Founder-Involvement in R&D and SMEs performance: an expanded mediated-moderated framework

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Abstract

Objectives. The aim of the paper is to shed light on the pivotal role of founders' involvement in R&D and its reflexes on SMEs performance.

Methodology. A conceptual framework was outlined and operationalized in terms of a mediation/moderation model. Hypotheses were developed and tested it on a random sample of 350 SMEs locate in low research-intensive areas of Southern Italy. An augmented cross-sectional design, which measures key variables using different sources at different time points, was employed. We adopted a seemingly unrelated regression to jointly analyze variables and their interactions.

Findings. We observe that founders' involvement in R&D influence positively SMEs' performance. We also found evidence that founders' involvement in R&D-SMEs performance association is mediated by R&D resources, Quality of the technological knowledge, and innovation outputs. At the same time the R&D resources - Quality of the technological knowledge association is positively moderated by the share of R&D subsidies.

Research limits. Our study is affected by various limitations. As an example, only revenue-based measures are used as a proxy of firm performance. In addition, for controlling heterogeneity in estimates, data refer to a well-defined time window as well as to manufacturing SMEs located in specific low-research intensity geographic areas of Italy.

Practical implications. Our study reveals that founders - with their firm- and context-specific capabilities - while enmeshed with R&D activities, contribute to SMEs performance. Policy makers should create incentives for founders to be involved to some extent in inventive activities. Further implications are also envisaged for both funding and training educational services.

Originality of the study. Building on the intersection between resource orchestration and competence-based perspectives, we conceived and empirically analyzed founders as key actors for inventive resource orchestration at the firm level and how and under what conditions the resource orchestration made by founders is likely to nurture the performance even of low research-intensive SMEs.

Key words: resource orchestration view and competence-based perspectives; founders involvement in R&D; SMEs performance.

1. Introduction

Studies of economics, organizational theory, and technology management (Crossan and Apaydin, 2010; Anderson *et al.*, 2014; Botelho *et al.*, 2021) have long acknowledged the essential role of innovation as an engine of economic growth as well as of firms core competencies and sustainable competitive advantage (Schumpeter, 1934; Porter, 1980). This holds especially true when it comes to Small and Medium-sized Enterprises (SMEs), i.e. firms separately owned that are not dominant in their field of business (D'Amboise and Muldowney, 1988). Despite their limited size, SMEs are an important source of economic development and job creation at a national level (Acs and Audretsch, 1991; Acs, 1992; Dallago, 2000; Chege and Wang, 2020; Batrancea, 2022). In the United States, on data released in 2021 by Census Bureau, SMEs accounted for 39% and 47% of the total payroll and the total employment in 2018, respectively. In China, according to the OECD scoreboard 2020, SMEs contribute up to 60% of the GDP and up to 75% of job creation. In Europe, data by the Eurostat released in 2022 outlined that in the last five years, SMEs have created around 85% of new jobs and provided two-thirds of the total private sector employment, while representing 99,8% of all non-financial businesses in the EU-27 (see also European Commission, 2021). In Italy, SMEs matter too, being long at the core of national research in management (e.g., Lorenzoni, 1969; Golinelli, 1974; Varaldo and Bellandi, 1974; Rullani and Vicari, 1999; Silvestrelli, 2004).

Even in light of SMEs' limited size, resource poverty, and vulnerability to competitive threats (D'Amboise and Muldowney, 1988; Chen and Lee, 2023), innovation is essential to SMEs' performance (Harrison *et al.*, 1997; Bruque and Moyano, 2007; Haeussler *et al.*, 2019). In particular, SMEs can achieve several unique benefits from innovations (Rosenbusch *et al.*, 2011; Zhang *et al.*, 2022) such as higher quality and better products and services (Damanpour *et al.*, 2009; Demirkan *et al.*, 2022) which, once introduced in specific market spaces, offer SMEs opportunities to grow without experiencing through head-to-head rivalry with main competitors (Porter, 1980; Fabrizio *et al.*, 2022).

However, innovation is also a source of significant complexity for SMEs. Because of their resource poverty, the limited availability of financial and human resources constraints SMEs on the number of innovations that can be introduced (Madrid-Guijarro *et al.*, 2009), not to mention the possibility to alternate from one technology to another over time (Caputo *et al.*, 2002). Moreover, decisions in SMEs are often highly unstructured, the owners-founders resist delegation and play a key role in the decision-making process (Wittmeyer, 2003). Knowledge, skills, and relationships are necessary elements of human capital to generate innovations. Having formed and established their companies, founders human capital is constituted by prior knowledge of technologies and ways to serve markets (Marvel and Lumpkin, 2007; Ng and Kee, 2018), learned skills to handle the firm evolution (Wang *et al.*, 2010; Kato *et al.*, 2015), and established network ties (Tang and Murphy, 2012). Given resource poverty in SMEs and the founder-owner pivotal organizational role in the SMEs, founders'

capabilities that spurred out from their human capital turn out to be an important driver of SMEs innovation (Gao and Hafsi, 2015) to a greater extent than large organizations in which innovations relate more to the overall firm's strategy and organization (Welsh and White, 1981; Kato *et al.*, 2015; Davis and Bendickson, 2021; Grilli *et al.*, 2022). Such a conclusion echoes Schumpeter's (Schumpeter, 1934) observation that in organizations, particularly in startups and businesses of more limited size (Shane, 2012), innovations can be introduced only by «the same people who control the productive or the commercial process (in the enterprise)» (pp. 66-68).

Given the relevance and at the same time, the complexity of innovation in SMEs, understanding whose competencies are the leading forces that enable SMEs to successfully introduce innovations is a topic of great interest for research in the field of management. Building on the intersection between the literature on orchestrating capabilities in a firm strategy (Sirmon *et al.*, 2011) and the capabilities-based perspective (Hodgson, 1998; Penrose, 1959), an early study has addressed the positive influence of founders' initial and enduring involvement in inventive activities on high-research intensive SMEs performance (Haeussler *et al.*, 2019). However, such involvement was linked to a founder's participation in patenting activities in high-research intensive organizations as well as founders' centrality in collaborative patented inventive activities (Jiang *et al.*, 2021). Another study addressed the same relation in SMEs operating in low-research intensity regions, considering also two mechanisms, namely R&D expenditures and innovation outcomes, through which founders' involvement in R&D is likely to be channeled to SMEs performance, the latter measured with sales from new products and revenues growth (Vagnani *et al.*, 2022). In our study, considering the pivotal role of owner-founder capabilities for SMEs innovation (Thong and Yap, 1995; Lee and Cheung, 2004; Liu *et al.*, 2022), we contribute to the considered research stream on the linkage between founders' involvement in R&D and firms performance (Fini *et al.*, 2009; Haeussler *et al.*, 2019; Jiang *et al.*, 2021; Vagnani *et al.*, 2022) by theoretically exploring and empirically analyzing an expanding chain of consequences of the strategic decision of founders to be involved and remain engaged in R&D on SMEs' performance, with the latter measured with sales from new products, revenues growth, market share and sales volatility.

Specifically, while already discussed and analyzed the founders' involvement in the R&D-SMEs performance association (Haeussler *et al.*, 2019) and R&D resources and innovation outputs as mediators in the considered association (Vagnani *et al.*, 2022), we introduced the Quality of the technological knowledge as an additional mediator that stands in the R&D resources-innovation outputs linkages. Such an additional mediator is to further capture the quality of orchestrating capabilities fluxing out from founders' involvement in R&D. In addition, because of resource poverty, founders can finance their R&D expenditures with subsidies (Xiang *et al.*, 2022). Whatever is acquired, these subsidies will expose SMEs to other parties' knowledge and skills. Even in the simple case of non-cooperative R&D subsidies, at the early stage, an SME has to make an application, which somehow requires the firm itself to interact with other external

consultants. Once approved, a firm needs to report and thus interact with the granting institutions and their representatives. All these interactions will input external knowledge into SMEs research activities (Durst *et al.*, 2022), which, in turn, mixed with internally developed knowledge, via combinatory processes (Xiao *et al.*, 2022), will enhance the positive effect of R&D resources on the Quality of the technological knowledge.

Our hypotheses were tested on a random sample of 350 manufacturing located in low research-intensive areas of Southern Italy. From the results, we observed that founders' involvement in R&D is likely to increase SMEs' performance. The main effect is mediated by R&D resources, Quality of the technological knowledge, and Innovation outputs. We further observed that the R&D subsidies have a positive moderating effect on the R&D resources - Quality of the technological knowledge association. Our paper delves into the contribution of founders' involvement in R&D on their SMEs' performance. It also elaborates on potential mechanisms, that as mediators, particularly the Quality of the technological knowledge, and as moderators, the share of R&D subsidies, contribute to channeling the positive effect of founders' involvement in R&D on SMEs' performance. Our paper discusses the implications of our findings for scholars and practitioners.

2. Theoretical framework

2.1 A theory of resource orchestration

Within the resource-based view, resources include all assets, capabilities, organizational processes, firm attributes, information, knowledge. controlled by a firm on a semi-permanent base that enable a firm to conceive of and implement strategies that improve its efficiency and effectiveness (Barney, 1991). To contribute to firms competitive advantage, owned resources must be strategically important (Barney, 1991) and used with proficiency (Penrose, 1959). As for the strategic importance, resources need to be valuable, rare, difficult to copy, and organizational-specific (Barney, 1991; Grant, 2021). As for their use, resources need to be orchestrated (Ndofor *et al.*, 2011; Sirmon *et al.*, 2011) and, as well established by the Italian business management tradition (Fazzi, 1982; Ceccanti, 1996; Golinelli, 2000), such an orchestration requires key people using their skills and capabilities to structure resources, bundle and thus leverage them to set up strategies that lead to a sustainable competitive advantage (Porter, 1985).

Among key people orchestrating resources within SMEs, founders with their competencies are relevant. In general, competencies are defined as the ability of an individual or a team to perform with a minimum level of functionality and with repeated, reliable performance a coordinated set of activities, utilizing organizational resources, for the purpose of achieving a particular end result (Helfat and Peteraf, 2003). In SMEs, founders contribute with their beliefs and expectations to set up the firm, bring to the firm their competencies and in the firm make their competencies

to develop and enrich in a path-dependent manner. Their competencies, combined with other organizational capabilities, make it possible to shape key elements of the firm, such as its organizational structure, decisions, boundaries, performance, life-cycle, and dynamics (Hodgson, 1998; Colombo and Grilli, 2005; Barroso-Castro *et al.*, 2022). Therefore, founders are the key candidates to play the role of resource orchestrator, especially in the R&D of SMEs (Haeussler *et al.*, 2019; Baier-Fuentes *et al.*, 2023).

Fig. 1: The proposed expanded mediated-moderated framework
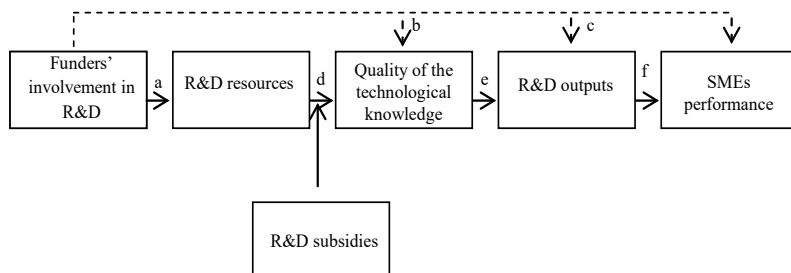
Source: our elaboration

Accordingly, an interpretative framework linking founders' involvement in R&D and SMEs performance, given mediators (R&D resources, Quality of the technological knowledge and R&D outputs) and moderator variable (R&D subsidies) is proposed (Fig. 1). Arrows with the solid line are to represent indirect effects while the one in the dotted line is to indicate the direct effect of founders' involvement in R&D on SMEs performance. The idea behind underlying the depicted framework is that founders' specific competencies are key inputs to transform R&D resources into enhanced SMEs performance.

2.2 SMEs founders and their contribution to SMEs performance

Prior studies have well established that the founders' mix of entrepreneurial, financial business management, human relations, and networking competencies (Gerli *et al.*, 2012; Kato *et al.*, 2015) are valuable, rare, difficult to imitate as well as replace, resources, since these competencies are heterogeneous across different firms and, once combined with other firms resources and capabilities, they become also organizational-specific (Mitchelmore and Rowley, 2010). Far from just stating that founders' competencies matter, extant literature assumes that they produce significant, positive benefits for firms' performance (Chandler and Hanks, 1994) in general, and for SMEs (Man *et al.*, 2002), especially when such competencies are infused into R&D activities (Haeussler *et al.*, 2019; Vagnani *et al.*, 2022). Therefore, we suggest the following baseline hypothesis.

H1. SMEs with founders involved in R&D display a higher performance than SMEs without founders' involvement in R&D.

Starting from the aforesaid baseline hypothesis, we advance that the positive effect of founders' involvement in R&D on SMEs' performance is channeled via the R&D resources (Vagnani *et al.*, 2022). In structuring R&D activities, founders and other individuals are very different (Liu *et al.*, 2010). Founders' involvement in R&D is an indication of the functional orientation of the firm (Boeker, 1989), inventive activities matter and, given that resource allocation is influenced by set priorities (Gouda *et al.*, 2013), R&D activities deserve attention in terms of resource allocation. In addition, despite resource poverty in SMEs, founders involved in R&D have more power and entrepreneurial status to influence the share of resources to be allocated toward inventive activities rather than other individuals (Fahlenbrach, 2009). Indeed, founders' resource allocation decisions have the inherent legitimacy afforded the owners of private property; thus, while managers have to compete with others in charge of different functions in the allocation of scarce resources, founders can override such a competition, being likely to define the share of resources to be invested in R&D. Furthermore, although the resources to be invested in different firms areas is a fixed pie for other individuals, founders can exploit their networking capacities and knowledge of investors (Mitchelmore and Rowley, 2010; Haffar *et al.*, 2021), thus making available to the SMEs more resources to be invested in R&D activities. In addition, because of their involvement within firms, along with their equity shares, founders may have a very different risk attitude from other individuals (Crovini *et al.*, 2021). Such a risk profile can induce founders to divert more available scarce resources from current combinations to newly productive activities (Block, 2012). There is empirical evidence that a major obstacle in R&D investments in SMEs is the owner's unwillingness to get involved in innovative activities (Kalantaridis, 1999). Moreover, when the CEO position is held by a founder, firms invest more in R&D than other businesses in which the same role is played by a professional manager (Lee *et al.*, 2016). Remembering that innovation is generally a network-based or collaborative phenomenon (Endquist, ed., 1997, pp. 8-9), founders' involvement in R&D is relevant even when SMEs are part of "helix" partnerships, also because founders are particularly able to use public and private (formal and informal) channels for knowledge exchanges (Haeussler *et al.*, 2019; Mueller *et al.*, 2020). Therefore, we suggest the following hypothesis.

H2. SMEs with founders involved in R&D are likely to invest more in R&D resources than SMEs without founders' involvement in R&D.

Because of the inherent uncertainty, unknowability, and variability, R&D activities require stability, particularly in long-term goals and priorities (Thamhain, 2003). Such stable long-term goals and priorities are anchors on which very complex activities can be built. The stability of long-term goals and priorities affects people involved in R&D, especially in those leading inventive activities. Since founders are less likely to be changed than other individuals engaged in inventive activities (Fahlenbrach, 2009), the former can provide research activities the required stability - at least in terms of goals and priorities - on which successful inventive outcomes may

be grounded. In addition to a stabilizing function, founders' involvement in R&D contributes to enriching the R&D activities, thanks to founders' specific capabilities (De Silva *et al.*, 2021), such as technical competencies, the ability to motivate other individuals individually and in work-teams, and human relations skills. In summary, founders can contribute to enhance the Quality of the technological knowledge that stems from inventive activities, by «directly stabilizes and enriches firms' technical capabilities while at the same time enhancing founders' competence as they deepen their technological knowledge» (Haeussler *et al.*, 2019, p. 293).

H3. Given founders' involvement in R&D, higher R&D resources are likely to increase to a greater extent the Quality of the technological knowledge in SMEs

Once contributing to structuring inventive activities, Founders' involvement in R&D will further contribute to structure research asset stocks developed out of inventive activities. Through stabilizing, enriching and pioneering (Sirmon *et al.*, 2011), founders can contribute to develop high-quality technological knowledge out of SMEs' inventive activities. Given the inherent stability that founders' grant to inventive activities, research team may have the opportunity to fine-tuning and thus improving existing technological knowledge. At the same time, founders can provide a direction to the creative process which mixes and consistently combines existing and new ideas to generate new configurations of products and processes (Gelderen, 2016), contributing to enriching and pioneering a firm's technological knowledge. Founders' specific capabilities like intuition, imagination, and seeing the big picture about SMEs' potential areas of competitive advantage and an understanding of customers' needs, give a preferred direction to inventive activities toward the production of high-quality technological knowledge. From an empirical perspective, firms' ownership by lone founders positively affects investments in R&D resources and the quality of their outputs (Block, 2012). Therefore, we suggest the following hypothesis.

H4. Given founders involvement in R&D, higher Quality of the technological knowledge will increase the R&D output in SMEs

Since leveraging is the process of using a company's capabilities to achieve performance benefits (Sirmon *et al.*, 2011), an SME which has successfully structured and bundled R&D resources, thus it owning or controlling them to establish capabilities, has still to exploit such capabilities to generate value (Lichtenstein and Brush, 2001). This component of resource orchestration is driven by entrepreneurial competencies including, among others, founders' specific skills in identifying viable market spaces, introducing valuable products to the customers, and defining appropriate distribution channels (Mitchelmore and Rowley, 2010). Assuming that «leveraging strategies are often idiosyncratic to a firm's capabilities» (Sirmon *et al.*, 2007, p. 284), founders' involvement in R&D enmeshes R&D resources and capabilities with entrepreneurial-specific capabilities that

were accumulated over time (Dierickx and Cool, 1989; Hwang *et al.*, 2020), and, at the same time, it infuses the same resource and capabilities with founders vision which comprises the direction of perceived opportunities which a firm should navigate to. As leveraging implies moving resources toward a goal (Sirmon *et al.*, 2011), founders can contribute with their competencies in searching, seizing, and exploiting market opportunities (Danneels, 2002; Gruber *et al.*, 2013; Glavas *et al.*, 2019; Barrett *et al.*, 2021). Thanks to founders' involvement in R&D, structured resources and developed high-quality knowledge become organization-specific, thus nurturing a firm's sustainable competitive advantage. In other words, «founder involvement in R&D goes beyond purely possessing technical capabilities: It spurs the ability to leverage them by delinking technological resources from specific applications as well as relinking them to specific products and market needs» (Haeussler *et al.*, 2019, p. 293). This way, founders possess specific capabilities that, combined with the potential induced by R&D outputs, allow SMEs to achieve superior performance (Vagnani *et al.*, 2022). Therefore, we suggest the following hypothesis.

H5. Given founders involvement in R&D, higher R&D outputs are likely to enhance SMEs performance.

2.3 *The mediating effects of R&D resources, Quality of the technological knowledge and R&D outcomes*

In their seminal work, Baron and Kenny (1986) clarified that «a variable functions as a mediator when it meets the following conditions: (a) variations in levels of the independent variable significantly account for variations in the presumed mediator (i.e., Path a), (b) variations in the mediator significantly account for variations in the dependent variable (i.e., Path b), and (c) when Paths a and b are controlled, a previously significant relation between the independent and dependent variables is no longer significant, with the strongest demonstration of mediation occurring when Path c is zero» (pag. 1176). In our theoretical framework, controlling for R&D resources, Quality of the technological knowledge, and R&D outputs, the founders' involvement in R&D-SMEs performance direct effect is expected to weaken. For example, a founder with specific capabilities in exploring and/or exploiting new technological and/or market opportunities could have very little effect on SME innovation. This is because founders, although involved in R&D, could be unable to make available adequate resources for inventive activities. Even if available, such a greater amount of resources may produce technological knowledge of mediocre quality. Constraints in available resources may also limit R&D outputs which, in turn, prevent firms from superior performance. In the same vein, thanks to the promotion effect of founders' involvement in R&D inventive, Consequently, founders' involvement in R&D, even if occurring in SMEs, might have very little effect on firm performance, given the supposed mediocre Quality of the technological knowledge and R&D outputs. In other words, what matters for SMEs' performance is the substantial and effective founders' involvement in R&D. A merely formal

participation of founders in SMEs' inventive activities is here conceived as rather irrelevant This discussion leads to the following hypothesis.

H6. Founders' involvement in R&D-SMEs performance relationship is mediated by R&D resources, Quality of the technological knowledge and R&D outputs

2.4 The moderating effect of R&D subsidies

Given resource poverty, SMEs are likely to supplement internal financing of R&D activities with external sources, via R&D subsidies Among different sources to finance R&D, subsidies unleash liquidity constraints faced by SMEs in sustaining their R&D activities without challenging their existing ownership structure or consolidated financial leverage (Guo *et al.*, 2022; Moon, 2022). We advanced that in using government subsidies to finance R&D, SMEs remain exposed to knowledge that is external to the firm (Sala *et al.*, 2016; Afcha and Lucena, 2022). For example, a call for R&D grants application can indicate some specific research directions. The preparation of the application form may require SMEs to interact with external consultants. The subsidy may be associated with some cooperative activities between the applicants and other organizations. In providing evidence of the money spent, SMEs will interact with experts designed by the granting institutions. All these occasions will favor SMEs to acquire external knowledge because it concerns information, data, facts, and circumstances that have not been developed or nurtured within a focal organization (Cassiman and Veugelers, 2006). The role of external knowledge is critical, in general, in fostering valuable innovation (Cohen and Levinthal, 1990; Chesbrough, 2003; Tortoriello *et al.*, 2015; Hervas-Oliver *et al.*, 2021) and it has been considered an essential component of resource orchestration at the firm level (Sirmon *et al.*, 2011).

Once acquired, the level of external knowledge facilitates firms' innovation. March (1991) theorized that knowledge infused in an organization by newcomers does not trade off with a firm's extant knowledge base, facilitating enhancements and changes in firms' activities and outputs. The contribution of external knowledge is relevant to innovative activities (Agarwal and Gort, 2002; Sirmon *et al.*, 2011; Torchia and Calabrò, 2019). The knowledge external to the firm brings general, related-industry, and industry-specific components that once infused into SMEs' inventive activities, will facilitate leveraging of resource asset stocks.

Thanks to non-redundant knowledge about different industries, markets, and institutional contexts, external financing of R&D activities can contribute to injecting within SMEs different visions of how and where to exploit the potential of resource assets stocks (Simons, 1994). This new external knowledge, once combined with existing ones via bricolage processes (Chen, 2021; Baier-Fuentes *et al.*, 2023) will enlarge the set of exploitable alternatives to deploy the outcome of inventive activities into the market. Such potential is vital for managing resource stocks, particularly in SMEs (Ricci *et al.*, 2021). In sum, R&D subsidies will facilitate SMEs acquisition of external-to-the-firm knowledge, which, in turn, will augment

the positive effect of R&D expenditures on the Quality of the technological knowledge. From the discussion, we propose the following hypothesis.

H7. R&D subsidies positively moderate the R&D resources - Quality of the technological knowledge association.

3. Method

To empirically test our hypotheses, a survey is the chosen method. Although data as R&D resources, R&D subsidies, sales from new products, sales growth, market share, and sales volatility are available from public sources, other information such as founders' involvement in R&D, Quality of the technological knowledge and R&D outputs, in particular, the number of innovations produced by R&D activities, remain generally undisclosed, particularly in SMEs located in low research-intensive areas. Moreover, a survey allowed us to better unfold and measure the mediators and moderators that stand in the founders' involvement in R&D-SMEs performance linkage. Data on these mediators and moderators rest undisclosed and thus unavailable from other sources. To address some common biases in surveys, we also combined archival (e.g., R&D expenditures, R&D subsidies, sales growth, turnover from newly introduced products) and non-archival data (e.g., founders' involvement in R&D).

As for the potential inability to derive causal conclusions because of the lack of temporal precedence between dependent and independent variables (Bowen and Wiersema, 1999), it is a material problem in all non-experimental settings, longitudinal research included. Nevertheless, such an issue is here faced by the adoption of a model channeling the effect of an independent variable on the dependent variable via mediators and moderators. At the same time, following extant literature (Aguinis *et al.*, 2017), the survey was split into three periods, respectively related to the measurement of R&D resources, Quality of the technological knowledge, R&D outcomes, and SMEs performance.

3.1 Sample

In our study, we first defined the population of interest made by SMEs. An SME is defined as a business, independently operated, with a total number of full-time equivalent employees of less than 250 and with a turnover of fewer than 50 million euros. To reduce unexplained heterogeneity and to test our hypothesis, in areas of low research intensity, the population of interest was confined to manufacturing firms operating in the Southern part of Italy (i.e., Basilicata, Calabria, Campania, Puglia, Sardegna, and Sicilia). Note that, according to the "Europe 2020 indicators - R&D and innovation" report by Eurostat, the aforementioned areas are positioned in the lowest two quintiles of the distribution of the share of research and development expenditures on regional GDP, the share of resources in science and technology, the share of R&D personnel, the

number of high-tech patented innovations. According to Eurostat, high-tech patents are those concerning computer and automated business equipment, aviation, micro-organism and genetic engineering, laser, semiconductors, communication technology, and biotechnology.

From the AIDA database, the total population of manufacturing SMEs located in the selected regions was 65,356, out of which 565,582 firms are located in the selected Southern Italy regions, 492,092 SMEs are firms with employees less than 250 and turnover of less than 50 million of euro. We selected a sample of 10% from the total universe. We also checked if, in each sampled SME, founders were still currently operating in the firm, at least as owner or as director. In cases of founders already left the firm, the organization was substituted by another randomly selected alternative. Firms included in the first sample were mailed to their legal address to participate in the survey; a month later, a reminder letter to not responding firms was sent. In total, we collected a declaration of participation from 366 firms.

Then, an agenda of appointments for a face-to-face interview was set: out of 366 firms, 16 SMEs decided not to further participate in the survey. After collecting the data, we used the Mann-Whitney U test to detect differences between prompt/early participants and late/solicited participants. We also compared a subsample of firms that decided to participate in the survey with firms that later decided not to participate on publicly available data. From these comparisons, we did not observe any significant difference.

For the distribution of the sampled firms by industry, 47% are in the agri-food businesses, 6% in transportation services, 8% in the metal mechanical sector, 14% in furniture and wood industries, 12% in clothing and textile, 5% in chemical, 8% in computer, electronics and precision equipment. It must be observed that the latter two industries are generally considered high-research intensive (Haeussler *et al.*, 2019). However, our sample is extracted from a homogeneous geographic area, and SMEs included in the considered two industries show distributions of both R&D intensity and granted high-tech patents that are not significantly different from their counterparts in other industries. By region, the distribution is 9% in Basilicata, 21%, 10% in Calabria, in Campania, 23% in Puglia, 11% in Sardegna, and 26% in Sicilia.

3.2 Variables

The main variables are here defined and measured as in the study of Vagnani *et al.* (2022). In testing the main effect, we introduced two additional measures of performance, namely market share and sales volatility.

Given antecedent variables measured at time t, the former is to capture the competitive position of an SME and it is calculated, at time t + 1, an SME's sales divided by the total sales of the industry in which the focal firm is included. The latter is to capture the risk of an SME and it is calculated as the standard deviation of the focal firm sales over a three-year period, starting from time t + 1.

Tab. 1: Descriptions of all the variables used in the analyses

Definition	Label	Measure	Role in the model
SMEs performance	*Npd*	Share of sales from newly introduced products over total sales at time t+1	Dependent variable
	Sales_g	Sales growth at time t+1 minus sales growth at the industry level	Dependent variable
	Ms	Sales at time t+1 divided by sales at the industry level in which the firm is included in	*Dependent variable*
	Vol	Standard deviation of sales in periods t, t+1, and t+2	Dependent variable
R&D resources	*R&d_i*	Expenditures over total sales at time (average over three years period)	Mediator
R&D outputs	*R&D_o*	Number of innovations, distinguished in i) new materials, ii) new use for existing materials, iii) new product functionalities iv) new product designs; v) new production processes; (vi) new organizational and managerial methods	Mediator
Quality of the technological knowledge	*TN_q*	"How much an SME knowledge is cutting edge or state-of-the-art in the industry?", ranging from 5 (at all) to 1 (not at all).	Independent variable
Founder involvement in R&D	*I_rd*	A dummy variable: founder involvement in R&D in periods t, t-1, t-2, and t-3: 1 if yes, 0 otherwise	Independent variable
R&D subsidies	*R&D_s*	Yearly R&D subsidies divided by R&D expenditures in periods t, t-1, t-2, and t-3:	Moderator
Founder gender	*Gender*	1 if founder involved in R&D is male, 0 otherwise.	Control variable
Founder age	*Age*	Age of founder involved in R&D at time t	Control variable
Founder tenure	*Tenure*	Founder involved in R&D number of years of in the firm at time t	Control variable
Founder education	*Education*	Founder involved in R&D highest degree (post graduate, graduate, high-school, mid-school, primary school)	Control variable
Localness of founder previous experience	*Localness*	1 if previous experience of the founder involved in R&D is in the same city in which he/she was born; 0.5 if in the same region in which he/she was born; 0 if outside the region in which he/she was born	Control variable
SME size	*Size*	Average number of full-time equivalent employees at time t	Control variable
Family involvement in the firm	*Family*	Number of other family members working in the firm at time t	Control variable
Industry	*Industry*	A dummy variable: 1 if the firm belongs to the selected industry, 0 otherwise	Control variable

Source: our elaboration

We further introduced the Quality of the technological knowledge as the availability of a focal SME, at time t, of cutting-edge or state-of-the-art knowledge in the technological field (Han *et al.*, 2018). To measure such a component, we asked the founder to describe and details her SME's available knowledge in its technological field. We asked then each founder to indicate at least two other SME's member to be interviewed on the same topic. We acquired all descriptions, merged them into one document, and then ask a panel of three industry experts to independently rate the Quality of the technological knowledge of each sampled SMEs. We asked experts the following question: «how much is the described knowledge is cutting edge or state of the art in the industry?», using a scale ranging from 1 to 5, where 5 indicated at all and 1 not at all. We calculate also inter-rate agreements between experts, and their level was greater than .98. We further measured the R&D subsidies as the subsidies received by a firm in

the last three years, normalized of the total R&D expenditures. Details of variables are in Tab. 1.

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3.3 Regression procedure

To test our hypothesis, given the independent, mediators, moderator, dependent, and control variables, seemingly unrelated regression (SUR) equations were adopted (Zellner, 1962). Such a model uses an asymptotically efficient, feasible, generalized least-squares algorithm that is particularly suitable to fit mediation and moderation models (Beasley, 2008). In this vein, SUR can jointly estimate parameters that can be used to separate the total direct effect of founders' involvement in R&D on SMEs' performance and the indirect effect channeled via mediators (i.e., R&D resources and R&D outcomes), given the role of the moderating variable.

The selected procedure is also able to handle contemporaneous cross-equation error correlation, which is often observable in linear regression equations adopted in mediation/moderation analyses (Preacher and Hayes, 2008). Extant empirical research has also used the SUR for assessing the performance of SMEs (Yan and Guan, 2019; Johann *et al.*, 2021) as well as for estimating and comparing indirect effects on categorical independent variables (Rochon, 1996), by using the procedure suggested by Hayes and Preacher (2014). In this study, three sets of linear regression equations were simultaneously estimated: (1) the effect of founders' involvement in R&D and potential confounders on the R&D resources; (2) the effect of founders' involvement in R&D, R&D resources, Quality of the technological knowledge, and potential confounders on R&D outputs; and (3) the effect of founders' involvement in R&D, R&D resources, Quality of the technological knowledge, R&D outputs, and potential confounders on SMEs performance.

Using the delta method as operationalized in the STATA command named nlcom (Feiveson, 1999), the total indirect effect of founders' involvement in R&D via mediators/moderators on the SMEs' performance was calculated. Since nlcom is based on the delta method, which assumes that the total indirect effect is normally distributed (Oehlert, 1992), standards errors and confidence interval using a bootstrap procedure (Preacher and Hayes, 2008) were calculated too. Finally, the variance inflation factor (VIF) is introduced to detect multicollinearity in regression estimates (Mansfield and Helms, 1982). Endogeneity in estimates was addressed by using an instrumental variables analysis with a generalized method of moments (gmm) estimator (Greene, 1993). Results are here omitted for space reasons, but available on request from the Authors.

4. Research findings

Pairwise correlation matrix among our variables of interest is reported in Tab. 2.

Tab. 2: Correlation table

	1	2	3	4	5	6	7	8
1. *Npd*	1							
2. *Sales_g*	0.15*	1						
3. *Ms*	0.02	-0.14*	1					
4. *Vol*	0.17*	0.22*	0.08	1				
5. *R&d_i*	0.17*	0.10*	-0.02	0.00	1			
6. *R&d_o*	0.27*	0.11*	0.03	-0.01	0.25*	1		
7. *Tn_q*	0.18*	0.07	0.02	0.05	0.43*	0.29*	1	
8. *I_rd*	0.15*	0.14*	0.13*	0.07	0.13*	0.19*	0.15*	1
9. *R&D_s*	0.13*	0.03	0.01	-0.05	0.44*	0.28*	0.36*	0.08
10. *Gender*	0.01	-0.03	-0.01	0.02	-0.01	0.05	0.07	-0.09
11. *Age*	-0.01	0.03	-0.01	-0.18*	-0.01	0.04	-0.01	-0.01
12. *Tenure*	-0.06	0.02	-0.03	-0.22*	-0.04	0.08	0.00	0.00
13. *Education*	0.07	0.02	0.03	-0.06	0.18*	0.08	0.14*	-0.09
14. *Localness*	-0.13*	-0.18*	-0.01	-0.15*	-0.12*	-0.12*	-0.12*	-0.00
15. *Size*	-0.05	-0.24*	0.09	-0.12*	-0.02	0.16*	0.12*	-0.08
16. *Family*	0.01	-0.06	0.05	-0.08	0.05	0.16*	0.22*	-0.04
Mean	7.47	-.01	1.26	0.40	1.69	0.46	0.15	0.36
SD	15.56	0.80	9.44	0.40	5.63	0.18	0.25	0.48
	9	**10**	**11**	**12**	**13**	**14**	**15**	**16**
9. *R&D_s*	1							
10. *Gender*	-0.08	1						
11. *Age*	0.02	-0.09	1					
12. Tenure	-0.01	-0.12*	0.17*	1				
13. *Education*	0.19*	0.11*	-0.17*	-0.28*	1			
14. *Localness*	-0.15*	0.12*	-0.14*	-0.12*	-0.18*	1		
15. *Size*	0.08	0.14*	0.06	0.06	0.14*	0.01	1	
16. *Family*	0.12*	0.13*	0.05	0.05	0.12*	-0.03	0.54*	1
Mean	5.66	0.75	45.51	22.66	3.11	0.66	15.48	4.21
SD	5.09	0.42	10.50	11.439	0.73	0.47	21.89	9.13

* $p < .05$; N = 350; For space reasons, control variables related to the industry are omitted.

Source: our elaboration.

Given correlations, mean and standard deviation values of the considered variables, as in Tab. 2, we controlled for the matrix of correlation coefficients to be semidefinite positive. The presence of potential multi-collinearity conditions in used data was explored by inspecting the magnitude of inter-variables correlations, particularly in cases where the coefficient is greater than .7 (Mansfield and Helms, 1982). We also tested for the effect of potential non-normality data in our estimates by comparing the correlation coefficients in Tab. 2 with those obtained from the Spearman pairwise correlations. We observed that signs and significance levels of our correlation coefficients hold constant.

4.1 Main effects

The main effect was tested by running a regression of founders' involvement in R&D on SMEs' performance. For every model in which the main effect is significant, the delta value calculated according to Oster (2019) is reported. Note, the closer the delta value to zero the more results are likely to be dependent on third unobservable variables (see Tab. 3).

Tab. 3: Impact of founders' involvement in R&D on SMEs performance

Dependent variables:	Model (1) Ndp	Model (2) Sales_g	Model (3) MS	Model (4) Vol
I_rd	4.22**	.21**	2.95**	.04
	(1.76)	(.07)	(1.05)	(.04)
Gender	.95	.04	-.35	.04
	(1.95)	(.09)	(1.21)	(.05)
Age	.21	.01	.06	.01
	(.16)	(.01)	(.09)	(.01)
Tenure	-.24	.01	-.08	-.01**
	(.15)	(.01)	(.09)	(.00)
Education	.92	.05	.07	-.10**
	(1.26)	(.06)	(.77)	(.03)
Localness	-3.69*	-.29**	-.19	-.19**
	(1.80)	(.09)	(1.11)	(.04)
Size	-.04	-.01**	.51†	-.01
	(.04)	(.00)	(.02)	(.01)
Family	.01	.01	-.01	-.01
	(.11)	(.01	(.06)	(.01)
lowRes	8..75*	-.12	1.09	.03
	(3.39)	(.13)	(1.61)	(.06)
Constant	-.81	-.08	-1.46	.99**
	(6.78)	(.33)	(4.08)	(.17)
Industry dummies	YES	YES	YES	YES
R-squared	.10	.11	.03	.12
N	350	350	350	350
Vif	1.81	1.95	1.95	1.98
δ	4.41	12.74	6.91	n.s.

† p < .10 * p < .05; ** p<.01; In control variables, we introduced a dummy whose value is equal to 0 if a sampled SME has R&D expenditures equal to zero and 1 otherwise. Standard errors in parenthesis; coefficients are standardized betas. δ is calculated according to Oster procedure, with R-max set, as suggested, to a value equal to 1,5*Model R-squared.

Source: our elaboration

Only considering direct effects, we observed that founders' involvement in R&D has a positive and significant effect on SMEs' performance, without increasing their risk. Among controls, founders' education, tenure, and localness have a significant effect on reducing SMEs' risk. Concerning all SME's measures of performance, the significant effect of founders' involvement in R&D holds positive and significant even if we use an instrumental variable (gmm) regression, with the resulting $\chi2$ endogeneity test between I_rd and SMEs performance that turns to be insignificant. Results are here omitted for space reasons, but available on request from the Authors. As a consequence, the analysis in Tab. 3 provides robust evidence that confirms our hypothesis 1. Thus, founders' involvement in R&D matters also for SMEs' performance.

4.2 Mediation effects

Mediation effects were tested by using SUR, where models from (1) to (6) are jointly estimated. Results are reported in Tab. 4.

Tab. 4: SUR of founders' involvement in R&D and SMEs performance by considering mediators (R&D_i, Tn_q, and R&D_o) and a moderator variable (R&D_s)

Dependent variables:	Model (1) R&D_i	Model (2) Tn_q	Model (3) R&D_o	Model (4) Npd	Model (5) Sales_g	Model (6) Ms
I_rd	1.62**	.04*	.06**	2.17	.16†	5.05*
	(.58)	(.02)	(.01)	(1.73)	(.09)	(2.70)
R&d_i		.02**	.01†	.13	.01	-.05
		(.00)	(.00)	(.16)	(.01)	(.26)
Tn_q			.13**	5.15	.19	19.08**
			(.04)	(3.99)	(.20)	(6.27)
R&D_s		.01				
		(.01)				
R&D_sx R&D_i		.01**				
		(.00)				
R&d_o				18.40**	.46*	2.69
				(4.70)	(.22)	(7.39)
Sex	-.21	.01	.03	.22	.02	.64
	(.64)	(.02)	(.02)	(1.88)	(.10)	(2.95)
Age	.01	-.01*	-.01†	.28†	.01	-.07
	(.05)	(.00)	(.00)	(.15)	(.01)	(.24)
Tenure	-.01	.01†	.01*	-.33*	-.01	.02
	(.05)	(.00)	(.00)	(.14)	(.01)	(.23)
Education	1.12*	.01	.01	.26	.04	-.3.04
	(.41)	(.01)	(.01)	(1.22)	(.06)	(1.94)
Localness	-.56	-.02	-.03†	-2.69	-.27**	-.66
	(.59)	(.02)	(.02)	(1.73)	(.09)	(2.71)
Size	-.01	-.01	.01*	-.05	-.01**	.01
	(.01)	(.01)	(.01)	(.04)	(.00)	(.07)
Family	.01	.01*	.01	-.03	.01	.07
	(.04)	(.00)	(.01)	(.11)	(.01)	(.17)
R&D Dummy		-.01	-.06**	.73	.08	-.40
		(.02)	(.02)	(2.07)	(.10)	(3.26)
Constant	-2.95	.08	.46**	-8.46	-.30	13.28
	(1.25)	(.09)	(.07)	(7.17)	(.37)	(11.27)
Industry dummies	YES	YES	YES	YES	YES	YES
R-squared	.21	.45	.22	.16	.14	.11
N	350	350	350	350	350	350
F-stat	6.68**	16.01**	6.00**	3.59**	3.01**	2.53**

† p < .10; * p < .05; ** p<.01; Standard errors in parenthesis; coefficients are unstandardized betas. Endogeneity also examined by mean the Breusch-Pagan test of independence: χ2(15) = 2.58, p = 0.99.

Source: our elaboration

The significance of mediators in channeling the effects of founders' involvement in R&D to SMEs' performance is here analyzed by observing the magnitude of both the coefficients I_rd in models (1)-(6) and of the indirect effects represented by R&D_i Tn_q, and R&D_o. On the one hand, Tab. 3 offered empirical evidence of the significant, positive influence of founders' involvement in R&D on SMEs' performance, once controlled for mediators, such significance turns to reduce.

The significance of the indirect effects depicted in Fig. 1 was assessed by the following equation: (βa x βd x βe + βb x βe βc) x βf, with the beta coefficients taken from Tab. 4. The total indirect effect calculated according to the delta method for SMEs performance is equal to 1.61 (Standard error

= .77, p < .05) and with bootstrap procedures is equal to 1.59 (Standard error = .78; p < .05). Within the overall indirect effect, the share of sales of newly introduced products benefits from the highest indirect effect of founders' involvement in R&D and market share the lowest one.

The magnitude of the indirect effects over the total direct effect of founders' involvement in R&D on SMEs' performance was determined by means of the ratio of the indirect effect over the sum of indirect and direct effects, with a resulting value that is equal to 19,21% (=1.61/(1.61+2.17+.16+5.05)).

From our data, consistently with hypotheses 2, 3, 4, and 5, we observed that founders' involvement in R&D is likely to produce positive effects on R&D investments and, at the same time, that increased investments in inventive activities improve the Quality of the technological knowledge, which will ramp up innovation outputs and, in turn, enhance SMEs performance. In addition, results offer evidence that founders' involvement in R&D-SMEs performance is mediated by R&D resources, Quality of the technological knowledge, and R&D outputs, as predicted by hypothesis 6.

4.3 Moderation effects

We tested the moderating effect of SMEs' use of R&D subsidies on the R&D expenditures over sales - Quality of the technological knowledge association. As expected, the interaction effect between R&D_i and R&D_s is positive and significant at the level of $p < .01$. To take into account the full effect of the moderating variable, we tested the joint significance levels of R&D_s and I_rd x R&D_i, finding a value of $F(2, 1991)$ equal to 3.82 ($p < .02$). Our results provide evidence that once founders are involved in R&D and inventive activities are supported by R&D subsidies, the effect of R&D expenditures on the Quality of the technological knowledge will be enhanced. Therefore, hypothesis 7 is confirmed by the data. In testing the moderation effect, as in Vagnani *et al.* (2022), we additionally control for the number of other functions founders were involved in. Despite the introduced new control variable, our main results hold constant.

5. Conclusions

This study tested the effect of founders' involvement in R&D activities on SMEs' performance. After developing six hypotheses, we found strong empirical evidence that founders' involvement in R&D matters. Furthermore, the founders' involvement in R&D-SMEs performance association is significantly channeled through inventive activities expenditures, Quality of the technological knowledge, and the innovation outputs. In addition, when R&D activities are financed with research grants, the effect of founders' involvement in inventive activities is magnified. Thus, our findings provide evidence that even in low-research intensive areas, where environmental factors do not strongly support and even encourage research and innovation, SMEs can innovate and through their innovations can sustain their performance. In addition, in the same context, there are

individuals, particularly founders, who, despite unfavorable contexts in which they operate (Cabiddu and Pettinao, 2008), possess motivations and capabilities to be involved in inventive activities and such involvement, sustained by effective resource orchestration activities, will have a positive effect on SMEs' performance.

Our analysis has important implications for academics and firms responsible and/or policymakers alike.

Our paper builds on the orchestration theory to discuss and analyze the pivotal role of founders in structuring, bundling, and leveraging inventive resources (Haeussler *et al.*, 2019; Vagnani *et al.*, 2022). We addressed not only who and whose role is important for inventive resource orchestration (Chirico *et al.*, 2011; Haeussler *et al.*, 2019) but also "how" and "under what conditions" such a role is made relevant for SMEs' performance. In this vein, our study connects the research stream on the founders' knowledge and skills and SMEs' performance. We argue that not only what founders know matters (Chandler and Hanks, 1994), but actually what founders do is relevant for SMEs' performance. Our study also suggests that it is not enough for founders to be involved in inventive activities to promote their SMEs' performance (Haeussler *et al.*, 2019), but also how they perform their role is relevant. Concerning "how", we connect to studies on founders' involvement in R&D-SMEs performance association and add that this association is mediated not only by R&D resources and outcomes (Han *et al.*, 2018; Vagnani *et al.*, 2022) but also by the Quality of the technological knowledge and moderated by the share of R&D subsidies. Our study links with the research stream on founders' succession or founders' teaming up with external managers in SMEs (LeCounte, 2022). Thus, within the debate on the founders' role (Zuzul and Tripsas, 2020), whether founders exit (Willard *et al.*, 1992; Loane *et al.*, 2014) or stay in the firm (Haeussler *et al.*, 2019) is better for firm performance, we advanced that SMEs performance will be enhanced if founders got involved in R&D and from their involvement R&D investments, Quality of the technological knowledge and innovation outputs arising from such investments are greatly increased. If either R&D resource, Quality of the technological knowledge, or R&D outputs or both were not enhanced, founders' involvement in R&D would provide no systematic benefit to SMEs' performance. Our study has also implications for the process of resource accumulation. Founders' capabilities are history-developed firm-specific. However, to contribute to SMEs' performance, these capabilities must be nurtured, developed and maintained valuable, rare, difficult to copy, and specific (Dierickx and Cool, 1989). Founders' involvement in R&D will make them learn about new knowledge, play with new practices, and collaborate with different scientists, which all will enrich their available capabilities. In addition, being enmeshed in firms' specific activities, founders' capabilities are likely to accumulate more and more, while keeping their strategic nature, in particular their firms' specific signature. Finally, within the debate around founders' effect on SMEs' risks (Crovini *et al.*, 2021), we offer some initial evidence that founders' involvement in R&D does not increase SMEs' risks while contributing to enhancing their performance.

Our study has also some implications for practice. On the one hand, founders involved in R&D activities boost the performance of their firms: with their specific capabilities, founders offer an important contribution to structure, bundle, and leverage firms' R&D resources, thus making the latter positively impact firms' performance. In addition, scholars have theoretically discussed and empirically observed the benefits of experimentation and research thinking in decision-making activities (Camuffo *et al.*, 2020). Being involved in inventive activities, founders can play with scientific methods and learn their inherent procedures and techniques. The acquired knowledge can enhance founders' capability to make more informed decisions, and better gather information about potential alternatives to be developed and their effects, while expanding the scope of their search for more promising innovations. In other words, founders involved in R&D, while orchestrating inventive activities, will be exposed to scientific methods, which, in turn, will further enhance their capabilities to orchestrate research resources, with subsequent benefits for their SMEs. On the other hand, policymakers should acknowledge such an important role of founders in SMEs and thus create incentives to stimulate founders of SMEs to be more involved in R&D, for example via research grants in collaborative inventive activities in which founders are required to participate. Lastly, our findings are important for education/training programs: founders' involvement in R&D matters, although it requires founders to acquire and develop advanced knowledge and skills. Academic institutions can provide such advanced knowledge, helping founders involved in inventive activities effectively play their role.

Our study is not without limitations. The dependent variable, i.e., SME performance, was operationalized and calculated using different measures, mainly revenue-based. Other studies could test the same variable by adopting multiple performance measures, even cost- and/or income-based. Moreover, the impact of founders' involvement in R&D firstly on innovative performance and, then, on firm performance as a whole could be inquired. The considered hypothesis, here tested on manufacturing SMEs in Southern Italy, could be empirically analyzed in other geographic areas and/or in non-manufacturing SMEs. Instead of the cross-sectional design here employed, further studies could adopt a longitudinal design and, given the underlying theoretical background, test the suggested associations over longer periods.

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References

AFCHA S., LUCENA A. (2022), "R&D subsidies and firm innovation: does human capital matter?", *Industry and Innovation*, vol. 29, n. 10, pp. 1171-1201.

AGARWAL R., GORT M. (2002), "Firm and product life cycles and firm survival", *American Economic Review*, vol. 92, n. 2, pp. 184-190.

AGUINIS H., EDWARDS J.R., BRADLEY K.J. (2017), "Improving our understanding of moderation and mediation in strategic management research", *Organizational Research Methods*, vol. 20, n. 4, pp. 665-685.

BAIER-FUENTES H., ANDRADE-VALBUENA N.A., GONZALEZ-SERRANO M.H., GAVIRIA-MARIN M. (2023), "Bricolage as an effective tool for the survival of owner-managed SMEs during crises", *Journal of Business Research*, vol. 157, 113608.

BARNEY J. (1991), "Firm resources and sustained competitive advantage", *Journal of Management*, vol. 17, n. 1, pp. 99-120.

BARON R.M., KENNY D.A. (1986), "The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations", *Journal of Personality and Social Psychology*, vol. 51, n. 6, pp. 1173-1182.

BARRETT G., DOOLEY L., BOGUE J. (2021), "Open innovation within high-tech SMEs: A study of the entrepreneurial founder's influence on open innovation practices", *Technovation*, vol. 103, 102232.

BARROSO-CASTRO C., DOMÍNGUEZ DE LA CONCHA CASTAÑEDA M., RODRÍGUEZ SERRANO M.D.L.Á. (2022), "Listed SMEs and innovation: the role of founding board members", *International Entrepreneurship and Management Journal*, vol. 18, n. 2, pp. 901-934.

BEASLEY T.M. (2008), "Seemingly unrelated regression (SUR) models as a solution to path analytic models with correlated errors", *Multiple Linear Regression Viewpoints,* vol. 34, n. 1, pp. 1-7.

BLOCK J.H. (2012), "R&D investments in family and founder firms: An agency perspective", *Journal of Business Venturing*, vol. 27, n. 2, pp. 248-265.

BOEKER W. (1989), "Strategic change: The effects of founding and history", *Academy of Management Journal*, vol. 32, n. 3, pp. 489-515.

BOWEN H.P., WIERSEMA M.F. (1999), "Matching method to paradigm in strategy research: limitations of cross-sectional analysis and some methodological alternatives", *Strategic Management Journal,* vol. 20, n. 7, pp. 625-636.

CABIDDU F., PETTINAO D. (2008), "Determinanti relazionali e sopravvivenza delle imprese familiari in contesti sfavorevoli: un'analisi qualitativa", *Piccola Impresa/Small Business*, vol. 3, n. 1, pp. 9-35.

CAMUFFO A., CORDOVA A., GAMBARDELLA A., SPINA C. (2020), "A scientific approach to entrepreneurial decision making: Evidence from a randomized control trial", *Management Science*, vol. 66, n. 2, pp. 564-586.

CASSIMAN B., VEUGELERS R. (2006), "In search of complementarity in innovation strategy: Internal R&D and external knowledge acquisition", *Management Science*, vol. 52, n. 1, pp. 68-82.

CECCANTI G. (1996), *Corso di tecnica imprenditoriale*, Cedam, Padova.

CHANDLER G.N., HANKS S.H. (1994), "Founder competence, the environment, and venture performance", *Entrepreneurship Theory and Practice*, vol. 18, n. 3, pp. 77-89.

CHEN P. (2021), "Recombinant reuse or recombinant creation? The impact of knowledge recombination strategies on new product performance", *Technology Analysis and Strategic Management*, Published online: 09 Nov 2021, pp. 1-15.

CHESBROUGH H. (2003), *Open Innovation*, Harvard University Press, Cambridge, MA.

CHIRICO F., SIRMON D.G., SCIASCIA S., MAZZOLA P. (2011), "Resource orchestration in family firms: Investigating how entrepreneurial orientation, generational involvement, and participative strategy affect performance", *Strategic Entrepreneurship Journal*, vol. 5, n. 4, pp. 307-326.

COHEN W.M., LEVINTHAL D.A. (1990), "Absorptive capacity: A new perspective on learning and innovation", *Administrative Science Quarterly*, vol. 35, n. 1, pp. 128-152.

COLOMBO M.G., GRILLI L. (2005), "Founders' human capital and the growth of new technology-based firms: A competence-based view", *Research Policy*, vol. 34, n. 6, pp. 795-816.

CROVINI C., OSSOLA G., BRITZELMAIER B. (2021), "How to reconsider risk management in SMEs? An advanced, reasoned and organised literature review", *European Management Journal*, vol. 39, n. 1, pp. 118-134.

CROVINI C., SANTORO G., OSSOLA G. (2021), "Rethinking risk management in entrepreneurial SMEs: towards the integration with the decision-making process", *Management Decision*, vol. 59, n. 5, pp. 1085-1113.

DANNEELS E. (2002), "The dynamics of product innovation and firm competences", *Strategic Management Journal,* vol. 23, n. 12, pp. 1095-1121.

DE SILVA M., AL-TABBAA O., KHAN Z. (2021), "Business model innovation by international social purpose organizations: The role of dynamic capabilities", *Journal of Business Research*, vol. 125, pp. 733-749.

DIERICKX I., COOL K. (1989), "Asset stock accumulation and sustainability of competitive advantage", *Management Science*, vol. 35, n. 12, pp. 1504-1511.

FAHLENBRACH R. (2009), "Founder-CEOs, investment decisions, and stock market performance", *Journal of Financial and Quantitative Analysis*, vol. 44, n. 2, pp. 439-466.

FAZZI R. (1982), *Il governo d'impresa*. (Parte prima), Giuffrè, Milano.

FEIVESON A.H. (1999), "What is the delta method and how is it used to estimate the standard error of a transformed parameter?", Available at: http://www.stata.com/support/faqs/stat/deltam.html, vol.

GELDEREN M.V. (2016), "Entrepreneurial autonomy and its dynamics", *Applied Psychology*, vol. 65, n. 3, pp. 541-567.

GERLI F., TOGNAZZO A., GIUBITTA P. (2012), "What makes Italian sme entrepreneurs successful? The leverage effect of relational competencies", *Piccola Impresa/Small Business*, vol. 3, n. 1, pp. 71-97.

GLAVAS C., MATHEWS S., RUSSELL-BENNETT R. (2019), "Knowledge acquisition via internet-enabled platforms: Examining incrementally and non-incrementally internationalizing SMEs", *International Marketing Review*, vol. 36, n. 1, pp. 74-107.

GOLINELLI G.M. (2000), *L'approccio sistemico al governo dell'impresa. L'Impresa sistema vitale*, Cedam, Padova.

GOUDA K., RADHIKA T., AKSHATHA M. (2013), "Priority based resource allocation model for cloud computing", *International Journal of Science, Engineering and Technology Research (IJSETR)*, vol. 2, n. 1, pp. 215-219.

GRANT R.M. (2021), *Contemporary strategy analysis*, John Wiley & Sons, New York.

GREENE W.H. (1993), *Econometric analysis*, Macmillan, New York.

GRUBER M., MACMILLAN I.C., THOMPSON J.D. (2013), "Escaping the prior knowledge corridor: What shapes the number and variety of market opportunities identified before market entry of technology start-ups?", *Organization Science*, vol. 24, n. 1, pp. 280-300.

GUO D., GUO Y., JIANG K. (2022), "Government R&D support and firms' access to external financing: funding effects, certification effects, or both?", *Technovation*, vol. 115, pp. 102469.

HAEUSSLER C., HENNICKE M., MUELLER E. (2019), "Founder–inventors and their investors: Spurring firm survival and growth", *Strategic Entrepreneurship Journal*, vol. 13, n. 3, pp. 288-325.

HAFFAR M., OZCAN R., RADULESCU M., ISAC N., NASSANI A.A. (2021), "Hegemony of network capabilities, frugal innovation and innovation strategies: The innovation performance perspective", *Sustainability*, vol. 14, n. 1, pp. 1-12.

HAN J., JO G.S., KANG J. (2018), "Is high-quality knowledge always beneficial? Knowledge overlap and innovation performance in technological mergers and acquisitions", *Journal of Management and Organization,* vol. 24, n. 2, pp. 258-278.

HAYES A.F., PREACHER K.J. (2014), "Statistical mediation analysis with a multicategorical independent variable", *British Journal of Mathematical and Statistical Psychology*, vol. 67, n. 3, pp. 451-470.

HELFAT C.E., PETERAF M.A. (2003), "The dynamic resource-based view: Capability lifecycles", *Strategic Management Journal,* vol. 24, n. 10, pp. 997-1010.

HERVAS-OLIVER J.L., SEMPERE-RIPOLL F., BORONAT-MOLL C. (2021), "Technological innovation typologies and open innovation in SMEs: Beyond internal and external sources of knowledge", *Technological Forecasting and Social Change*, vol. 162, pp. 120338.

HODGSON G.M. (1998), "Competence and contract in the theory of the firm", *Journal of Economic Behavior and Organization*, vol. 35, n. 2, pp. 179-201.

HWANG W.S., CHOI H., SHIN J. (2020), "A mediating role of innovation capability between entrepreneurial competencies and competitive advantage", *Technology Analysis and Strategic Management*, vol. 32, n. 1, pp. 1-14.

JOHANN M.S., BLOCK J.H., BENZ L. (2021), "Financial performance of hidden champions: Evidence from German manufacturing firms", *Small Business Economics*, vol. 59, n. 10, pp. 1-20.

KALANTARIDIS C. (1999), "Processes of innovation among manufacturing SMEs: The experience of Bedfordshire", *Entrepreneurship and Regional Development*, vol. 11, n. 1, pp. 57-78.

KATO M., OKAMURO H., HONJO Y. (2015), "Does founders' human capital matter for innovation? Evidence from Japanese start-ups", *Journal of Small Business Management*, vol. 53, n. 1, pp. 114-128.

LECOUNTE J.F. (2022), "Founder-CEOs: Succession planning for the success, growth, and legacy of family firms", *Journal of Small Business Management*, vol. 60, n. 3, pp. 616-633.

LEE M., KIM J.J., BAU J. (2016), Are founder CEOs better innovators? Evidence from S&P500 firms, Academy of Management Proceedings, Available at: https://doi.org/10.5465/ambpp.2016.13311abstract.

LICHTENSTEIN B.M.B., BRUSH C.G. (2001), "How do "resource bundles" develop and change in new ventures? A dynamic model and longitudinal exploration", *Entrepreneurship Theory and Practice*, vol. 25, n. 3, pp. 37-58.

LIU X., WRIGHT M., FILATOTCHEV I., DAI O., LU J. (2010), "Human mobility and international knowledge spillovers: evidence from high-tech small and medium enterprises in an emerging market", *Strategic Entrepreneurship Journal*, vol. 4, n. 4, pp. 340-355.

LOANE S., BELL J., CUNNINGHAM I. (2014), "Entrepreneurial founding team exits in rapidly internationalising SMEs: A double edged sword", *International Business Review,* vol. 23, n. 2, pp. 468-477.

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MAN T.W., LAU T., CHAN K. (2002), "The competitiveness of small and medium enterprises: A conceptualization with focus on entrepreneurial competencies", *Journal of Business Venturing*, vol. 17, n. 2, pp. 123-142.

MANSFIELD E.R., HELMS B.P. (1982), "Detecting multicollinearity", *The American Statistician*, vol. 36, n. 3a, pp. 158-160.

MARCH J.G. (1991), "Exploration and exploitation in organizational learning", *Organization Science*, vol. 2, n. 1, pp. 71-87.

MITCHELMORE S., ROWLEY J. (2010), "Entrepreneurial competencies: A literature review and development agenda", *International journal of entrepreneurial Behavior & Research*, vol. 16, n. 2, pp. 92-111.

MOON B. (2022), "Unleash liquidity constraints or competitiveness potential: The impact of R&D grant on external financing on innovation", *European Research on Management and Business Economics*, vol. 28, n. 3, pp. 100195.

MUELLER E., SYME L., HAEUSSLER C. (2020), "Absorbing partner knowledge in R&D collaborations–the influence of founders on potential and realized absorptive capacity", *R&d Management*, vol. 50, n. 2, pp. 255-276.

NDOFOR H.A., SIRMON D.G., HE X. (2011), "Firm resources, competitive actions and performance: Investigating a mediated model with evidence from the in-vitro diagnostics industry", *Strategic Management Journal,* vol. 32, n. 6, pp. 640-657.

OEHLERT G.W. (1992), "A note on the delta method", *The American Statistician,* vol. 46, n. 1, pp. 27-29.

OSTER E. (2019), "Unobservable Selection and coefficient stability: Theory and evidence", *Journal of Business and Economic Statistics*, vol. 37, n. 2, pp. 187-204.

PENROSE E.T. (1959), *The theory of the growth of the firm*, Basil Blackwell, Oxford.

PORTER M.E. (1985), *Competitive advantage: Creating and sustaining superior performance*, Free Press, New York.

PREACHER K.J., HAYES A.F. (2008), "Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models", *Behavior Research Methods*, vol. 40, n. 3, pp. 879-891.

RICCI R., BATTAGLIA D., NEIROTTI P. (2021), "External knowledge search, opportunity recognition and industry 4.0 adoption in SMEs", *International Journal of Production Economics*, vol. 240, pp. 108234.

ROCHON J. (1996), "Analyzing bivariate repeated measures for discrete and continuous outcome variables", *Biometrics*, vol. 52, n. 2, pp. 740-750.

SALA A., LANDONI P., VERGANTI R. (2016), "Small and Medium Enterprises collaborations with knowledge intensive services: an explorative analysis of the impact of innovation vouchers", *R&d Management*, vol. 46, n. S1, pp. 291-302.

SIMONS R. (1994), "How new top managers use control systems as levers of strategic renewal", *Strategic Management Journal,* vol. 15, n. 3, pp. 169-189.

SIRMON D.G., HITT M.A., IRELAND R.D. (2007), "Managing firm resources in dynamic environments to create value: Looking inside the black box", *Academy of Management Review*, vol. 32, n. 1, pp. 273-292.

SIRMON D.G., HITT M.A., IRELAND R.D., GILBERT B.A. (2011), "Resource orchestration to create competitive advantage: Breadth, depth, and life cycle effects", *Journal of Management*, vol. 37, n. 5, pp. 1390-1412.

THAMHAIN H.J. (2003), "Managing innovative R&D teams", *R&d Management*, vol. 33, n. 3, pp. 297-311.

TORCHIA M., CALABRÒ A. (2019), "Open innovation in SMEs: A systematic literature review", *Journal of Enterprising Culture*, vol. 27, n. 2, pp. 201-228.

TORTORIELLO M., MCEVILY B., KRACKHARDT D. (2015), "Being a catalyst of innovation: The role of knowledge diversity and network closure", *Organization Science*, vol. 26, n. 2, pp. 423-438.

VAGNANI G., PROIETTI L., GATTI C. (2022), "Does the founders' involvement in R&D influence SMEs' performance?", *Technology Analysis and Strategic Management*, vol. Published online: 26 Aug 2022, pp. 1-16.

WILLARD G.E., KRUEGER D.A., FEESER H.R. (1992), "In order to grow, must the founder go: A comparison of performance between founder and non-founder managed high-growth manufacturing firms", *Journal of Business Venturing*, vol. 7, n. 3, pp. 181-194.

YAN Y., GUAN J. (2019), "Entrepreneurial ecosystem, entrepreneurial rate and innovation: The moderating role of internet attention", *International Entrepreneurship and Management Journal*, vol. 15, n. 2, pp. 625-650.

ZELLNER A. (1962), "An efficient method of estimating seemingly unrelated regressions and tests for aggregation bias", *Journal of the American statistical Association*, vol. 57, n. 298, pp. 348-368.

ZUZUL T., TRIPSAS M. (2020), "Start-up inertia versus flexibility: The role of founder identity in a nascent industry", *Administrative Science Quarterly*, vol. 65, n. 2, pp. 395-433.

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