesses high levels of firm-specific tacit knowledge, i.e., intangible resources that are difficult to duplicate (Habbershon & Williams, 1999; Sirmon & Hitt, 2003). Such human capital (tacit knowledge), which accumulates during long tenure in the organization, supports knowledge transfer and mutual learning, and is found to increase the innovativeness of FFs (König, Kammerlander, & Enders, 2013). Second, FFs are known for their patient capital, defined as "financial capital that is invested without threat of liquidity for long periods" (Sirmon & Hitt, 2003, p. 343). Given that patient capital promotes a long-term perspective (Habbershon & Williams, 1999; Sirmon & Hitt, 2003), it may boost innovation capabilities in FFs (De Massis et al., 2018a; Llach & Nordqvist, 2010). Third, the preservation of ties with external stakeholders (e.g., more effective relationships with suppliers) (Habbershon & Williams, 1999; Sirmon & Hitt, 2003) also helps FFs transform R&D resources into innovation outcomes.

Nonetheless, FFs also have certain unique characteristics that may negatively affect innovation performance. To begin with, their desire to maintain ownership and control of the firm in the hands of family members (Gomez-Mejia, Makri, & Larraza-Kintana, 2010) leads them to adopt a conservative stance (Habbershon, Williams, & MacMillan, 2003). FFs are often reluctant to recruit outside employees, and the ensuing lack of more talented employees in managing R&D projects (Chang, Wu, & Wong, 2010; Chen & Hsu, 2009) might negatively affect innovation performance. Similarly, some FFs allocate resources for family purposes, giving preferential treatment to family members (Miller et al., 2015). Nepotism often erodes innovation capabilities. Finally, FFs tend to avoid external financing, as this source of capital may threaten the family's control of the firm. However, limited access to external financial resources (Gallo, Tapies, & Cappuyns, 2004) may ultimately reduce the FF's propensity to select valuable innovation projects.

Family Firms' Internal and External R&D Loci and Innovation Performance

While the importance of combining internal and external knowledge in developing innovative products and processes has been recognized for many years, both theory and practice remain ambiguous as to whether internal and external R&D loci complement each other (Cassiman & Veugelers, 2006). On the one hand, research suggests that firms simultaneously engaging in internal and external R&D sustain innovation, achieving reliability while enabling organizational renewal, thus enjoying enhanced innovation performance (Stettner & Lavie, 2015). It is well documented that rather than solely relying on knowledge from external loci, firms need to engage in their own internal R&D activities to successfully develop new products and services (Cassiman & Veugelers, 2006; Dahlander & Gann, 2010; Krzeminska & Eckert, 2016; Lokshin, Belderbos, & Carree, 2008). Indeed, the role of absorptive capacity as the "ability of a firm to recognize the value of new, external information, assimilate it and apply it to commercial ends" (Cohen & Levinthal, 1990, p. 128) becomes essential to successfully develop new products and services (Brinkerink, 2018; Krzeminska & Eckert, 2016; Lane, Koka, & Pathak, 2006; Tortoriello, 2015; Tsai, 2001; Todorova & Durisin, 2007; Volberda, Foss, & Lyles, 2010). Specifically, acquisition and assimilation (i.e., building potential absorptive capacity) as well as transformation and exploitation (i.e., realized absorptive capacity) enable firms to derive new insights when incorporating transformed knowledge into operations (Zahra & Georges, 2002). Finally, economies of scope, which manifest when firms share resources for different R&D activities (Cassiman & Veugelers, 2002; Krzeminska & Eckert, 2016), and knowledge spillovers (Krzeminska & Eckert, 2016), enable firms to achieve better innovation performance when combining internal and external R&D rather than when engaging in either internal or external R&D in isolation.

In contrast, another theoretical orientation casts doubt on the prevailing assumption that combining knowledge generated through internal R&D with knowledge from external R&D leads to better innovation performance. The risks associated with knowledge transfer (Schmiedeberg, 2008) include opportunistic exploitation by a partner (Krzeminska & Eckert, 2016) and questioning the legitimacy of internal R&D efforts when engaging in external R&D, leading to resistance among organizational members seeking to protect their own interests (Katz & Allen, 1982; Lichtenthaler & Ernst, 2006). These risks help explain a detrimental effect of combined R&D on innovation performance. Similarly, coordination and communication issues, such as the need for (and difficulty of) coordinating internal and external R&D, the risk of a misalignment between internal and external R&D, and communication barriers between both R&D loci, make it difficult to transfer knowledge, especially tacit knowledge (Krzeminska & Eckert, 2016). Lastly, knowledge from external loci is not only associated with increasing identification, assimilation, and utilization costs (Belderbos, Faems, Leten, & Van Looy, 2010; Laursen & Salter, 2006; Salge, Farchi, Barrett, & Dopson, 2013), but also potential appropriation concerns (Alexy, George, & Salter, 2013; Almirall & Casadesus-Masanell, 2010).

Extending this line of reasoning, we now propose that compared to non-FFs, FFs will be particularly successful at combining in-house R&D with external know-how, with a positive effect on innovation performance. According to the RBV, the interaction between the family and the business (Habbershon & Williams, 1999) means that FFs own a unique bundle of resources referred to as ‘familiness’. “Familiness is defined as the unique bundle of resources a particular firm has because of the systems interaction between the family, its individual members, and the business” (Habbershon & Williams, 1999, p. 11). Although this familiness may be seen as a potential source of competitive disadvantage (for instance, FFs may suffer from limited resources given their preference for internal resources), this resource constraint is likely to increase the efficiency and parsimony of their use of resources (Carney, 2005;

Sirmon & Hitt, 2003; Zellweger, 2017). Thus, family-provided resources can lead to a competitive advantage for FFs (Zellweger, 2017).

First, in terms of human capital, using resources to satisfy family preferences via nepotism, i.e., favoring the hiring of family members over more talented external professionals, may limit the quality and quantity of human capital (Sirmon & Hitt, 2003), robbing the firm of the resources needed to innovate (Miller et al., 2015). This will negatively affect the FF's assimilation and leverage of external knowledge, and its ability to combine such resources into a stock of internal knowledge (negative familiness). However, as part of the FF resource endowment, family members — who in many cases have actually grown up in the FF — have learned skills and practices involving a set of core values that are specific to the firm. This tacit knowledge cannot be easily transferred to other individuals or redeployed outside the business (Tokarczyk, Hansen, Green, & Down, 2007; Sirmon & Hitt, 2003). Therefore, while FFs may have a competitive disadvantage in terms of human capital, they are likely to have deeper levels of tacit knowledge (human capital) than non-FFs (Sirmon & Hitt, 2003), providing the former with distinct intangible resources (positive familiness). As a result, FFs are expected to have stronger absorptive capacity (particularly realized absorptive capacity), which allows them to reinforce current R&D and increase the efficiency of the innovation process (innovation outcomes) (Cohen & Levinthal, 1990; Zahra & George, 2002). Moreover, through their personal identification with the firm (Gomez-Mejia et al., 2007), the extraordinary commitment of family members facilitates strong personal ties among firm members, even creating "cultures in which there are powerful reciprocal loyalties among the family and its staff […] This can create energized and highly productive human capital resources that non-family firm rivals that are more formalized, bureaucratic, and impersonal would find difficult to imitate" (Miller et al., 2015, p. 34). The uniqueness of FFs' internal stock of R&D knowledge should lead to recognizing, understanding, and evaluating relevant external knowledge resources that can be combined with in-house knowledge (Berchicci, 2013; Cohen & Levinthal, 1990; Grimpe & Kaiser, 2010). As the risk of unwanted knowledge when combining internal and external R&D is likely to be lower in FFs, absorptive capacity (realized) will be strengthened in these businesses, with a positive impact on innovation performance.

Second, although the desire to maintain control in the family usually makes FFs more reluctant to resort to external funds, hence limiting the availability of financial capital (negative familiness; Gallo et al., 2004; Zellweger, 2017), FF's transgenerational goals create patient capital (positive familiness). Patient capital is positively related to the development of long-term knowledge, and thus a potential resource advantage "given the risks and lags in revenue generation entailed by many innovations" (Miller et al., 2015). Hence, family members will be more likely to focus on pursuing long-term benefits for both the family and the firm (James, 1999). Overall, patient capital fosters a long-term orientation that will help FFs combine external and internal R&D, obtaining better innovation performance than non-FFs. As Zellweger (2017, p. 139) recently pointed out, "family-provided capital can thus serve as a competitive advantage, as it enables long-term strategies that are difficult to imitate".

Establishing effective, long-term, and trust-based relationships with external stakeholders, such as suppliers (Duran et al., 2016; Sirmon & Hitt, 2003), is crucial for FFs. A long-term perspective "creates leeway for organizational members to engage in grounded non-formalized screening and the exploration of […] new opportunities, even if those opportunities involve variability and risk" (König et al., 2013, p. 424). FFs' longer-term perspective (Carnes & Ireland, 2013; Le Breton-Miller & Miller, 2006; Zellweger, 2007, 2017) enables them to pursue activities that may be costly in the short run but highly profitable in the long run, such as innovation. In particular, FFs' long-term orientation will influence the nature of relationships they seek to establish with external R&D providers. Guided by their long-term orientation, FFs become more generous and responsive to business partners (Miller et al., 2015), and less inclined to act in ways that might violate a business partner's trust (Duran et al., 2016). FFs are likely to engage with external R&D providers whose knowledge and skills are specifically suited to their needs and long-term vision, and their realized absorptive capacity (i.e., knowledge transformation and exploitation) is therefore likely to be high (Zahra & George, 2002), leading to valuable innovation outcomes (e.g., expanding current products and services, increasing the efficiency of existing processes).

Third, many FFs typically build strong social capital from both intra- and inter-organizational relationships (e.g., Arregle, Hitt, Sirmon, & Very, 2007; Sanchez-Ruiz, Daspit, Holt, & Rutherford, 2019; Sirmon & Hitt, 2003; Uhlaner, Matser, Berent-Braun, & Flören, 2015) or "the sum of the actual and potential resources embedded within, available through, and derived from the network of relationships possessed by an individual or social unit" (Nahapiet & Ghoshal, 1998, p. 243) – see the review by Payne, Moore, Griffis, & Autry (2011). Social capital is a source of positive familiness (Zellweger, 2017) that will facilitate access to external resources (Hitt, Ireland, Camp, & Sexton, 2002), internal coordination, knowledge creation and accumulation (Arregle et al., 2007; Sirmon, Hitt, & Ireland, 2007). Although this social capital may turn into a competitive disadvantage under certain conditions, such as outdated and closed networks (negative familiness) (Zellweger, 2017), it is a highly powerful resource allowing FFs to establish effective networks (Sirmon & Hitt, 2003) facilitating innovation. As recently highlighted "family firms have privileged network access, as family firm owners' nonfinancial goals direct the attention of family firms to building up and maintaining long-term and trust-based relationships with external stakeholders […] Family firms are particularly likely to receive valuable support from their network partners" (Duran et al., 2016, pp. 1229–1230). Given that their reputation is closely linked to the family members' identity (Berrone et al., 2012), FFs may care more about their business partners than non-FFs, working harder to align their own and their suppliers' goals (Cennamo, Berrone, Cruz, &

Gomez-Mejia, 2012). FFs will therefore be less likely to engage in activities that could damage their reputation (Berrone, Cruz, Gomez-Mejia, & Larraza-Kintana, 2010). Additionally, FFs will look for partners who can help identify promising trends and inventions, and provide valuable and timely feedback throughout the development process. This is also consistent with the recent study of Uhlaner et al. (2015) who hypothesize and find partial support for the argument that internal social capital is more likely to lead to the mobilization of external networks in firms with family identity than non-FFs. Thus, when FFs combine internal and external R&D loci, they are expected to select R&D partners that better suit their R&D activities. This will facilitate communication and decision-making with external R&D suppliers, reducing coordination costs. Moreover, strong personal ties established through interfirm socialization have the potential to positively affect their predisposition to not only share proprietary knowledge, but also absorb knowledge inputs from external partners (Husted & Michailova, 2002; Van Wijk, Jansen, & Lyles, 2008). The propensity to select promising partners and better assimilate external resources will therefore enable FFs to achieve better innovation performance than non-FFs.

Finally, family managers, usually highly involved in the decision-making process, have a major concern for control, and a long-term perspective (Gomez-Mejia et al., 2007). They are expected to draw up detailed contracts to reduce any potential negative effects when engaging in outsourced R&D, involving a detailed discussion of communication procedures, the roles and responsibilities of parties, extensive contingency planning, and the explicit inclusion of dispute resolution provisions. This will likely reduce potential conflicts with external R&D providers arising from opportunistic behavior (Argyres & Mayer, 2004, 2007). As a result, FFs are expected to be highly efficient in integrating internal and external R&D. Accordingly, we hypothesize:

Hypothesis 1 (H1): Family firms using a combined R&D strategy, i.e., simultaneously engaging in internal and external R&D, are more likely to record better innovation performance than non-family firms using a combined R&D strategy.

Family Firms' Internal and External R&D Loci and Innovation Performance: The Role of Negative Performance-Aspiration Gaps

Here we argue that below-par performance reinforces the outcomes of innovation performance using combined R&D loci in FFs. FFs are characterized by high ownership concentration (Faccio & Lang, 2002), and the family's entire economic, social, and emotional endowment invested in the firm is consequently at risk when performance is below par (Gomez-Mejia et al., 2010). Negative performance feedback will therefore alarm managers in FFs even more so than in non-FFs. Faced with weaker performance, FFs will be driven more by goals that go beyond affective attachment because meeting the firm's financial obligations will become a necessary condition for family decision-makers to achieve any family-centered noneconomic and economic goals (Gomez-Mejia, Campbell, Martin, Hoskisson, Makri, & Simon, 2014; Gomez-Mejia et al., 2018).

Drawing on the behavioral perspective, prior studies suggest that faced with performance below aspirations, FFs will invest more in R&D than non-FFs (Chrisman & Patel, 2012), and make exploratory R&D investments (Patel & Chrisman, 2014). Below-par performance levels will be interpreted by the family as threatening the firm's longevity (Gomez-Mejia et al., 2018), intensifying the need to reverse a deteriorating financial situation to preserve socio-emotional and financial wealth. As loss-averse FFs will accept more risks to protect their long-term socioemotional endowment than non-FFs, a better reaction to negative performance feedback is expected. In particular, family decision-makers' incentives will be stronger to ensure that the financial resources allocated to acquiring new technologies are harvested efficiently and that new knowledge is used intensively (Carney, 2005). Moreover, family decision-makers are expected to invest effort and time in such knowledge, and incorporate it into their self-domain (Ciarrochi & Forgas, 2000). In such circumstance, family members will likely attempt to leverage resources through the combination of internal and external R&D loci to ensure innovation and firm survival (Kotlar, Fang, De Massis, & Frattini, 2014b), even if R&D outsourcing decisions may imply risks (e.g., questioning the legitimacy of internal R&D efforts, appropriation concerns, etc.). In essence, family decision-makers will have a strong incentive to transform and apply new knowledge once assimilated to reinforce existing products, services, and processes. Hence, under below-par performance, FFs are likely to better integrate existing internal R&D knowledge with new knowledge from external R&D loci to build reliable social capital (Matzler et al., 2015), long-lasting relationships with external stakeholders (Miller & Le Breton-Miller, 2005), and more effective networks (Uhlaner et al., 2015). In sum, we expect that improvements in innovation performance from combined R&D loci will be more apparent in FFs dealing with a drop in performance. We therefore posit:

> **Hypothesis 2 (H2)**: The positive relationship between family firms' simultaneous use of internal and external R&D and innovation performance is stronger under conditions of a negative performance-aspiration gap.

Methods

Our dataset consists of a panel of 3,547 manufacturing firms (27,438 firm-year observations) over a 26-year period (1990 to 2016) extracted from the Spanish Survey of Business Strategies (SSBS). This is a yearly survey conducted by the SEPI Foundation with the support of the Spanish Ministry of Industry. The SSBS covers a wide range of Spanish firms operating in all manufacturing sectors. One of the SSBS's main features is the representativeness of the reference population composed of Spanish firms with 10 or more employees in one of the two-digit manufacturing subsectors in NACE Rev. 2 (European industrial classification scheme). Firms in the SSBS dataset are selected combining census schemes (for firms with more than 200 employees) and random sampling (for firms with 10 to 200 employees). The SSBS captures information on each firm's services and products, innovation activities, foreign trade (e.g., exports), employment, technological activities, and accounting data (performance, productivity). All the information contained in the SSBS is subject to quality and consistency controls. This dataset has been used by many researchers to study topics related to FFs and innovation strategies (e.g., Diéguez-Soto, Manzaneque, & Rojo-Ramírez, 2016; Greenwood, Díaz, Li, & Lorente, 2010; Kotlar et al., 2013, 2014b; Mazzelli, Nason, De Massis, & Kotlar, 2018).

Dependent variable

The dependent variable in the empirical models is *innovation performance*, a dummy variable that indicates whether the firm has introduced a new product or process in a given year. Firm-year observations are therefore coded 1 if the firm has introduced a new product or process, 0 otherwise. Innovation outcome is usually the key dependent variable in empirical studies related to innovation (Crossan & Apaydin, 2010). Given the dummy nature of the dependent variable, we estimate the empirical models to test our hypotheses using a random-effects panel data probit estimator[2].

All variable descriptions are provided in the Appendix. We apply a one-year lag between the dependent variable and other variables to ensure the direction of causality.

Independent variables

Regarding the explanatory variables of interest, we built three dummy variables: *no R&D*, which takes value 1 when the firm neither conducts nor outsources R&D activities (0 otherwise); *uncombined R&D*, which takes value 1 when the firm conducts R&D activities but

[2] The likelihood ratio test (χ^2) formally compares the pooled probit estimator with the random-effects probit estimator. As shown in Tables 4, 5, and 6, we reject the null hypothesis that the random-effects probit estimator and the pooled estimator are similar. Therefore, this significant likelihood ratio test tells us that it would not be appropriate to use a pooled probit model, as the panel-level variance component is important.

does not outsource them to third parties, or outsources R&D activities to third parties but does not conduct them (0 otherwise); finally, *combined R&D*, which takes value 1 when the firm conducts and outsources R&D to third parties (0 otherwise).

Second, we consider that a family controls the firm when their members are actively involved in management. This measure is more appropriate than measures based on ownership given our application of the behavioral and resource-management frameworks (as explained in the theoretical background section). Accordingly, we define the level of family involvement as a continuous variable counting the number of family members involved in management (*family management*). We thus adopt an objective measure of family influence on decision-making, focusing on the family status of the top management team. This FF definition is consistent with prior family business studies (e.g., Cruz, Gomez-Mejia, & Becerra, 2010; Manzaneque, Rojo-Ramírez, Diéguez-Soto, & Martínez-Romero, 2018; Kotlar et al., 2013; Kotlar, De Massis, Fang, & Frattini, 2014a).

Finally, we assess performance using return on assets (ROA), defined as net operating income divided by total assets. As a measure of performance, ROA is commonly used to analyze firm performance, including FF performance (e.g., Anderson & Reeb, 2003; Miller, Minichilli, & Corbetta, 2013; Minichilli, Corbetta, & MacMillan, 2010), and particularly manufacturing firms (e.g., Kotlar et al., 2013). As a measure of short-term accounting performance (Short, Ketchen, Palmer, & Hult, 2007), ROA also seems particularly apt to proxy the short-term financial performance of FFs compared to their long-term goals. We look for a negative gap between aspirations and performance measured in terms of any difference with the performance of referent competitors. Following prior research (Chrisman & Patel, 2012; Kotlar et al., 2014b), we construct a continuous variable to measure negative gaps between aspirations and profitability. The negative profitability-aspiration gap is calculated as the absolute difference between the focal firm's performance (i.e., ROA) and the average performance of other firms in the relevant two-digit National Classification of Economic Activities (CNAE) industry if negative (0 otherwise). This reflects the assumption that in the event of any shortfall between the firm's performance and the performance of its competitors, decision-makers are more likely to perceive gaps between current performance and aspirations (Iyer & Miller, 2008; Kotlar et al., 2013). To increase the robustness of our findings, we also check that the results using ROE (return on equity) — considered particularly suitable to compare profitability under different economic cycles (e.g., Minichilli, Brogi, & Calabrò, 2016) — are qualitatively similar[3].

Control Variables

We control for a number of other factors identified in prior literature as having an impact on innovation performance. Specifically, the firm-level characteristics included in the empirical models as control variables are labelled *previous performance, current ratio*, *firm size*, *firm age*, *R&D intensity*, *collaboration agreements*, *export intensity*, *foreign ownership*. In addition, all the models include time dummies to control for possible macroeconomic effects on innovation performance, and sector dummies to account for industry differences in innovation (Malerba, 2005).

Regarding firm-level characteristics, previous performance and liquidity are important for firms to have the leeway to invest in R&D (e.g., García-Quevedo, Pellegrino, & Vivarelli, 2014). Performance is measured in terms of ROA, and the ratio of current assets to current liabilities is included to control for any liquidity effects. Firm size is likely to affect innovation performance. Larger firms may have more market power and enjoy economies of scale and scope, or risk diversification advantages, increasing the profitability of an innovation strategy (Becheikh, Landry, & Amara, 2006; Cohen & Levinthal, 1989; Link & Bozeman,

[3] Estimation results using ROE are available from the authors upon request.

1991; Shefer & Frenkel, 2005). On the other hand, smaller firms tend to be more flexible and adaptive, and might thus outperform their larger counterparts in terms of innovation efficiency (Acs & Audretsch, 1987). We include firm age to control for the possibility of entrenchment in FFs (Chrisman & Patel, 2012), as younger firms may have different innovation behavior (García-Quevedo et al., 2014). R&D investments are essential for a firm to accumulate higher technological and market capabilities to develop and achieve innovation, and the ratio of the firm's R&D expenditure to total sales serves as a reasonable indicator of innovation input (Block, 2009). Collaboration agreements with other companies or not-for-profit entities are traditionally used to explain innovation results (Faems, Van Looy, & Debackere, 2005). In contrast to R&D outsourcing, where contractors deliver certain technological knowledge, collaborative R&D involves the joint efforts of partners and the co-creation of knowledge (Hagedoorn, Link, & Vonortas, 2000), excluding subcontracting work without active cooperation. Export intensity is used here as a proxy for the extent to which a firm faces international competition (Grimpe & Kaiser, 2010), and thus for the stimulus and demand for new products. Moreover, the firm's presence in foreign markets enables it to acquire knowledge (Zahra, Ireland, & Hitt, 2000) for innovation (Frenz, Girardone, & Ietto-Gillies, 2005), and foreign ownership may influence a firm's R&D decisions (Un, 2011).

Instrumental Variables

We use the Heckman (1979) two-stage procedure (e.g., Gomez-Mejia et al., 2007) to control for the possible endogeneity of family management due to unobservable organizational or environmental characteristics that are not captured in the control variables. This procedure consists of an equation for the outcome (i.e., innovation performance), and an equation for the endogenous regressor (i.e., a first-stage model on whether or not the firm is an FF). The inverse Mills ratio from the first-stage model is included as an additional control in the regression models on innovation performance.

We use two instrumental variables: the fraction of family firm industry sales (*industry family firm sales/total industry sales*), and the fraction of family firm regional sales (*regional family firm sales/total regional sales*). From a theoretical point of view, we chose these variables as instruments because the literature on institutional pressure suggests that families are more likely to maintain control of their firms when located in areas with a higher concentration of FFs, and when these firms are more widespread in the corresponding industry (Greenwood & Suddaby, 2006). Therefore, both instruments are expected to be related to the probability that a firm in the industry is an FF.[4] At the same time, there is no theoretical basis to link either of these variables directly with innovation performance.[5] In addition, similar measures have been used in previous family business (Fang, Kotlar, Memili, Chrisman, & De Massis, 2016) and finance studies (Campa & Kedia, 2002).

Results

Descriptive Analyses

Panels A and B in Table 1 provide the summary statistics of the variables used in the analyses and several differences of means tests to check whether FFs and non-FFs differ in terms of the characteristics considered in these analyses. Most firms in our sample do not perform R&D activities (63.5%), 17.5% pursue either internal or external R&D activities, and the remaining firms (19%) simultaneously perform both internal and external R&D. Therefore, the frequency with which firms combine internal and external R&D is high in our sample. Compared to FFs, non-FFs are characterized by higher innovation performance. Innovation is reported as an activity in 47% of non-FF observations, while this occurs in only 24.4% of FF observations. Moreover, independently of the locus of innovation, the incidence of R&D is

[4] Indeed, the estimation results for the first-stage probit model (available upon request) show that the two instrumental variables are significantly and positively related to the likelihood that the firm is family managed. Combined, these two instruments are highly significant ($\chi 2$-statistic = 98.88, $p < .001$).

[5] The instrumental variables proposed have no significant impact on innovation performance once we include all the control variables in the main empirical model together with the *family management* variable (results available upon request).

substantially higher in non-FFs than in FFs: the average ratio of investments in R&D to total sales (*R&D intensity*) for non-family (family) firms is 0.84% (0.53%). Finally, foreign ownership, export intensity, firm size, and firm age are significantly higher in non-FFs than in FFs.

[INSERT TABLE 1 ABOUT HERE]

Table 2 provides the correlation matrix. Regarding the bivariate correlations, worth noting is that the two innovation loci are positively correlated with innovation performance. Interestingly, the R&D locus with the highest correlation with innovation performance is the combination of internal and external R&D (*combined R&D*). Individual values of the variance inflation factor (VIF) that exceed 10, combined with average VIF values over six, are often regarded as indicating multicollinearity (Neter, Wasserman, & Kutner, 1989). The highest VIF value is 2.5, which is significantly lower than the threshold, suggesting the absence of multicollinearity.

[INSERT TABLE 2 ABOUT HERE]

Table 3 cross-tabulates our innovation performance measure (percentage of observations introducing new products or services) with different R&D loci (i.e., different combinations of internal and external R&D). The results indicate, as expected, that non-innovative firms have the lowest innovation performance. In contrast, the most productive innovation strategy would seem combined internal and external R&D, with 74.19% of firms combining both R&D loci (*combined R&D*) and introducing new products and/or processes – a figure that is, on average, about 15% higher than firms relying exclusively on one R&D locus (*uncombined R&D*).

[INSERT TABLE 3 ABOUT HERE]

Regression Results

Table 4 reports the results of the random-effects panel data probit regressions. In Model 1, we show the results obtained estimating a model with controls only. The results in this model suggest that large firms and more intensive innovation spenders are likely to enjoy better innovation performance. Similarly, more export-oriented firms are more productive in innovation, presumably due to the more competitive environments they face. In addition, we find a significant and positive relationship between foreign ownership and innovation performance, and between collaboration agreements and innovation performance. Past performance also positively impacts innovation performance.

[INSERT TABLE 4 ABOUT HERE]

In Model 2, we extend our model specification to include the main independent variables, namely, FF, innovation loci, and below-par performance. This model shows that FFs are non-significantly associated with the likelihood of introducing new products or processes. In addition, the coefficients for *uncombined R&D* and *combined R&D* are highly significant and positive. Therefore, regardless of the R&D loci, engaging in innovation is associated with significantly higher innovation performance than either not conducting or outsourcing R&D activities.

While in Model 2 we looked at how *combined R&D* and *uncombined R&D* are related to innovation performance, in Model 3 (columns 3 and 4), we also include the interaction between *family management* and R&D loci. Column 3 presents the parameter estimates and column 4 the corresponding marginal effects[6]. The term *combined R&D x family management* tests the null hypothesis that the estimated coefficient of *combined R&D* for FFs is equal to the estimated coefficient of *combined R&D* for non-FFs. In column 3, we can see that FFs simultaneously involved in internal and external R&D are more likely to record better innovation performance relative to the reference category (i.e., those firms neither con-

[6] Given the non-linearity of the random-effects model, its estimated coefficients do not capture the marginal effect on innovation performance when an explanatory variable changes. Therefore, marginal effects measure the discrete change in the dependent variable as the binary independent variable changes from 0 to 1.

ducting nor outsourcing R&D activities) than non-FFs ($\beta = 0.064$, $p < 0.05$). From the marginal effects reported in column 4, we conclude that *combined R&D* leads to a 25.5 percent increase in the likelihood of innovation performance (relative to firms without R&D activities), plus an additional 2 percent increase in the FFs' probability of innovation performance. Therefore, the difference between combined R&D strategy users and non-R&D users is larger among FFs than in the group of non-FFs. Also worth noting is that the estimated coefficient of *uncombined R&D* x *family management* is non-significant in column 3. Overall, therefore, Model 3 shows a significant effect of *family management* for *combined R&D* and a non-significant effect for *uncombined R&D*. In other words, FFs using an uncombined R&D strategy, i.e., either conducting R&D activities but not outsourcing them to third parties, or outsourcing R&D activities to third parties but not conducting them, are associated with an innovation performance likelihood that is not significantly different from that of non-FFs also using uncombined R&D strategies. Thus, it is the use of a combined R&D strategy that makes a difference for FFs in terms of innovation performance.

Column 5 (Table 4) further includes the interaction of the variable measuring below-par performance with the family involvement metrics and the two innovation loci. An examination of the interaction between *combined R&D* and the FF metrics and below-par performance reveals a positive coefficient that is statistically different from 0 ($\beta = 0.008$, $p < 0.05$). Thus, consistent with H2, when performance falls below a referent firm's performance, the impact on innovation is significantly larger among those FFs using both external and internal R&D loci. In other words, FFs that use internal and external R&D loci and record below-par performance are significantly more likely to be innovative than non-FFs.

Figure 2 provides a graphic depiction of these findings. . Figure 2 illustrates the predicted marginal effects of Family Ownership on leverage for firms with a male CEO and firms with a female CEO, separately by subsamples depending of % Board Independence (below sample-median levels and above sample-median levels of board independence). Control variables are hold constant at mean levels. We observe that the negative influence of female leadership in the association between family ownership and leverage completely disappears and reverses in the subsample with greater independence of the board of directors. Therefore, for the female presence in a same leadership position (CEO), the existence of a more independence board promotes the use of debt in more family-owned firms.

[INSERT FIGURE 2 ABOUT HERE]

Robustness Checks

We conduct additional tests to check the robustness of our results. First, we repeat the analyses explicitly considering the dynamism of the innovation activities in which the firm is engaged. We therefore define a categorical variable (*continuous innovation performance*) as the accumulation of the variable innovation performance for year *t* and *t-1*. This approach helps overcome certain limitations related to temporal measures of innovation, in line with, for example, Diéguez-Soto et al. (2016), and Laursen, Masciarelli, and Prencipe (2012). This new variable takes the value 0 when the firm has not introduced any innovations in this two-year period, takes the value 1 when the firm has introduced product or process innovations in one year of the two-year period, and finally, takes the value 2 when the firm has introduced new products or processes in both years. We therefore replace our previous dependent variable (*innovation performance*) with the variable *continuous innovation performance*. The regression results are presented in Table 5. The regression results presented in Model 3 corroborate that FFs involved in both internal and external R&D are more likely to record higher innovation performance than non-FFs ($\beta = 0.018$, $p < 0.05$). Moreover, consistent with H2, the new empirical evidence in Model 4 confirms that the interaction between *combined R&D* and the FF metrics and below-par performance has a positive coefficient that is statistically different from 0 ($\beta = 0.004$, $p < 0.05$).

[INSERT TABLE 5 ABOUT HERE]

In addition, as environmental conditions may impair firm performance, we use an indicator available in the SSBS dataset that reflects changes in the firm's market share, which allows controlling for external shifts in a firm's target market (Shinkle, 2012). For each year, this dataset reports a dummy variable indicating whether the firm's target market share has shrunk (see the Appendix for the definition of variables). The regression results are provided in Table 6, which shows that the inclusion of this variable leads to similar conclusions. Corroborating our line of reasoning, the positive impact of the combined use of external and internal R&D on innovation performance is enhanced when FFs face negative external economic prospects (i.e., a reduction in the firm's market share).

[INSERT TABLE 6 ABOUT HERE]

Finally, we use a quasi-experimental matching method (Rosenbaum & Rubin, 1983) to estimate the causal effect of family management on the likelihood of innovation performance among those firms using combined R&D strategies. This ensures checking whether FFs using a combined R&D strategy are more likely to record better innovation performance than non-FFs using a combined R&D strategy (H1). For this purpose, we first derive the propensity scores from the estimation of a probit model where the treatment variable (i.e., whether or not there is family involvement in the firm) is regressed against the same controls employed in the estimation of the first-stage treatment model referred to in the instrumental variables subsection — except for the variable collecting R&D loci (since we apply matching to the subsample of firms using combined R&D strategies). In a second step, we carry out the matching for all pair-wise combinations. Once each treated observation is matched to a control group observation, the difference between innovation performance for the treated (FFs) versus the control (non-FFs) observations is computed. The average treatment effect on the treated (ATT) is then obtained by averaging these differences (Heckman, Lalonde, & Smith, 1999).

Table 7 displays the ATT from alternative propensity score matching methods (nearest-neighbor and kernel-based matching)[7]. In all instances, family management has a significant and positive effect that fluctuates from 4.9 to 5.0 percentage points (the ATT values remain fairly robust to the choice of matching method). Therefore, the likelihood of innovation performance among firms using combined R&D strategies is larger for FFs than for non-FFs. As the average effect on innovation performance of combined R&D strategies among FFs is positive, it implies that FFs using a combined R&D strategy are more likely to record better innovation performance than non-FFs using a combined R&D strategy (H1).

[INSERT TABLE 7 ABOUT HERE]

Second, to test the robustness of our results in relation to H2, we estimate the average treatment effect on the treated (ATT) of a combined R&D strategy for the subsample of firms whose performance falls below the referent firms' performance. As Table 8 shows, family management shows a significant and positive ATT, implying that the effects of a combined R&D strategy on innovation performance under a negative aspiration gap are larger for FFs than for non-FFs. Therefore, when performance falls below the referent firms' performance, the positive impact of simultaneously using internal and external R&D loci on innovation performance is significantly larger in FFs. These findings are in line with H2.

[INSERT TABLE 8 ABOUT HERE]

Discussion and Conclusion

Drawing on RBV and the behavioral theory of the firm, our study has analyzed whether and why FFs are better at reaping innovation benefits from combined internal and external R&D (vis-à-vis non-FFs), as well as the contingency effect of a performance-aspiration gap on this relationship.

[7] We use the publicly available Stata command developed by Leuven & Sianesi (2003). Caliendo and Kopeinig (2008) summarize and discuss the matching methods employed.

While previous research has found that FFs tend to invest less intensively in innovation than non-FFs (Classen, Carree, Van Gils, & Peters, 2014), other studies find that FFs are particularly efficient in turning innovation inputs into innovation outputs (Duran et al., 2016; Matzler et al., 2015). Our study contributes to this research strand by extending our understanding of how their attributes enable FFs to benefit from external knowledge while still preserving their propensity to promote internal innovation activities (Le Breton-Miller & Miller, 2006).

Although internal R&D is traditionally viewed as an important locus of knowledge acquisition, no firm can be entirely self-sufficient in terms of the resources required for innovation (Feranita, Kotlar, & De Massis, 2017). The need for resources leads firms to acquire them from external organizations, to the extent that the sourcing of technology and R&D knowledge from outside parties has been identified as a critical competence for sustained innovation success. Consequently, most firms have increasingly acquired R&D knowledge in recent years. The outsourcing of activities that are also performed internally fosters the growth of the product portfolio, as well as new product success, as this allows a firm to access knowledge developed outside the firm while maintaining its competencies (Grimpe & Kaiser, 2010; Rothaermel, Hitt, & Jobe, 2006).

We have developed arguments explaining how FFs' allocation and management of their stock of resources (e.g., human capital, patient capital, and social capital) leads to enhanced innovation performance due to the combination of in-house R&D and external know-how. Consistent with this logic, our results suggest that FFs are particularly better than non-FFs at turning combined R&D activities into innovation performance. We therefore advance existing literature by understanding the means through which FFs can facilitate innovation performance compared to non-FFs – a topic that has received scant attention despite the abundance of studies on FF innovation (e.g., Calabrò et al., 2018; Duran et al., 2016).

Furthermore, we go a step further by offering a deeper understanding of the contingent effect of negative performance gaps with respect to industry competitors on the effectiveness of a combined R&D strategy in FFs. Drawing on behavioral theory, we have identified performance-aspiration gaps as a key contingency influencing the family decision-makers' behavior and ultimately the innovation success of combined R&D. Prior studies have emphasized that, given a negative performance-aspiration gap, divergence among affective goals and financial concerns might be mitigated due to the fact that family decision-makers' behavior is more aligned with future financial wealth to ensure firm survival (Gomez-Mejia et al., 2018). Our results show that when performance is below par, FFs' propensity to convert internal and external R&D loci into innovation outputs is strengthened.

To conclude, our theoretical analysis suggests that FFs' innovation performance from the combination of internal and external R&D loci is understood better when paying careful attention to their resource endowment (H1) and the role of behavioral factors (H2).

Implications

Our results challenge existing research supporting the reluctance of FFs to engage in R&D activities by suggesting that complementing their internal knowledge base with externally sourced technology is an excellent compromise to improve the innovation performance of FFs that typically underplay internal R&D investments. In line with the RBV, FFs are rich in intangible resources (Habbershon & Williams, 1999), and must allocate and deploy these effectively to safeguard them from the possible negative side-effects of combined R&D. Prior literature stresses that FFs are better at exploiting their given R&D investments (Duran et al., 2016), as they are more likely to engage in building social capital that is unique to them (Matzler et al., 2015). In addition, FFs tend to be long-term oriented as well as community oriented, investing in social capital to build long-lasting relationships with external stakeholders (Miller & Le Breton-Miller, 2005), and deemed more likely to benefit from the utilization of such outside networks (Uhlaner et al., 2015). Accordingly, it seems that the management of firm-specific resources (e.g., human capital, patient capital, social capital) makes a difference in terms of innovation performance when FFs engage in a combined R&D strategy compared to their non-family counterparts. The empirical evidence illustrates that family presence may prove an important predictor of the difference in innovation performance compared to non-FFs.

In addition, the economic and family-centered noneconomic goals of FFs may be compromised when they observe below-par performance outcomes (Gomez-Mejia et al., 2010). Our results suggest that the benefits associated with combining internal and external R&D become more evident in FFs seeking to recover innovativeness in the face of declining referent-target aspirations. This result is consistent with the family's need to guarantee the long-term survival of a healthy business to uphold the family dynasty and preserve its legacy, enabling it to survive in highly dynamic and competitive markets, and realize its long-term vision (Gomez-Mejia et al., 2018; James, 1999). Therefore, despite FFs' preference for the in-house development of innovation (Nieto, Santamaría, & Fernández, 2015), and the risks associated with external technology sourcing, FFs need to be enterprising and take risks if they want to achieve superior innovation performance. In this context, FFs may accelerate R&D investments through the use of external R&D loci, which enable them to benefit from the diversity of knowledge amidst negative performance feedback, with ensuing improvements in innovation performance. FFs under threat may have a greater propensity for change and risk-taking. Instead of being at a disadvantage when there is a downturn in the firm's competitive positioning, the simultaneous use of external and internal R&D loci would enable FFs to transform this circumstance into better innovation outputs. This evidence provides new insights into the tensions between economic and socioemotional factors in FFs (Gomez-Mejia et al., 2018; Kotlar et al., 2018), helping to explain why FFs are particularly more efficient at turning innovation inputs into outputs in the face of negative performance gaps (Duran et al., 2016). Overall, this is a step forward in understanding the distinctive “innovation efficiency” of FFs.

Limitations and Future Research

This study has certain limitations that provide opportunities for further research. As in most prior research on FFs, our definition of FF is based on archival data (e.g., Kotlar et al., 2013, 2014; Miller, Le Breton-Miller, & Lester, 2010). We are therefore only able to capture the dimension of family involvement, not its essence (Chrisman, Chua, Pearson, & Barnett, 2012). A second limitation refers to the heterogeneity among FFs (e.g., Chrisman, Fang, Kotlar, & De Massis, 2015; Chua, Chrisman, Steier, & Rau, 2012). We have examined a firm-level driver of heterogeneity among FFs, namely, negative performance feedback, and welcome future scholars to consider other possible drivers of such heterogeneity at the firm-, family- or individual-level of analysis to shed further light on how variation among different types of FFs may affect the combined R&D strategy they adopt and their effect on innovation performance. Considering FFs as a heterogeneous group of organizations could provide new insights into the family’s influence on strategic decision-making, such as the selection of R&D sources. For instance, this study does not examine how family-specific attributes (e.g., trust-based culture, family structures, functions, interactions and events) might influence firm innovation performance, which is an area ripe for future research. Third, understanding how factors external to the firm, such as recession or environmental dynamism, might affect the process of combining internal and external R&D requires further inquiry. Likewise, studies using sampling frames other than Spanish manufacturing firms are needed to extend the validity of our findings to firms outside Spain. Lastly, this paper focuses on a specific form through which technology can be acquired from an external locus, namely, R&D contracting. Future research is thus needed to extend our findings to other forms of innovation from external loci, such as in-licensing, joint ventures, non-equity alliances, or mergers and acquisitions. Similarly, we suggest future scholars distinguish between product, process, and business model innovation, as this may lead to a more fine-grained understanding of our research topic.

In short, this study uses panel data from a large sample of manufacturing firms to report on the differences between FFs and non-FFs when effectively integrating internal and external R&D as part of a combined R&D strategy. Our findings reveal that FFs can better exploit the benefits of combined R&D loci, highlighting the meaningful role of resource-bundling to better understand FFs' propensity to generate complementarity in terms of innovation. Interestingly, we also find that behavioral factors matter, and FFs' positive relationship between combined R&D and innovation performance is strengthened in times of below-par performance.

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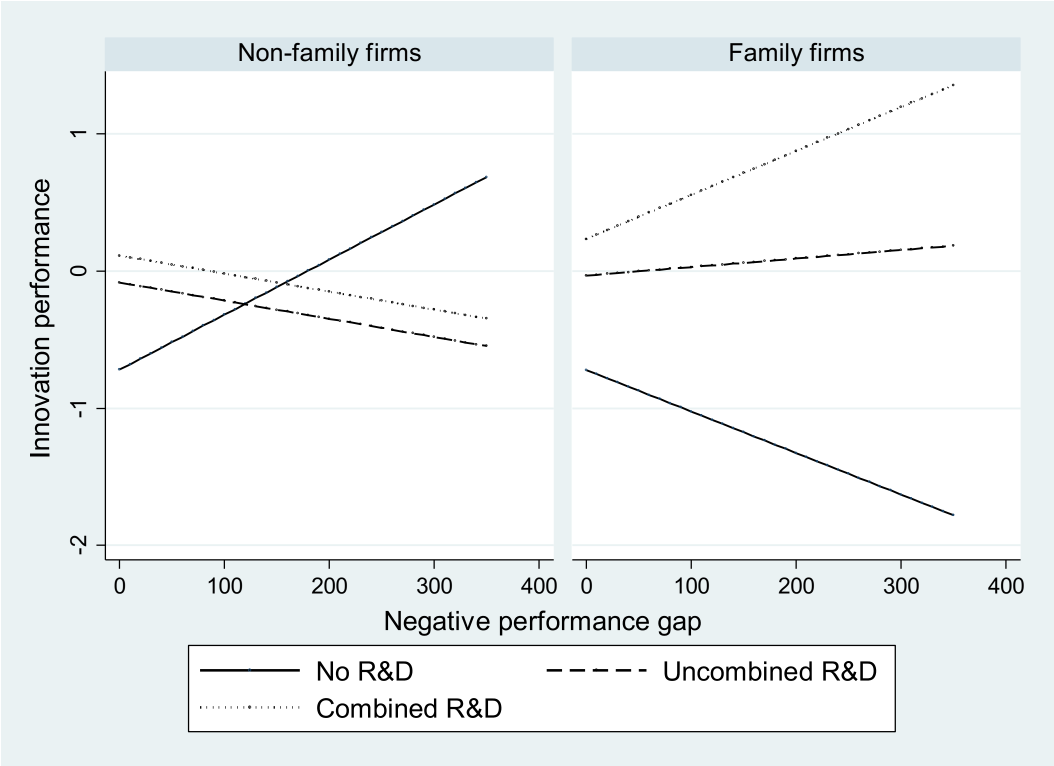

Figure 1. Joint effects of different innovation strategies (based on R&D loci) and performance below aspirations on innovation performance by family firm status.

Table 1. Summary Statistics and Mean Difference Tests (Family vs. Non-Family Firms).

Panel A: Summary Statistics			Panel B: Descriptive Analysis		
Variable	Mean	Std. Dev.	Non-FFs	FFs	t-statistic
Family management	0.767	0.996	(1)	(2)	(1) – (2)
Innovation performance	0.392	0.488	0.440	0.337	17.576
No R&D	0.635	0.481	0.530	0.756	-39.988
Uncombined R&D	0.175	0.38	0.222	0.121	22.187
Combined R&D	0.190	0.392	0.248	0.123	26.743
Negative performance gap	5.288	8.691	5.560	4.976	5.562
R&D intensity (%)	0.701	1.79	0.848	0.533	14.534
Collaboration	0.033	0.18	0.051	0.014	17.208
Export propensity	21.406	27.9	27.231	14.717	38.022
Age	31.222	22.193	33.901	28.147	21.602
Foreign ownership	15.889	35.502	28.491	1.418	68.129
Firm size	0.039	0.101	0.063	0.011	43.911
ROA	11.908	15.873	11.862	11.961	-0.518
Current ratio	2.414	13.326	2.106	2.768	-4.106
Robustness test variables					
Continuous innovation performance	1.221	1.226	1.366	1.053	20.466
Shrinking market share	0.191	0.393	0.164	0.222	-12.020

Notes: Panel B shows the results of a t-test comparing the mean values of each variable across two groups: family (FFs) and non-family firms (NFFs).

Table 2. Correlation Matrix.

Variable		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	VIF
Innovation performance	(1)	1.000														-
Family management	(2)	-0.062***	1.000													1.17
No R&D	(3)	-0.393***	0.161***	1.000												-
Uncombined R&D	(4)	0.171***	-0.092***	-0.607***	1.000											1.57
Combined R&D	(5)	0.317***	-0.109***	-0.639***	-0.223***	1.000										2.50
Negative performance gap	(6)	-0.066***	-0.047***	0.033***	-0.008	-0.032***	1.000									1.80
R&D intensity	(7)	0.246***	-0.067***	-0.514***	0.130***	0.505***	0.040***	1.000								2.33
Collaboration	(8)	0.136***	-0.085***	-0.245***	0.057***	0.246***	0.003	0.195***	1.000							1.11
Export propensity	(9)	0.197***	-0.159***	-0.361***	0.181***	0.269***	-0.022***	0.213***	0.122***	1.000						1.34
Age	(10)	0.099***	-0.077***	-0.227***	0.093***	0.189***	0.003	0.096***	0.100***	0.166**	1.000					1.20
Foreign ownership	(11)	0.145***	-0.311***	-0.260***	0.175***	0.150***	0.001	0.076***	0.118***	0.303**	0.197**	1.000				1.39
Firm size	(12)	0.177***	-0.193***	-0.304***	0.106***	0.270***	-0.039***	0.120***	0.203***	0.185**	0.263**	0.339***	1.000			1.40
ROA	(13)	0.050***	0.012+	0.009	0.000	-0.011+	-0.617***	-0.049***	-0.014*	-	-	0.015*	0.006	1.000		1.84
Current ratio	(14)	-0.021***	0.019**	0.018**	-0.015*	-0.008	-0.003	-0.005	-0.006	-0.007	0.005	-0.019**	-0.017**	-	1.000	1.00
Mean VIF																2.31

Notes: $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 3. Frequency of Innovations Strategies and Innovation Performance.

Innovation strategy	Frequency	% Introducing new products or processes
No R&D	17,587 (64.10%)	23.47%
Uncombined R&D	4,660 (16.98%)	59.70%
Combined R&D	5,191 (18.92%)	74.19%
Total	27,438 (100%)	39.22%

Table 4. Random-Effects Panel Data Probit Analysis of Innovation Performance.

	(1) Control variables	(2) Indep. variables	(3) Two-way interact.	(4) Two-way interact. (ME)	(5) Three-way interact.	(6) Three-way interact. (ME)
Family management	-	0.013	0.005	0.002	0.014	0.004
		(0.014)	(0.018)	(0.005)	(0.018)	(0.006)
Negative performance gap	-	0.000	0.002	0.001	0.003	0.001
		(0.002)	(0.002)	(0.001)	(0.002)	(0.001)
FM x Negative perf. gap	-	-	-0.002	-0.001	-0.004*	-0.001*
			(0.001)	(0.0004)	(0.002)	(0.001)
Uncombined R&D	-	0.648***	0.640***	0.195***	0.650***	0.198***
		(0.046)	(0.053)	(0.016)	(0.054)	(0.016)
Uncombined R&D x Family manag.	-		0.022	0.007	0.010	0.003
			(0.030)	(0.009)	(0.034)	(0.010)
Uncombined R&D x Negative perf. gap	-	-	-0.002	-0.001	-0.004	-0.001
			(0.003)	(0.001)	(0.004)	(0.001)
Uncombined R&D x Family manag. x Negative perf. gap		-	-	-	0.003	0.001
					(0.004)	(0.001)
Combined R&D	-	0.869***	0.835***	0.255***	0.855***	0.260***
		(0.052)	(0.058)	(0.017)	(0.059)	(0.018)
Combined R&D x Family manag.	-	-	0.064*	0.020*	0.029	0.009
			(0.032)	(0.01)	(0.036)	(0.011)
Combined R&D x Negative perf. gap	-	-	-0.002	-0.0004	-0.005	-0.002
			(0.003)	(0.001)	(0.004)	(0.001)
Combined R&D x Family manag. x Negative perf. gap	-	-			0.008*	0.002*
					(0.004)	(0.001)
Firm size	1.419***	4.321***	4.239***	1.291***	4.249***	1.295***
	(0.182)	(0.839)	(0.844)	(0.257)	(0.844)	(0.257)
Age	0.001	-0.000	-0.000	-0.0001	-0.000	-0,0001
	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.000)
Age^2	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Foreign ownership	0.002***	0.011***	0.011***	0.003***	0.011***	0.003***
	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)
Export propensity	0.006***	0.007***	0.007***	0.002***	0.007***	0.002***
	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)
R&D intensity	0.548***	0.191***	0.190***	0.058***	0.190***	0.058***
	(0.026)	(0.033)	(0.033)	(0.010)	(0.033)	(0.010)
Collaboration	0.229***	0.138*	0.143*	0.043*	0.143*	0.044*
	(0.067)	(0.066)	(0.066)	(0.020)	(0.066)	(0.020)
ROA	0.005***	0.002**	0.002**	0.001**	0.002**	0.001**
	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)
Current ratio	-0.002	-0.002	-0.002	-0.001	-0.002	-0.001
	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)
Inverse Mills ratio	-	-0.735***	-0.714***	-0.218***	-0.716***	-0.218***
		(0.186)	(0.187)	(0.057)	(0.187)	(0.057)
Intercept	-0.537***	-0.081	-0.088	-	-0.093	-
	(0.133)	(0.168)	(0.168)		(0.169)	
Firm RE	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
$\ln(\sigma^2_v)$	0.036	-0.120*	-0.121*	-	-0.120*	-
	(0.046)	(0.047)	(0.047)		(0.047)	
σ_v	1.018	0.942	0.941	-	0.942	-
ρ	0.509	0.470	0.470	-	0.470	-
χ^2	1329.312	1710.505	1716.503	-	1719.580	-
N	27,438	27,438	27,438	27,438	27,438	27,438

Notes: ME= Marginal effects. Standard errors in parentheses; significance: $^{+}p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Table 5. Robustness Tests of Family Firm Innovation Performance: Continuous Innovation Performance.

	(1) Control variables	(2) Independent variables	(3) Two-way interactions	(4) Three-way interactions
Family management		0.006	0.004	0.008
		(0.005)	(0.007)	(0.007)
Negative performance gap dummy		-0.000	0.001	0.001
		(0.001)	(0.001)	(0.001)
FM x Negative perf. gap dummy			-0.000	-0.001*
			(0.001)	(0.001)
Uncombined R&D		0.392***	0.395***	0.400***
		(0.019)	(0.022)	(0.022)
Uncombined R&D x FM			0.005	-0.003
			(0.012)	(0.014)
Uncombined R&D x Negative perf. gap			-0.002	-0.003+
			(0.001)	(0.001)
Uncombined R&D x FM x Negative perf. gap				0.002
				(0.001)
Combined R&D		0.522***	0.518***	0.526***
		(0.022)	(0.024)	(0.024)
Combined R&D x FM			0.018*	0.002
			(0.008)	(0.014)
Combined R&D x Negative perf. gap			-0.002**	0.004*
			(0.001)	(0.001)
Combined R&D x FM x Negative perf. gap			-	0.005*
				(0.002)
Firm size	0.611***	1.741***	1.690***	1.693***
	(0.076)	(0.336)	(0.338)	(0.338)
Age	-0.000	-0.001	-0.002	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Age^2	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Foreign ownership	0.001***	0.005***	0.005***	0.005***
	(0.000)	(0.001)	(0.001)	(0.001)
Export propensity	0.002***	0.003***	0.003***	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)
R&D intensity	0.345***	0.135***	0.136***	0.136***
	(0.011)	(0.014)	(0.014)	(0.014)
Collaboration	0.142***	0.097***	0.099***	0.099***
	(0.026)	(0.026)	(0.026)	(0.026)
ROA	0.002***	0.001*	0.001*	0.001*
	(0.000)	(0.000)	(0.000)	(0.000)
Current ratio	-0.000	-0.001+	-0.001+	-0.001+
	(0.000)	(0.000)	(0.000)	(0.000)
Inverse Mills ratio		-0.304***	-0.292***	-0.293***
		(0.075)	(0.075)	(0.075)
Constant	1.195***	1.492***	1.485***	1.481***
	(0.085)	(0.096)	(0.096)	(0.096)
Firm RE	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
σ_v	0.524	0.488	0.487	0.487
ρ	0.445	0.413	0.413	0.412
χ^2	2360.924	3216.900	3224.361	3232.790
N	27,438	27,438	27,438	27,438

Notes: Standard errors in parentheses; significance: $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 6. Robustness Tests of Family Firm Innovation Performance: Shrinking Market Share.

	(1) Control variables	(2) Independent variables	(3) Two-way interactions	(4) Three-way interactions
Family management		0.012	0.004	0.006
		(0.014)	(0.018)	(0.018)
Shrinking market share		-0.181***	-0.198***	-0.185***
		(0.030)	(0.047)	(0.051)
FF x Shrinking market share			-0.053+	-0.067+
			(0.030)	(0.037)
Uncombined R&D		0.654***	0.598***	0.593***
		(0.047)	(0.053)	(0.054)
Uncombined R&D x FM			0.027	0.037
			(0.032)	(0.034)
Uncombined R&D x Shrinking market share			0.229**	0.263**
			(0.075)	(0.092)
Uncombined R&D x FM x Shrinking market share				-0.060
				(0.076)
Combined R&D		0.857***	0.803***	0.816***
		(0.054)	(0.059)	(0.060)
Combined R&D x FM			0.067*	0.047
			(0.034)	(0.035)
Combined R&D x Shrinking market share			0.086	-0.006
			(0.078)	(0.093)
Combined R&D x FM x Shrinking market share				0.171*
				(0.087)
Firm size	1.478***	4.294***	4.146***	4.159***
	(0.190)	(0.831)	(0.834)	(0.834)
Age	0.002	0.000	0.000	0.000
	(0.002)	(0.002)	(0.002)	(0.002)
Age2	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Foreign ownership	0.002***	0.011***	0.010***	0.010***
	(0.001)	(0.002)	(0.002)	(0.002)
Export propensity	0.006***	0.007***	0.006***	0.006***
	(0.001)	(0.001)	(0.001)	(0.001)
R&D intensity	0.567***	0.216***	0.208***	0.205***
	(0.028)	(0.034)	(0.034)	(0.034)
Collaboration	0.209**	0.122+	0.129+	0.132+
	(0.070)	(0.069)	(0.069)	(0.069)
ROA	0.005***	0.002**	0.002**	0.002**
	(0.001)	(0.001)	(0.001)	(0.001)
Current ratio	-0.009**	-0.008**	-0.008**	-0.008**
	(0.003)	(0.003)	(0.003)	(0.003)
Inverse Mills ratio		-0.724***	-0.692***	-0.692***
		(0.184)	(0.184)	(0.184)
Intercept	-0.551***	-0.065	-0.072	-0.073
	(0.139)	(0.174)	(0.175)	(0.175)
Firm RE	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
ln(σ2ν)	0.079+	-0.083+	-0.083+	-0.083+
	(0.048)	(0.049)	(0.049)	(0.049)
σν	1.040	0.959	0.959	0.960
ρ	0.520	0.479	0.479	0.479
χ2	1259.991	1640.927	1654.529	1658.736
N	25330	25330	25330	25330

Notes: Standard errors in parentheses; significance: $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 7. Robustness Tests of Family Firm Innovation Performance: Average Treatment Effects on the Treated (ATT) – Subsample of Firms using Combined R&D

Matching Method	Treated	Matched Control	ATT
Nearest-neighbor with Replacement	0.777	0.727	0.049** (0.022)
Kernel Matching:			
Gaussian kernel	0.777	0.726	0.050*** (0.015)
Epanechnikov kernel	0.777	0.727	0.049** (0.017)

Notes: Treatment refers to being a family firm. Matching is always carried out with common support. The entries in brackets refer to bootstrapped standard errors (500 replications). $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 8. Robustness Tests of Family Firm Innovation Performance: Average Treatment Effects on the Treated (ATT) – Subsample of Firms using Combined R&D and with Negative Performance Gap

Matching Method	Treated	Matched Control	ATT
Nearest-neighbor with Replacement	0.749	0.706	0.043** (0.014)
Kernel Matching:			
Gaussian kernel	0.749	0.701	0.049** (0.022)
Epanechnikov kernel	0.749	0.704	0.045* (0.023)

Notes: Treatment refers to being a family firm. Matching is always carried out with common support. The entries in brackets refer to bootstrapped standard errors (500 replications).$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Appendix

Definition of Variables

Variable	*Definition*
Panel A: Dependent variable	
Innovation performance	Dummy variable with value 1 if the firm has introduced either a new product or a new process (0, otherwise)
Panel B: Independent and moderating variables	
Family management	Number of members of the owner-family who occupy managerial positions at the firm at year *t*
No R&D	Dummy variable that equals 1 if the firm does not engage in R&D activities
Uncombined R&D	Dummy variable that equals 1 if the firm engages in either internal R&D activities or sources innovation via contracting mechanisms (i.e., R&D contracting)
Combined R&D	Dummy variable that equals 1 if the firm engages in internal R&D activities and sources innovation via contracting mechanisms
Negative performance gap	Absolute difference between the focal firm's performance (in terms of ROA) and the average performance of other firms in the relevant two-digit CNE industry if negative, 0 otherwise
Panel C: Control variables	
R&D intensity	Ratio of the firm's investment in R&D activities to total sales
Collaboration	Dummy variable that equals 1 if the firm establishes collaboration agreements (e.g., technological agreements with other firms or research organizations)
Export propensity	Ratio of the firm's sales in foreign markets to total sales
Age	Number of years since the firm's foundation
Foreign ownership	Percentage of firm capital in non-domestic hands
Firm size	Total firm sales (expressed in billion euro)
ROA	Return on assets
Current ratio	Current assets to current liabilities ratio
Year	Year dummies
Industry	Industry dummies
Panel C: Robustness test variables	
Continuous innovation performance	Categorical variable collecting the accumulation of innovation performance for year *t* and *t-1*. It varies between 0 and 2, with higher values indicating better innovation performance over time
Shrinking market share	Dummy variable that equals 1 if the firm's focal market share is constant or shrinking