Cuervo-Cazurra, A., Nieto, M. J. & Rodríguez, A. (2018). The impact of R&D sources on new product development: Sources of funds and the diversity versus control of knowledge debate. *Long Range Planning, 51*(5), 649–665.

DOI: 10.1016/j.lrp.2017.06.004

THE IMPACT OF R&D SOURCES ON NEW PRODUCT DEVELOPMENT: SOURCES OF FUNDS AND THE DIVERSITY VERSUS CONTROL DEBATE *

Alvaro CUERVO-CAZURRA[1]
Northeastern University, D'Amore-McKim School of Business
360 Huntington Avenue, Boston, MA 02115, USA
Phone: 1-617-373-6568, Fax: 1-617-373-8628, email: a.cuervocazurra@neu.edu

María Jesús NIETO
University Carlos III of Madrid, Business Management Division,
C/ Madrid, 126. 28903 Getafe (Madrid), Spain
Phone: +34 916245826, Fax: +34 916245707, mnieto@emp.uc3m.es

Alicia RODRÍGUEZ
University Carlos III of Madrid, Business Management Division,
C/ Madrid, 126. 28903 Getafe (Madrid), Spain
Phone: +34 916245822, Fax: +34 916245707, alicia.rodriguez@uc3m.es

Long Range Planning

[1] * Authors appear in alphabetical order. We thank Tina Ambos, anonymous reviewers, and participants at the European International Business Academy annual meeting for useful suggestions for improvement. We thank the National Statistics Institute, the Science and Technology Foundation, and the Foundation for Technical Innovation of Spain for access to the database. This project was funded by the Ministry of Economy and Competitiveness (ECO2015-67296-R, MINECO/FEDER, UE),) and the Community of Madrid and the European Social Fund (S2015/HUM-3417, INNCOMCON-CM). Cuervo-Cazurra thanks the Walsh Research Professorship and the Robert Morrison Fellowship for financial support. Rodríguez thanks Ramón Areces Foundation for financial support.

[1] Corresponding author

THE IMPACT OF R&D SOURCES ON NEW PRODUCT DEVELOPMENT: SOURCES OF FUNDS AND THE DIVERSITY VERSUS CONTROL DEBATE

Abstract:

We build on the knowledge-based view to study the relative impact of alternative sources of R&D on innovation performance. We contrast two arguments: One is that diversity of knowledge is better for innovation, because the integration of a larger variety of knowledge helps create new products that can fulfill unmet customer needs; another is that control of knowledge is better, because the incentive and contextual system of the firm facilitates employees' experimentation, which leads to novel products. We clarify this debate by contrasting both arguments and arguing that their relative importance depends on the sources of finance to fund innovation. We find that in general control is relatively better than diversity for the sale of new products. However, we also find that alternative sources of finance moderate the relationships: internal funds strengthen the impact of R&D sources with more knowledge diversity on the sale of new products, while the use of external funds strengthens the impact of R&D sources with more knowledge control on the sale of new products.

Keywords: R&D, innovation, outsourcing, offshoring, finance.

INTRODUCTION

In innovation studies, there is a stream of research that has focused on studying the effects of internal and external R&D, within the country or across countries, on innovation (for a recent discussion see Contractor *et al*., 2010; Hsuan and Mahnke, 2011; West et al, 2014). For example, some studies focus on contrasting the effects of onshore insourcing and outsourcing R&D on new product sales (Berchicci, 2013; Grimpe and Kaiser, 2010), offshore insourcing and outsourcing R&D on product and process innovation (Nieto and Rodríguez, 2011), or onshore and offshore outsourcing R&D on innovation results (Bertrand and Mol, 2013). This discussion has accompanied the increase in the use of outsourced R&D to enhance innovativeness by firms, with companies relying on others for specialized R&D, such as pharmaceutical firms relying on biotechnology companies or automobile firms relying on component suppliers for advanced R&D. However, although important and increasingly being used, it is not clear how managers can choose among the alternatives to ensure a higher likelihood of success. Most studies have analyzed a few alternatives at a time but not all of them jointly (Berchicci, 2013; Bertrand and Mol, 2013; Cassiman and Veugelers, 2006; Grimpe and Kaiser, 2010; Nieto and Rodríguez, 2011), while managers have limited budgets and thus may want to know which of the different R&D investments may be relatively better than others.

Hence, in this paper, we extend previous studies by addressing the debate on the selection among R&D sources in terms of the knowledge diversity versus control they provide and their ultimate impact on innovation performance. Specifically, we identify four types of R&D activities by their ownership (insourcing versus outsourcing) and by their location (onshore versus offshore): onshore insourcing, onshore outsourcing, offshore insourcing, and offshore outsourcing. Each of these options gives the company a different degree and combination of diversity and control of knowledge, and thus each is expected to have a different impact on innovation performance. Building on previous studies on R&D sources (Frenz and Ietto-Gillies, 2009; Garriga, Van Krogh, and Spaeth, 2013; Laursen and Salter, 2006; Monteiro, Mol, and Birkinshaw, 2016), we analyze two arguments about R&D sources and their impact on innovation. One argument builds on the idea that diversity of knowledge is good for knowledge creation (Almeida and Phene, 2004; Hayek, 1945; Tsoukas, 1996). Sources of knowledge that are more diverse and different provide the firm with knowledge it lacks and can help it innovate (Chesbrough, 2003; Rodan and Galunic, 2004; van Beers and Zand, 2014). Thus, sources of R&D which can potentially provide the greatest knowledge diversity (outsourced and offshore) should help the firm the most in new products. The other argument builds on the idea that the control exercised within the firm enables it to better combine and transfer complex knowledge across operations and countries (Kogut and Zander, 1992, 1993; Szulanski, 1996). Controls can encourage the creation of knowledge to innovate (Cardinal, 2001; Rijsdijk and van den End, 2011). Following this logic, sources of R&D that are under the greatest control within the firm (insourced and onshore) should help it the most in creating novel knowledge and increasing new product development.

Additionally, we advance this debate by arguing that the type of finance source the company uses fund innovation activities alters the relationship between R&D sources and innovation. Previous studies have analyzed the role of finance in innovation (Greve, 2003; Hall and Lerner, 2010; Hall *et al.*, 2016; Monteiro *et al.*, 2016; among others), especially the effects of the availability of financial resources on innovation (Himmelberg and Petersen, 1994; Hottenrott and Peters, 2012; Mohnen *et al.*, 2008; Monteiro *et al.*, 2016; Savignac, 2008). Building on these studies, we differentiate between internal and external sources of finance and analyze how these sources of funds influence the previous relationship. Specifically, we propose that the use of internal funds strengthens the impact of R&D sources with more diversity of knowledge on innovation, because internal funds provide managers with more leeway and flexibility to undertake riskier and more challenging innovation projects that have more diverse external knowledge. We also propose that, in contrast, the use of external funds for innovation strengthens the impact of R&D sources with more control of knowledge on innovation, because external funds create pressures for undertaking innovation projects that are less risky and have lower uncertainty.

We test these ideas using a sample of 8,359 manufacturing and services firms in Spain in the period 2004-2007. We find that, in general terms, control is relatively better than diversity for innovation, because onshore insourcing R&D has the highest impact on the sale of new products, followed by onshore outsourcing and offshore insourcing; offshore outsourcing R&D does not appear to affect the sale of new products in comparison to other sources of R&D. We also find that the source of finance modifies these relationships. Specifically, we find that internal funds weaken the relationship between onshore insourcing R&D and onshore outsourcing R&D and innovation, while external funds strengthen the relationship between onshore insourcing R&D and innovation performance.

Our study makes two contributions. First, from a theoretical viewpoint, we contribute to the literature that has studied R&D sources by analyzing the consequences on innovation performance of four types of R&D sources jointly. Much of the literature has focused on analyzing the determinants of the selection among the four alternatives (e.g., Kedia and Mukherjee, 2009; Mudambi, 2008; Poppo and Zenger, 1998) rather than analyzing how the four alternatives affect innovation performance. We go beyond the analysis of one or two sources at a time, which has been done in previous studies (Berchicci, 2013; Bertrand and Mol, 2013; Cassiman and Veugelers, 2006; Grimpe and Kaiser, 2010; Nieto and Rodríguez, 2011), and provide a relative comparison of the four alternatives, ranking them according to their relative contribution to innovation driven by diversity and control.

Second, we contribute to clarifying the debate on the relative importance of control and diversity to achieve innovation by arguing and explaining how funding sources moderate the impact of R&D sources on innovation outcomes. This deepens our understanding of the interaction between finance and innovation by going beyond the direct impact of access to funds on innovation (Hall *et* *al.*, 2016; Honttenrott and Peters, 2012) and looking at finance as a potential moderator of the relationship between sources of knowledge and innovation performance (Monteiro *et al.*, 2016). Distinguishing sources of finance by their type becomes an important moderation, as they alter the general relationship between sources of funds and innovation performance.

These ideas are particularly important for managers. Firms have a limited budget to conduct R&D and thus managers can benefit from knowing which type of R&D source would be relatively better for innovation performance to decide the amount allocated to each source, rather than simply knowing whether to invest in a particular R&D source or not. Here we provide an explanation of not only the different impact of the alternative sources of R&D on innovation, but also a discussion of how the availability of particular types of funds in the firm influences the relationships.

THEORETICAL FRAMEWORK

The literature analyzing sources of R&D can be organized in terms of two main decisions: the ownership decision of who undertakes the R&D activities and the location decision of where the R&D activities take place. In terms of ownership, a firm will decide between performing the R&D activities itself or subcontracting them (i.e. the question of who carries out R&D production). In terms of location, a firm will decide between developing R&D activities in the home country or in a foreign country (i.e. the question of where R&D production takes place). The combination of these two dimensions results in four alternative R&D sources in which to invest, each providing different benefits and costs: onshore insourcing R&D, when the firm invests in R&D in its own facility in its home country; offshore insourcing R&D, when the firm invests in R&D in its own facility in a foreign country; onshore outsourcing R&D, when the firm purchases R&D services from another firm in its home country; and offshore outsourcing R&D, when the firm purchases R&D services from another firm in a foreign country.

This classification of activities into ownership and location has resulted into two main research streams and an emerging one connecting them. One research stream analyzes the ownership decision. Within this large stream, studies have analyzed internal and external R&D activities (Arora, Belenzon, and Rios, 2014; Chesbrough, 2003; Hsuan and Mahnke, 2011; Narula, 2001; Veugelers and Cassiman, 1999), reflecting a shift of the dominant logic of R&D away from internal and toward external engagement (West *et al.,* 2014). Studies that compare the different choices simply analyze the effects of insourcing versus outsourcing on a measure of firm performance (e.g., Grimpe and Kaiser, 2010; Mata and Woerter, 2013). These comparative studies of internal versus external R&D sources find that both are useful for explaining innovation performance (Berchicci, 2013; Frenz and Ietto-Gillies, 2009), although firms need to balance them to optimize the benefits (Cassiman and Veugelers, 2006; Grimpe and Kaiser, 2010).

Another research stream studies the location decision. This stream analyzes the costs and benefits (or pains and gains) of performing R&D activities internationally. The emergence of R&D offshoring provided firms with additional sources of R&D, and simultaneously created a debate over the best option (Anderson and Pedersen, 2010; Bardhan, 2006; Contractor *et al*., 2010; Howells, 2008; Nieto and Rodríguez, 2011; Bertrand and Mol, 2013). This line of research has examined in detail decisions on R&D activities from the perspective of location (Ambos and Ambos, 2011; Jensen and Pedersen, 2011), weighing the benefits of offshore R&D activities.

The most advanced studies consider the two dimensions together (ownership and location), but even these studies only compare pairs of options. Thus, for R&D outsourcing options, Bertrand and Mol (2013) show that offshore R&D outsourcing leads to more positive innovation outcomes than onshore R&D outsourcing. And for R&D offshoring options, Nieto and Rodríguez (2011) reveal that internal (captive) offshoring has a greater effect on product and process innovation than offshore R&D outsourcing. Unfortunately, it is uncommon to find studies that offer a full picture of the relative impact of all four alternative R&D sources.

Our research makes it possible to go beyond previous work in this field by comparing the four available R&D sources and ranking them by diversity and control according to their contribution to innovation performance. We aim to shed light to the debate between diversity and control by providing a deep and nuanced explanation of the logic behind these two drivers. We then provide a solution to the debate by proposing that particular sources of finance strengthen the impact of one or the other R&D source alternatives. Figure 1 illustrates the relationships we analyze in the paper. In hypotheses 1a and 1b we propose to address the debate on the relative ranking of R&D sources in terms of their impact on innovation by their degree of diversity or control of knowledge, while in hypotheses 2a and 2b we propose that the sources of funds (internal and external) modify the influence of alternative R&D sources on innovation performance.

*** Insert Figure 1 about here ***

Diversity of knowledge and innovation

One strand of the literature argues that diversity of knowledge enables the firm to generate new knowledge and an associated competitive advantage (Grant and Baden-Fuller, 2004; Almeida and Phene, 2004). Knowledge is imperfectly distributed among individuals in the firm (Tsoukas, 1996), among individuals in a country (Hayek, 1945), and among countries (Cantwell and Santangelo, 1999; Kogut, 1991). The heterogeneity of knowledge facilitates new combinations and thus enhances the likelihood of development of new ideas, which then may become innovative products (Rodan and Galunic, 2004). To generate new knowledge, the company establishes the incentives and organizational procedures that induce individuals to create novel combinations of their knowledge and that of other individuals within and outside the firm (Kogut and Zander, 1992). The existence of barriers to the free flow of knowledge across companies (Szulanski, 1996) and across countries (Kogut, 1991; Teece, 1977) means that the firm has to actively invest in R&D to obtain the knowledge it lacks and create innovations. The organization of R&D activities with external sources allows the firm to benefit from the diversity of knowledge provided by these external sources (Chesbrough, 2003; Frenz and Ietto-Gilles, 2009). Additionally, the firm may access diverse sets of innovation inputs across its operations from a variety of country locations and take advantage of the diversity of international knowledge (Berry, 2014; Bertrand and Mol, 2013; Phene, Faldmoe-Lindquist, and Marsh, 2006). Consequently, the firm's R&D decisions in terms of ownership (insourcing versus outsourcing) and location (onshore versus offshore) determine the degree of diversity of knowledge that the firm can access.

Focusing on the ownership dimension, the firm can increase its knowledge base by subcontracting R&D to other companies or institutions (Berchicci, 2013; Chesbrough, 2003; Hsuan and Mahnke, 2011). This does not mean that the firm will stop undertaking internal R&D; it needs to do the latter in order to be able to understand and incorporate external knowledge (Chatterji, 1996; Cohen and Levinthal, 1989). What it means is that the company has access to a richer picture of different actors working together, obtaining from other firms some knowledge it lacks (Laursen and Salter, 2006), and thus increasing its technological base to better adapt to changes in the environment (Nagarajan and Mitchell, 1998) and bridge technological gaps (Nieto and Santamaria, 2010). As most innovation requires a mixing of resources, ideas, and technologies in novel ways, a productive innovation environment requires the constant flow of knowledge from other places (Fey and Birkinshaw, 2005). In this sense, a company that subcontracts R&D to other firms would increase its diversity of knowledge sources, because the contractor is likely to work with other companies and to have access to different knowledge sources. This would help the firm improve the probability that it can create innovations from this extended knowledge base (e.g., Cassiman, Di Guardo, and Valentini, 2009; Pisano, 1990; Vega-Jurado *et al*., 2009), and hence improve its innovation performance.

Alternatively, looking at the location dimension, the firm can access the knowledge base of individuals and organizations in other countries and increase its diversity of knowledge by offshoring R&D (Nieto and Rodríguez, 2011). Countries have diverse institutions and systems that support different innovation systems (Edquist, 2005; Freeman, 1995). As a result, countries differ markedly in terms of knowledge profiles and the innovativeness of their firms (Furman, Porter, and Stern, 2002). This is helpful for firms that decide to offshore their R&D activities to augment their current stock of knowledge (Florida, 1997; Kuemmerle, 1999; Manning *et al.,* 2008; Lewin *et al.*, 2009). Knowledge exchanges with the host country allow the firm to access new knowledge combinations due to the different approaches, histories, and varieties of experience and competence of firms in the region (Almeida and Phene, 2004). Thus, firms that offshore gain access to highly qualified personnel (Kedia and Mukherjee, 2009; Lewin *et al*., 2009), create transnational teams that enable the firm to obtain and apply knowledge more effectively (Hass, 2006), and gain access to new knowledge and technology (Maskell *et al*., 2007). Therefore, a firm that accesses this diversity of knowledge across locations can generate more innovations by benefitting from worldwide learning (Bartlett and Ghoshal, 1989; Doz, Santos, and Williamson, 2001). This diversity of knowledge helps the firm innovate and improve its innovation performance (Almeida and Phene, 2004).

We summarize these arguments that diversity is better for new product development in the following hypothesis.

Hypothesis 1a (diversity): Offshore outsourcing has the highest positive impact on the sale of new products, followed by offshore insourcing, onshore outsourcing, and onshore insourcing.

Control of knowledge and innovation

Another strand of the literature argues that control is better for innovation. The firm can be viewed as an instrument that facilitates the creation and transfer of knowledge in ways that cannot be achieved in the market by providing the incentives and infrastructure needed to transfer and combine knowledge and generate new knowledge (Kogut and Zander, 1992). The use of controls enables managers to direct attention and motivate and encourage individuals to act to meet the firm's objectives (Eisenhardt, 1985) and thus allows the firm to benefit from its knowledge creation activities (Turner and Makhija, 2006). In this sense, a firm is viewed as being superior to the market in facilitating the creation of knowledge (Kogut and Zander, 1992) and the transfer of knowledge across countries (Kogut and Zander, 1993). Most studies in this research stream have focused on studying whether firms or markets are better at knowledge transfer (Almeida, Song, and Grant, 2002) or analyzing how firms manage the transfer of knowledge across subsidiaries and countries (Szulanski, 1996; Szulanski and Jensen, 2006). The controls that the firm can establish are stronger within than outside the organization, and within than outside the country (Kogut and Zander, 1993). Thus, when selecting among sources of R&D, the firm focuses on the establishment of controls that enable it to have exclusive access and use of knowledge; these controls help the firm create unique innovations that differentiate it from competitors (Cardinal, 2001). As above, we analyze differences in terms of ownership and location and how these facilitate control and innovation.

First, looking at the ownership dimension, the firm can establish stronger controls that facilitate the creation, transfer, and use of knowledge in an R&D facility within the firm than it can in an R&D facility in another firm. Three mechanisms explain this. The first mechanism is the increased flexibility in decision-making within the firm. For a manager, it is easier to specify and modify controls and monitoring systems within the company because the employment contract is highly flexible in terms of what the manager and workers agree to do (Conner and Prahalad, 1996); if an unclear or unspecified situation arises, the manager can easily create a new rule. In contrast, it is more difficult to create new rules when the manager is dealing with another firm from which it subcontracts R&D. The contract may specify rules and ways to solve problems, but rarely gives the manager power to decide; instead it may refer the manager and subcontractor to a renegotiation of the contract. Consequently, tacitness, complexity, systemic relationships, and plain secrecy are easier to manage within the company because managers have more control over the employment relationships with workers in the firm (Kogut and Zander, 1992, 1996). The second mechanism is compensation systems in which final outcomes are not the only determinant of rewards; these enable individuals to risk failure by exploring new ideas and concepts. An organizational climate (Ashkanasy, Wilderom, and Peterson, 2000) that supports risk taking increases the knowledge creation capability (Smith, Collins, and Clark, 2005). Innovation results are difficult to establish a priori and there is no specific path to success for innovation. When employees undertake R&D

activities, it is very common to face high levels of uncertainty. For this reason, individuals need to experiment with different combinations of knowledge, some of which may not succeed, and not be afraid of failure. Moreover, the failures created are a form of knowledge on their own and thus can help the firm better focus additional R&D efforts as it learns which avenues are unsuccessful. Thus, the incentives for long-term efforts existing inside the firm can help employees explore and create knowledge; this contrasts with the high-powered incentives typical of subcontractual relationships in which the subcontractor only gets paid for results rather than for effort (Milgrom and Roberts, 1992). The third mechanism is the socialization process inside the firm, which facilitates the communication and integration of knowledge in a more efficient manner. The existence of a common language within the company facilitates interaction, information, and knowledge transfer between individuals and groups (Szulanki, 1996), and thus the combination and creation of knowledge. Long-term relationships that exist within the company facilitate the establishment of a shared common code and thus result in greater learning and knowledge creation (Smith, Collins, and Clark, 2005). Moreover, the use of organizational controls can be particularly relevant for novel innovation (Cardinal, 2001).

Second, focusing on the location dimension, a manager is better able to establish controls to create and manage knowledge in R&D activities within the same country than across countries with different cultures and languages. Employees are influenced by organizational and professional cultures that differ across countries (Teixeira, Santos, and Oliveira-Brochado, 2008; O'Leary and Cummings, 2007). Culture and language differences hinder communication and lead to poor results (Metters, 2008). Even if individuals know a common language well, cultural frictions in the form of subtle differences in cultural expectations and assumptions may interfere with the transfer of knowledge (Stringfellow *et al.,* 2008). In addition to these usual country differences, other barriers limit the transfer of knowledge across countries (Kogut, 1991). For example, institutions also create barriers to benefitting from R&D offshoring. The company knows the legal and contractual systems of its home country better and can more easily design contracts that give incentives to providers to create and protect the knowledge. However, when performing R&D across countries, the firm faces a different legal system. In some countries the protection of intellectual property is limited, thus inducing the firm to rely more on within-company controls (Zhao, 2006). Moreover, the foreign firm may be subjected to discrimination in the court system that limits its ability to benefit from operating across borders (Mezias, 2002).

We summarize these arguments that control is better for product innovation in the following hypothesis:

Hypothesis 1b (control): Onshore insourcing has the highest positive impact on the sale of new products, followed by offshore insourcing, onshore outsourcing, and offshore outsourcing.

Sources of finance and the debate between control and diversity

We aim to clarify the theoretical debate between control and diversity by bringing in the role of finance. We argue that depending on the type of finance the firm uses, the effects of alternative R&D sources on innovation can be strengthened or weakened. Finance has been acknowledged as playing an important role in innovation (Greve, 2003; Hall and Lerner, 2010; Monteiro et al., 2016; among others). One typical argument is that companies that have more access to funds are able to engage in innovative activities, this is the "more money, more innovation" story (Hottenrott and Peters, 2012). Innovation is a long-term and risky activity that requires the firm to have excess funds to support these investments (Hall et al., 2016), which may help the firm to create new products and increase sales in the future. Previous studies have focused mostly on financial constraints on innovation (Mohnen et al., 2008; Savignac, 2008); for example, for firms to be able to benefit from open innovation they need to have funds, and those companies that lack funds may suffer as a result (Monteiro *et al.*, 2016).

We go beyond these ideas and propose that internal and external sources of finance modify the relationship between R&D sources and innovation performance. On the one hand, internal sources of finance provide managers with the leeway and patient capital that is needed to fund investments in innovations (Himmelberg and Petersen, 1994; Ughetto, 2008). These internal funds are controlled by managers who can assign them to alternative projects with different rates of return and allow firms to rely on projects with a long-term period (Hall, 2005). The absence of short-term pressures to get returns allows employees to experiment with more heterogeneous inputs and integrate external knowledge in the innovation process. With internal funds the company can take the risk of searching for new and diverse sources of knowledge that can be challenging to manage but can provide the firm with new knowledge and ideas that the firm has not considered. Thus, the firm is more likely to get innovative results from R&D sources with a higher degree of diversity of knowledge when managers have internal funds for innovation activities.

In sum, internal funds provide managers with the flexibility and ability to engage in complex and risky investments that may have a high potential innovative impact on the firm, particularly in terms of new products. As a result, the use of internal sources of funds can help the firm to better take advantage of R&D source strategies with more diversity of knowledge to achieve innovation results. We summarize these ideas in the following hypothesis:

Hypothesis 2a (internal funds): The use of internal sources of finance strengthens the positive impact of offshore outsourcing on the sale of new products, followed by offshore insourcing, onshore outsourcing, and onshore insourcing.

On the other hand, when using external sources of finance to fund innovation activities, information asymmetries gain prominence because providers of external funds face difficulties in knowing and assessing the firm's innovation projects (Binks, Ennew, and Reed, 1992; De Mezza and Webb, 1987; Ughetto, 2008). The innovation efforts of a firm are uncertain and difficult to assess in terms of their likelihood of success by external parties and thus external providers of funds may be reluctant to provide the needed funds (Mina, Lahr, and Hughes, 2013). When external providers decide to finance an innovation project, they will expect to get returns in a predetermined amount of time. Such expectations, and the associated pressures by investors on managers, may lead managers to try to minimize the risks and uncertainties inherent to the innovation process by increasing control. When the employees are faced with novelty, the knowledge integration is particularly difficult (Majchrzak, More, and Faraj, 2012), therefore, the short-term pressure to achieve innovation results makes it difficult to use external knowledge in the innovation process. When the firm faces short-time pressures to achieve innovation results, it is easier to use internal knowledge that employees can control and manage with a higher chance of success.

In sum, with external funds the company will tend to increase control to minimize the uncertainty and difficulties of using new and different external knowledge and increase the possibilities of success in the innovation process in a limited period of time. We summarize these ideas in the following hypothesis:

Hypothesis 2b (external funds): The use of external sources of finance strengthens the positive impact of onshore insourcing on the sale of new products, followed by offshore insourcing, onshore outsourcing, and offshore outsourcing.

RESEARCH DESIGN

Database

We use the Technological Innovation Panel (TIP) to analyze these ideas. This panel is compiled by Spain's National Statistics Institute, Science and Technology Foundation, and Foundation for Technical Innovation. These institutions construct this database on the basis of the annual Spanish responses to the Community Innovation Survey (CIS). The panel provides information on different aspects of firms' innovation and internationalization strategies, ownership structures, and other general and economic information. The TIP collects data on firms from all sectors of the Statistical Classification of Economic Activities in the European Community (NACE) for different years.

We use a balanced panel of 8,359 Spanish manufacturing and services firms for the period from 2004 to 2007, compiled on a yearly basis. Spain is an appropriate empirical setting to analyze

R&D sources because it has much in common with many countries, occupying a middling position in the technological league table of countries – neither a technological leader like the US or Japan, nor a bottom-ranked country (UNCTAD, 2005). Therefore, this study's findings should be widely generalizable across firms in most countries. This database has been used before by other researchers to study innovation performance (e.g. Molero and García, 2008; Rodríguez and Nieto, 2016), among others.

Variables and measures

We analyze innovation as an outcome – which is usually the key dependent variable in empirical studies related to innovation (Crossan and Apaydin, 2010) and, specifically, we examine the novelty of innovation (Nieto and Santamaría, 2007) depending on whether it is a product new to the company or to the market (García and Calantone, 2002; de Jong and Vermeulen, 2006). In order to capture the innovation outcomes, in the empirical analyses we use three dependent variables. First, we use *Sale of New Product*. This is a dichotomous variable that indicates whether the company has introduced a new product; otherwise its value is 0. It is considered that a new product is introduced when the firm indicates: (i) new product has been introduced into the market; or (ii) existing product has been significantly improved or important changes have been made to its basic characteristics, intangible components, or desired purposes. Second, we identify the degree of novelty of innovation by distinguishing between products new to the firm and products new to the market (OECD, 2005; Barbosa, Faria, and Eiriz, 2014). To do this, we use two additional dependent variables: *Sale of Product New to the Firm* and *Sale of Product New to the Market.* Products new to the firm are defined as substantially improved or entirely new to the company but which can already exist in the market. Products new to the market refer to a first appearance on the market and therefore are new not only to the firm but also to the market. Both dependent variables are dichotomous (Dachs, Ebersberger, Kinkel, and Som, 2015).

The independent variables are the four sources of R&D. *Onshore Insourcing R&D* is the logarithm of internal R&D expenses in the home country. *Onshore Outsourcing R&D* is the logarithm of external R&D service expenses via a contract with a third party in the home country. *Offshore Insourcing R&D* is the logarithm of internal R&D expenses in the foreign country involving affiliates. *Offshore Outsourcing R&D* is the logarithm of external R&D expenses in the foreign country involving other firms, public administrations, universities, or non-domestic organizations. We use these measures to test H1a and H1b.

To estimate the moderation effect, we introduce the different sources of finance by classifying sources of funds used in innovation into two groups: those that are internal to the firm, including internal funds and funds from other firms in the group; and those that are external to the firm, including funds from other firms and organizations. We use bivariate indicators to indicate whether the firms use *Internal sources of finance* to fund R&D or *External sources of finance* to fund R&D (Mina *et al*., 2013). We introduce the interaction between these indicators and the four R&D sources to test H2a and H2b. We use bivariate indicators to facilitate the interpretation of the coefficients. The interaction terms we use to test the hypotheses are continuous variables given that we are multiplying the bivariate indicators of the type of finance by the continuous indicators of type of R&D expenditures. However, due to the nature of the dataset we do not have information on the specific types of finance that companies use for particular sources of R&D; we acknowledge this as a limitation.

Consistent with existing literature, we include a series of variables to capture other firm-specific characteristics that may be related to innovation performance (Belderbos, Carree, and Lokshin, 2004; Gooroochurn and Hanley, 2007; Grimpe and Kaiser, 2010; Veugelers and Cassiman, 1999). First, we control for *Size* since it is important in determining the firm's innovative behavior (Becheikh, Landry, and Amara 2006; Link and Bozeman, 1991; Shefer and Frenkel, 2005); we measure this by the logarithm of the total number of employees (Monteiro et al., 2016). Second, we control for *New firm,* since younger firms may have a different innovation behavior (García-Quevedo, Pellegrino, and Vivarelli, 2014); we control for whether the company is a new firm using a dichotomous variable that takes the value 1 if the firm has been set up in the previous two years and zero otherwise. Third, since belonging to a business group provides better access to resources (Galunic and Eisenhardt, 2001; Khanna and Yafeh, 2007) and this may affect the firm's innovation behavior, we include *Group,* a dichotomous variable that takes the value 1 if the firm is part of a group of firms under Spanish ownership. Fourth, we control for possible advantage of foreignness in innovation (Un, 2011), which may influence a firm's R&D decision, by including *Foreign ownership,* a dichotomous variable that takes the value 1 if at least 50% of the firm's capital is in non-domestic hands. Fifth, we control for the international activity of the firm since a presence in foreign markets allows firms to acquire knowledge (Zahra, Ireland, and Hitt, 2000) that helps them innovate (Frenz, Girardone, and Ietto-Gillies, 2005). Thus, we include *International* as a dichotomous variable that takes the value 1 if the firm sells its products or services abroad. Sixth, we control for whether the firm engages in technological collaboration because traditionally this is considered relevant to explain the innovation results (Faems, Van Looy, and Debackere, 2005). Technological cooperation consists in the active participation in innovation activities with other companies or non-for-profit entities. This excludes the subcontracting of work without active cooperation. Thus, we include *Collaboration* as a dichotomous variable that takes the value 1 when the firm collaborates on innovation activities with other firms or organizations. Seventh, we control for legal and strategic protection mechanisms, which allow the firm to protect inventions and thus appropriate revenue from them (Hurmelinna-Laukkanen and Olander, 2014); specifically, we include two dichotomous variables: *Patent*, which indicates whether the firm applied for a patent in the year (Monteiro et al., 2016), and *Intellectual Property Rights*, which indicates whether the firm registered an industrial design, brand name, or copyright in the year. Eighth, we control for the effort made by the firm to achieve innovation to gauge the innovation opportunities that the firm has by including

Innovation effort. This variable is calculated by dividing the firm's total innovation expenses by its total sales (Nieto and Rodríguez, 2011). Ninth, we control for *Multilocation,* which captures the presence of R&D activities in multiple locations, since a multilocation company may be able to draw different ideas from separate locations (Singh, 2008; Sole and Edmondson, 2002). Unfortunately, we do not have information on the location of the firm outside Spain, and we only have information on the autonomous community of Spain in which the firm has R&D activities not the specific city; Spain is divided into 17 autonomous communities and 2 autonomous cities. Thus, we use a bivariate indicator that measures whether the firm has R&D employees in more than one autonomous community in Spain or only in one. Tenth, we control for *Sector* with a set of bivariate indicators for each industry; this is included in all the models to capture the effect of industrial sectors, given the large differences in innovation and R&D across industries (Malerba, 2005). Finally, we control for *Year* with bivariate indicators for each year of analysis to account for possible temporal effects.

All the previously described independent and control variables are included with a one-period lag since R&D investments require some time to translate into innovative outputs (Belderbos *et al*., 2004). This is common in these types of analyses (e.g., Calantone and Stanko, 2007; Santamaría, Nieto, and Barge, 2009).

Method of analysis

Since our measures for the dependent variables are dichotomous, a probit model is specified for each dependent variable: *Sale of New Product*, *Sale of Product New to the Firm* and *Sale of Product New to the Market*. Specifically, we use a random-effects panel probit model, which addresses concerns of unobserved heterogeneity (Arellano and Bover, 1990). Our decision to use a random-effects model instead of a fixed-effects model is based on the following: (1) our sample is drawn from a large population, which may make it more appropriate to view individual specific constant terms as randomly distributed across cross-sectional units (Greene, 2000); (2) estimates computed using fixed-effects models can be less efficient for panels over short periods. This problem does not exist with random-effects models (Heckman, 1981; Hsiao, 1986), which is an important consideration for panels like ours of only four years' duration; and (3) fixed-effects models cannot include time-independent covariates. Moreover, the 'within' variations of the dependent variable and the explanatory variables – the changes in these variables over time for a specific firm – is very low, which makes it impossible to identify the parameters in any fixed-effects model.

The model we use to analyze the relationships is the following:

Sale of New Product (new to the firm and to the market, new to the firm, new to the market)$_{it}$ = β_0+ β_1 * Onshore Insourcing R&D$_{it-1}$ + β_2 * Onshore Outsourcing R&D$_{it-1}$ + β_3 * Offshore Insourcing R&D $_{it-1}$ + β_4 * Offshore Outsourcing R&D $_{it-1}$ + β_5 * Internal sources of finance $_{it-1}$ + β_6 * Internal sources of finance $_{it-1}$ + β_7 * Size $_{it-1}$ + β_8 * New firm $_{it-1}$ + β_9 * Group $_{it-1}$ + β_{10} * Foreign Ownership $_{it-1}$ + β_{11} * International $_{it-1}$ + β_{12} * Collaboration $_{it-1}$ + β_{13} * Patent $_{it-1}$ +β_{14} * Intellectual property rights $_{it-1}$ +β_{15} * Innovation effort $_{it-1}$ + β_{16} * Multilocation $_{it-1}$ + β_{17} * Sector$_{n\ it}$ + β_{18} * Year$_{t\ it}$ + ε_i

where α is the constant intercept, β is the coefficient vector, and ε is the error term.

To evaluate the relative impact of alternative R&D sources on *Sale of New Product*, *Sale of Product New to the Firm* and *Sale of Product New to the Market,* we perform a set of Wald tests for the coefficients of independent variables in each model. The first group (Comparison tests) allows us to test the difference of coefficients compared by pairs, and the second group (Joint tests) allows simultaneous conditions to be tested, determining the joint significances of the coefficients for different restrictions.

To test the moderating effects of sources of finance on the relationships between R&D sources and innovation performance, we include the interaction terms between the four R&D source variables and two finance source variables in the model described above.

EMPIRICAL RESULTS

Descriptive statistics and correlation matrix

Table 1 contains the descriptive statistics, correlations, and collinearity diagnostics of the independent and control variables used in this study (with the exception of the sector and year dummies). The average company has 384 employees, about 12% of the companies applied for patents in a year, and 23% of the companies registered an industrial design, brand name, or copyright in a year. About 49% of the companies have sales of new products, 38% have sales of products new to the firm, and 28% have sales of products new to the market.

There are no multicollinearity problems in the models. This is confirmed with the analyses of the variance of inflation (VIF). The highest VIF value in the models is 2.39, which is significantly lower than the threshold points, suggesting the absence of multicollinearity (see Table 1). Individual values of VIF that exceed 10, combined with average VIF values greater than 6, are often regarded as indicating multicollinearity (Neter, Wasserman, and Kutner, 1989). The three dependent variables have relatively high correlation, but since they are never used in the same model their correlation is irrelevant.

*** Insert Table 1 about here ***

Table 2 provides the results of the analyses of the relative influence of the alternative R&D sources on the different innovation outcomes: *Sale of New Product* (Models 2a, 2b), *Sale of Product New to Firm* (Models 2c, 2d) and *Sale of Product New to the Market* (Model 2e, 2f). Model 2a, 2c, and 2e include only the control variables and Models 2b, 2d, and 2f include the independent variables. Table 3 provides the Wald test results of the differences among the coefficients of the independent variables of interest.

*** Insert Table 2 and 3 about here ***

The findings of these analyses provide support for Hypothesis 1b and not for Hypothesis 1a, indicating that the R&D options that provide higher control enable the firm to achieve better innovation performance than the R&D options that provide higher diversity. Specifically, we find *Onshore Insourcing R&D* has the highest coefficient in all cases, followed by *Offshore Insourcing R&D* and *Onshore Outsourcing R&D.* To rank the different R&D sources we need to know if coefficients are statistically different. In Table 3, we present the Wald tests performed on the difference between the coefficients separately and on joint (simultaneous) restrictions. The Wald tests of equality of coefficients and joint restrictions reveal significant differences between the coefficients. First, we show the results of the Wald tests performed on the difference between the coefficients comparing pairs to pairs. All tests comparing pairs of alternative R&D sources are significant for *Sale of New Product.* The tests comparing pairs of alternative R&D sources are significant for *Sale of Product New to the Firm* and *Sale of Product New to the Market,* with two exceptions: (i) *Offshore Insourcing R&D* and *Onshore Insourcing R&D* for *Sale of Product New to the Firm*; and (ii) *Offshore Insourcing R&D* and *Onshore Outsourcing R&D* for *Sale of Product New to the Market.*

Table 4 contains the models with interaction variables to evaluate the relative impact of alternative R&D sources and funding sources on *Sale of New Product*, *Sale of Product New to the Firm* and *Sale of Product New to the Market*, The results provide partial support to Hypotheses 2a and 2b. Hypothesis 2a indicated that the use of internal sources of finance strengthens the positive impact of offshore outsourcing on *Sale of New Product*, followed by offshore insourcing, onshore outsourcing, and onshore insourcing. Hypothesis 2b indicated that the use of external source of finance strengthens the positive impact of onshore insourcing on *Sale of New Product*, followed by offshore insourcing, onshore outsourcing, and offshore outsourcing. Specifically, we find that the coefficient of interaction between *Internal sources of finance* and *Onshore Internal R&D* and *Onshore External R&D* are negative and statistically significant; while the coefficient of interaction between *External sources of finance* and *Onshore Internal R&D* is positive and statistically significant.

*** Insert Table 4 about here ***

Some of the control variables are statistically significant. Specifically, the coefficients of *New Firm, International*, *Collaboration*, *Patent*, and *Intellectual property rights* are positive and statistically significant, while the coefficient of *Size* is negative and statistically significant in all the models. We also find that the coefficients of *Innovation effort* and *Multilocation* are positive and statistically significant in some models.

Robustness checks[2]

We checked the robustness of these results in several ways. These analyses support similar conclusions to the ones derived from the analyses presented and they are available upon request.

First, we used alternative continuous measures to check for the robustness of the analyses to a different specification of the dependent variable. Thus, we use the percentage of sales coming from new products as the dependent variable (Monteiro et al., 2016). Following previous research, the dependent variable is used in its logarithmic form since it reduces the problem of non-normality of the residuals (Berchicci, 2013; Greene, 2003; Laursen and Salter, 2006). In these analyses we use a tobit model because the variables are left censored (Gujarati, 1995; Berchicci, 2013; Grimpe and Kaiser, 2010; Wu and Wu, 2014). Specifically, we use a random-effects panel tobit model, which addresses concerns of unobserved heterogeneity (Arellano and Bover, 1990). The results for these dependent variables (Sales from new product, Sales from product new to the firm and Sales from product new to the market) yield similar conclusions to the analysis of the dichotomous variables.

Second, since firms that generate sales from new products in one period may continue commercializing the new products in the next one, we checked for a potential serial correlation by performing an auto-regressive regression (Baum and Wally, 2003; García-Manjón and Romero-Merino, 2012). We ran the analyses including lagged values of the dependent variables (Coad and Rao, 2008; Rodríguez and Nieto, 2016). The findings show that the coefficients of lagged dependent

[2] We thank the anonymous reviewers for suggesting these robustness tests.

variables are positive and significant and the rest of the coefficients are similar to those obtained in the analyses presented, thus supporting the same conclusions we discussed before.

Third, we performed analyses including two-year lags to elucidate the long-term impact of R&D sources and to analyze the stability of the previous findings over time, or to simply capture the possibility that these strategies require further time to have an effect on sales (Coad and Rao, 2008; Del Monte and Papagni, 2003; Rodríguez and Nieto, 2016). We find support for the conclusions reached.

Fourth, we ran analyses in which we interact internal R&D with offshore R&D outsourcing to check for the potential influence of a dimension of absorptive capacity on innovation. The logic is that firms that are more innovative may be better at extracting more value from external knowledge obtained through R&D outsourcing and thus may be more innovative. The results of including this interaction show support for the conclusions discussed, as the direct effects of onshore internal R&D, onshore external R&D, and offshore internal R&D are positive and statistically significant while the coefficient of offshore outsource R&D is not statistically significant.

Lastly, we explore the possibility of potential endogeneity by undertaking an instrumental variable approach. Hence, we first analyze the determinants of R&D outsourcing (onshore and offshore) in the year, including additional controls as instruments (training expenditures, R&D personnel, gender of R&D employees as percentage, leverage). We then use the predicted values from this first step in the second step in which we explain new products (new, new to the firm, and new to the market). The results of these analyses indicate support for conclusions similar to the ones discussed in the manuscript.

Discussion

These analyses support two findings. First, the results indicate that in general terms the options with greater control over R&D activities have a greater impact on the sale of new products than those with greater knowledge diversity. Specifically, for onshore insourcing R&D, the greater control within the organization and in the same country allows firms to benefit from the creation, transfer, and use of knowledge. In contrast, the greater difficulty in establishing controls both outside firms and across countries makes offshore outsourcing R&D a poor option for developing new products. The challenges of interacting and communicating across firms add to the cultural, institutional, and language challenges across countries, resulting in less learning and knowledge creation. Furthermore, access to diverse sets of knowledge inputs from international operations in different country locations does not by itself guarantee that firms will be able to exploit or augment this advantage to achieve better innovation results (Martin and Salomon, 2003). Simple access to and transfer of knowledge may not be sufficient, as not all firms are able to combine knowledge from different source locations to generate novel innovations (Berry, 2014). The transfer of R&D inputs depends largely on their complexity and degree of tacitness (Cummings & Teng, 2003). Firms operating overseas find it more difficult to incorporate highly tacit knowledge obtained abroad into their innovation processes (Hu, 1995). Firms with well-developed capabilities are able to manage tacit knowledge in a geographically dispersed context (Cantwell and Santangelo, 1999). The R&D sources that combine elements of control and knowledge diversity fall in the middle of the ranking: onshore R&D outsourcing and offshore R&D insourcing. The first option combines knowledge diversity generated by contracting R&D services from an external supplier with control provided by a greater ease of contract design thanks to operating in the firm's home country. The second option allows firms to take advantage of knowledge diversity by performing R&D activities overseas, while limiting the risks of offshore outsourcing by maintaining the activity in-house and allowing greater control over employees. In summary, the combination of diversity and control results in beneficial R&D options that help firms achieve the sale of new products; which is in line with 'the paradox of openness' that highlights the need to balance heterogeneity and protection of knowledge to succeed in innovation (Laursen and Salter, 2014).

Second, the results indicate that the sources of finance of R&D activities modify these previous relationships. Specifically, internal sources of funds strengthen the impact of R&D sources with more knowledge diversity on the sale of new products, while the external sources of funds strengthen the impact of R&D sources with more knowledge control on the sale of new products. Companies that use internal sources of finance to fund innovation are able to benefit more from R&D source options with a higher level of diversity of knowledge. Internal funds provide managers with the flexibility and ability to engage in complex and risky investments that may have a high potential innovative impact on the firm. In contrast, companies that use external sources of finance to fund innovation get more innovation advantages from R&D sources with a higher level of control of knowledge. The external sources of funds may induce managers to minimize the uncertainties and difficulties of the innovation process by reducing the use of external knowledge, and increasing the likelihood of achieving the sale of new products, so that external providers of finance can receive the repayment of their funds.

CONCLUSIONS

Managers of firms that perform R&D activities are faced with many decisions, two of which are of a strategic nature: the organization or ownership of the R&D activities (insourcing or outsourcing), and the location of the R&D activities (onshore or offshore). Combining these two dimensions, managers need to decide among four alternatives, each with its own distinct degree of knowledge diversity and control: onshore insourcing, onshore outsourcing, offshore insourcing, and offshore outsourcing. In principle, all sources of R&D are useful for firms that are looking to improve innovation performance, but it is unclear which one is best. In this paper we study the relative contributions of these four sources of R&D on innovation performance and introduce the moderating role of sources of finance in these relationships as one important factor in the selection of sources.

From a theoretical point of view, we extend previous literature by addressing the debate on the ranking among R&D sources in terms of their impact on innovation, extending knowledge-based view arguments. One argument, which we termed diversity, builds on the idea that diversity of knowledge is good for knowledge creation (Almeida and Phene, 2004; Hayek, 1945; Tsoukas, 1996) and can promote innovation (Chesbrough, 2003; Rodan and Galunic, 2004; van Beers and Zand, 2014). The other argument, which we termed control, builds on the idea that the control exercised within the firm enables it to enhance the transfer of complex knowledge across countries and operations (Kogut and Zander, 1992, 1993; Szulanski, 1996), and the use of appropriated control mechanisms can encourage the creation of knowledge to innovate (Cardinal, 2001; Rijsdijk, and van den End, 2011). We enrich this debate between diversity and control of knowledge by introducing the role of internal and external sources of finance to fund innovation activities as one solution to the debate.

From an empirical point of view, we test the theoretical framework on a panel dataset of manufacturing and services firms in Spain. The empirical findings support some interesting conclusions. The findings reveal that onshore insourcing R&D has the highest contribution to new product sales and offshore outsourcing R&D has the lowest. The two intermediate alternatives – offshore insourcing R&D and onshore outsourcing R&D – both help firms achieve new product development. When firms are looking to develop products new to the firm, R&D offshore insourcing is positioned as a more useful option than R&D onshore outsourcing; whereas if firms are most interested in getting new products to the market, both R&D sources (onshore outsourcing and offshore insourcing) have a similar impact since there is no significant difference between them. Moreover, we find that the use of internal sources of funds in innovation strengthens the diversity relationship between sources of R&D and new product sales, while the use of external sources of funds strengthens the control relationship between sources of R&D and new product sales.

This research contributes to the literature in several ways. First, it contributes to the knowledge-based view by applying the ideas of diversity and control to alternative R&D sources and innovation results. The paper focuses on the relative benefits that four R&D options provide firms, ranking them by combining two strands of this theoretical framework. Second, the paper contributes to the analysis of R&D sources and performance by explaining how to rank them. Although debate is growing over the merits of offshoring (see Contractor *et al*., 2010), most research does not provide a comparison to other actions. Additionally, the paper casts light on the debate over open innovation strategies (Chesbrough, 2003; Monteiro *et al.,* 2016; West *et al.*, 2014) by combining the analysis of internal and external R&D with the location dimension. In line with this, we consider the four sources of R&D and offer empirical evidence for the relative contribution of each to new product development. Lastly, we introduce the role of sources of finance as a factor that modifies the relationship between different R&D sources on innovation performance, and thus helps address the debate between diversity and control by providing a condition under which one argument or the other dominates.

In empirical terms, this research advances on previous research in three ways: (1) it includes the investment effort made by firms for each of the alternative R&D sources; (2) it explains the impacts of these alternatives in terms of the sale of innovative products, whereas most previous research bases its analysis on dichotomous explanatory variables for decision choices to perform or not perform a specific type of R&D activity (Bertrand and Mol, 2013; Nieto and Rodríguez, 2011) and does not analyze the novelty of innovation results; and (3) it considers different types of sources of finance (internal and external) as moderators of the previous relationships, going beyond the analysis of financial decisions to invest in R&D (Bougheas, 2004; Mina *et al.*, 2013) or the effects of financial constraints (Monteiro *et al*., 2016; Savignac, 2008) addressed in most previous studies.

Managerial implications

Our findings are useful for managers planning R&D investments. The results reveal the relative contribution of different R&D sources on innovation, thereby helping managers plan R&D investments accordingly. Given that R&D budgets are limited, managers should prefer to invest predominantly in internal R&D, perhaps with some outsourcing of R&D within the country, especially when they are using external sources of funds. When the goal is benefiting from diversity across countries, channeling some of the R&D budget to offshore insourcing R&D strategies is also an attractive option. Although several academic studies underline the importance of sources that are external to the firm and located in other countries, managers should consider the impact of knowledge integration and recombination. They need to weigh the relative importance of control and diversity of knowledge and be aware of the difficulties that can arise in creating and sharing new knowledge for innovation.

Managers also need to take into account the importance of the sources of funds for innovation that they are using and not just whether or not their firms have the funds to support innovation. Whether a firm uses internal or external sources of funds matters, not only in terms of the direct effect they have on innovation, but also in terms of their moderating effects on innovation via R&D sources. Internal sources of funds appear to have a strengthening impact on the use of R&D sources with more diverse knowledge, while external sources appear to have a strengthening impact on the use of R&D sources under more control of knowledge.

Limitations and future research

This study has limitations as a result of the specific survey used that provide potential areas for further research. First, it would be desirable to have more precise information about the different R&D sources and the type of knowledge involved, particularly the degree of tacitness of the knowledge. More detailed information about offshore insourcing (for example, the organizational characteristics) and onshore outsourcing (for example, about the supplier in the country of origin) could enrich the analysis and help provide more accurate conclusions regarding these two intermediate choices of R&D sources. In addition, many different ways to capture knowledge diversity exist, some of which could be analyzed by future studies. This may be particularly relevant depending on the characteristics of the knowledge involved. More tacit knowledge may require a higher degree of colocation and only companies with well-developed capabilities can generate tacit knowledge in a geographically dispersed manner (Cantwell & Santangelo 1999; 2000). Moreover, other factors that may enhance or moderate the effect of technological diversity merit attention. These include factors such as the number and diversity of suppliers or the variety of networks that result from the relational process of novel information sharing among suppliers (Gao, Xie, and Zhou, 2015).

Second, in our database, we can only observe that a focal firm uses certain types of sources of R&D and certain sources of finance. Although our analyses include multiple interactions related to the combinations of R&D sources and financial sources and thus enable us to the test the arguments, it is not possible for us to distinguish how the firm allocates particular funds to specific R&D sources. Futures studies with the appropriate data could extend the arguments presented here by performing more-fine grained analyses on the specific relationships between the type of finance and R&D sources on the firm's innovation results; for example, by analyzing whether internal funds are used for one particular type of R&D while external funds are used for another type of R&D.

Third, the study of the specific location of R&D activities (both within and outside the country) would be an interesting avenue for future research. One reason to internationalize activities in a particular location may be the need to access a locally embedded specialization (Cantwell and Santangelo, 1999). More detailed information on the destination countries for R&D investments, e.g., their levels of technological development or protection of property rights (Jandhyala, 2013), would furnish additional explanations when gauging the impact on innovation results. The opportunities to learn and innovate differ greatly between locations. Along these lines, other studies can take into account the specific location (both at the national and international level) of the R&D facilities in order to better appreciate the benefits of any source of R&D. A particularly interesting line of research could be the study of location in the industrial clusters and specialized global centers (Hannigan, Cano-Kollmann, and Mudambi, 2015).

Related to the location of activities abroad, it would be interesting to analyze the particular activities undertaken in foreign locations, as the knowledge generated by the firm and thus its impact on the sales of new products may differ. For example, operations in a host country that have a mandate to manufacture may result in higher investments in process innovation and subsequent improvements in efficiency and thus more sales of not only new but also old products, while operations in a host country to engage in pure R&D may result in product innovations and thus more sales of products that may not only be new to the firm but also to the market.

REFERENCES

Almeida, P., Song, J., Grant, R. M. 2002. Are firms superior to alliances and markets? An empirical test of cross-border knowledge building. *Organization Science*, 13: 147-161.

Almeida, P., Phene, A. 2004. Subsidiaries and knowledge creation: the influence of the MNC and host country on innovation. *Strategic Management Journal*, 25: 847–864.

Ambos, B., Ambos, T.,C., 2011. Meeting the challenge of offshoring R&D: an examination of firm- and location-specific factors. *R&D Management,* 41: 107-119.

Anderson, U., Pedersen, T. 2010. Organizational design mechanisms for the R&D function in a world of offshoring. *Scandinavian Journal of Management,* 26: 431-438.

Arellano, M., Bover, O. 1990. La econometría de datos de panel. *Investigaciones Económicas,* 14: 3-45.

Arora, A., Belenzon, S., Rios, L. A. 2014. Make, buy, organize: The interplay between research, external knowledge, and firm structure. *Strategic Management Journal*, 35(3): 317-337.

Ashkanasy, N. M., Wilderom, C. P. M., Peterson, M. F. 2000. Introduction. In N. Ashkanasy, C. P. M. Wil derom, & M. F. Peterson (Eds.), *Handbook of Organizational Culture & Climate*: 1-18. Thousand Oaks, CA: Sage.

Atuahene-Gima, K., Li, H. 2004. Strategic Decision Comprehensiveness and New Product Development Outcomes in New Technology Ventures. *Academy of Management Journal*, 47 (4): 583-597.

Barbosa, N., Faria, A. P., Eiriz, V. 2014. Industry-and firm-specific factors of innovation novelty. *Industrial and Corporate Change,* 23(3): 865-902.

Bardhan, A. D., 2006. Managing globalization of R&D: Organizing for offshoring innovation. *Human System Management,* 25: 103-114.

Barlett, C. A., Ghoshal, S. 1989. *Managing across Borders: The transnational Solution.* Harvard Business School Press. Boston, MA.

Baum, R. J., Wally, S. 2003. Strategic decision speed and firm performance. *Strategic Management Journal,* 24(11): 1107-1129.

Becheikh, N., Landry, R., Amara, N. 2006. Lessons from Innovation Empirical Studies in the Manufacturing Sector: a Systematic Review of the Literature from 1993-2003. *Technovation,* 26, 644-664.

Belderbos, R., Carree, M., Lokshin, B. 2004. Cooperative R&D and firm performance. *Research Policy,* 33: 1477-1492.

Berchicci, L. 2013. Towards an open R&D system: Internal R&D investment, external knowledge acquisition and innovative performance. *Research Policy,* 42 (1): 117–127.

Berry, H. 2014. Global integration and innovation: Multicountry knowledge generation within MNCs. *Strategic Management Journal,* 35: 869–890.

Bertrand, O., Mol, M. J. 2013. The antecedents and innovation effects of domestic and offshore R&D outsourcing: The contingent impact of cognitive distance and absorptive capacity. *Strategic Management Journal,* 34: 751–760.

Binks, M.R., Ennew, C. T., Reed, G.V., 1992. Information Asymmetries and the Provision of Finance to Small Firms. *International Small Business Journal,*11 (1): 35-46.

Calantone, R. J., Stanko, M. A. 2007. Drivers of outsourced innovation: An exploratory study. *Journal of Product Innovation Management*, 24: 230–241.

Cantwell, J., Santangelo, G. D. 1999. The frontier of international technology networks: sourcing abroad the most highly tacit capabilities. *Information Economics and Policy*, 11(1): 101-123.

Cantwell, J., Santangelo, G. D. 1999. Capitalism, profits and innovation in the new techno-economic paradigm. *Journal of Evolutionary Economics*, 10 (1/2): 137-163.

Cardinal, L. 2001. Technological Innovation in the Pharmaceutical Industry: The Use of Organizational Control in Managing Research and Development. *Organization Science,* 12(1): 19-36.

Cassiman, B., Di Guardo, M. C., Valentini, G. 2009. Organising R&D projects to profit from innovation: insights from co-opetition. *Long Range Planning*, 42: 216-233.

Cassiman, B., Veugelers, R. 2006. In search of complementarity in innovation strategy: Internal R&D and external knowledge acquisition. *Management Science*, 52(1): 68-82.

Chatterji, D. 1996. Accessing external sources of technology. *Research Technology Management*, 39(2), 48-56.

Chesbrough, H., 2003. *Open Innovation: The New Imperative for Creating and Profiting from Technology.* Harvard University Press, Cambridge, MA.

Coad, A., Rao, R. 2008. Innovation and firm growth in high-tech sectors: A quantile regression approach. *Research Policy,* 37(4): 633-648.

Cohen, W. M., Levinthal, D.A. 1989. Innovation and learning: the two faces of R&D. *The Economic Journal,* 99: 569-596.

Conner, K. R., Prahalad, C. K. 1996. A resource-based theory of the firm: knowledge versus opportunism. *Organization Science,* 7(5): 477–501.

Contractor, F. J., Kumar, V., Kundu, S. K., Pedersen, T. 2010. Reconceptualizing the firm in a world of outsourcing and offshoring: the organizational and geographical relocation of high-value company functions. *Journal of Management Studies*, 47: 1417-1433.

Crossan, M. M., Apaydin, M. 2010. A multi-dimensional framework of organizational innovation: A systematic review of the literature. *Journal of Management Studies*, 47(6): 1154-1191.

Cummings, J. L., Teng, B. S. 2003. Transferring R&D knowledge: the key factors affecting knowledge transfer success. *Journal of Engineering and Technology Management*, 20(1), 39-68.

Dachs, B., Ebersberger, B., Kinkel, S., Som, O. 2015. The effects of production offshoring on R&D and innovation in the home country. *Economia e Politica Industriale*, 42(1): 9-31

De Jong, J. P., Vermeulen, P. A. 2006. Determinants of product innovation in small firms a comparison across industries. *International Small Business Journal*, 24(6): 587-609.

De Meza, D., Webb, D. C. 1987. Too much investment: A problem of asymmetric information. *Quarterly Journal of Economics,* 102(2):281-292.

Del Monte, A., Papagni, E. 2003. R&D and the growth of firms: empirical analysis of a panel of Italian firms. *Research Policy*, 32(6): 1003-1014.

Doz, Y. L., Santos, J., Williamson, P. 2001. *From Global to Metanational: How Companies Win in the Knowledge economy.* Harvard Business Press. Boston, MA.

Edquist, C. 2005. Systems of innovation. In Fagerberg, J., Mowery, D. C., and Nelson, R. R. (Eds.) *The Oxford Handbook of Innovation*. Oxford University Press, New York, 181-208.

Eisenhardt, K. M. 1985. Control: Organizational and economic approaches. *Management Science,* 31:134–149

Eisenhardt, K. M., Santos, F. M., 2002. Knowledge-based view: a new theory of strategy?. In Pettigrew, A.M., Thomas, H., and Whittington, R. (Eds.) *Handbook of Strategy and Management*. Sage Publications Ltd., London, 139-164.

Faems, D., Van Looy, B., Debackere, K. 2005. Interorganizational Collaboration and Innovation: Toward a Portfolio Approach. *Journal of Product Innovation Management,* 22: 238–250

Fagerberg, J., Mowery, D. C., Nelson, R. R. (Eds.), 2005. *The Oxford Handbook of Innovation*. New York: Oxford University Press.

Fey, C. F., Birkinshaw, J. 2005. External Sources of Knowledge, Governance Mode, and R&D Performance. *Journal of Management*, 31, 597-621.

Florida, R. 1997. The globalization of R&D: Results of a survey of foreign-affiliated R&D laboratories in the USA. *Research Policy,* 26(1): 85–103.

Foss, N. J. 1996. Knowledge-based approaches to the theory of the firm: some critical comments. *Organization Science*, 7: 470-476.

Freeman, C. 1995. The 'National System of Innovation' in historical perspective. *Cambridge Journal of Economics*, 19: 5-24.

Frenz, M., Ietto-Gillies, G. 2009. The impact on innovation performance of different sources of knowledge: Evidence from the UK Community Innovation Survey. *Researh Policy*, 38, 1125-1135.

Frenz, M., Girardone, C., Ietto-Gillies, G., 2005. Multinationality Matters in Innovation: The Case of the UK Financial Services. *Industry and Innovation,* 12(1), 65-92.

Furman, J. L., Porter, M. E., Stern, S. 2002. The determinants of national innovative capacity. *Research Policy,* 31: 899-933.

Galunic, D. C., Eisenhardt, K. M. 2001. Architectural Innovation and Modular Corporate Forms. *Academy of Management Journal,* 44(6): 1229-1249.

Gao, G. Y., Xie, E., Zhou, K. Z. 2015. How Does Technological Diversity in Supplier Network Drive Buyer Innovation? Relational Process and Contingencies. *Journal of Operations Management,* 36: 165-177.

Garcia, R., Calantone, R. 2002. A critical look at technological innovation typology and innovativeness terminology: a literature review. *Journal of Product Innovation Management,* 19(2), 110-132.

García-Manjón, J. V., Romero-Merino, M. E. 2012. Research, development, and firm growth. Empirical evidence from European top R&D spending firms. *Research Policy,* 41(6): 1084-1092.

García-Quevedo, J., Pellegrino, G., Vivarelli, M. 2014. R&D drivers and age: Are young firms different?. *Research Policy,* 43(9), 1544-1556..

Garriga, H., von Krogh, G., Spaeth, S. 2013. How constraints and knowledge impact open innovation. *Strategic Management Journal*, 34(9): 1134-1144.

Gooroochurn, N., Hanley, A. 2007. A tale of two literatures: Transaction costs and property rights in innovation outsourcing. *Research Policy*, 36: 1483-1495.

Grant, R., 1996. Toward a knowledge-based theory of the firm. *Strategic Management Journal,* 17: 109-122.

Grant, R. M., Baden-Fuller, C. 2004. A knowledge accessing theory of strategic alliances. *Journal of Management Studies,* 41: 61-84.

Greene, W.,2000. *Econometric Analysis.* 4th edition Upper Saddle River, N.J. Prentice Hall.

Greve, H. R. 2003. A behavioral theory of R&D expenditures and innovations: Evidence from shipbuilding. *Academy of Management Journal*, 46(6): 685-702.

Griffith, R., Huergo, E., Mairesse, J., Peters, B. 2006. Innovation and Productivity Across Four European Countries. *Oxford Review of Economic Policy,* 22 (4): 483-498.

Grimpe, C., Kaiser, U. 2010. Balancing internal and external knowledge acquisition: the gains and pains from R&D outsourcing. *Journal of Management Studies*, 47: 1483-1509.

Gujarati, D. N. 1995. Basic Econometrics, 3rd ed. McGraw-Hill, New York.

Hage, J., Meeus, M. 2006. *Innovation, Science and Institutional Change*. New York: Oxford University Press.

Hall, B. H. 2005. *The financing of innovation.* In Shane, S. (Ed.) The Handbook of Technology and Innovation Management, 409-430.

Hall, B. H., Lerner, J. 2010. The Financing of R&D and Innovation. In Hall, B. H. and N. Rosenberg (eds.), Handbook of the Economics of Innovation, Elsevier-North Holland.

Hall, B., Lotti, H., Mairesse, J. 2013. Evidence on the impact of R&D and ICT investments on innovation and productivity in Italian firms. *Economics of Innovation and New Technology,* 22(3): 300-328.

Hall, B. H., Moncada-Paternò-Castello, P., Montresor, S., Vezzani, A. 2016. Financing constraints, R&D investments and innovative performances: new empirical evidence at the firm level for Europe. *Economics of Innovation and New Technology*, 25(3): 183-196.

Hannigan, T. J., Cano-Kollmann, M., Mudambi, R. 2015. Thriving innovation amidst manufacturing decline: the Detroit auto cluster and the resilience of local knowledge production. *Industrial and Corporate Change*, 24(3): 613-634.

Hass, M. R.,2006. Acquiring and applying knowledge in transnational teams: the roles of cosmopolitans and locals. *Organization Science,* 17: 367-384.

Hayek, F. A.,1945. The use of knowledge in society. *The American Economic Review,* 35: 519-530.

Heckman, J. 1981. Statistical models for discrete panel data. In D. McFadden & C. Manski (Eds.), *The Econometrics of Panel data*. MA: MIT Press, Cambridge, 114-178.

Himmelberg, C. P., Petersen, B. C. 1994. R & D and internal finance: A panel study of small firms in high-tech industries. *The Review of Economics and Statistics*, 38-51.

Hottenrott, H., Peters, B. 2012. Innovative capability and financing constraints for innovation: More money, more innovation?. *Review of Economics and Statistics*, 94(4): 1126-1142.

Howells, J. 2008. New directions in R&D: current and prospective challenges. *R&D Management,* 38(3): 241-252.

Hsiao, C.,1986. *Analysis of Panel Data*. Cambridge University Press, New York.

Hsuan, J., Mahnke, V. 2011. Outsourcing R&D: a review, model, and research agenda. *R&D Management,* 41: 1-7.

Hu, Y. S. 1995. The international transferability of the firm's advantages. *California Management Review*, 37(4), 73-88.

INE. 2015. Estadística sobre Actividades en I+D. Resultados definitivos. Año 2013. (Statistics on R&D activities. Final version. Year 2013). Madrid: Instituto Nacional de Estadística http://www.ine.es/prensa/np889.pdf. Accessed April 18, 2016.

Jensen, P.O., Pedersen, T. 2011. The Economic Geography of Offshoring: The Fit between Activities and Local Context. *Journal of Management Studies,* 48 (2): 352-372.

Khanna, T., Yafeh, Y. 2007. Business groups in emerging markets: paragons or parasites?, *Journal of Economic Literature*, 45: 331-372.

Kedia, B. L., Mukherjee, D. 2009. Understanding offshoring: A research framework based on disintegration, location and externalization advantages. *Journal of World Business*, 44: 250-261.

Kogut, B. 1991. Country capabilities and the permeability of borders. *Strategic Management Journal,* 12: 33–47.

Kogut, B., Zander, U. 1992. Knowledge of the firm, combinative capabilities and the replication of technology. *Organization Science*, 3: 383-397.

Kogut, B., Zander, U. 1993. Knowledge of the firm and the evolutionary theory of the multinational corporation. *Journal of International Business Studies*, 24: 625-645.

Kogut, B., Zander, U. 1996. What firms do? coordination, identity, and learning. *Organization Science,* 7: 502-518.

Kogut, B., 1991. Country capabilities and the permeability of borders. *Strategic Management Journal,* 12 (S1): 33-47.

Kuemmerle, W. 1999. The Drivers of Foreign Direct Investment into Research and Development: An Empirical Investigation. *Journal of International Business Studies,* 30(1): 1-24.

Laursen, K., Salter, A. 2006. Open for innovation: The role of openness in explaining innovation performance among U.K. manufacturing firms. *Strategic Management Journal*, 27, 131-150.

Laursen, K., Salter, A. 2014. The paradox of openness: Appropriability, external search and collaboration. *Research Policy,* 43(5): 867-878.

Lewin, A. Y., Massini, S., Peeters, C. 2009. Why are companies offshoring innovation? The emerging global race for talent. *Journal of International Business Studies,* 40: 901–925.

Link, A. N., Bozeman, B. 1991. Innovative behavior in small-sized firms. *Small Business Economics,* 3(3): 179-184.

Liu, X., Buck, T. 2007. Innovation performance and channels for international technology spillovers: Evidence from Chinese high-tech industries. *Research Policy,* 36(3): 355–366.

Majchrzak, A., More, P. H., Faraj, S. 2012. Transcending knowledge differences in cross-functional teams. *Organization Science*, 23(4), 951-970.

Malerba, F. 2005. Sectoral systems: how and why innovation differs across sectors. In: Fagerberg, J., Mowery, D., Nelson, R. (Eds.), *Oxford Handbook of Innovation*. New York: Oxford University Press.

Manning, S., Massini, S., Lewin, A. Y. 2008. A Dynamic perspective on next-generation offshoring: the global sourcing of science and engineering talent. *Academy of Management Perspectives,* 22 (3): 35-54.

Martin X., Salomon R. 2003. Knowledge transfer capacity and its implications for the theory of the multinational corporation. *Journal of International Business Studies,* 34: 356–373.

Maskell, P., Pedersen, T., Petersen, B., Dick-Nielsen, J. 2007. Learning paths to offshore outsourcing: From cost reduction to knowledge seeking. *Industry and Innovation,* 14: 239–257.

Mata, J., Woerter, M. 2013. Risky innovation: The impact of internal and external R&D strategies upon the distribution of returns. *Research Policy,* 42(2): 495–501.

Metters, R. 2008. A typology of offshoring and outsourcing in electronically transmitted services, *Journal of Operations Management,* 26: 198-211.

Mezias, J. M. 2002. Identifying liabilities of foreignness and strategies to minimize their effect: The case of labor lawsuits judgments in the United States. *Strategic Management Journal,* 23: 229-244.

Milgrom, P., Roberts, J. 1992. *Economics, Organization and Management*. Prentice Hall.

Mina, A., Lahr, H., Hughes, A. 2013. The demand and supply of external finance for innovative firms. *Industrial and Corporate Change,* 22(4): 869-901.

Mohnen, P., Palm, F. C., Van Der Loeff, S. S., Tiwari, A. 2008. Financial constraints and other obstacles: are they a threat to innovation activity?. *De Economist,* 156(2): 201-214.

Molero, A., García, A. 2008. The innovative activity of foreign subsidiaries in the Spanish Innovation System: An evaluation of their impact from a sectoral taxonomy approach, *Technovation*, 28: 739-757.

Monteiro, F., Mol, M., Birkinshaw, J. 2016. Ready to be Open? Explaining the Firm Level Barriers to Benefiting From Openness to External Knowledge. *Long Range Planning*. doi:10.1016/j.lrp.2015.12.008

Mudambi, R. 2008. Location, control and innovation in knowledge-intensive industries. *Journal of Economic Geography*, 8: 699–725.

Nagarajan, A., Mitchell, W. 1998. Evolutionary diffusion: internal and external methods used to acquire encompassing, complementary, and incremental technological changes in the lithotripsy industry: 1989-1991. *Strategic Management Journal*, 19: 1063-1077.

Narula, R. 2001. Choosing between internal and non-internal R&D activities: some technological and economic factors. *Technology Analysis & Strategic Management,* 13(3): 365-387.

Neter, J., Wasserman, W., Kutner, M.H. 1989. *Applied Regression Models*. Homewood, IL: Irwin.

Nieto, M. J., Rodríguez, A. 2011. Offshoring of R&D: Looking abroad to improve innovation performance. *Journal of International Business Studies,* 42: 345-361.

Nieto, M. J., Santamaría, L. 2007. The importance of diverse collaborative networks for the novelty of product innovation. *Technovation*, 27(6), 367-377.

Nieto, M. J., Santamaría, L. 2010. Technological collaboration: bridging the innovation gap between small and large firms. *Journal of Small Business Management*, 48: 44-69.

Nonaka, I. 1994. A dynamic theory of organizational knowledge creation. *Organization Science,* 5: 14-37.

O'Leary, M. B., Cummings, J. N. 2007. The spatial, temporal, and configurational characteristics of geographic dispersion in teams. *MIS Quarterly,* 31(3), 433-452.

OECD. 2005. Oslo manual: Guidelines for collecting and interpreting innovation data. 3rd edn. Organisation for Economic Co-operation and Development, Paris.

Patel, P. C., Fernhaber, S. A., McDougall-Covin, P. P., van der Have, R. P. 2014. Beating competitors to international markets: The value of geographically balanced networks for innovation. *Strategic Management Journal,* 35: 691–711.

Penrose, E.T. 1959. *The Theory of the Growth of the Firm*. Oxford: Blackwell

Phelan, S. E., Lewin, P. 2000. Arriving at a strategic theory of the firm, *International Journal of Management Reviews*, 2: 305–323.

Phene, A., Fladmoe-Lindquist, K., Marsh, L. 2006. Breakthrough innovations in the U.S. biotechnology industry: the effects of technological space and geographic origin. *Strategic Management Journal,* 27, 369-388.

Pisano, G. P. 1990. The R&D boundaries of the firm: an empirical analysis. *Administrative Science Quarterly*, 35: 153-176.

Poppo, L., Zenger, T. 1998. Testing alternative theories of the firm: transaction cost, knowledge-based, and measurement explanations for make-or-buy decisions in information services. *Strategic Management Journal*, 19: 853-877.

Rijsdijk, S. A., van den Ende, J. 2011. Control Combinations in New Product Development Projects. *Journal of Product Innovation Management,* 28: 868–880.

Rodan, S., Galunic, C. 2004. More than network structure: how knowledge heterogeneity influences managerial performance and innovativeness. *Strategic Management Journal,* 25, 541–562.

Rodríguez, A., Nieto, M. J. 2016. Does R&D offshoring lead to SME growth? Different governance modes and the mediating role of innovation. *Strategic Management Journal*. 37: 1734-1753.

Santamaría, L., Nieto, M. J., Barge-Gil, A. 2009. Beyond formal R&D: Taking advantage of the other sources of innovation in low- and medium-technology industries. *Research Policy*, 38: 507-517.

Savignac, F. 2008. Impact of financial constraints on innovation: what can be learned from a direct measure?. *Economics of Innovation and New Technology*, 17(6): 553-569.

Shefer, D., Frenkel, A., 2005. R&D, firm size and innovation: an empirical analysis. *Technovation,* 25(1): 25–32.

Singh, J. 2008. Distributed R&D, cross-regional knowledge integration and quality of innovative output. *Research Policy*, 37(1): 77-96.

Smith, K. G., Collins, C. J., Clark, K. D. 2005. Existing knowledge, knowledge creation capability, and the rate of new product introduction in high-technology firms. *Academy of Management Journal,* 48(2): 346-357.

Sole, D., Edmondson, A. 2002. Situated Knowledge and Learning in Dispersed Teams. *British Journal of Management,* 13: S17–S34.

Spender, J. C., Grant, R. M. 1996. Knowledge and the firm: overview. *Strategic Management Journal*, 17 (winter special issue): 5-9.

Stringfellow, A., Teagarden, M. B., Nie, W. 2008. Invisible costs in offshoring services work. *Journal of Operations Management,* 26: 164-179.

Szulanski, G. 1996. Exploring internal stickiness: impediments to the transfer of best practice within the firm. *Strategic Management Journal*, 17 (winter special issue): 27-43.

Szulanski, G., Jensen, R. J. 2006. Presumptive adaptation and the effectiveness of knowledge transfer. *Strategic Management Journal*, 27: 937-957.

Teece, D. J. 1977. Technology transfer by multinational firms: the resource cost of transferring technological know-how. *The Economic Journal,* 87: 242-261.

Teixeira, A. A. C., Santos, P., Oliveira-Brochado, A. 2008. International R&D cooperation between low-tech SMES: the role of cultural and geographical proximity. *European Planning Studies,* 16(6): 785-810.

Tsoukas, H. 1996. The firm as a distributed knowledge system: A constructionist approach. *Strategic Management Journal*, 17 (winter special issue): 11-25.

Turner, K. L., Makhija, M. V. 2006. The role of organizational controls in managing knowledge. *Academy of Management Review,* 31(1): 197-217.

Ughetto, E. 2008. Does internal finance matter for R&D? New evidence from a panel of Italian firms. *Cambridge Journal of Economics,* 2 (6): 907-925.

Un, C. A. 2011, The advantage of foreignness in innovation. *Strategic Management Journal*, 32: 1232-1242.

United Nations Conference and Trade and Development (UNCTAD). 2005. *Transnational Corporations and the Internationalization of R&D*. World Investment Report, United Nations: New York.

van Beers, C., Zand, F. 2014. R&D Cooperation, Partner Diversity, and Innovation Performance: An Empirical Analysis. *Journal of Product Innovation Management,* 31: 292–312.

Vega-Jurado, J., Gutiérrez-Gracia, A., Fernández-de-Lucio, I. 2009. Does external knowledge sourcing matter for innovation? Evidence from the Spanish manufacturing industry. *Industrial & Corporate Change*, 18: 637-670.

Veugelers, R., Cassiman, B. 1999. Make and buy in innovation strategies: evidence from Belgian manufacturing firms, *Research Policy*, 28: 63–80.

Wernerfelt, B. 1984. A resource-based view of the firm. *Strategic Management Journal,* 5: 171-180.

West, J., Bogers, M. 2014. Leveraging External Sources of Innovation: A Review of Research on Open Innovation. *Journal of Product Innovation Management*, 31: 814–831.

West, J., Salter, A. Vanhaverbeke, W., Chesbrough, H. 2014. Open innovation: The next decade. *Research Policy,* 43 (5): 805–811.

Wu, J. 2012. Technological collaboration in product innovation: The role of market competition and sectoral technological intensity. *Research Policy*, 41 (2): 489–496.

Wu, J., Wu, Z. 2014. Local and international knowledge search and product innovation: The moderating role of technology boundary spanning. *International Business Review,* 23 (3):542-551.

Zhao, M. 2006. Conducting R&D in countries with weak intellectual property rights protection. *Management Science*, 52: 1185-1199.

Zahra, S. A., Ireland, R. D., Hitt, M. A. 2000. International expansion by new venture firms: International diversity, mode of market entry, technological learning, and performance. *Academy of Management Journal,* 43(5): 925-950.

Figure 1. Theoretical framework

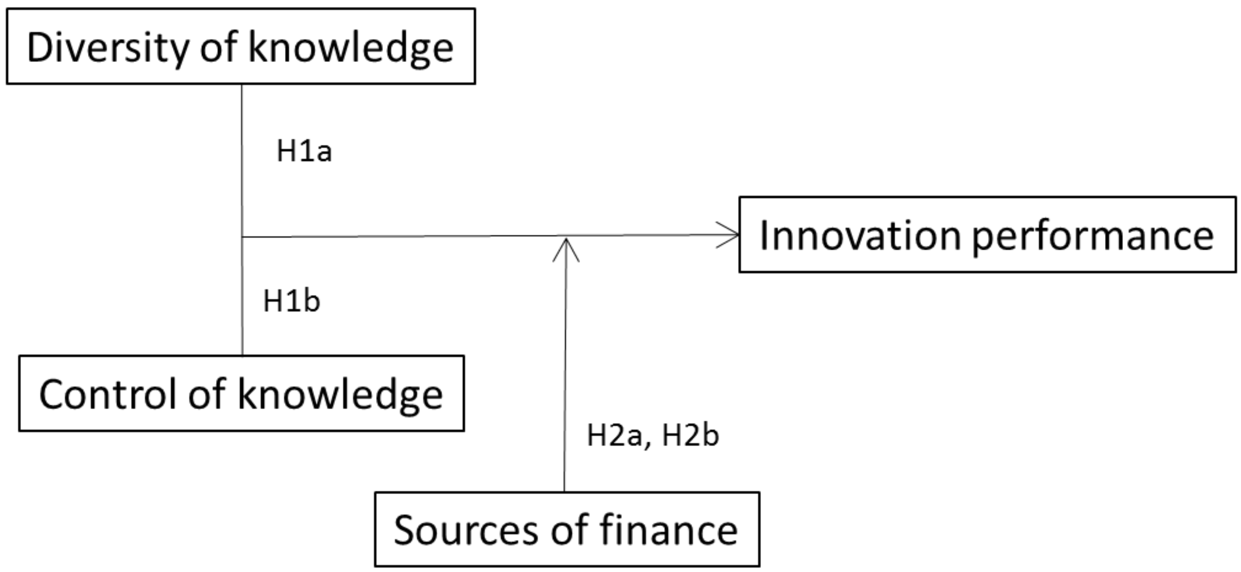

Table 1. Descriptive statistics, correlation matrix and collinearity diagnostic

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	VIF
1.Sale of new product	1.000																			-
2.Sale of product new to the firm	0.45***	1.000																		-
3.Sale of product new to the market	0.63***	0.05***	1.000																	-
4.Onshore insourcing R&D	0.54***	0.18***	0.44***	1.000																2.06
5.Onshore outsourcing R&D	0.28***	0.09***	0.24***	0.40***	1.000															1.38
6.Offshore insourcing R&D	0.07***	0.02***	0.05***	0.06***	0.06***	1.000														1.07
7.Offshore outsourcing R&D	0.11***	0.02***	0.10***	0.18***	0.27***	0.07***	1.000													1.10
8. Size	-0.09***	-0.07***	-0.05***	-0.06***	0.02***	0.09***	0.06***	1.000												1.29
9. New firm	0.05***	0.06***	0.03***	0.04***	0.02***	-0.01*	0.00	-0.08***	1.000											1.03
10. Group	-0.01***	-0.01	-0.01**	0.01	0.02***	-0.00	0.03***	0.22***	0.01*	1.000										1.14
11.Foreign ownership	0.02***	-0.00	0.02***	0.03***	-0.00	0.22***	0.04***	0.25***	-0.01***	-0.19***	1.000									1.26
12. International	0.27***	0.09***	0.21***	0.33***	0.17***	0.08***	0.11***	0.00	-0.03***	-0.01	0.18***	1.000								1.22
13. Collaboration	0.30***	0.10***	0.25***	0.36***	0.38***	0.08***	0.15***	0.03***	0.04***	0.06***	0.03***	0.14***	1.000							1.27
14. Patent	0.26***	0.05***	0.26***	0.28***	0.21***	0.04***	0.13***	-0.00	0.01	0.00	0.01*	0.17***	0.17***	1.000						1.26
15.Intellectual property rights	0.25***	0.07***	0.23***	0.22***	0.17***	0.00	0.08***	-0.00	0.03***	-0.01**	-0.03***	0.17***	0.14***	0.38***	1.000					1.22
16.Innovation effort	0.25***	0.10***	0.23***	0.37***	0.22***	0.00	0.10***	-0.29***	0.13***	-0.05***	-0.07***	0.01**	0.19***	0.12***	0.09***	1.000				1.34
17.Multilocation	0.11***	0.01**	0.12***	0.20***	0.15***	0.05***	0.08***	0.11***	-0.00	0.05***	0.08***	0.06***	0.13***	0.07***	0.04***	0.07***	1.000			1.08
18.Internal sources of finance	0.30***	0.10***	0.24***	0.52***	0.23***	0.03***	0.10***	-0.06***	0.00	-0.01*	0.00	0.22***	0.22***	0.16***	0.14***	0.19***	0.10***	1.000		2.39
19.External sources of finance	0.09***	0.01***	0.09***	0.18***	0.15***	0.00	0.07***	-0.01**	0.00	0.01	-0.01***	0.07***	0.15***	0.06***	0.04***	0.15***	0.06***	0.68***	1.000	1.83
Mean	0.49	0.38	0.28	6.17	2.49	0.18	0.33	4.51	0.01	0.21	0.12	0.58	0.27	0.12	0.23	0.03	0.27	0.73	0.58	
Stand. Dev.	0.50	0.48	0.45	6.13	4.59	1.50	1.88	1.59	0.09	0.41	0.33	0.49	0.44	0.32	0.42	0.08	0.16	0.44	0.49	
Mean VIF																				1.37

Significance levels: ***p<0.01, **p<0.05,*p<0.10. N=25077.

Table 2.- R&D sources on sale of new product, sale of product new to the firm, and sale of product new to the market

	Sale of new product		Sale of product new to the firm		Sale of product new to the market	
	Model 2a	Model 2b	Model 2c	Model 2d	Model 2e	Model 2f
Onshore insourcing R&D$_{t-1}$	--	0.109***	--	0.0749***	--	0.0913***
		(0.00440)		(0.00393)		(0.00432)
Onshore outsourcing R&D$_{t-1}$	--	0.0355***	--	0.0184***	--	0.0212***
		(0.00484)		(0.00407)		(0.00424)
Offshore insourcing R&D$_{t-1}$	--	0.0756***	--	0.0544***	--	0.0219*
		(0.0164)		(0.0126)		(0.0123)
Offshore outsourcing R&D$_{t-1}$	--	-0.00533	--	-0.00498	--	-0.00762
		(0.0115)		(0.00910)		(0.00898)
Internal sources of finance$_{t-1}$	1.062***	0.825***	0.782***	0.612***	0.864***	0.650***
	(0.0495)	(0.0503)	(0.0438)	(0.0445)	(0.0478)	(0.0491)
External sources of finance$_{t-1}$	0.0602	0.0310	-0.0209	-0.0390	0.142***	0.122**
	(0.0649)	(0.0646)	(0.0529)	(0.0524)	(0.0537)	(0.0531)
Size$_{t-1}$	-0.00670	-0.0594***	0.00463	-0.0336*	0.0279	-0.0227
	(0.0213)	(0.0208)	(0.0189)	(0.0186)	(0.0197)	(0.0197)
New firm$_{t-1}$	1.182***	1.155***	0.880***	0.863***	0.415**	0.392**
	(0.190)	(0.188)	(0.162)	(0.161)	(0.176)	(0.174)
Group$_{t-1}$	-0.0125	-0.0331	-0.00502	-0.0206	0.00386	-0.0107
	(0.0668)	(0.0655)	(0.0592)	(0.0582)	(0.0613)	(0.0610)
Foreign ownership$_{t-1}$	-0.0558	-0.0341	-0.0976	-0.0978	0.0384	0.0783
	(0.0857)	(0.0846)	(0.0756)	(0.0751)	(0.0778)	(0.0781)
International$_{t-1}$	0.592***	0.442***	0.431***	0.328***	0.436***	0.317***
	(0.0567)	(0.0558)	(0.0508)	(0.0504)	(0.0538)	(0.0538)
Collaboration$_{t-1}$	0.746***	0.523***	0.498***	0.361***	0.509***	0.349***
	(0.0481)	(0.0482)	(0.0407)	(0.0410)	(0.0418)	(0.0425)
Patent$_{t-1}$	0.643***	0.485***	0.174***	0.0860	0.531***	0.429***
	(0.0709)	(0.0702)	(0.0567)	(0.0561)	(0.0572)	(0.0569)
Intellectual property rights$_{t-1}$	0.595***	0.544***	0.372***	0.329***	0.480***	0.427***
	(0.0516)	(0.0513)	(0.0438)	(0.0435)	(0.0454)	(0.0452)
Innovation effort$_{t-1}$	3.789***	1.015***	1.607***	0.0649	3.168***	1.286***
	(0.301)	(0.299)	(0.241)	(0.247)	(0.253)	(0.261)
Multilocation$_{t-1}$	0.757***	0.219	0.285**	-0.0269	0.614***	0.267**
	(0.148)	(0.146)	(0.117)	(0.116)	(0.117)	(0.115)
Industry dummies	Included	Included	Included	Included	Included	Included
Year dummies	Included	Included	Included	Included	Included	Included
Intercept	-1.883**	-2.146***	-2.062***	-2.266***	-2.140***	-2.302***
	(0.827)	(0.805)	(0.724)	(0.716)	(0.712)	(0.706)
Wald test of full model (χ^2)	2744.8	3003.1	1833.5	2090.6	2008.1	2222.3
Log. likelihood	-9877.1	-9493.4	-11406.9	-11190.0	-9673.5	-9406.2

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Number of observations: 25077

Table 3. Wald tests results

	Sale of new product$_t$	Sale of product new to the firm$_t$	Sale of product new to the market$_t$
Comparison Tests	(Model 2b)	(Model 2d)	(Model 2f)
$\beta^{\text{onshore insourcing}} > \beta^{\text{onshore outsourcing}}$:	χ^2 =113.88***	χ^2 =88.67***	χ^2 =120.31***
$\beta^{\text{onshore insourcing}} > \beta^{\text{offshore insourcing}}$:	χ^2 = 3.91**	χ^2 = 2.43	χ^2 = 28.58***
$\beta^{\text{onshore insourcing}} > \beta^{\text{offshore outsourcing}}$:	χ^2 =84.56***	χ^2 =64.31***	χ^2 =97.28***
$\beta^{\text{offshore insourcing}} > \beta^{\text{onshore outsourcing}}$:	χ^2 = 5.47**	χ^2 = 7.33***	χ^2 = 0.00
$\beta^{\text{onshore outsourcing}} > \beta^{\text{offshore outsourcing}}$:	χ^2 = 9.74***	χ^2 = 5.01**	χ^2 = 7.58***
$\beta^{\text{offshore insourcing}} > \beta^{\text{offshore outsourcing}}$:	χ^2 =16.40***	χ^2 =14.59***	χ^2 =3.71**
Joint tests			
$\beta^{\text{onshore insourcing}} > \beta^{\text{offshore insourcing}} > \beta^{\text{onshore outsourcing}} > \beta^{\text{offshore outsourcing}}$:	χ^2 = 168.85***	χ^2 = 126.44***	χ^2 = 180.00***

Significance levels: ***p<0.01, **p<0.05,*p<0.10.

Table 4.- Sources of funds and R&D sources on sale of new product, sale of product new to the firm, and sale of product new to the market

	Sale of new product	Sale of product new to the firm	Sale of product new to the market
	Model 4a	Model 4b	Model 4c
Onshore insourcing R&D$_{t-1}$	0.0792***	0.0572***	0.0761***
	(0.00628)	(0.00584)	(0.00660)
Onshore outsourcing R&D$_{t-1}$	0.0711***	0.0673***	0.0388***
	(0.00836)	(0.00774)	(0.00883)
Offshore insourcing R&D$_{t-1}$	0.0653***	0.0404**	0.0249
	(0.0223)	(0.0205)	(0.0223)
Offshore outsourcing R&D$_{t-1}$	0.00802	0.00910	0.00214
	(0.0260)	(0.0240)	(0.0276)
Internal sources of finance$_{t-1}$	1.608***	1.381***	1.240***
	(0.108)	(0.0987)	(0.107)
External sources of finance$_{t-1}$	-0.991***	-0.928***	-0.653***
	(0.121)	(0.108)	(0.115)
Onshore insourcing R&D X	-0.0289***	-0.0376***	-0.0306***
Internal sources of finance	(0.0108)	(0.00981)	(0.0105)
Onshore insourcing R&D X	0.100***	0.0829***	0.0675***
External sources of finance	(0.00997)	(0.00887)	(0.00943)
Onshore outsourcing R&D X	-0.0571***	-0.0689***	-0.0291***
Internal sources of finance	(0.0110)	(0.00959)	(0.0105)
Onshore outsourcing R&D X	0.00385	0.00500	0.00921
External sources of finance	(0.00902)	(0.00723)	(0.00730)
Offshore insourcing R&D X	-0.00423	0.0222	-0.00503
Internal sources of finance	(0.0345)	(0.0273)	(0.0277)
Onshore insourcing R&D X	0.0341	-0.00426	0.00129
External sources of finance	(0.0327)	(0.0222)	(0.0209)
Offshore outsourcing R&D X	-0.0290	-0.00537	-0.0208
Internal sources of finance	(0.0311)	(0.0268)	(0.0306)
Offshore outsourcing R&D X	0.0206	-0.0115	0.0160
External sources of finance	(0.0221)	(0.0164)	(0.0165)
Size$_{t-1}$	-0.0606***	-0.0311*	-0.0231
	(0.0209)	(0.0187)	(0.0198)
New firm$_{t-1}$	1.116***	0.850***	0.387**
	(0.188)	(0.162)	(0.174)
Group$_{t-1}$	-0.0263	-0.0160	-0.00558
	(0.0657)	(0.0583)	(0.0612)
Foreign ownership$_{t-1}$	-0.0144	-0.0815	0.0988
	(0.0850)	(0.0753)	(0.0784)
International$_{t-1}$	0.407***	0.304***	0.299***
	(0.0561)	(0.0506)	(0.0540)
Collaboration$_{t-1}$	0.513***	0.353***	0.341***
	(0.0484)	(0.0411)	(0.0426)
Patent$_{t-1}$	0.483***	0.0872	0.429***
	(0.0704)	(0.0562)	(0.0570)
Intellectual property rights$_{t-1}$	0.541***	0.328***	0.427***
	(0.0515)	(0.0436)	(0.0453)
Innovation effort$_{t-1}$	0.915***	-0.00714	1.224***
	(0.300)	(0.247)	(0.261)
Multilocation$_{t-1}$	0.210	-0.0149	0.258**
	(0.146)	(0.117)	(0.115)
Industry dummies	Included	Included	Included
Year dummies	Included	Included	Included
Intercept	-2.231***	-2.357***	-2.364***
	(0.812)	(0.718)	(0.712)
Wald test of full model (χ^2)	3035.5	2164.4	2230.0
Log. likelihood	-9402.5	-11110.1	-9368.6

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Number of observations: 25077