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DOES R&D OFFSHORING LEAD TO SME GROWTH? DIFFERENT GOVERNANCE MODES AND THE MEDIATING ROLE OF INNOVATION

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Research summary: In this paper we address the role of R&D offshoring strategies in the sales growth of small and medium-sized enterprises (SMEs). We propose that different governance modes of R&D offshoring –insourcing versus outsourcing– may lead to growth, but that they differ in their effects. In turn, we argue that innovation mediates the relation between international R&D sourcing strategies and sales growth. Based on a large database of SME manufacturing enterprises in Spain, we find that offshore outsourcing positively affects sales growth both directly and indirectly, while offshore insourcing only affects sales growth indirectly via innovation results. The analysis reveals different contributions of each governance mode to sales growth and the mediating role of innovation in the relation between R&D offshoring and firm growth.

Managerial summary: We analyze how different governance modes of international R&D sourcing –offshore insourcing and outsourcing– may contribute to growth in SMEs. Modes of offshore R&D outsourcing positively affect the growth of sales in two ways. One effect is direct, produced by improved efficiency, flexibility, enhanced resources and access to new markets. And the other effect is indirect, as offshore R&D outsourcing favors the achievement of innovations and this in turn positively affects firm growth. For their part, captive modes only exert an indirect effect. Offshore R&D insourcing contributes to the achievement of innovations, and thus ultimately to firm growth in so far as these innovations enable SMEs to increase sales. Therefore, innovation results perform a mediating role in the relation between R&D offshoring and sales growth.

Keywords: Sales growth, Offshore R&D insourcing, Offshore R&D outsourcing, Innovation, Mediation, SME.

INTRODUCTION

Sales growth in small and medium-sized enterprises (SMEs) is a current topic of debate for academics and practitioners (Lechner, Soppe and Dowling, 2014; Cowling *et al.*, 2014, Wright *et al.,* 2015), with discussion continuing over the factors that may influence the growth of these firms (Freel and Robson, 2004; Golovko and Valentini, 2011; Love and Roper, 2015). In recent years, R&D investment and innovation have been analyzed as sources of firm growth (Audrescht, Coad and Segarra, 2014; Nunes, Serrasqueiro and Litão, 2012). The relation among R&D, innovation and firm growth is not straightforward, but is often positive (Coad, 2009). Beyond the inconclusive findings of the previous literature, questions such as the potential impact of international sourcing of R&D activities still remain unexplored. In this paper we address the role of R&D offshoring[1] strategies on the growth of SMEs.

Previous research shows that firms performing R&D offshoring strategies enhance their innovation capabilities (Bertrand and Mol, 2013; Mihalache *et al*., 2012; Nieto and Rodríguez, 2011). The implications of R&D offshoring strategies, though, are not limited to improved innovation results; they can also include multiple strategic objectives (Jensen and Pedersen, 2011). Previous work –based on data from the Offshoring Research Network (ORN) on managers' perceptions– indicates that the development of R&D offshoring strategies may represent a way of overcoming the restrictions that potentially hinder the achievement of growth targets in today's hyper-competitive markets (Massini *et al*., 2010; Lewin and Peeters, 2006b). These limitations are especially relevant for SMEs, which may see international R&D sourcing as an attractive strategy to overcome their limited resources, particularly in terms of R&D investment (Buse, Tiwari and Herstatt, 2010).

[1] In this work offshoring strategies are defined as a sourcing of activities outside a firm's base country in order to serve its home country or global operational requirements (Elia, Caniato, Luzzini and Piscitello, 2014; Massini, Perm-Ajchariyawong and Lewin, 2010). Furthermore, since the terms 'offshoring' and 'international sourcing' are sometimes used synonymously (Coucke and Sleuwagen, 2008; Nassimbeni, 2006), we use the terms 'R&D offshoring' and 'international R&D sourcing' interchangeably in the text.

When firms offshore R&D activities they must choose between performing R&D activities overseas via foreign-based affiliates (i.e., offshore R&D insourcing or captive) or via relationships with independent third parties (i.e., offshore R&D outsourcing) (Manning *et al*., 2008; UNCTAD, 2004). The choice of governance mode may bring different advantages for access to resources, as well as gains in organizational efficiency and/or flexibility (Kedia and Mukherjee, 2009; Metters, 2008). In general, no one governance mode is inherently superior (Gooris and Peeters, 2014; Metters, 2008) –not even (and contrary to general expectations) for SMEs (Roza *et al*., 2011).

In this paper, therefore, we investigate how the different governance modes of R&D offshoring may affect sales growth in SMEs. In line with Singh and Mitchell (2005), we focus on business sales as a measure of performance for two basic reasons. First, sales and sales growth are relevant as managers frequently take these factors into account in their decisions. Second, sales growth is especially important for SMEs because it is critical for their competitiveness and survival (Golovko and Valentini, 2011). With this in mind, we explore the potential effects of both governance modes –insourcing/captive and outsourcing– on sales growth in two ways. First, we explore if R&D offshoring directly affects sales growth. And second, we question whether an indirect effect is exerted via innovation. Previous studies reveal the existence of two relations: (i) the positive relation between R&D offshoring and innovation results (Bertrand and Mol, 2013; Nieto and Rodríguez, 2011); and (ii) the positive relation between innovation and firm growth (Cho and Pucik, 2005; Golovko and Valentini, 2011; Love, Roper and Bryson, 2011). These findings lead us to analyze how innovation may mediate the relation between the two governance modes of R&D offshoring (captive and outsourcing) and firm growth. In summary, we aim to discover how the different governance modes of international R&D sourcing may be beneficial for SMEs –directly and/or indirectly via innovation– in terms of sales growth. To perform the empirical analysis, we use a large sample of SMEs in different manufacturing sectors for the period from 2004 to 2007.

The contribution of this paper is threefold. First, the paper contributes to the discussion on the relations among R&D investment, innovation and firm growth (Corsino and Gabriele, 2010; Choi and Williams, 2014; Coad and Rao, 2008). The evidence supporting these relations has not always been consistent (Audretsch *et al*. 2014), with the lack of conclusive findings on the effect of innovation on firm growth possibly resulting from the use of highly different measures that sometimes confuse innovation inputs and outputs. In this paper, we clearly distinguish between inputs (R&D activities) and outputs (innovation results) and analyze the mediating role of innovation between R&D offshoring and sales growth in SMEs. In this way, we contribute to the literature by providing a more complete vision of the potential interrelations among them. We also extend previous work that finds a positive relation between domestic R&D and sales growth (García-Majón and Romero-Merino, 2013; Del Monte and Papagni, 2003), advancing in this stream of research by introducing the dimension of international location of R&D. And unlike previous studies that simply analyze R&D investments, we identify whether R&D activities performed overseas are 'make or buy' and examine whether offshore insourcing and outsourcing have different implications for firm growth. Second, the work contributes to the offshoring knowledge services literature -particularly R&D offshoring- and specifically, on the implications and opportunities that these strategies may bring for firms (Bunyaratavej et al., 2011). As far as we are aware, most of the literature focuses on the motives for R&D offshoring (Lewin *et al*., 2009; Ambos and Ambos, 2011) and the choice of location (Demirbag and Glaister, 2010; Jandhyala, 2013; Jensen and Pedersen, 2011; Hahn and Bunyaratevej, 2010; Martínez-Noya, García-Canal, Guillén, 2012), limiting the analysis of the consequences of R&D offshoring to productivity (Tang and Livramento, 2010) or innovation (Bertrand and Mol, 2013; Mihalache *et al.,* 2012; Nieto and Rodríguez, 2011). We contribute to this line of research by examining theoretical and empirical evidence on the effects of different governance modes of R&D offshoring on sales growth. Third, this paper focuses on SMEs and offers evidence on the potential benefits of R&D offshoring and contributory factors to firm growth. On the one hand,

the analysis of factors that contribute to growth in SMEs remains crucial in order to contribute to the competitiveness and survival of these firms (Golovko and Valentini, 2011; Nunes, Serrasqueiro and Litão, 2012). And on the other, the study of offshoring in SMEs is still in its infancy, even though these firms play a central role in many economies and are opting for both insourcing and outsourcing offshore strategies more and more frequently (Roza, *et al*. 2011). Offshoring strategies are of particular interest for SMEs as they provide them with opportunities to augment their limited in-house R&D capacities (Buse, Tiwari and Herstatt, 2010) and identify new business opportunities (Angeli and Grimaldi, 2010).

The structure of the paper is as follows. The first section contextualizes the strategic advantages that move SMEs to offshore and develops the theoretical framework and hypotheses. The study then goes on to describe the database and methodological approach and the empirical results obtained. The paper finishes with a discussion of its findings and implications, along with some limitations and ideas for future research.

THEORETICAL DEVELOPMENT AND HYPOTHESES

Strategic advantages that lead SMEs to offshore

Firms that perform R&D offshoring strategies are looking for different strategic advantages (Ambos and Ambos, 2011) related to cost reductions, efficiency gains, resource enhancement, and market opportunities. The differences in factor costs can provide firms with significant advantages. Since each country has different sources of relative efficiencies (Bunyaratavej *et al*., 2008), the degree of cost savings depends on location. In many destination countries, the savings derived from lower wages and other operational and factor costs can be substantial. Emerging markets (which traditionally display the greatest differences in factor cost levels) are attractive for small firms. Despite their limited resources, these firms look to near-shore locations such as western European countries as destinations, as well as (and contrary to general expectations) to far-shore locations with lower costs (Roza *et al*., 2011).

Firms in search of advantages linked to factor costs will favor developing countries for their operations, but cost may not be the only aspect that they consider when choosing an overseas base (Bunyaratavej *et al*., 2007). Access to better resources and knowledge is another of the advantages that R&D offshoring strategies can supply. Offshoring firms obtain a gateway to qualified personnel who may be scarce in their home countries, but widely available in other parts of the world (Manning *et al*., 2008) –a benefit of particular value for small firms. Thanks to the growing availability of external service providers and multiple offshore locations with relevant and competitive resources, then, SMEs can overcome size disadvantages and resource constraints –especially their limited in-house R&D endowments (Buse *at el.*, 2010; Lewin *et al*., 2009).

In addition to advantages related to cost savings, efficiency, and enhanced global resources, offshoring enables firms to become embedded in the local context. In this way, firms can learn from international experience and adapt to rapidly changing offshoring environments and opportunities (Angeli and Grimaldi, 2010). Consequently, these companies explore and stretch the boundaries of the firm, thereby improving the odds of identifying new opportunities and entering new markets. Beyond this, offshoring firms are able to leverage their experiential knowledge and social networking advantages in order to drive their expansion into foreign markets (Di Gregorio *et al*., 2009), benefits that are particularly appealing to SMEs.

The opportunities for SMEs to take advantage of offshoring advantages are constantly growing due to advances in information and communication technology (ICT) that enable them to interact globally (Bunyaratevej et al., 2008; Contractor et al., 2010; UNCTAD, 2004). These advantages will differ depending on the governance mode of offshoring. And firms would benefit from knowing how each governance mode of offshore R&D activities may contribute to growth.

The direct effect of R&D offshoring on sales growth: Leveraging the advantages from different governance modes

Differences in cost and the availability of enhanced resources among countries make it possible for firms to increase their competitiveness when they offshore their activities (Berry, 2005;

Chung and Yeaple, 2008; Coucke and Sleuwaegen, 2008; UNCTAD, 2004). Additionally, firms see offshoring as a way to: open new markets (Jensen, 2009; Lewin and Peeters, 2006a); gain flexibility (Lewin and Couto, 2007); or increase the speed to market (Heijmen *et al*., 2009; Lewin *et al*. 2009). All these potential advantages of international sourcing may help firms –particularly SMEs– position themselves better in the market and increase sales. It is important to note, however, that different governance modes may have different implications for performance (Castañer *et al*., 2014; Elia *et al*., 2014). Consequently, we analyze each of the potential advantages associated with international sourcing strategies that contribute to sales growth, highlighting if and how they are related to each governance mode.

Access to enhanced resources. R&D offshoring offers the possibility of gaining access to new and improved resources and specialized knowledge in the host country (Lewin *et al*., 2009; Manning *et al*., 2008). These resource-specific advantages in offshore locations allow firms to incorporate higher quality inputs and serve their domestic or international markets with improved products and services (Bardhan, 2006; Tate *et al.*, 2009). And the improved products leave firms better placed in markets, thereby increasing their sales. A priori, both governance modes provide access to these resource advantages. The establishment of captive centers requires firms to hire personnel to create their own internal units to develop the activity in the value chain and take advantage of overseas technical expertise. This technical expertise has a positive impact on firms, but is easier to maintain up to date when outsourced rather than performed in-house (Metters, 2008), since outsourcing modes provide firms with access to a wide range of suppliers with the latest technologies (Quinn and Hilmer, 1994). Outsourcing to specialized suppliers permits firms to complement their resources and absorb new knowledge that would be unobtainable in any other way. Firms, then, are able to obtain advantages from suppliers in those activities in which they lack skills or need external knowledge to maintain their competitiveness (Jabbour, 2010), which is particularly important for SMEs given their unique resource constraints.

Access to new markets. In the case of important activities such as R&D, firms are likely to make a significant effort to improve knowledge of the environment in which they will be operating. Accordingly, R&D offshoring organizations acquire useful knowledge to gain access to new markets through different international R&D sourcing activities –via affiliates or independent parties. R&D offshoring organizations are immersed in an intense process of learning about the international environment, as well as developing the capabilities required to compete on the international stage. On the one hand, offshoring firms will reduce the perceived risk in their international operations by improving the skills required to operate abroad. And on the other, firms will be better positioned to identify and exploit business opportunities. All of this will encourage firms to look abroad and thus increase their sales.

The installation of a captive center in which to conduct R&D activities requires firms to hire and train employees, acquire official permits, and manage the daily business in host countries. This experience enables them to familiarize themselves with the host country's institutions, as well as its legal system, language and culture (Metters, 2008). For their part, firms that choose to outsource will endeavor to locate potential suppliers that can provide the best service in order to minimize the inherent risks of subcontracting these activities (Ellram, Tate and Billington, 2008). Firms need to negotiate and contract suppliers abroad that equip them with greater skills for marketing their products and/or services to prospective buyers.

Firms accumulate experience from operating in these markets, all the while learning to collaborate and negotiate better contracts (Coltman *et al*., 2009) and thereby develop their contract design capabilities (Argyres and Mayer, 2007). Enhanced contract and relational capabilities are potential contributors to improved satisfaction and performance (Poppo and Zenger, 2002) and can be an important source of competitive advantage (Argyres and Mayer, 2007). Moreover, this process will provide firms with a larger network of international contacts that may aid subsequent or greater international expansion (Di Gregorio *et al*., 2009). The network relationships developed via international sourcing operations are invaluable for

facilitating the internationalization of SMEs (Holmlund and Kock, 1998; Zain and Ng, 2006). In line with this, previous studies find that inward operations often precede outward operations, especially in the SME setting (Holmlund, Kock and Vanyushyn, 2007; Korhonen, Welch and Luostarinen, 1993). Therefore, international R&D sourcing strategies help SMEs develop enhanced capabilities to tackle new international markets and augment the client base.

Cost savings and efficiency gains. In hyper-competitive markets, cost savings and efficiency gains allow firms to position themselves better and thereby augment their sales. While offshoring in general provides access to more economical inputs, it is offshore outsourcing that has traditionally been seen as a more appropriate strategy to cut costs and increase efficiency (Farrell, 2005; Hutzschenreuter, Lewin and Dresel, 2011). These benefits are likely to be higher for activities such as R&D (Massini *et al*., 2010). This is particularly the case in so far as these projects require skilled and experienced workers who may be difficult and expensive for SMEs to find in their home countries, and yet widely available and relatively cheaper in other locations (Manning *et al*., 2008). In developing countries local suppliers can obtain benefits by paying lower salaries, while in developed countries firms can benefit from superior technology or economies of scale (Bertrand, 2011). Even in locations where cost differences are not so great, offshore R&D outsourcing can provide cost advantages for SMEs thanks to access to providers' scale advantages that SMEs do not typically enjoy (Roza *et al*., 2011). External suppliers have the capacity to aggregate the demands of a wide set of buyers (Poppo and Zenger, 1998). The opportunity to choose among suppliers from all around the world improves firms' chances of finding scale and concomitant cost advantages. Thus, offshore outsourcing is a beneficial strategy for cost-saving and efficiency gains that betters the competitive position of SMEs. Additionally, offshore outsourcing frees up resources (Mukherjee *et al*., 2013) that can be re-allocated to other areas such as market research and marketing, which is another factor that can help boost sales.

Improved flexibility and time to market. Another critical dimension for strengthening competitive position and winning customer orders is enhancing flexibility across the value chain.

Organizations seek value chain flexibility (Zhang and Vonderembse, 2002) and can achieve it via the disintegration and externalization of the value chain overseas (Kedia and Murkherjee, 2009; Mukherjee *et al*., 2013). These moves contribute to the firm's capacity to take advantage of offshore R&D resources quickly in order to adjust volume of products to fluctuations in demand and increase speed to market (Lewin *et al*., 2009; Manning *et al*., 2008). Time to market is a highly competitive issue (Vesey, 1991), with speed-based agility representing a source of competitive advantage (Nayyar and Bantel, 1994). Firms with a propensity for change, then, are able to gain market share by reducing the time to market and enhancing product profitability (McNally, Akdeniz and Calantone, 2011; Vesey, 1991). Offshore outsourcing has been linked to greater flexibility (Farrell, 2005). This governance mode requires a lower level of resource commitment and permits firms to choose the supplier that delivers the maximum advantage in each case. In addition, offshore outsourcing could allow firms to concentrate on their core capacities, with each party specializing on the area where it possesses the greatest competitive advantage, thus allowing offshoring firms to leverage the capabilities of foreign suppliers (Kedia and Murkherjee, 2009; Mukherjee *et al*., 2013) and take advantage of the shortened time to market. Flexibility and time-to-market benefits are crucial for SMEs to strengthen their ability to react to changing market requirements, which in turn will increase their chances of dominating market niches and boosting sales.

In conclusion, R&D offshoring strategies result in enhanced competitiveness that leaves firms better placed to win market share and augment sales. More specifically, some of the advantages inherent to international R&D sourcing are predominantly linked with offshore outsourcing strategies. Offshore outsourcing, then, is likely to be the governance mode that exerts a greater direct impact on sales growth. The reasons for this reside in its ability to deliver higher levels of efficiency, flexibility and access to a deeper pool of specialized resources by leveraging the capabilities of foreign suppliers. Moreover, these suppliers make it possible to increase speed to market, which also contributes to sales growth. This is especially important for SMEs, which may

find more difficulties to stay up to date via captive centers. These arguments lead us to expect that both governance modes of R&D offshoring will have a direct effect on firm growth, but that outsourcing modes will have a greater effect on sales growth in SMEs than insourcing modes. Therefore, we postulate the following hypothesis:

> *Hypothesis 1: R&D offshoring will have a positive and direct effect on sales growth in SMEs, with offshore R&D outsourcing having a greater effect than offshore R&D insourcing.*

The indirect effect of R&D offshoring on sales growth: the mediating role of innovation

Building on previous work pointing to a relation between R&D offshoring and innovation (Bertrand and Mol, 2013; Nieto and Rodríguez, 2011) and between innovation and firm growth (Freel, 2000; Golovko and Valentini, 2011; Love *et al*., 2011), we study the indirect relation between R&D offshoring and sales growth, considering the mediating role of innovation.

R&D offshoring provides firms with an opportunity to gain access to highly qualified engineers and scientists who may be difficult to find within their own borders (Lewin *et al*., 2009; Manning *et al*., 2008). Offshoring, then, is an effective method of obtaining or improving the inputs necessary for innovation (Couto *et al.*, 2007). In this way, firms are able to benefit from R&D developed overseas, as well as from interaction with actors endowed with complementary knowledge from different and dispersed locations (Bertrand and Mol, 2013). R&D offshoring, therefore, gives firms the advantages of specialization and of specific resources located overseas, advantages that can deliver better innovation results, as Nieto and Rodríguez (2011) show. Although the two governance modes of R&D offshoring contribute positively to innovation, these authors point out that captive R&D offshoring has a greater impact than offshore R&D outsourcing. The former has a stronger effect because it offers firms the advantages of R&D offshoring, providing greater control and minimizing the inherent risks of knowledge transfer (e.g., information leakage or appropriability problems). For SMEs, international R&D sourcing

makes it possible to surmount barriers to innovation that are related to their smaller size and limited resources. These firms, then, view global innovation as a means of mitigating the problems they face to innovate in the home country (Buse *et al*., 2010).

For its part, the capacity of firms to innovate is also positively related to firm growth (Geroski and Toker, 1996; Love *et al.*, 2011; Nelson and Winter, 1982). Firms with heavy investments in R&D display higher growth rates in so far as this R&D expense translates into successful new products for the market (Del Monte and Papagni, 2003; García-Manjón and Romero-Merino, 2012). Innovative products provide firms with the opportunity to differentiate themselves from competitors (Kleinschmidt and Cooper, 1991). These new products allow firms to remain competitive by adapting and re-inventing themselves (Brown and Eisnhardt, 1995), as well as helping to boost demand and market share (Madrid-Guijarro, García and Van Auken, 2009). In line with this, Freel (2000) finds that innovative small UK manufacturing firms are more likely to experience particularly rapid growth than non-innovative ones.

All these arguments lead us to postulate that both governance modes of R&D offshoring have an indirect effect on firm growth. In other words, since offshore R&D insourcing and outsourcing contribute to the achievement of innovation results and these in turn are linked to higher growth in SMEs, an indirect effect via innovation is likely to exist between international R&D sourcing strategies and sales growth. The following hypothesis captures this idea:

> *Hypothesis 2: R&D offshoring will have a positive and indirect effect via innovation on sales growth in SMEs, with offshore R&D insourcing having a greater effect on innovation than offshore R&D outsourcing.*

EMPIRICAL ANALYSIS

Sample

The empirical analysis is performed on a sample of small and medium-sized enterprises (SMEs) from Spain. The data used is the Technological Innovation Panel (TIP), which is compiled by

Spain's National Statistics Institute, Science and Technology Foundation, and Foundation for Technical Innovation; other researchers have already used this data source (Molero and García, 2008; Trigo and Vence, 2012; among others). The survey is compiled on a yearly basis and provides information on different aspects of innovation and firms' growth strategies, along with other general and economic information. Specifically, the available data provide information on whether firms perform offshore R&D outsourcing or insourcing.

In this study, we use an unbalanced panel with more than 3,800 Spanish manufacturing SMEs for the period from 2004 to 2007. The selection of SMEs is in accordance with the European Union (EU) recommendation 2003/361/CE. This recommendation defines SMEs as firms with fewer than 250 employees, and an annual turnover of no more than 50 million euros or whose annual balance sheet total does not exceed 43 million euros; the EU categorization of SMEs has been adopted by several other studies (Nunes, Serrasqueiro and Leitão, 2012; Roza *et al*., 2011; Wiklund and Shepherd, 2003). The sample of SMEs used in our paper is from Spain, a country whose industrial structure closely matches that of the EU where 99.8% of all businesses are SMEs (in accordance with the previously mentioned EU definition). In this context, SMEs provide two out of three private sector jobs and contribute to more than half of the total value-added created by businesses in the EU.

SMEs more and more frequently engage in offshoring strategies (Angeli and Grimaldi, 2010; Buse *et al.*, 2010; Roza *et al*., 2011). In particular, concerning the choice between captive and offshore outsourcing by SMEs, empirical evidence exists indicating that size does not affect the implementation of one or other governance mode (Roza et al., 2011). These considerations make this sample especially appropriate for our purposes.

Variables

Dependent Variable

Sales growth. We use growth in sales to analyze firm growth. We obtain this continuous variable by dividing the difference between sales figures in year t and year t-1 by the sales figures in year

t-1 (Baum and Wally, 2003; Donaldson, 1987; Mishina, Pollock and Porac, 2004). Growth in sales and growth in number of employees are the most commonly used indicators of firm growth. In those cases where a single measure is used, the literature reveals a preference for sales (Singh and Mitchell, 2005; Stuart, 2000; Weinzimmer, Nystrom and Freeman, 1998; Zheng, Singh and Mitchell, 2014).

Independent Variables

Offshore R&D outsourcing is a dichotomous variable that takes value 1 when the firm buys R&D services from other firms, public administrations, universities, or organizations abroad. And *Offshore R&D insourcing* is a dichotomous variable that takes value 1 when the firm acquires R&D services from an affiliate or captive center (Nieto and Rodríguez, 2011).

In addition, to test our second hypothesis, we use *Innovation* as an independent and as a dependent variable to analyze its mediating role. *Innovation* measures innovation performance; it is a dichotomous variable that takes value 1 when the firm has achieved a product or process innovation.

The independent variables should be measured temporally antecedent to any dependent variable(s) because mediation hypotheses entail causation (Ndofor, Sirmon and He, 2011). Likewise, investments in R&D activities normally require time to generate innovation results (Belderbos, Carree, and Lokshin, 2004; Calantone and Stanko, 2007; Un, Cuervo-Cazurra and Asakawa, 2010), just as further time is needed for these innovations to have an effect on firm growth (Choi and Williams, 2014; Coad, 2009; Coad and Rao, 2008). In our analyses, then, we include the variables for governance modes of offshoring –*Offshore R&D outsourcing* and *Offshore R&D insourcing*– with two-period lags, and *Innovation* with a one-period lag (see figure 1 and model specifications below).

Control Variables

We include controls for innovation decisions, firm-specific characteristics and sector of activity in all the models. Most scholars consider that R&D expenses are relevant to innovate (Becheikh, Landry, & Amara, 2006) and to grow (García-Manjón and Romero-Merino, 2012). For this reason, we control for domestic R&D investment via a dichotomous variable that indicates whether the firm performs R&D activities in the home country; *Domestic R&D* is included with a two-period lag as an innovation input in the models. The study also controls for firm size, as this is typically linked to rates of firm growth (Becchetti and Trovato, 2002; Bentzen, Madsen and Smith, 2012; Dunne and Hughes, 1994); the variable *Size* is measured via the logarithm of the number of employees in period t (Baum and Wally, 2003). Given that younger firms are more likely to display higher rates of growth than older firms, most studies include age as a variable that may be related to firm growth (Becchetti and Trovato, 2002; Clarysse, Wright and Van de Velde, 2011; Dunne and Hughes, 1994). In line with this practice, we include the dichotomous variable *New firm* as a proxy for the age of the firm; it takes value 1 if the firm has been set up during the previous two years. Membership of a group or the participation of a foreign firm in the capital is another factor that may affect firm growth (Lockett *et al.*, 2011). Although these firms will enjoy better access to other resources, they will also need to take into account the decisions of the business group or the foreign parent firm. To control for these aspects, we include the variables *Group* and *Foreign ownership. Group* is a dichotomous variable that indicates whether the firm belongs to a group. And *Foreign ownership* is a dichotomous variable that takes value 1 if at least 50% of the firm's capital is in foreign hands. We also control for the international presence of the firm via the dichotomous variable *International activity*; this variable takes value 1 if the firm sells its products abroad. The study also controls for technology intensity with dummy variables that indicate if the firm can be classified into a high, medium or low tech sectors, according to the OECD classification. The variables *High tech* and *Low tech* are included in the analyses (with *Medium tech* acting as the baseline category to avoid problems of perfect

multicollinearity). Lastly, we include sectoral dummies to capture the effects of sector characteristics.

Descriptive statistics

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 sectoral dummies).

[Insert table 1 about here]

Given the importance of the variables related to offshoring for our study, we include information on their distribution in the sample. Table 1 indicates that 3% of firms in the sample undertake offshore R&D outsourcing activities and 1% undertakes offshore R&D insourcing, with standard deviations of 18 and 10 respectively. In tables 2 and 3, we provide a full picture of the number of observations in our analyses by showing the frequencies of captive offshoring and outsourcing for each dependent variable (*Sales growth$_t$ and Innovation$_{t-1}$*).

[Insert tables 2 and 3 about here]

Table 4 shows the distribution by sectoral groups (high-tech, medium-tech and low-tech) of firms that perform offshore R&D activities. The highest percentages of offshoring firms are in the high-tech sectors. An examination of the firms that implement modes of offshoring R&D outsourcing or insourcing reveals that in all sectors (high, medium and low-tech) the highest percentage corresponds to organizations performing offshore R&D outsourcing. And a comparison of offshore R&D outsourcing and insourcing by sectoral groups shows that the biggest difference between the two governance modes is in high-tech firms. Specifically, high-tech firms show higher levels of offshore R&D outsourcing. This is in line with Mazzanti, Montresor and Pini (2009), who find that outsourcing decisions may be guided by the resources competence approach more than by the transaction cost economics approach. This may be particularly important in high-tech industries because in these environments firms need to gain

quicker access to more diverse resources and technologies, which favors the inter-firm transaction of technologies (Revilla and Fernández, 2013). The examination also reveals that medium-tech firms show higher levels of offshore R&D insourcing. These firms are frequently in 'mature industries', where market conditions and technologies may change more slowly (Von Tunzelmann and Acha, 2005). Ambos and Ambos (2011) indicate that although knowledge-seeking activities usually lead to the establishment of laboratories abroad, they are less necessary in industries where R&D intensity is lower. Consequently, the number of knowledge-seeking laboratories should be lower in less R&D intensive industries (e.g., low-tech firms). Likewise, Martinez-Noya, Garcia-Canal and Guillen (2012) conclude that it is the more R&D intensive (high-tech) firms that benefit the most from the R&D global outsourcing market. Medium-sized firms, therefore, have a greater incentive than low-tech firms to set up captive centers abroad. But as they do not operate in such a demanding environment as high-tech firms, they are not under the same pressure to turn to the global R&D outsourcing market. Another point of interest is that the differences among percentages of firms performing offshore R&D outsourcing versus offshore R&D insourcing decrease as the level of technological intensity falls. Firms in low-tech sectors, then, display the smallest differences in percentages of organizations implementing offshore R&D insourcing versus outsourcing.

Lastly, we check for possible multicollinearity by examining the variance inflation factor (VIF) values of independent and control variables. 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 highest VIF values in the models are 1.18 and 1.32, which are significantly lower than the threshold points, suggesting the absence of multicollinearity (see table 1).

[Insert table 4 about here]

Methodology

We test hypothesis 1 with an auto-regressive regression model that analyzes the direct impact of the offshore R&D activities on sales growth (model 1). This model includes lagged values of the dependent variable *Sales growth* as a covariate. The inclusion of this lagged dependent variable makes it possible to capture a potential serial correlation of the errors, as well as to account for the effect of the firm-specific characteristics and past growth on current growth (Baum and Wally, 2003; Golovko and Valentini, 2011; Lockett *et al*., 2011). In addition, since a high proportion of firms in the sample does not perform offshoring activities, we need to assess and correct the potential selection bias. To do this, we estimate the most likely value for R&D offshoring using a previous probit model.[2] This model provides us with a prediction that we include in the auto-regressive model. More formally, model 1 has the following econometric specification:

$$
\begin{aligned}
\text{(a)} \quad (\text{Sales growth})_{it} = {} & \alpha + \beta_1 (\text{Offshore R\&D outsourcing})_{it-2} \\
& + \beta_2 (\text{Offshore R\&D insourcing})_{it-2} + \beta_3 (\text{Sales growth})_{it-1} \\
& + \beta_4 (\text{Domestic R\&D})_{it-2} + \beta_5 (\text{Size})_{it-2} + \beta_6 (\text{New firm})_{it-2} \\
& + \beta_7 (\text{Group})_{it-2} + \beta_8 (\text{Foreign ownership})_{it-2} \\
& + \beta_9 (\text{International activity})_{it-2} + \beta_{10} (\text{High-tech})_{it} + \beta_{11} (\text{Low-tech})_{it} \\
& + \beta_{12} (\text{Prediction})_{it} + \beta_{13} (\Sigma \ \text{Sector}_n)_{it} + \varepsilon_i
\end{aligned}
$$

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

To test hypothesis 2 (which postulates an indirect effect via innovation of both modes of R&D offshoring on sales growth), we use the methodology described by Baron and Kenny (1986) and formal significance tests. Baron and Kenny's (1986) methodology has been used to analyze the

[2] In this probit model, we include those variables that affect the likelihood of performing R&D offshoring. Specifically, we include: *Technology intensity* (three dichotomous variables that classify firms as high, medium or low tech; high-tech and low-tech are included in the models, while medium-tech has been left as the baseline category); *International collaboration* (a dichotomous variable that takes value 1 when the collaborating partner is based in a foreign country); and *Size by sales* (measured via the logarithm of the sales figure in period t); All these variables are included with a two-period lag. We also control for activity via the variable *Sector*. The results of this probit model are available on request.

presence of mediator variables in a multitude of studies (Dou *et al.*, 2010; Giarratana and Mariani, 2013; Gómez and Maicas, 2011; Holcomb, Holmes and Connelly, 2009; among many more). Recent studies adopt Baron and Kenny's (1986) methodology in conjunction with Sobel (1982) tests (Ethiraj, Ramasubbu and Krishnan, 2012; Holcomb, Holmes and Connelly, 2009; Miron-Spektor, Erez and Naveh, 2011; Ndofor, Sirmon and He, 2011), while others go further and include bootstrapped confidence intervals (CIs) (Boxall, Ang and Bartram, 2011; Reiche, Kraimer and Harzing, 2011). In accordance with this, we use Baron and Kenny's (1986) methodology to analyze the mediating role of innovation in the relation between governance modes of R&D offshoring and sales growth. In addition, we use Sobel tests and bootstrapping confidence intervals to test the indirect effect of both governance modes of R&D offshoring.

Baron and Kenny's (1986) methodology describes four steps that are necessary to establish that a variable mediates the relation between an independent variable and a dependent variable. Step 1 of the test for mediation is to show that a significant relation exists between the independent variable and the dependent variable; Step 2 is to show that a significant relation exists between the independent variable and the mediator; Step 3 is to show that the mediator variable is related to the dependent variable; and step 4 is to show that the effect of the independent variable on the dependent variable is less when the mediator variable is included in the model. If these four conditions described by Baron and Kenny (1986) are met, we are able to conclude that a mediation effect occurs.

In line with this procedure, Baron and Kenny (1986) recommend estimating three regression equations: i) Regression of the independent variable (X) on the dependent variable (Y) (model 1); ii) Regression of the independent variable (X) on the mediator variable (M) (model 2); and iii) Regression including the independent variable (X) and the mediator (M) on the dependent variable (Y) (model 3).

The dependent variable in both models 1 and 3 is *Sales growth.* The econometric specifications correspond with specification (a), as previously described. Model 3 also includes the mediator variable (*Innovation*). To estimate model 2, where the dependent variable (*Innovation*) is dichotomous, we use a probit model. Formally, the empirical model has the following econometric specification:

$$\begin{aligned}(b)\quad \text{Prob (Innovation)}_{it-1} = {} & \alpha_p + \beta_1 (\text{Offshore R\&D outsourcing})_{it-2} \\ & + \beta_2 (\text{Offshore R\&D insourcing})_{it-2} \\ & + \beta_3 (\text{Domestic R\&D})_{it-2} + \beta_4 (\text{Size})_{it-2} \\ & + \beta_5 (\text{New firm})_{it-2} + \beta_6 (\text{Group})_{it-2} \\ & + \beta_7 (\text{Foreign ownership})_{it-2} \\ & + \beta_8 (\text{International activity})_{it-2} + \beta_9 (\text{High-tech})_{it} \\ & + \beta_{10} (\text{Low-tech})_{it} + \beta_9 (\Sigma\ \text{Sector}_n)_{it} + \varepsilon_i\end{aligned}$$

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

As previously mentioned, we use both Sobel tests (Baron & Kenny, 1986; Sobel, 1982) and bootstrap confidence intervals (CIs). The Sobel test assumes that the indirect effect of the independent variable is normally distributed, an assumption that may make this a conservative test (Mackinnon, Warsi & Dwyer, 1995). The indirect effect is considered to be significant when the Sobel test Z value is significant (>1.96). For its part, the bootstrapping approach (Bollen & Stine, 1990; Shrout & Bolger, 2002) is a non-parametric method that makes different assumptions about normal distribution and symmetries. When the resultant bootstrapped confidence intervals (CIs) do not contain value 0, the indirect effect is different from 0. Since these tests make different assumptions, it is advisable to use them both.

EMPIRICAL RESULTS

Table 5 displays the results of the econometric models estimated to test the hypotheses. The three models are statistically significant at the 1% level.

[Insert table 5 about here]

The results in the first column correspond to the regression model used to test hypothesis 1 (model 1). The coefficient for *Offshore R&D outsourcing* is positive and significant. In contrast, the coefficient for *Offshore R&D insourcing* is not significant. These results provide support for hypothesis 1 in so far as offshore R&D outsourcing positively and directly affects sales growth. Likewise, the coefficient for *Offshore R&D outsourcing* is higher than that for *Offshore R&D insourcing*.

The growth regression models (1 and 3) include sales growth in the previous year, the control variables and the prediction variable. The signs and significances of all these variables are the same in both models. The coefficient for *Sales growth* in the previous year is negative and significant, thus indicating a negative and direct relation between previous and current growth. This result is coherent with that of Lockett *et al*. (2011), who find that organic growth in the previous period exerts a detrimental effect on current growth –a finding that may be explained by the difficulty of continuing to expand when growth has occurred in the previous period. Of the control variables included in these models, the coefficient for *Domestic R&D* is positive and significant, in line with previous work that finds a positive relation between domestic R&D and sales growth (García-Majón and Romero-Merino, 2013; Del Monte and Papagni, 2003). The coefficients for *Size* and *New Firm* are both positive and significant, indicating that among SMEs larger size and greater youth are related with greater sales growth. The coefficient for *Group* is also positive and significant, supporting the idea that membership of a group allows firms better access to other resources, which may affect growth. The coefficient for *Foreign ownership* is not significant, while the coefficient for *International activity* is negative and significant. Lastly, the *Prediction* variable has a negative and significant coefficient in both models (1 and 3), a finding that provides support for the use of two-stage models in the analysis.

To test hypothesis 2, we have to analyze the positive and indirect effect of R&D offshoring on sales growth. To do this, we need to examine the positive and indirect effect of both governance

modes of R&D offshoring on sales growth via innovation. For *Offshore R&D outsourcing*, we follow Baron and Kenny's procedure and find that the four steps are fulfilled. Step 1 is fulfilled as a positive and direct effect exists on *Sales growth* (hypothesis 1); step 2 is satisfied as a positive and significant relation exists between *Offshore R&D outsourcing* and *Innovation* (model 2); step 3 is verified as a significant relation exists between the mediator variable *Innovation* and the dependent variable *Sales growth*; and in step 4 we find that the magnitude and significance of the coefficient for *Offshore R&D outsourcing* is reduced when the mediator variable *Innovation* is included in the model. The results of the formal tests of the indirect effects are shown in table 6. The results of the Sobel test ($Z = 1.99$; $p<0.05$) provide significant evidence of the existence of an indirect effect (as the Sobel Z is significant: $Z >1.96$). The bootstrap results confirm the Sobel test, with a bootstrapped 95% of CIs not containing zero (percentile CI = 0.00029, 0.00249; bias-corrected CI = 0.00031, 0.00251).

[Insert table 6 about here]

In the case of *Offshore R&D insourcing*, we do not find a direct relation (X and Y are not associated). In these situations, Baron and Kenny's methodology is not applicable, as it makes no sense to analyze the mediating role here. The absence of an association between X and Y, however, does not mean that offshore R&D insourcing cannot exert an indirect effect on sales growth via innovation ($X\rightarrow M\rightarrow Y$) (Hayes, 2009). For this reason –and taking into account that the significance of the association between X and Y is not a rigid requirement to establish the existence of an indirect effect (Hayes, 2009; Shrout and Bolger, 2002)– we focus on the indirect path ($X\rightarrow M\rightarrow Y$) and test it with the previously described formal significance tests (Sobel and bootstrap confidence intervals). Thus, model 2 makes it possible to check the positive and significant impact of *Offshore R&D insourcing* on *Innovation* ($X\rightarrow M$). For its part, model 3 provides evidence of the positive and significant effect of *Innovation* on *Sales growth* ($M\rightarrow Y$). The results of the Sobel test ($Z = 2.24$; $p<0.05$) and the bootstrapped CIs (percentile CI =

0.00083, 0.00552; bias-corrected CI = 0.00102, 0.00588) show significant evidence of the existence of an indirect effect (see table 6). These results, therefore, enable us to conclude that *Offshore R&D insourcing* exerts an indirect effect via *Innovation* on *Sales growth*. These findings offer empirical support for hypothesis 2, as both *Offshore R&D outsourcing* and *Offshore R&D insourcing* positively and indirectly influence sales growth via innovation results, with a greater effect of *Offshore R&D insourcing* on *Innovation* (see the coefficients in column 2 of table 5).

Additional and robustness tests

We perform the analysis for large firms and examine whether different dynamics and patterns emerge for SMEs. The patterns of offshoring strategies and *Innovation* as the mediator variable are different for large firms. Specifically (and in contrast with SMEs), only offshore R&D outsourcing affects sales growth in large firms. Moreover, offshore R&D outsourcing exerts a direct effect only; the coefficient and significance of the offshore R&D outsourcing variable does not vary when the mediator variable is included. Furthermore (and once again in contrast with SMEs), its effect is negative for large firms.

We also address endogeneity issues in our analyses. Specifically, we analyze if our mediator variable is exogenous, in line with Antonakis, Bendahan, Jacquart and Lalive (2010). According to these authors, if the covariance of the disturbances is significant (the Hausman test), the mediator variable is endogenous with respect to the dependent variable. The results of these estimates show that endogeneity does not exist in the mediator variable (innovation), as the covariance of the disturbances is not significant. Lastly, we test the robustness of our results via additional analyses. First, we use different analytical measuring tools (binary_mediation, sgmediation and sem in Stata). Second, we estimate model 2 on the same sample as models 1 and 3 –by using *Innovation* in *t*. And third, we perform the analyses without the *Prediction* variable, and then without the autoregressive term ($Growth_{t-1}$). In all cases we obtain similar results. All these results are available on request.

DISCUSSION AND CONCLUSIONS

Offshoring innovation activities such as R&D is becoming a more and more common strategy (Ambos and Ambos, 2011; Contractor et al., 2010) and firms need to become increasingly aware of its implications, particularly for the growth of SMEs. Research in this field, however, remains limited. In this study we theoretically and empirically analyze the potential effects on sales growth in SMEs of offshoring R&D strategies. Specifically, we identify whether R&D activities performed overseas are 'make or buy' –offshore insourcing or outsourcing– and examine their potential direct effects on sales growth in SMEs. Additionally, we analyze potential indirect effects by analyzing the mediating role of innovation.

We look at possible direct effects since we argue that the advantages provided by both governance modes of R&D offshoring (e.g., access to enhanced resources and new markets, and gains in flexibility and efficiency) are themselves sufficient to boost sales in SMEs. In our analysis of possible direct effects, we evaluate how each governance mode may contribute to sales growth. In particular, outsourcing modes of governance give firms access to a greater range of specialized suppliers with competitive advantages that could improve the efficiency and flexibility of processes (Farrell, 2005; Roza *et al.,* 2011), thereby making it possible to adapt transaction volumes more rapidly. The availability of a wider range of suppliers also provides access to the latest technology and complementary resources, which may help SMEs position themselves better in the market and increase sales. In addition, outsourcing modes require less commitment than insourcing modes and allow firms to concentrate on their core capabilities and reallocate resources to more productive areas (Mukherjee *et al*., 2013). The empirical results, based on a wide sample of SMEs in manufacturing sectors, show that offshore R&D outsourcing exerts a positive direct effect, while offshore R&D insourcing has no significant direct impact. The greater advantages in terms of sales growth associated with outsourcing modes provide the explanation for these results. Thus, the access to enhanced and specialized resources, gains in organizational efficiency, flexibility and time to market that flow from offshore R&D outsourcing make this governance mode a useful strategic option to stimulate sales growth.

In analyzing the indirect effect we take as our starting point the evidence available on the implications of R&D offshoring indicating that both governance modes of R&D offshoring exert a positive influence on the innovation results of firms (Nieto and Rodríguez, 2011). Taking this evidence and the recognized effects of innovation on firm growth as a point of departure (Cho and Pucik, 2005; Golovko and Valentini, 2011; Love *et al.*, 2011), we examine the possible indirect effect that could exist via innovation. Our results show that both offshore R&D insourcing and outsourcing modes positively and indirectly affect the growth of SMEs via innovation. In other words, international R&D sourcing strategies contribute to sales growth in SMEs in so far as this strategy improves the innovation results of the firm.

In summary, our findings reveal that R&D offshoring strategies have a positive impact on sales growth in SMEs and that the different governance modes exert different effects. Offshore R&D outsourcing directly and indirectly affects sales growth in SMEs, while offshore R&D insourcing exerts only an indirect effect. The direct relation indicates that the gains in competitiveness related to international R&D sourcing strategies permit SMEs to boost their sales. And the indirect relation indicates that the benefits of R&D offshoring need to be translated into innovation outcomes before they can stimulate growth.

This paper contributes to the literature on R&D management, innovation and performance in SMEs (Audrestch *et al*., 2014; Nunes *et al*., 2012; O'Regan and Kling, 2011) by examining the relation between international sourcing strategies and sales growth in these firms. R&D offshoring strategies enable firms to gain access to and integrate more diverse and specialized knowledge from offshore locations. These strategies also allow SMEs to obtain advantages that help make them more competitive and augment their sales. In this paper we clearly distinguish between inputs (R&D activities) and outputs (innovation results) in order to explain how each one affects the growth of SMEs, as well as paying particular attention to how innovation results may play a mediating role between R&D offshoring and firm growth. The combined analysis of the direct and indirect effects of international R&D sourcing on sales growth makes it possible to

offer a comprehensive picture of relations that the literature has until now considered in isolation. Moreover, studying these relations in the context of SMEs allows us to contribute evidence on new factors that may influence the growth of these firms.

Additionally, we provide new insights to the offshoring literature. Although SMEs more and more frequently engage in offshoring strategies, little research has focused on this area (Roza *et al*., 2011; Angeli and Grimaldi, 2010), particularly in terms of its consequences on firm performance. Specifically, we advance our knowledge of offshoring knowledge-based services by analyzing two governance modes of offshoring and drawing conclusions on their different impacts on sales growth in SMEs. Research on the implications of offshoring knowledge-based services remains limited, particularly in the context of SMEs. The results of this paper provide evidence of the benefits of offshoring for smaller firms in terms of growth. Furthermore, our findings reveal that SMEs can benefit from both governance modes.

This paper's findings have managerial implications. Managers of SMEs need to develop strategies that make them more competitive and increase sales in order to mitigate the constantly growing threats they face in the market. Given this reality, these managers would benefit from knowing how international sourcing strategies can help their firms overcome their unique resource constraints. The increasing globalization of today's markets allows firms of all sizes to reap the advantages of diverse locations. Indeed, offshoring can increase the efficiency of R&D activities and improve innovation results, while simultaneously favoring the achievement of firms' strategic growth objectives. The analysis of two governance modes of R&D offshoring leads to useful recommendations for achieving growth in SMEs. Our results provide managers of SMEs with highly useful information on the effects of both governance modes –insourcing and outsourcing. Managers responsible for designing international R&D sourcing strategies, then, could find it helpful to bear two points in mind. First, offshore R&D insourcing contributes to sales growth in so far as SMEs achieve innovation results; and second, offshore R&D outsourcing contributes to sales growth both directly and indirectly (via innovation). In sectors or

contexts where innovation plays a central role, managers should be aware of the importance of choice of R&D offshoring mode, in so far as offshore R&D insourcing may be a more effective instrument for achieving innovations and consequently sales growth. In other sectors where competitiveness is more dependent on the quest for efficiency and flexibility, firms looking to grow should opt for modes based on offshore R&D outsourcing. Although both strategies bring benefits to SMEs in terms of growth, it is incumbent on managers to balance the risks inherent to each governance mode and the limitations of the firm to face them. Specifically, managers opting for forms of offshore R&D outsourcing must not lose sight of potential problems related to long-term internal risks, along with difficulties associated with the outsourcing partner and organizational commitment. Similarly, managers choosing forms of offshore R&D insourcing must consider labor costs, technical expertise, high demand variance and expensive capital goods requiring scale (Metters, 2008).

The study has limitations that provide potential areas for further research. We do not have information on country of destination. Information on where offshoring R&D activities take place would be particularly interesting, as it would make it possible to analyze the different impacts of these activities depending on the location selected. In some countries, for example, firms may be looking for cost savings, while in others they may be searching for improved access to skilled employees and new knowledge. Another line of research could examine the different effects of international R&D sourcing depending on the activity of the firm and across industries. Previous research suggests that the knowledge intensity of different industries will have an impact on the firm's internationalization strategies (Chung and Alcacer, 2002). In this context, future papers could identify and analyze the influence of international R&D sourcing strategies according to sector (e.g., depending on level of technological intensity).

This study has analyzed the effects of two governance modes of R&D offshoring and revealed that each one has different implications for firm growth. It would be interesting to continue deepening our knowledge of the implications of these international R&D activities for firm

performance. In the case of offshore R&D outsourcing, for instance, future work should explore the impacts of different contractual modalities (e.g., duration of contract, diversity of partners, etc.) on a variety of measures of firm performance.

Lastly, some studies recognize the growing importance of examining the simultaneous use of different governance modes –so-called 'concurrent sourcing' (Parmigiani and Mitchell, 2009), 'plural sourcing' (Krzeminska, Hoetker and Mellewigt, 2013) or 'bi-sourcing' (Beladi and Mukherjee, 2012)– which arises when firms both 'make and buy' the same inputs. As these studies typically focus on internal and external sourcing performed domestically (in the home country), it would be interesting to extend this line of research to international R&D sourcing. These strategies bring their own advantages and risks and therefore are likely to have different consequences for firm performance that merit attention in future research.

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Table 1. Descriptive statistics, correlations and collinearity diagnostics of the independent and control variables

	1	2	3	4	5	6	7	8	9	10		VIF[a]	VIF[b]
1. Offshore R&D outsourcing$_{t-2}$	1.000											1.02	1.02
2. Offshore R&D insourcingt$_{-2}$	0.0619***	1.000										1.05	1.05
3. Innovation$_{t-1}$	0.0743***	0.0457***	1.000									-	1.32
4. Domestic R&D$_{t-2}$	0.0834***	0.0038	0.4750***	1.000								1.11	1.37
5. Size$_{t-2}$	0.0581***	0.1147***	0.1052***	0.1008***	1.000							1.20	1.20
6. New firm$_{t-2}$	-0.0021	-0.0100	0.0235**	0.0292***	-0.0818***	1.000						1.02	1.02
7. Group$_{t-2}$	0.0519***	0.0338***	0.0326***	0.0476***	0.2199***	0.0420***	1.000					1.07	1.07
8. Foreign ownership$_{t-2}$	0.0177	0.2194***	0.0478***	0.0349***	0.2253***	-0.0040	-0.1269***	1.000				1.12	1.12
9. International activity$_{t-2}$	0.0844***	0.0499***	0.2071***	0.2097***	0.2211***	-0.0554***	0.0509***	0.1208***	1.000			1.13	1.15
10. High tech	0.0435***	-0.0145	0.0473***	0.0909***	-0.0711***	-0.0104	-0.0022	-0.0000	0.0541***	1.000		1.12	1.12
11. Low tech	-0.0460***	-0.0456***	-0.1449***	-0.2321***	0.0787***	0.0074	0.0237**	-0.1150***	-0.1875***	-0.3153***	1.000	1.22	1.23
Mean	0.03	0.01	0.76	0.65	3.80	0.01	0.16	0.08	0.73	0.09	0.50		
St. dev.	0.18	0.10	0.42	0.47	0.97	0.08	0.36	0.27	0.44	0.29	0.50		
Min	0	0	0	0	0	0	0	0	0	0	0		
Max	1	1	1	1	5.52	1	1	1	1	1	1		
									Mean VIF			1.11	1.15

***p<0.01, **p<0.05,*p<0.10. [a]Models 1 and 2; [b]Model 3

Table 2.- Frequencies of offshoring outsourcing/insourcing and *Sales growth*$_t$

		Offshore R&D outsourcing$_{t-2}$		*Offshore R&D insourcing*$_{t-2}$		
		0	*1*	*0*	*1*	**Total**
Sales growth$_t$	*0*	2,216	57	2,252	21	2,273
	1	4,959	189	5,090	58	5,148
Total		7,175	246	7,342	79	**7,421**

Note: In the case of sales growth, we use a dichotomous variable that take value 1 whether firm have grown (Sales growth >0) to be able to present the raw frequencies.

Table 3.- Frequencies of offshoring outsourcing/insourcing and *Innovation*$_{t-1}$

		Offshore R&D outsourcing$_{t-2}$		*Offshore R&D insourcing*$_{t-2}$		
		0	*1*	*0*	*1*	**Total**
Innovation$_{t-1}$	*0*	1,624	13	1,634	3	1,637
	1	5,510	228	5,663	75	5,738
Total		7,134	241	7,297	78	**7,375**

Table 4. R&D offshoring implementations by governance mode and sector categories

	Observation frequency by sector category	Offshore R&D insourcing	Offshore R&D outsourcing	Differences between governance modes
High tech	9.0	0.7	5.4	4.7
Medium tech	40.7	1.7	3.5	1.8
Low tech	50.3	0.6	2.2	1.7
Full sample		1.0	3.0	

Percentage of observations.

Table 5. Governance modes of R&D offshoring and sales growth

	Model 1	Model 2	Model 3
	Sales growth$_t$	*Innovation$_{t-1}$*	*Sales growth$_t$*
Offshore R&D outsourcing$_{t-2}$	0.029**	0.445***	0.027*
	(2.00)	(3.11)	(1.91)
Offshore R&D insourcing$_{t-2}$	0.010	0.844***	0.007
	(0.39)	(3.04)	(0.28)
Growth$_{t-1}$	-0.024**	-	-0.026**
	(-2.09)		(-2.28)
Innovation$_{t-1}$	-	-	0.022***
			(3.13)
Domestic R&D$_{t-2}$	0.016***	1.292***	0.008
	(2.86)	(33.43)	(1.27)
Size$_{t-2}$	0.027***	0.114***	0.026***
	(7.57)	(5.65)	(7.39)
New firm$_{t-2}$	0.087***	0.275	0.086***
	(3.22)	(1.35)	(3.16)
Group$_{t-2}$	0.013*	-0.044	0.013*
	(1.76)	(-0.81)	(1.77)
Foreign ownership$_{t-2}$	-0.001	-0.024	-0.001
	(-0.14)	(-0.31)	(-0.14)
International activity$_{t-2}$	-0.020***	0.309***	-0.022***
	(-3.63)	(7.94)	(-3.93)
High-tech	0.009	-0.197*	0.010
	(0.62)	(-1.84)	(0.68)
Low-tech	0.019	-0.333**	0.021
	(1.00)	(-2.56)	(1.12)
Prediction	-0.627***	-	-0.623***
	(-5.36)		(-5.33)
Intercept	-0.049**	-0.383***	0.058***
	(-2.38)	(-2.78)	(-2.78)
	F-test (29, 7345) = 7.97***	$\chi^2(27)$= 1830.2***	F-test (30, 7344) = 8.04***

Number of observations: 7,375
T-value shown in parentheses. Sectoral dummies are included.
***p<0.01,**p<0.05, *p<0.10

Table 6. Tests of the indirect effects

Dependent variables	Sobel's test	Bootstrap (95 % Confidence Intervals)	
	Z	CI (P)[a]	CI (BC)[b]
Offshore R&D outsourcing	1.99**	(0.00029, 0.00249)	(0.00031, 0.00251)
Offshore R&D insourcing	2.24**	(0.00083, 0.00552)	(0.00102, 0.00588)

***p< 0.01; **p<0.05; [a]Percentile confidence interval; [b]Bias-corrected confidence interval