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New product development and supplier involvement: the role of R&D collaboration with supporting organisations

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Abstract
Existing research highlights the importance of sourcing external knowledge in manufacturers' innovative processes. Specifically, supplier involvement in new product development (NPD) has been widely analysed but without conclusive results. To shed light on this matter, this paper provides a deeper insight by analysing the indirect effects in the relationship between supplier involvement and two NPD dimensions (efficiency and effectiveness). In particular, it examines R&D collaboration with supporting organisations as a mechanism by which knowledge provided by suppliers may lead to better innovation performance. This study focuses on 155 high-tech and medium–high-tech Spanish firms to test indirect effects through the PROCESS macro. The results show that while there is a positive and significant indirect effect of supplier involvement on NPD efficiency through R&D collaboration with supporting organisations, that indirect effect is not significant in increasing NPD effectiveness. This research contributes to the literature on inter-organisational networks and NPD by analysing the effects of supplier involvement on NPD through the role played by supporting organisations, with different empirical evidence for each NPD dimension and practical implications.

Keywords New product development · Networks · Suppliers · Supporting organisations · R&D collaboration

JEL Classification O32: Management of Technological Innovation and R&D

1 Introduction

In this increasingly competitive and dynamic environment, in addition to developing new products for the market, innovative firms need also to produce these to a given lead time, stick to cost targets and meet strict quality standards, among other requirements (Suurmond et al., 2020; Yeniyurt et al., 2014). As a result, firms rely on a diverse network of collaborators to obtain, create and combine different sources of knowledge with the aim

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of achieving new product configurations (Delgado-Verde et al., 2013; Poppo & Zenger, 2002; Stojčić, 2021; Xia, 2013). Supplier involvement has been considered a particularly valuable external source of knowledge, increasing firms' innovative performance (Hoegl & Wagner, 2005; Kaufmann & Tödtling, 2001). This is because suppliers with successful involvement in new product development (NPD) may help firms have advantages over their competitors in terms of the technologies used and developments in cost and time (Belderbos et al., 2015).

However, the empirical evidence on the role of suppliers in innovative performance is inconclusive (e.g. Johnsen, 2009; Primo & Amundson, 2002; Suurmond et al., 2020) because while some studies have found a positive direct effect (e.g. Song & Di Benedetto, 2008; Thomas, 2013; Un et al., 2010), others have found a non-significant or even a negative one (e.g. Cruz-González et al., 2015; Koufteros et al., 2005; Yan & Dooley, 2013). In this sense, the first group understood that new knowledge provided by suppliers gives access to useful knowledge, since it differs from that held by the firm and is specialised while also being suitable for combining with the firm's knowledge to achieve better innovation performance (Un et al., 2010). Furthermore, suppliers make investments in equipment or training, therefore supporting the firm's own R&D investments, resulting in advantages such as faster response times and better use of potential market opportunities (Song & Di Benedetto, 2008; Thomas, 2013). In contrast, Koufteros et al. (2005) argued that partnering with suppliers to attain better innovation results involves risk, time and financial resources because there are problems associated with collaborating with unqualified suppliers. In addition, other complications arise from the lack of alignment of interests and actions, that is, uncooperative and uncoordinated behaviour, respectively (Yan & Dooley, 2013).

This lack of consensus may arise from the need to pay attention to other agents that also have contact with firms. As a result, studies on links between different partners have received less attention and much of the research has compared the effect of suppliers with the effect of other external sources of knowledge—end-users, competitors and supporting organisations—without clearly stating the different role in innovative performance played by each kind of inter-organisational collaboration (Amara & Landry, 2005; Fritsch & Franke, 2004; Keld Laursen & Salter, 2006; Tödtling et al., 2009).

Along with supplier involvement, R&D collaboration with supporting organisations, such as research institutes, universities, technical consultants, etc., has been considered one of the most important sources of external knowledge when explaining new product development (NPD) (Hervas-Oliver et al., 2011; Sofka & Grimpe, 2010; Un et al., 2010). The influence of supporting organisations on NPD has evolved from being associated with obtaining basic research towards playing an active and critical role in transferring knowledge along with all the NPD processes (Tödtling et al., 2009). R&D collaboration with supporting organisations stimulates the generation of more advanced innovation, as these organisations provide experience, ideas and knowledge that help when developing new products (Amara & Landry, 2005). In the specific case of universities, firms which collaborate with them gain technological economies of scope and increased commercialisation options (Cunningham & Link, 2014), thus enhancing innovation performance from two NPD dimensions: efficiency and effectiveness, respectively. The first dimension refers to issues relating to development speed and costs, and the second refers to aspects related to quality and market requirements.

Establishing R&D collaboration with supporting organisations, as well as suppliers, through their involvement in NPD, has a direct and independent effect on innovation performance. However, it may also have an indirect effect understood from two viewpoints: (i)

supporting organisations can act as a bridge for the influence of suppliers on innovation. They provide know-how derived from other innovation agents to which they are connected, helping to apply knowledge gained from suppliers in the development of successful innovations (Ehls et al., 2020; Lambooy, 2004); and (ii) relationships with suppliers provide a body of knowledge to allow for the comprehension and application of the knowledge from supporting organisations that might otherwise be difficult for firms to understand given its characteristics (Sofka & Grimpe, 2010).

Given these questions, we propose to evaluate the influence of suppliers and supporting organisations on the NPD performance of firms, understanding R&D collaboration with supporting organisations to be a key condition for developing knowledge from suppliers. In this, supporting organisations are understood to be "repositories of knowledge" (McEvily & Zaheer, 1999), relationships with suppliers to be an enabling condition for leveraging R&D collaboration with supporting organisations and supplier involvement to be "memories of the network" (Soda et al., 2004). That is, firms that follow a supplier-supporting organisation path in their relationships will improve their NPD performance.

Considering the above, this study addresses the following research questions: Do different inter-organisational R&D relationships contribute to improving innovation performance in a combined way? Is there some kind of integration between the knowledge provided by the different external agents with whom the firm maintains a relationship? What role does each external agent play in achieving the different elements of NPD performance (efficiency *vs* effectiveness)?

Therefore, we aim to contribute by building on the existing theory about the influence of different inter-organisational knowledge relationships on NPD performance using an "indirect effects" analysis. We contribute to the current literature in three ways. First, the innovation literature has led to more research on how different inter-organisational relationships affect firms' capacities to develop knowledge. However, most research has been focused on the independent contribution that each kind of collaboration makes (Cruz-González et al., 2015; Ehls et al., 2020). In this research, we propose a model whereby R&D collaboration with supporting organisations helps with integrating knowledge from suppliers and whereby knowledge developed through supplier involvement acts as an input to facilitate R&D collaboration with supporting organisations. In the academic literature, there are several approaches to address external collaboration designed to improve innovation performance, such as the Transaction Cost Perspective, the Resource-Based View, and the Theory of Organisational Learning. Specifically, we mainly start from the Knowledge-Based View (Grant, 1996; Kogut & Zander, 1992) and the Social Capital perspective (Adler & Kwon, 2002; Nahapiet & Ghoshal, 1998; Phelps et al., 2012) to explain how firms leverage knowledge and specific routines acquired in their relationships with suppliers into their R&D collaboration with supporting organisations. Suppliers and supporting organisations form a network of relationships around a firm that condition its learning ability and its capacity to collectively create new knowledge inside the network (Ahuja et al., 2012; Inkpen & Tsang, 2016). In this sense, organisational learning also plays an important role in understanding the successful running of inter-organisational networks.

Second, we contribute to the literature by splitting the concept of NPD performance into two main dimensions: efficiency and effectiveness, since prior studies have not adequately recognised these (Suurmond et al., 2020). We do this through consideration of different inter-organisational relationships. Innovation performance is the result in relation to the product's efficiency, in terms of lower costs or a shorter time to market, and its effectiveness, understood as the quality of the products and their market success (Brown & Eisenhardt, 1995). Although these are closely related dimensions, previous studies on

new product development have associated the lack of consensus in explaining NPD performance with a failure to consider these dimensions (e.g. Brown & Eisenhardt, 1995; Chang & Taylor, 2016; Chiang & Wu, 2016). By considering these two dimensions, we can more effectively disentangle how different inter-organisational relationships affect NPD performance.

Finally, we contribute by extending previous studies that have evaluated the role of supporting organisations on innovation (Cruz-González et al., 2015; Un et al., 2010; Vázquez-Carrasco et al., 2016) by including these two dimensions of NPD performance. In this sense, some studies have found that supporting organisations are a useful source of pure scientific knowledge, considering them more effective for developing advanced innovations than for applied research focusing on commercialisation, but not clearly considering the specific mechanisms that explain this relationship (Grigouriou & Rothaermel, 2017; Tödtling et al., 2009; Xia & Dimov, 2017). In terms of the two dimensions of NPD performance, it can be argued that supporting organisations increase NPD efficiency by lowering production costs and speeding up the process, while NPD effectiveness is more related to how supporting organisations help to identify new commercial demands or products of a higher quality than the existing ones.

Below, the hypotheses are developed from the consideration of the existing literature on how supplier involvement affects the two dimensions of NPD. The sample and measures for the variables, as well as the validation methods and empirical findings, are then explained. Finally, the conclusions, implications, and limitations, along with future research directions, are presented.

2 Theoretical framework

Acquisition of external knowledge from different sources has become a central issue in developing new products and, therefore, obtaining competitive advantages (Chen et al., 2011; Laursen, 2012; Stojčić, 2021; West & Bogers, 2014). Supplier involvement, as a type of collaboration to access external knowledge, plays an important role in NPD. Specifically, we must consider the extent of this involvement, which consists mainly of supplier development responsibility or design integration (Suurmond et al., 2020).

There are different approaches to understanding how collaboration with different agents can benefit innovation. From a transaction-cost perspective, collaborations are mainly understood as an alternative to developing input-related activities inside the firm. In this sense, the boundaries of the firm, and consequently the scope of cooperative agreements with suppliers and clients, are determined by ex-post opportunism arising from the holding up of specific investments and misappropriation of proprietary knowledge (Santos & Eisenhardt, 2005; Teece, 1986). In order to offer a deeper understanding of organisational boundaries, Santos and Eisenhardt (2005) proposed a broader view and established four organisational boundary conceptions in their work. In addition to the conception linked more directly to transaction costs, that is, boundaries of efficiency, one of these refers to the boundaries of competence. This last one is understood as the strategic logic of setting boundaries to maximise the opportunity value of the resource portfolio, giving way to another important approach, the so-called Resource-Based View.

In the Resource-Based View, which highlights the importance of firms' internal factors for attaining a sustainable competitive advantage (e.g. Barney, 1991; Grant, 1991; Wernerfelt, 1984), factors with intangible characteristics, which are scarce and valuable,

could be key when it comes to accessing external knowledge with the aim to develop new products. Specifically, given that NPD is a knowledge-based activity and simultaneously a social-interaction process (Liu et al., 2012), Social Capital Perspective (Adler & Kwon, 2002; Nahapiet & Ghoshal, 1998) provides a useful approach to analyse the relationship between supplier involvement and NPD. That is because it shows how the characteristics of the social relationships and networks established by firms influence their ability to access, transfer, absorb and apply knowledge among firms. Although closely linked to the Knowledge-Based View (Kogut & Zander, 1992; Nonaka, 1994), Social Capital Perspective changes the point of view from an autonomous, self-reliant view of a firm's actions and outcomes to one that is essentially relational. In addition, all these arguments are applied to R&D collaboration with supporting organisations, which will be integrated into our research model.

More to the point, given the importance of developing relational capabilities, a successful R&D collaboration between different partners -in our case both suppliers and supporting organisations- depends on the joint learning process (Bäck & Kohtamäki, 2016). "Learning processes are driven by experience" (Levinthal & March, 1993), so prior knowledge plays a key role when a firm wants to acquire new external knowledge and achieve better innovation results from collaborative efforts between parties. Taking a step forward, joint learning is understood as a relational dynamic capability which provides collaborative advantages for all partners (Huikkola et al., 2013). Therefore, external R&D interactions also reflect the importance of paying attention to the Theory of Organisational Learning, since through the development of learning capabilities the parties involved in R&D collaboration can identify improvements relating to cost, speed, quality or reliability in NPD, as argued by Selnes and Sallis (2003) in their analysis of customer–supplier relationships.

All of the above provides the basis for establishing the relevance of organisational learning from R&D collaboration with external agents by developing collaboration routines, especially in high-technology areas (Wagner, 2010), where relational capability learning can ensure that new useful knowledge is obtained and subsequently appropriately and successfully used. This way, R&D collaboration with supporting organisations facilitates the integration of knowledge received from suppliers and knowledge emerging from supplier involvement provides an input to assist in R&D collaboration with supporting organisations. This is because relationship learning is a process which improves future behaviour in a relationship and develops a competitive advantage (Selnes & Sallis, 2003).

Particularly, suppliers can provide valuable and specialised knowledge on new technologies, advising on new design ideas or providing feedback on all the processes involved in the design of the product (Wagner, 2010). They can bring experience to the firm from the early stages of the development of new products, supplying the components and equipment needed through coordinated efforts, reducing any design errors that may appear (Suurmond et al., 2020; Takeishi, 2001). This collaboration with suppliers allows for better NPD results, in terms of both efficiency and effectiveness.

Therefore, suppliers' design and technology expertise is an important aspect of the NPD process and it is essential to carry out parallel engineering and/or manufacturing design to achieve better NPD (Birou & Fawcett, 1994). In particular, these authors argue that integrated product development brings several advantages, such as "reduced development lead times with fewer costly redesigns; better communication and a subsequent reduction in duplicated efforts; substantial cost savings from higher productivity and lower maintenance; or more reliable products with fewer recalls and enhanced customer satisfaction" (p.5). All of these represent the main aspects covered by the two NPD dimensions: faster

development times and lower production unit costs (efficiency); and better reliability and overall product quality (effectiveness) (Primo & Amundson, 2002).

In relation to efficiency, collaboration with suppliers leads to reduced times and costs due to a reduction in the complexity of the design project, which in turn results in faster and more productive product development. In addition, the intensive participation of suppliers in NPD can result in the anticipation of potential future problems, leading to such problems being resolved more easily and faster as they are addressed in a timely manner (Brown & Eisenhardt, 1995). This will lower costs while improving speed to market.

In relation to effectiveness, collaboration between suppliers and manufacturing firms also leads to improvements in product quality and market requirements, since suppliers provide important knowledge about the overall product concept and its architecture, which can result in better products (Suurmond et al., 2020). In fact, Ragatz et al. (2002) assert that suppliers often help modify products in real-time, allowing companies to meet market requirements through a better fit and finish for the products.

Taking these arguments as the main ideas behind the benefits of supplier involvement in NPD, we proceed to break down the path followed by companies to achieve better NPD results by considering the role played by supporting organisations within this process, as explained above.

2.1 Supplier involvement prior to R&D collaboration with supporting organisations

Supplier involvement has been proven to be particularly suitable for providing detailed knowledge about components, interdependencies between different elements of new products or even for designing the overall resulting product (Suurmond et al., 2020). It tends to be of limited novelty for the firm, but easily accessible and quite specialised in the industry (Un et al., 2010).

Compared with suppliers, supporting organisations tend to provide broader knowledge, which is more novel since it is the result of integrating different perspectives and agents (Cruz-González et al., 2015; Stuart et al., 2007; Zaheer & George, 2002). These supporting organisations possess a rich stock of physical and social capital, as well as the services of expert researchers and practitioners, and this can increase success in NPD (Lambooy, 2004; Soetanto and van Geenhuizen, 2015). So, supporting organisations are characterised by their wide range of knowledge sources. Since this knowledge is mostly tacit, firms establishing a collaboration with them need to develop specific routines and procedures that provide a kind of relational capability learning. In addition, each firm has a learning process determined by its prior and historical knowledge and its capacity to incorporate new knowledge depends on its existing stock of knowledge, which is the consequence of relationships developed with other partners (Teece et al., 1997; Zahra & George, 2002). This way, prior experience in making network connections is an important factor in developing successful collaborations (O'Dwyer et al., 2022). Thus, firms that have previously developed relationships with suppliers are better able to integrate the knowledge provided by supporting organisations into new products, since knowledge provided by suppliers acts as an enabling condition for successful R&D collaboration with supporting organisations. Therefore, firms involved in relationships with suppliers have a greater interest in and capacity for developing R&D collaboration with supporting organisations since they find it easier to learn from them. By developing relationships with suppliers, firms develop superior inter-firm knowledge-sharing routines that are not specific to the transaction with suppliers but applicable to collaboration with other agents. From this perspective,

inter-organisational relationships are a path-dependent process where prior relationships shape not only the sources of complementary knowledge but also the "memories of the network" (Soda et al., 2004) in terms of routines, procedures and practices developed along with alliance development (George et al., 2002). Based on that, we propose:

Hypothesis 1 Supplier involvement will be positively related to R&D collaboration with supporting organisations.

2.2 The influence of R&D collaboration with supporting organisations on NPD performance

Firms tend to be involved in a variety of inter-organisational relationships so that they can benefit from access to valuable and complementary knowledge (Cruz-González et al., 2015; Gulati, 1998). Supporting organisations, such as universities, research institutes and technical consultants, are also a source of useful knowledge for NPD (Ahuja, 2000; Baum et al., 2000; Cunningham & Link, 2014). Through their inter-organisational relationships, supporting organisations play the role of bridges, connecting firms that would otherwise not be connected. Since many other firms, institutions and clients have made contact with them in search of solutions to similar problems (Oliver, 2004; Stam, 2010), supporting organisations have access to a wide range of ideas, experience and knowledge that can result in broad and diffuse thinking (Belso-Martinez et al., 2015; Kwon et al., 2020). Having a supporting organisation as a partner is like having indirect access to new sources of knowledge since they are "repositories of knowledge" (McEvily & Zaheer, 1999), each supporting organisation being a kind of intermediary between a myriad of knowledge sources and their partners.

Therefore, firms involved with supporting organisations have access to new knowledge, requirements and trends provided by other agents also connected to the supporting organisations. This allows firms to identify these new trends more quickly and replace the expense of direct interactions with many other agents with the expense of having indirect ones through the supporting organisation (Burt, 2001). The experience supporting organisations have with connecting and accessing different sources of knowledge reduces the times and costs involved in developing new products (Ahuja et al., 2012; Shakeri & Radfar, 2017). Based on that, we propose the following:

Hypothesis 2 R&D collaboration with supporting organisations will be positively related to NPD efficiency.

The second dimension of NPD performance, namely NPD effectiveness, is more closely related to applying the acquired knowledge and the ability to incorporate this into new goods, systems or processes that the market demands (Wagner, 2010). Most supporting organisations are considered a valuable source of knowledge as they provide scientific research that, through an interactive relationship with them, firms can transform into new valuable products (Löfsten & Lindelöf, 2005; Rubin et al., 2015; Westhead, 1997). Traditionally, these supporting organisations have been more closely linked to technological knowledge, providing basic research rather than applied research, but they have also been shown to be valuable when commercialising products, as they are increasingly focussed on industry requirements (Un et al., 2010).

Supporting organisations offer a variety of skills and extensive experience as a result of their relationships with different sources of ideas, knowledge and experience, and this provides the potential for the generation of novel combinations in the overall design of the product (Deeds et al., 1999; George et al., 2002). They compile knowledge and experience from different partners, many of whom may be customers of the firms, creating a greater capacity for the integration and resolution of components and elements (Un et al., 2010). Rather than having access to existing knowledge, supporting organisations are a source of knowledge creation useful for advances in NPD, being able to identify new commercial demands or products of a superior quality to the existing ones (Chen et al., 2011; Luca & Atuahene-gima, 2007). Based on that, we propose that:

Hypothesis 3 R&D collaboration with supporting organisations will be positively related to NPD effectiveness.

As a consequence, firms creating stable R&D collaboration with supporting organisations as a way to increase their NPD performance also benefit from having relationships with suppliers.

This is because, on the one hand, supporting organisations work as a bridge, promoting the exchange of knowledge between the innovative agents linking to them, such as other firms or their clients. That is, they indirectly connect different sources of knowledge from firms that would otherwise not be connected (Ehls et al., 2020; Katila & Ahuja, 2002). This way, supporting organisations possess a rich stock of physical, human and social capital and this allows the knowledge provided by suppliers to be more fruitful (Lambooy, 2004; Stuart et al., 2007). Specific and practical knowledge about new products, components and materials provided by suppliers increases the chances of developing successful innovations through the bridging role of supporting organisations, which broaden the firm's focus with new perspectives and ideas through their role as "repositories of knowledge". On the other hand, there is a main drawback in accessing knowledge from supporting organisations and this is related to learning barriers, as firms tend to find it difficult to understand and incorporate knowledge coming from them (Sofka & Grimpe, 2010). Supporting organisations, more than the other sources of knowledge, have their routines, habits and norms and encompassing these requires the development of different organisational practices that firms can find especially difficult (Keld Laursen & Salter, 2006). In the face of this, relationships with suppliers confer a kind of relational capability learning (Dyer & Singh, 1998), or "memories of the network" (Ahuja et al., 2012; Soda et al., 2004), useful for increasing firms' capacities to acquire and incorporate the knowledge provided by supporting organisations. That is, once firms have learned from their suppliers, they are better able to leverage this knowledge and create new knowledge from their R&D collaboration with supporting organisations. So, they gain a greater benefit from this if they have already had experience with suppliers. Thus, relationships with suppliers can favour NPD indirectly, increasing the benefits associated with R&D collaboration with supporting organisations. This is especially important for increasing NPD performance, since firms can use their knowledge and relational experience from relationships with suppliers to shorten the time to market, increase the quality of the products or meet cost targets through their R&D collaboration with supporting organisations.

By doing so, they have access to different and complementary knowledge from suppliers based on similar routines and procedures and relational experience that increases both their efficiency and effectiveness through R&D collaboration with supporting organisations,

which moreover provides broader knowledge. Specifically, firms involved with suppliers can increase their NPD efficiency by shortening the time to market, as they can more easily understand the suggestions and ideas generated by supporting organisations and gathered through relationships those supporting organisations themselves have with other firms and clients. They can also reduce costs by identifying how to make better use of what research institutes, universities or technical consultants can offer the firm, such as procedures and tools. In the same vein, firms with successful supplier involvement can better integrate new trends and market requirements anticipated by supporting organisations as a way to increase their NPD effectiveness (Praest Knudsen & Bøtker Mortensen, 2011; Suurmond et al., 2020). Based on that, we propose the following hypotheses:

Hypothesis 4a Supplier involvement has an indirect effect on NPD efficiency through R&D collaboration with supporting organisations.

Hypothesis 4b Supplier involvement has an indirect effect on NPD effectiveness through R&D collaboration with supporting organisations.

3 Methodology

3.1 Research setting

Data were collected through a survey of Spanish firms in the high-tech and medium–high-tech manufacturing industries (Eurostat, 2020), which was carried out in 2015. Specifically, these firms were part of the following seven sectors: chemicals (NACE 20); pharmaceuticals (NACE 21); computer, electronic and optical products (NACE 26); electrical equipment (NACE 27); machinery and equipment n.e.c. (NACE 28); motor vehicles, trailers, and semi-trailers (NACE 29); and other transport equipment (NACE 30). These are the most R&D intensive manufacturing sectors according to the European Classification of Economic Activities and, therefore, the most suitable for an analysis of innovation performance. The population contained 1326 companies with 50 or more full-time employees and at least 5 years of experience (Orbis database, Bureau van Dijk). The aim was to capture information on new product development, as well as knowledge derived from inter-organisational R&D collaborations and applied to new products. The restrictions were therefore imposed because small companies and/or new ventures have different characteristics in terms of external knowledge sources compared to larger and/or established firms (Voudouris et al., 2012; Zahra & Bogner, 2000).

Two different managers from each firm were asked to answer question on diverse issues. To avoid common method bias, one respondent provided data on the dependent variable while the other provided data on the independent variables (Podsakoff et al., 2003). In particular, the company's CEO or, alternatively, the head of corporate marketing or sales director, answered questions on aspects regarding new product development (NPD), and the head of R&D was asked about supplier involvement and collaboration with supporting organisations (research institutes, universities and/or technical consultants). In addition to using two different sources to collect data, a Harman's single factor test was conducted to check the possibility of common method variance for all the variables in the study. There is no general factor in the un-rotated factor solution and the first factor explained 32.008% of the total variance, so the results do not suggest response bias problems.

The questionnaires were conducted by a polling company, using Computer Aided Telephone Interviewing (CATI), and a total of 202 firms provided data from both respondents, giving a response rate of 15.23%. To test for representativeness and non-response bias, differences between the final sample and the total population, and between respondents and non-respondents, were examined, respectively. T-tests showed no significant differences based on the number of full-time employees, total assets, or sales.

Specifically, considering that the aim of the research model[1] in this study is to examine antecedents of efficiency and effectiveness in new product development, only those firms which responded positively to the question "How many new or improved products has your company introduced in the last three years (2012–2014)?" were included in the analysis (N = 155). Managers of the innovative companies responding to the questionnaires had a total mean experience in their firm of 13.25 years (CEOs and heads of R&D), and in the sector of 17.24 years.

3.2 Measures and model validation

Since the research model includes "indirect effects" analyses,[2] the independent variables related to a period beginning two years earlier than that for the dependent variable (NPD). Moreover, that period has a duration of five years, so it allows us to capture the 'incubation time' of supplier involvement (independent variable) before is has an effect on R&D collaboration with supporting organisations (mediating variable). That is, a certain 'incubation' period may be needed to see the effect of supplier involvement and its contribution to R&D collaboration with supporting organisations, since at times the effect is not immediate (Belderbos et al., 2015).

The dependent variable, in this case new product development performance (NPD), was measured through five questions (see Appendix) addressed to the CEO to capture the two dimensions of NPD. Two items related to NPD efficiency in terms of speed and cost and aspects such as adherence to targets set and using fewer resources. Examples include time-to-market and manufacturing cost (based on Knudsen and Mortensen 2011; Suurmond et al., 2020; Thomas, 2013). Three items related to NPD effectiveness: commercial expectations, market success and market share, which reflect the resulting product's quality and market requirements (based on Chen et al., 2011; Luca & Atuahene-gima, 2007; Suurmond et al., 2020). A seven-point Likert scale (1 = strongly disagree and 7 = strongly agree) was used and respondents were asked about innovative products produced by their firms in the last three years. Both measures consisted of the average of the scores for the two efficiency items ($\alpha = 0.826$) and three effectiveness items ($\alpha = 0.753$).

Six items (see Appendix) were included in the questionnaire for the heads of R&D, designed to measure the independent and mediating variables, that is, the strength of inter-organisational collaboration with two different groups of external agents. And, to ensure

[1] The questions used in this paper are just part of a broader research project funded by the Spanish Ministry of Economy and Competitiveness.

[2] (Kline 2015:205) asserts that "an appropriate design for estimating mediation has time precedence where the cause is measured before the mediator, which in turn is measured before the outcome". This way, cross-sectional studies should apply the term "indirect effect" instead of "mediation". Even though different periods with several years are considered in the measurement scale as an attempt to overcome that limitation, we embrace this specification. However, we sometimes use the term "mediation" in explaining our model according to (Hayes 2018) to make it more understandable.

that they covered different times to those of the dependent variable, the questions related to the last five years. On a seven-point Likert scale, three items captured supplier involvement and another three captured R&D collaboration with supporting organisations. Based on Krause et al. (2007) and Blonska et al. (2013), these asked about improvement ideas and involvement efforts with external agents. In particular, this study paid attention to improvements in the design and quality of products and processes since this was a way to capture knowledge acquired from external agents (based on Kotabe et al., 2003), using two items for each kind of partnership. Through two other items, it also looked at the joint development of solutions (Reed et al., 2006; Subramaniam & Youndt, 2005; Youndt et al., 2004), asking for information on teamwork between the company and its suppliers, and between the company and universities, research centres and/or consultants, this being captured when they carry out collaborative processes. In relation to the dependent variables, both measures consisted of the average score across the three items they included ($\alpha = 0.862$ and $\alpha = 0.955$, respectively).

Regarding the control variables, firm size, firm age, technological environmental dynamism, and lack of innovation funding were used in the analysis. From information in the Orbis database, firm size was measured as the logarithm of the number of full-time employees and firm age was measured as the number of years since the founding date. The first of these captures differences in resources and the second differences in accessing external sources (Perols et al., 2013). To control the speed of change and instability of technology in a firm's external environment over the last three years, three items (see Appendix) were included in the questionnaire for CEOs and these measured technological environmental dynamism on a seven-point Likert scale (Cruz-González et al., 2015; Jaworski & Kohli, 1993). This consideration is relevant because technological turbulence could require the sourcing of external knowledge and differs between companies in different industries. This measure consisted of the average score for three items. Finally, on a seven-point Likert scale, each CEO was also asked about the extent to which a lack of finance hindered innovation activities. This was done through an item to capture barriers to innovation, both hampering barriers and deterring barriers, since their effects may vary across firms and sectors (D'Este et al., 2012; FECYT, 2016).

Table 1 shows the descriptive data and correlations, as well as the reliability and validity of the variables. In addition to using Cronbach's Alpha to analyse the internal consistency and reliability of each variable, we have also tested convergent and discriminant validity using Average Variance Extracted (AVE) and composite reliability (CR). To demonstrate convergent validity, the AVE of each variable should be greater than 0.5 and all the variables in the research model met this condition. Since the square root of the AVE is higher than the off-diagonal elements in the correlations matrix, the discriminant validity conditions are also met (Claver-Cortés et al., 2011). With respect to composite reliability, according to Fornell and Larcker (1981), this measure should be higher than 0.7 and all variables meet this required reliability level.

3.3 Results

In order to carry out "indirect effects" analyses, the modularity assumption is adopted, so the causal process is composed of separate parts (Rungtusanatham et al., 2014). In addition, we assume that the directionality of our proposal is correct based on the initial literature review (Kline, 2015).

Table 1 Descriptive statistics, correlations, reliabilities and validities

	Mean	s.d	1	2	3	4	5	6	7	8	AVE	CR
1. Age	32.10	17.62	1									
2. Size (log)	2.07	.35	.151	1								
3. Technological Environmental Dynamism	5.46	1.10	− .124	.034	**.799**						.638	.840
4. Lack Funding	3.81	2.11	− .019	.095	.096	1						
5. Suppliers Involvement	5.17	1.10	− .109	.066	.031	− .057	**.885**				.785	.916
6. Supporting Organizations	4.06	1.72	− .037	.315**	.017	.123	.273**	**.958**			.919	.971
7. NPD efficiency	4.69	1.60	.003	.143	.081	.102	.145	.237**	**.748**		.559	.717
8. NPD effectiveness	5.42	1.07	.253**	.055	.296**	− .012	.074	.021	.190*	**.815**	.664	.855

The square roots of the AVE are along the diagonal (in bold)

**Correlation is significant at the .01 level (bilateral)

*Correlation is significant at the .05 level (bilateral)

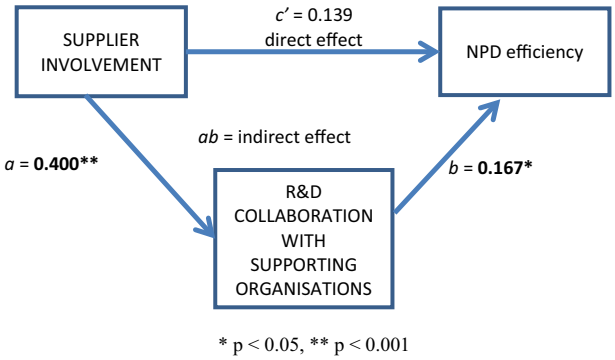

Fig. 1 Indirect effect model in explaining NPD efficiency

The proposed simple mediation model was tested using the PROCESS macro (model 4) for SPSS described by Hayes (2018), which estimates the regression coefficients by OLS regression. In this model, R&D collaboration with supporting organisations is analysed as a mediator in the link between supplier involvement and new product development. So, R&D collaboration with supporting organisations acts as a mediating variable through which supplier involvement influences NPD efficiency and effectiveness. To examine this research model, four variables were controlled for: firm size and age, technological environmental dynamism and lack of innovation financing.

In keeping with (Hayes, 2018), two paths of influence were tested, that is, the direct (*c'*) and indirect effect (*ab*) of the independent variable on the dependent variable, since the total effect is not required for the purposes of interpretation. In fact, this author argues that it is the test of the indirect effect that matters to establish mediation, not the test of the individual paths in the model. The bias-corrected and accelerated bootstrap was used to test the confidence interval (CI) because it is a method widely recommended for inferential tests for indirect effects in mediation analysis (Kline, 2015; Rungtusanatham et al., 2014). The indirect effect was tested using a 95% bootstrap CI and 5000 bootstrap samples.

In the research model, path *a* represents the effect of supplier involvement (independent variable) on R&D collaboration with supporting organisations (mediator); path *b* represents the effect of the mediator variable on new product development (dependent variable), controlling for the independent variable; path *c'* consists of analysing the direct effect of the independent variable on the dependent variable, controlling for the mediator variable; and finally, path *ab* represents the indirect effect of the independent variable on the dependent variable through the mediator.

Figures 1 and 2 illustrate the models and give a detailed description of the analyses for each dimension, efficiency and effectiveness, respectively. The results of path *a* show that greater supplier involvement was significantly associated with increased R&D collaboration with supporting organisations (B = 0.400; t = 3.38; $p = 0.0009$; CI = 0.166–0.633). So, the results support Hypothesis 1.

With respect to NPD efficiency, the results of path *b* indicate that higher levels of R&D collaboration with supporting organisations were significantly associated with increased NPD efficiency (B = 0.167; $t = 2.07$; $p = 0.0402$; CI = 0.008–0.326), in support of Hypothesis 2. Next, the results of path *c'* analysed the direct effect of supplier involvement on NPD efficiency and showed a positive but not statistically significant association between

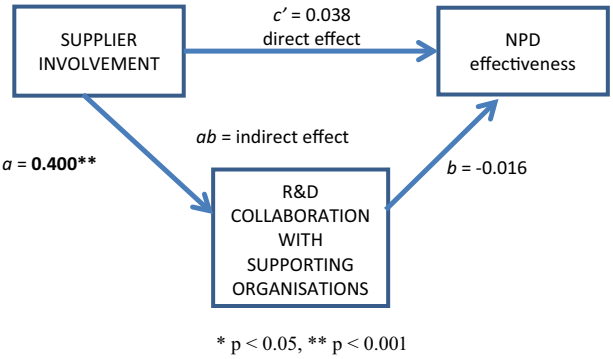

Fig. 2 Indirect effect model in explaining NPD effectiveness

these variables (B = 0.139; t = 1.16; $p = 0.2499$; CI = − 0.099–0.377). Finally, the results of the indirect effect (*ab*) of supplier involvement on NPD efficiency were tested, after controlling for R&D collaboration with supporting organisations as the mediator variable. These results showed a positive and significant association between these variables since the mediator is found to be significant when zero is not contained in the 95% CI (CI = 0.003–0.153). Therefore, Hypothesis 4a is supported.

However, with respect to NPD effectiveness, the results of path *b* indicate that lower levels of R&D collaboration with supporting organisations were associated with increased NPD effectiveness, but this is not statistically significant (B = −0.016; t = −0.31; $p = 0.755$; CI = − 0.119–0.086). This finding led to the rejection of Hypothesis 3.

Next, the results of path *c'* analysed the direct effect of supplier involvement on NPD effectiveness and showed a positive but not statistically significant association between these variables (B = 0.038; t = 0.50; $p = 0.6205$; CI = − 0.115–0.192). Finally, the results of the indirect effect (*ab*) of supplier involvement on NPD effectiveness were tested, after controlling for R&D collaboration with supporting organisations as the mediator variable. These results showed a negative but not significant association between these variables since significance of the mediator is found when zero is not contained in the 95% CI (CI = − 0.058–0.031). Therefore, Hypothesis 4b is not supported.

3.4 Discussion

Overall, the results highlight the importance of the role played by supporting organisations for firms partnering with suppliers on NPD. The results show a positive effect of supplier involvement on R&D collaboration with supporting organisations, considering that the relational experience and specific knowledge from suppliers can be leveraged into relationships with those supporting organisations, since firms can use this experience and knowledge to better understand and incorporate knowledge provided by those supporting organisations. In addition, R&D collaboration with supporting organisations had a direct positive effect on NPD efficiency but not NPD effectiveness. These results indicate that specific knowledge derived from R&D collaboration with supporting organisations has a positive effect on innovation performance by increasing its speed and reducing its costs, but not by improving commercial expectations and other aspects related to the market. In general terms, the results of this study are in line with those obtained by Stuart et al. (2007), who

confirmed that as firms become increasingly involved in how supporting organisations function, they increase their innovation activity. However, although abundant research has confirmed that relationships with universities increase the innovation of firms (Decarolis & Deeds, 1999; McEvily & Zaheer, 1999; Un et al., 2010), there are studies that find a negative effect (Cruz-González et al., 2015).

These results can be better understood considering that R&D collaboration with supporting organisations can provide depending on the knowledge shared. Previous research has clearly distinguished between technical knowledge and business information relationships (Balland et al., 2016; Giuliani, 2007). Morrison and Rabellotti (2009) relate the configuration of each relationship to the degree of codification of the knowledge shared. While business information can be easily transmitted, knowledge-based relationships need close collaboration with institutions. In this sense, these different kinds of knowledge could be connected with different types of institutions: technical knowledge would be more related to universities, scientists and engineers, and business information with associations (Belso-Martínez et al., 2018). Almeida and Kogut (1999) focused on how the relationship between universities, scientists, engineers, and firms affect the transmission of knowledge, while Swan and Newell (1995) found evidence of the positive effect of the role played by professional associations in the diffusion of knowledge. Considering the results of this research, it would be interesting to evaluate differences between institutions based on technical knowledge, such as universities and research institutions, and other institutions such as associations, that would be more information-based. In fact, there is a strong debate about the role that universities play in fostering NPD (Bakouros et al., 2002; Löfsten & Lindelöf, 2005) as there are communication problems between them and firms.

On the basis of the above, "indirect effects" analyses were proposed, where the involvement and understanding of knowledge provided by supporting organisations is given by relationships maintained with suppliers. It has been argued that firms may face difficulties in understanding and incorporating knowledge provided by supporting organisations (Díez-Vial & Fernández-Olmos, 2015), so a background of involvement with suppliers could be of great help. In addition, the findings tend to confirm that supporting organisations act as bridges, providing innovative firms not only with their own knowledge and experience but also that collectively formed through their relationships with other innovative agents, thus facilitating the successful application of supplier knowledge through involvement in NPD. With respect to NPD efficiency, previous studies have obtained similar results, since supporting organisations have been shown to be useful in speeding up the innovation process (Al-Laham et al., 2008; Belso-Martínez et al., 2015; McEvily & Zaheer, 1999; Powell et al., 1996). Rothaermel and Deeds (2004), in their study of biotechnological alliances, confirmed the important role of supporting organisations in the embodiment of new knowledge learned into a prototype product that can be extended into the testing and development process through preclinical trials.

Among the potential explanations for the lack of a significant relationship between supporting organisations and NPD effectiveness is the different perspectives that firms and supporting organisations have when dealing with market objectives. As Ferrara et al. (2016) pointed out, supporting organisations tend to have objectives more related to new product launches, patent applications and R&D investments, rather than financial results, so the short term benefits of adaptation to the market are less relevant for supporting organisations. In fact, the influence of supporting organisations on firms' innovative performance has been questioned on the basis that they could be assumed to provide scientific knowledge that is less useful for commercialisation purposes (Rothaermel & Deeds, 2004) and, in the specific case of universities, scholarly endeavour has different objectives than

commercial pursuits since they are more focussed on 'pure' research (Mosey et al., 2006). Many of the problems with commercialisation relate to the pressures on firms in projects with a strongly applied focus, under different time frames (George et al., 2002). It has also been pointed out (McNamara & Baden-Fuller, 2007) that dealing with and adapting to market needs requires more capital-intensive partners who can exploit existing technologies, relying on large and complex investments for the commercialisation of the products.

4 Conclusions and implications

The effect of supplier involvement on new product development (NPD) has been analysed in a large number of academic studies, but with inconclusive results. This paper attempts to shed light on this effect, paying attention to the indirect effect of R&D collaboration with supporting organisations in the relationship between supplier involvement and NPD performance. According to the results of this study, supplier involvement has no significant effect on NPD when considered in isolation, which provides an interesting insight into the innovation performance of firms. This finding highlights the need to maintain more relationships with external agents owing to the division of labour in the innovation process (Tödtling et al., 2009). This supports the argument that there is a key role for supporting organisations and that knowledge provided by suppliers is not enough to achieve better NPD performance.

The results confirm that supplier involvement prepares firms to take advantage of their R&D collaboration with supporting organisations through exploiting the knowledge provided by suppliers. Additionally, supporting organisations provide wider knowledge derived from their distinctive nature and their relationships with other agents. Thus, the results confirm the importance of relying on different sources of knowledge to improve NPD performance, as each provides different perspectives, resources and experience, and these can mutually reinforce each other. In particular, this research brings out how supplier involvement transmits its effect on NPD through relationships maintained with supporting organisations. Rather than assuming that firms can combine different sources of external knowledge, in this research we propose a theoretical model and confirm that firms use supplier involvement as a kind of knowledge input for establishing R&D collaboration with supporting organisations. Accordingly, the specialised knowledge provided by suppliers and the relational experience acquired in these relationships can be leveraged through both the bridging role that supporting organisations play and the scientific knowledge base they provide (Birou & Fawcett, 1994).

This paper has also provided interesting insights into the different aspects of NPD performance. While efficiency is more closely related to cost savings and a faster innovation process, effectiveness is oriented toward market requirements. While these two dimensions are closely related, they deal with different aspects that must be considered separately in any more refined evaluation of NPD. This has been revealed in this research, which confirms that supporting organisations increase NPD efficiency but not NPD effectiveness. While supplier involvement improves R&D collaboration with supporting organisations, this effect is reflected in higher efficiency. In contrast, it seems that differences in the objectives, timeframes and commercial aims of the firm and the supporting organisations are stronger than the benefits for effectiveness associated with supplier involvement.

Managers can extract interesting insights from this research. In particular, two main implications can be drawn for practitioners: first, managers should prioritise the kind of

relationships they establish with different external sources of knowledge. Rather than developing alliances with multiple agents, it seems better to adopt a model whereby firms learn from their relationships with suppliers and move on to R&D collaboration with supporting organisations as a way of achieving better innovation performance. Secondly, managers should consider what their main target is with their NPD strategy. The optimal partnership strategy will depend on whether they are searching for cost savings and a shorter time to market or instead are looking for greater adaptation to market needs.

Academics can also benefit from this research and its limitations can be seen as opportunities for future research. In our analysis, despite using different periods, in terms of the number of years, for each type of variable (independent and dependent variables), time lags are not fully considered since we use cross-sectional data. Based on the results of this research, it would be interesting to develop a future study examining possible lagged effects to capture sequential processes in detail as this would eliminate some problems relating to simultaneity.

In this study we highlight the importance of supporting organisations through their bridging role. Nevertheless, we do not differentiate between the different kinds of supporting organisation, such as research institutes, universities, and/or technical consultants. Future research could consider these separately to refine the results, identifying the role each kind of supporting organisation plays in the NPD performance dimensions, with special mention of universities for their important role in technological and business innovation because they can serve as an innovation ecosystem orchestrator (Heaton et al., 2019). Creating a model with more indirect effects, that is a multiple mediator model, might overcome some problems arising from applying a simple mediation analysis with only one mediator, an assumption that oversimplifies the issue studied (Hayes, 2018; Kline, 2015).

Moreover, the effect of supporting organisations is based on the argument that they play a bridging role connecting different sources of knowledge. Future studies could evaluate whether each kind of supporting organisation plays a different bridging role, as they could play a connector role with other supporting organisations, open the firm up to new partners through a gatekeeping role or play a more miscellaneous role, connecting a great diversity of partners (Belso-Martínez et al., 2018). This consideration may be useful in order to properly understand the bridging role played by supporting organisations in knowledge transfer processes, taking into account that technology transfer includes multiple parties with multiple goals and multiple effectiveness criteria (Bozeman et al., 2015). In addition, it would be interesting to differentiate between research-based institutions, such as laboratories and universities, and those trade associations more focused on commercialisation and regulation.

This study focuses on the extent of supplier involvement, but the timing of supplier involvement may be another interesting aspect, examining how early on in the process this occurs. We have also not considered the exact phases of the product development process in which a supplier is involved (Suurmond et al., 2020). More work on this issue could further clarify the complex innovation process involved when firms interact with different external agents, as in the case being analysed, focusing on several possible supplier involvement points.

Finally, contradictory findings in the literature could be due to different collaboration characteristics. Thus, paying specific attention to dynamic collaboration patterns arising from the persistence or interruption of such collaborations might provide important information and details on their potential different consequences in NPD (Belderbos et al., 2015). Considerations of geographical proximity among organisations (Stojčić,

2021) could also add value to our model. All these issues might capture interesting nuances within the different inter-organisation collaborations proposed in this work.

Appendix

Measures, reliabilities, and factor loadings.

All measures are on 7-point Likert-type scales, ranging from strongly disagree to strongly agree.

Variable name and items	Factor loading
New product development-efficiency (dependent variable). Respondent: CEO ($\alpha = 0.826$)	
New or significantly improved products introduced by the firm during the last 3 years (2012–2014, inclusive) have been developed in response to our…	
1. Speed expectations	0.915
2. Cost expectations	0.916
New product development-effectiveness (dependent variable). Respondent: CEO ($\alpha = 0.753$)	
New or significantly improved products introduced by the firm during the last 3 years (2012–2014, inclusive) have…	
1. Been developed in response to our commercial expectations	0.727
2. Been more successful in the market than those developed by our competitors	0.828
3. Led us to increase our market share	0.882
Supplier involvement (independent variable). Respondent: Head of R&D ($\alpha = 0.862$)	
During the last five years (2010 to 2014, inclusive), to what extent do you agree with the following statements regarding your firm's external relationships?	
1. We partner with our suppliers to develop solutions	0.884
2. We improve product quality and design through our relationships with suppliers	0.907
3. We improve process design through our relationships with suppliers	0.866
R&D collaboration with supporting organisations (mediating variable). Respondent: Head of R&D ($\alpha = 0.955$)	
During the last 5 years (2010 to 2014, inclusive), to what extent do you agree with the following statements regarding your firm's external relationships?	
1. We partner with research institutes/universities/technical consultants to develop solutions	0.957
2. We improve product quality and design through our relationships with research institutes/universities/technical consultants	0.980
3. We improve process design through our relationships with research institutes/universities/technical consultants	0.938
Technological environmental dynamism (control variable). Respondent: CEO ($\alpha = 0.711$)	
Please, indicate the degree to which the following statements describe your firm's main competitive environment during the last 3 years (2012–2014, inclusive):	
1. The technology is changing rapidly	0.863
2. It is very difficult to forecast where the technologies will be in the next five years	0.766
3. Technological changes provide big opportunities	0.763

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References

Adler, P. S., & Kwon, S. (2002). Social capital: Prospects for a new concept. *Academy of Management Review, 27*(1), 17–40.

Ahuja, G. (2000). Collaboration networks, structural holes, and innovation: A longitudinal study. *Administrative Science Quarterly, 45*(3), 425–455.

Ahuja, G., Soda, G., & Zaheer, A. (2012). The genesis and dynamics of organizational networks. *Organization Science, 23*(2), 434–448.

Al-Laham, A., Amburgey, T. L., & Bates, K. (2008). The dynamics of research alliances: Examining the effect of alliance experience and partner characteristics on the speed of alliance entry in the biotech industry. *British Journal of Management, 19*(4), 343–364. https://doi.org/10.1111/j.1467-8551.2007.00553.x

Almeida, P., & Kogut, B. (1999). Localization of knowledge and the mobility of engineers in regional networks. *Management Science, 45*(7), 905–917. https://doi.org/10.1287/mnsc.45.7.905

Amara, N., & Landry, R. (2005). Sources of information as determinants of novelty of innovation in manufacturing firms: Evidence from the 1999 statistics Canada innovation survey. *Technovation, 25*(3), 245–259. https://doi.org/10.1016/S0166-4972(03)00113-5

Bäck, I., & Kohtamäki, M. (2016). Joint learning in innovative R&D collaboration. *Industry and Innovation, 23*(1), 62–86. https://doi.org/10.1080/13662716.2015.1123613

Bakouros, Y. L., Mardas, D. C., & Varsakelis, N. C. (2002). Science park, a high-tech fantasy? An analysis of the science parks of Greece. *Technovation, 22*(2), 123–128. https://doi.org/10.1016/S0166-4972(00)00087-0

Balland, P. A., Belso Martínez, J. A., & Morrison, A. (2016). The dynamics of technical and business knowledge networks in industrial clusters: Embeddedness, status or proximity? *Economic Geography, 92*(1), 35–60. https://doi.org/10.1080/00130095.2015.1094370

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management, 17*(1), 99–120. https://doi.org/10.1177/014920639101700108

Baum, J. A. C., Calabrese, T., & Silverman, B. S. (2000). Don't go it alone: Alliance network composition and startups' performance in Canadian biotechnology. *Strategic Management Journal, 21*(3), 267–294.

Belderbos, R., Carree, M., Lokshin, B., & Fernández Sastre, J. (2015). Inter-temporal patterns of R&D collaboration and innovative performance. *Journal of Technology Transfer, 40*(1), 123–137. https://doi.org/10.1007/s10961-014-9332-4

Belso-Martínez, J. A., Díez-Vial, I., López-Sánchez, M. J., & Mateu-Garcia, R. (2018). The brokerage role of supporting organizations inside clusters: How does it work? *European Planning Studies, 26*(4), 706–725. https://doi.org/10.1080/09654313.2017.1422482

Belso-Martinez, J. A., Molina-Morales, F. X., & Martínez-Cháfer, L. (2015). Contributions of brokerage roles to firms' innovation in a confectionery cluster. *Technology Analysis and Strategic Management, 27*(9), 1014–1030. https://doi.org/10.1080/09537325.2015.1045858

Birou, L. M., & Fawcett, S. E. (1994a). Supplier involvement in integrated product development. *International Journal of Physical Distribution & Logistics Management, 24*(5), 4–14.

Blonska, A., Storey, C., Rozemeijer, F., Wetzels, M., & de Ruyter, K. (2013). Decomposing the effect of supplier development on relationship benefits: The role of relational capital. *Industrial Marketing Management, 42*(8), 1295–1306.

Bozeman, B., Rimes, H., & Youtie, J. (2015). The evolving state-of-the-art in technology transfer research: Revisiting the contingent effectiveness model. *Research Policy, 44*(1), 34–49. https://doi.org/10.1016/j.respol.2014.06.008

Brown, S. L., & Eisenhardt, K. (1995). Product development: Past research, present findings, and future directions. *Academy of Management Review, 20*(2), 343–378.

Burt, R. S. (2001). Structural holes versus network structure as social capital. In N. Lin, K. S. Cook, & R. S. Burt (Eds.), *Social capital: Theory and research* (pp. 31–56). Transaction Publishers.

Chang, W., & Taylor, S. A. (2016). The effectiveness of customer participation in new product development: A meta-analysis. *Journal of Marketing, 80*(1), 47–64.

Chen, J., Chen, Y., & Vanhaverbeke, W. (2011). The influence of scope, depth, and orientation of external technology sources on the innovative performance of Chinese firms. *Technovation, 31*(8), 362–373. https://doi.org/10.1016/j.technovation.2011.03.002

Chiang, I. R., & Wu, S. J. (2016). Supplier involvement and contract design during new product development. *IEEE Transactions on Engineering Management, 63*(2), 248–258.

Claver-Cortés, E., Pertusa-Ortega, E. M., & Molina-Azorín, J. F. (2011). Estructura organizativa y resultado empresarial: Un análisis empírico del papel mediador de la estrategia. *Cuadernos De Economia y Direccion De La Empresa, 14*, 2–13.

Cruz-González, J., López-Sáez, P., & Navas-López, J. E. (2015). Absorbing knowledge from supply-chain, industry and science: The distinct moderating role of formal liaison devices on new product development and novelty. *Industrial Marketing Management, 47*, 75–85. https://doi.org/10.1016/j.indmarman.2015.02.036

Cunningham, J. A., & Link, A. N. (2014). Fostering university-industry R&D collaborations in European Union countries. *International Entrepreneurship and Management Journal, 11*(4), 849–860. https://doi.org/10.1007/s11365-014-0317-4

D'Este, P., Iammarino, S., Savona, M., & Tunzelmann, N. (2012). What hampers innovation? Revealed barriers versus deterring barriers. *Research Policy, 41*, 482–488.

De Luca, L. M., & Atuahene-gima, K. (2007). Market knowledge dimensions and examining the different routes to cross-functional collaboration: Product innovation performance. *Journal of Marketing, 71*(January), 95–112.

Decarolis, D. M., & Deeds, D. L. (1999). The impact of stocks and flows of organizational knowledge on firm performance: An empirical investigation of the biotechnology industry. *Strategic Management Journal, 20*(10), 953–968.

Deeds, D. L., Decarolis, D. M., & Coombs, J. (1999). Dynamic capabilities and new product development in high technology ventures: An empirical analysis of new biotechnology firms. *Journal of Business Venturing, 15*, 211–229.

Delgado-Verde, M., Martín-de Castro, G., Navas-López, J. E., & Cruz-González, J. (2013). Social capital, intellectual capital and product innovation. Empirical evidence on intensive technology manufacturing sectors. *Innovar-Journal of Administrative Sciences, 23*(50), 93–110.

Díez-Vial, I., & Fernández-Olmos, M. (2015). Knowledge spillovers in science and technology parks: How can firms benefit most? *Journal of Technology Transfer, 40*(1), 70–84. https://doi.org/10.1007/s10961-013-9329-4

Dyer, J. H., & Singh, H. (1998). The relational view: Cooperative strategy and sources of interorganizational competitive advantage. *Academy of Management Review, 23*(4), 660–679. https://doi.org/10.5465/AMR.1998.1255632

Ehls, D., Polier, S., & Herstatt, C. (2020). Reviewing the field of external knowledge search for innovation: Theoretical underpinnings and future (re-)search directions. *Journal of Product Innovation Management, 37*(5), 405–430. https://doi.org/10.1111/jpim.12549

Eurostat (2020). Statistics explained. Glossary: High-tech classification of manufacturing. *Industries*. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:High-tech_classification_of_manufacturing_industries

FECYT. (2016). *Estudios econométricos PITEC 2016: Restricciones financieras y el abandono de proyectos de innovación en las empresas españolas,*. Madrid.

Ferrara, M., Lamperti, F., & Mavilia, R. (2016). Looking for best performers: A pilot study towards the evaluation of science parks. *Scientometrics, 106*(2), 717–750. https://doi.org/10.1007/s11192-015-1804-2

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with un- observable variables and measurement error. *Journal of Marketing Research, 18*, 39–50.

Fritsch, M., & Franke, G. (2004). Innovation, regional knowledge spillovers and R&D cooperation. *Research Policy, 33*(2), 245–255. https://doi.org/10.1016/S0048-7333(03)00123-9

George, G., Zahra, S. A., & Wood, D. R. (2002). The effects of business-university alliances on innovative output and financial performance: A study of publicly traded biotechnology companies. *Journal of Business Venturing, 17*(6), 577–609. https://doi.org/10.1016/S0883-9026(01)00069-6

Giuliani, E. (2007). The selective nature of knowledge networks in clusters: Evidence from the wine industry. *Journal of Economic Geography, 7*(2), 139–168. https://doi.org/10.1093/jeg/lbl014

Grant, R. M. (1991). Grant_1991. *Knowledge and Strategy*, 3–24.

Grant, R. M. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal, 17*, 109–122. https://doi.org/10.2307/2486994

Grigouriou, K., & Rothaermel, F. T. (2017). Organizing for knowledge generation: Internal knowledge networks and the contingent effect of external knowledge sourcing. *Strategic Management Journal, 38*(1), 395–414. https://doi.org/10.1002/smj

Gulati, R. (1998). Alliances and Networks. *Strategic Management Journal, 19*, 293–317. https://doi.org/10.2307/3094067

Hayes, A. F. (2018). Partial, conditional, and moderated moderated mediation: Quantification, inference, and interpretation. *Communication Monographs, 85*(1), 4–40.

Heaton, S., Siegel, D. S., & Teece, D. J. (2019). Universities and innovation ecosystems: A dynamic capabilities perspective. *Industrial and Corporate Change, 28*(4), 921–939. https://doi.org/10.1093/icc/dtz038

Hervas-Oliver, J. L., Albors Garrigos, J., & Gil-Pechuan, I. (2011). Making sense of innovation by R&D and non-R&D innovators in low technology contexts: A forgotten lesson for policymakers. *Technovation, 31*(9), 427–446. https://doi.org/10.1016/j.technovation.2011.06.006

Hoegl, M., & Wagner, S. M. (2005). Buyer-supplier collaboration in product development projects. *Journal of management, 31*(4), 530–548. https://doi.org/10.1177/0149206304272291

Huikkola, T., Ylimäki, J., & Kohtamäki, M. (2013). Joint learning in R&D collaborations and the facilitating relational practices. *Industrial Marketing Management, 42*(7), 1167–1180. https://doi.org/10.1016/j.indmarman.2013.07.002

Inkpen, A. C., & Tsang, E. W. K. (2016). Reflections on the 2015 decade award: Social capital, networks, and knowledge transfer: An emergent stream of research. *Academy of Management Review, 41*(4), 573–588. https://doi.org/10.5465/amr.2016.0140

Jaworski, B. J., & Kohli, A. K. (1993). Market orientation: Antecedents and consequences. *Journal of Marketing, 57*, 53–70.

Johnsen, T. E. (2009). Supplier involvement in new product development and innovation: Taking stock and looking to the future. *Journal of Purchasing and Supply Management, 15*(3), 187–197. https://doi.org/10.1016/j.pursup.2009.03.008

Katila, R., & Ahuja, G. (2002). Something old, something new: A longitudinal study of search behavior and new product introduction. *The Academy of Management Journal, 45*(6), 1183–1194.

Kaufmann, A., & Tödtling, F. (2001). Science-industry interaction in the process of innovation: The importance of boundary-crossing between systems. *Research Policy, 30*(5), 791–804. https://doi.org/10.1016/S0048-7333(00)00118-9

Kline, R. B. (2015). The mediation myth. *Basic and Applied Social Psychology, 37*(4), 202–213. https://doi.org/10.1080/01973533.2015.1049349

Kogut, B., & Zander, U. (1992). Knowledge of the firm, combinative capabilities, and the replication of technology. *Organization Science, 3*(3), 383–397.

Kotabe, M., Martin, X., & Domoto, H. (2003). Gaining from vertical partnerships: Knowledge transfer, relationship duration, and supplier performance improvement in the U.S. and Japanese automotive industries. *Strategic Management Journal, 24*, 293–316.

Koufteros, X., Vonderembse, M., & Jayaram, J. (2005). Internal and external integration for product development: The contingency effects of uncertainty, equivocality, and platform strategy. *Decision Sciences, 36*(1), 97–133. https://doi.org/10.1111/j.1540-5915.2005.00067.x

Krause, D. R., Handfield, R. B., & Tyler, B. B. (2007). The relationships between supplier development, commitment, social capital accumulation and performance improvement. *Journal of Operations Management, 25*, 528–545.

Kwon, S. W., Rondi, E., Levin, D. Z. Z., De Massis, A., & Brass, D. J. (2020). Network brokerage: An integrative review and future research agenda. *Journal of Management, 46*(6), 1–104.

Lambooy, J. G. (2004). The transmission of knowledge, emerging networks, and the role of universities: An evolutionary approach. *European Planning Studies, 12*(5), 643–657. https://doi.org/10.1080/09654310420000219996

Laursen, K. (2012). Keep searching and you'llfind: What do we know about variety creation through firms' search activities for innovation? *Industrial and Corporate Change, 21*, 1181–1220.

Laursen, Keld, & Salter, A. (2006). Open for innovation: The role of openness in explaining innovation performance among U.K. manufacturing firms. *Strategic Management Journal, 27*(2), 131–150. https://doi.org/10.1002/smj.507

Levinthal, D. A., & March, J. G. (1993). The myopia of learning. *Strategic Management Journal, 14*(2S), 95–112. https://doi.org/10.1002/smj.4250141009

Liu, Y., Wang, L., Yuan, C., & Li, Y. (2012). Information communication, organizational capability and new product development: An empirical study of Chinese firms. *The Journal of Technology Transfer, 37*, 416–432.

Löfsten, H., & Lindelöf, P. (2005). R&D networks and product innovation patterns—academic and non-academic new technology-based firms on science parks. *Technovation, 25*, 1025–1037. https://doi.org/10.1016/j.technovation.2004.02.007

McEvily, B., & Zaheer, A. (1999). Bridging ties: A source of firm heterogeneity in competitive capabilities. *Strategic Management Journal, 20*(12), 1133–1156. https://doi.org/10.1002/(SICI)1097-0266(199912)20:12%3c1133::AID-SMJ74%3e3.3.CO;2-Z

McNamara, P., & Baden-Fuller, C. (2007). Shareholder returns and the exploration-exploitation dilemma: R&D announcements by biotechnology firms. *Research Policy, 36*(4), 548–565. https://doi.org/10.1016/j.respol.2007.02.012

Morrison, A., & Rabellotti, R. (2009). Knowledge and information networks in an Italian wine cluster. *European Planning Studies, 17*(7), 983–1006. https://doi.org/10.1080/09654310902949265

Mosey, S., Lockett, A., & Westhead, P. (2006). Creating network bridges for university technology transfer: The medici fellowship programme. *Technology Analysis and Strategic Management, 18*(1), 71–91. https://doi.org/10.1080/09537320500520635

Nahapiet, J., & Ghoshal, S. (1998). Social Capital, Intellectual Capital, and the organizational advantage. *Academy of Management Review, 23*(2), 242–266. https://doi.org/10.2307/259373

Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization Science, 5*(1), 14–37.

O'Dwyer, M., Filieri, R., & O'Malley, L. (2022). Establishing successful university–industry collaborations: Barriers and enablers deconstructed. *Journal of Technology Transfer*, *Online*.

Oliver, A. L. (2004). Biotechnology entrepreneurial scientists and their collaborations. *Research Policy, 33*(4), 583–597. https://doi.org/10.1016/j.respol.2004.01.010

Perols, J., Zimmermann, C., Kortmann, S. (2013). On the relationship between supplier integration and time-to-market. *Journal ofOperations Management, 31*(3), 153–167. https://doi.org/10.1016/j.jom.2012.11.002

Phelps, C., Heidl, R., & Wadhwa, A. (2012). Knowledge, networks, and knowledge networks: A review and research agenda. *Journal of Management, 38*(4), 1115–1166. https://doi.org/10.1177/0149206311432640

Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y.Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology, 88*(5), 879–890. https://doi.org/10.1037/0021-9010.88.5.879

Poppo, L., & Zenger, T. R. (2002). Do formal contracts and relational governance function as substitutes or complements? *Strategic Management Journal, 23*(8), 707–725. https://doi.org/10.1002/smj.249

Powell, W. W., Koput, K. W., & Smith-Doerr, L. (1996). Interorganizational and the collaboration locus of innovation: Networks of learning in Biotechnology. *Administrative Science Quarterly, 41*(1), 116–145.

Praest Knudsen, M., & Bøtker Mortensen, T. (2011). Some immediate but negative effects of openness on product development performance. *Technovation, 31*(1), 54–64. https://doi.org/10.1016/j.technovation.2010.07.002

Primo, M. A. M., & Amundson, S. D. (2002). An exploratory study of the effects of supplier relationships on new product development outcomes. *Journal of Operations Management, 20*(1), 33–52. https://doi.org/10.1016/S0272-6963(01)00080-8

Ragatz, G. L., Handfield, R. B., & Petersen, K. J. (2002). Benefits associated with supplier integration into new product development under conditions of technology uncertainty. *Journal of Business Research, 55*(5), 389–400. https://doi.org/10.1016/S0148-2963(00)00158-2

Reed, K. K., Lubatkin, M., & Srinivasan, N. (2006). Proposing and testing an Intellectual Capital-Based View of the firm. *Journal of Management Studies, 43*(4), 867–892.

Rothaermel, F. T., & Deeds, D. L. (2004). Exploration and exploitation alliances in biotechnology: A system of new product development. *Strategic Management Journal, 25*(3), 201–221. https://doi.org/10.1002/smj.376

Rubin, T. H., Tor Helge Aas, Stead, A. (2015). Knowledge flow in Technological Business Incubators: Evidence from Australia and Israel. *Technovation, 41–42*, 11–24. https://doi.org/10.1016/j.technovation.2015.03.002

Rungtusanatham, M., Miller, J. W., & Boyer, K. K. (2014). Theorizing, testing, and concluding for mediation in SCM research: Tutorial and procedural recommendations. *Journal of Operations Management, 32*(3), 99–113. https://doi.org/10.1016/j.jom.2014.01.002

Soetanto, D., & van Geenhuizen, M. (2015).Getting the right balance: University networks' influence on spin-offs' attraction of funding for innovation. *Technovation, 36–37*, 26–38. https://doi.org/10.1016/j.technovation.2014.10.008

Santos, F. M., & Eisenhardt, K. M. (2005). Organizational boundaries and theories of organization. *Organization Science, 16*(5), 491–508. https://doi.org/10.1287/orsc.1050.0152

Selnes, F., & Sallis, J. (2003). Promoting relationship learning. *Journal of Marketing, 67*(3), 80–95.

Shakeri, R., & Radfar, R. (2017). Antecedents of strategic alliances performance in biopharmaceutical industry: A comprehensive model. *Technological Forecasting and Social Change, 122*, 289–302. https://doi.org/10.1016/j.techfore.2016.01.003

Soda, G., Usai, A., & Zaheer, A. (2004). Network memory: The influence of past and current networks on performance. *Academy of Management Journal, 47*(6), 893–906.

Sofka, W., & Grimpe, C. (2010). Specialized search and innovation performance - evidence across Europe. *R and D Management, 40*(3), 310–323. https://doi.org/10.1111/j.1467-9310.2010.00592.x

Song, M., & Di Benedetto, C. A. (2008). Supplier's involvement and success of radical new product development in new ventures. *Journal of Operations Management, 26*(1), 1–22. https://doi.org/10.1016/j.jom.2007.06.001

Stam, W. (2010). Industry event participation and network brokerage among entrepreneurial ventures. *Journal of Management Studies, 47*(June), 625–653. https://doi.org/10.1111/j.1467-6486.2010.00909.x

Stojčić, N. (2021). Collaborative innovation in emerging innovation systems: Evidence from Central and Eastern Europe. *Journal of Technology Transfer*. https://doi.org/10.1007/s10961-020-09792-8

Stuart, T. E., Ozdemir, S. Z., & Ding, W. W. (2007). Vertical alliance networks: The case of university-biotechnology-pharmaceutical alliance chains. *Research Policy, 36*(4), 477–498. https://doi.org/10.1016/j.respol.2007.02.016

Subramaniam, M., & Youndt, M. A. (2005). The influence of intellectual capital on the types of innovative capabilities. *Academy of Management Journal, 48*(3), 450–463.

Suurmond, R., Wynstra, F., & Dul, J. (2020). Unraveling the dimensions of supplier involvement and their effects on NPD Performance: A meta-analysis. *Journal of Supply Chain Management, 56*(3), 26–46. https://doi.org/10.1111/jscm.12221

Swan, J. A., & Newell, S. (1995). The role of professional associations in technology diffusion. *Organization Studies, 16*(5), 847–874.

Takeishi, A. (2001). Bridging inter- and intra-firm boundaries: Management of supplier involvement in automobile product development. *Strategic Management Journal, 22*(5), 403–433. https://doi.org/10.1002/smj.164

Teece, D. J. (1986). Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research Policy, 15*(6), 285–305.

Teece, D., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal, 18*, 509–533.

Thomas, E. (2013). Supplier integration in new product development: Computer mediated communication, knowledge exchange and buyer performance. *Industrial Marketing Management, 42*(6), 890–899. https://doi.org/10.1016/j.indmarman.2013.05.018

Tödtling, F., Lehner, P., & Kaufmann, A. (2009). Do different types of innovation rely on specific kinds of knowledge interactions? *Technovation, 29*(1), 59–71. https://doi.org/10.1016/j.technovation.2008.05.002

Un, C. A., Cuervo-Cazurra, A., & Asakawa, K. (2010). R&D collaborations and product innovation. *Journal of Product Innovation Management, 27*(5), 673–689. https://doi.org/10.1111/j.1540-5885.2010.00744.x

Vázquez-Carrasco, R., Barge-Gil, A., & Rico, A. M. (2016). Science and technology parks and cooperation for innovation: Empirical evidence from Spain. *Research Policy, 45*(1), 137–147. https://doi.org/10.1227/01.NEU.0000349921.14519.2A

Voudouris, I., Lioukas, S., Iatrelli, M., & Caloghirou, Y. (2012). Effectiveness of technology investment: Impact of internal technological capability, networking and investment's strategic importance. *Technovation, 32*, 400–414.

Wagner, S. M. (2010). Supplier traits for better customer firm innovation performance. *Industrial Marketing Management, 39*(7), 1139–1149. https://doi.org/10.1016/j.indmarman.2009.12.001
Wernerfelt, B. (1984). The resource-based view of the firm. *Strategic Management Journal, 5*(1), 171–180. https://doi.org/10.1177/1056492611436225
West, J., & Bogers, M. (2014). Leveraging external sources of innovation: A review ofresearch on open innovation. *Journnal of Product Innovation Management, 31*, 814–831.
Westhead, P. (1997). R&D "inputs" and "outputs" of technology-based firms located on and off Science Parks. *R&D Management, 27*(1), 45–62. https://doi.org/10.1111/1467-9310.00041
Xia, T. (2013). Absorptive capacity and openness of small biopharmaceutical firms - a European Union-United States comparison. *R&D Management, 43*(4), 333–351. https://doi.org/10.1111/radm.12017
Xia, T., & Dimov, D. (2017). Alliances and survival of new biopharmaceutical ventures in the wake of the global financial crisis. *Journal of Small Business Management, 00*(00), 1–24. https://doi.org/10.1111/jsbm.12331
Yan, T., & Dooley, K. J. (2013). Communication intensity, goal congruence, and uncertainty in buyer-supplier new product development. *Journal of Operations Management, 31*(7–8), 523–542. https://doi.org/10.1016/j.jom.2013.10.001
Yeniyurt, S., Henke, J. W., & Yalcinkaya, G. (2014). A longitudinal analysis of supplier involvement in buyers' new product development: Working relations, inter-dependence, co-innovation, and performance outcomes. *Journal of the Academy of Marketing Science, 42*(3), 291–308. https://doi.org/10.1007/s11747-013-0360-7
Youndt, M. A., Subramaniam, M., & Snell, S. A. (2004). Intellectual capital profiles: An examination of investments and returns. *Journal of Management Studies, 41*(2), 335–361.
Zaheer, A., & George, G. (2002). Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review, 27*(2), 185–203.
Zahra, S. A., & Bogner, W. C. (2000). Technology strategy and software new ventures' performance: Exploring the moderating effect of the competitive environment. *Journal of Business Venturing, 15*, 135–173.