OFFSHORE MANUFACTURING AND FIRM INNOVATION:

THE MODERATING ROLE OF TECHNOLOGICAL CAPABILITIES

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Abstract

Scholars have recently suggested that offshoring may favour firm innovation, as it allows firms to gain access to a broad and varied array of information and knowledge sources. However, we still know little about whether some firms are better suited than others to benefit from the learning opportunities that offshoring presents. Therefore, in this paper we analyse whether and how firm heterogeneity –in the form of technological capabilities– moderates the impact of offshoring (specifically, intermediate manufacturing offshoring) on firm-level innovation. Utilizing data for 1,359 Spanish manufacturing firms from 2006 to 2011, we find that, although both technologically leading and lagging firms apply for more patents and utility models subsequent to offshoring, the positive impact of offshoring on firms' innovative output is greater for the former than for the latter. Our results, thus, suggest that firm-specific capabilities play an important role in order to take advantage of the innovation benefits that offshoring may provide.

Keywords:

Offshoring; offshore manufacturing; innovation; firm heterogeneity; technological capabilities; R&D expenditures; intermediate manufacturing; Spanish manufacturing firms.

1. Introduction

Global competition, highly dynamic markets, and a rapidly changing business environment have characterized the competitive landscape for quite some time now. As scholars point out, innovation has become necessary to compete and thrive in such an environment (Revilla et al., 2013; Ribau et al., 2019). However, innovating is generally a challenging endeavour, since it not only requires substantial resources but, more importantly, it also necessitates new and/or complementary knowledge. In this vein, it is suggested that the breadth of information sources –e.g. customers and suppliers, and the variety of geographical locations where firms seek for that knowledge likely affects innovation outcomes (Leiponen and Helfat, 2010). In this context, and despite some potential drawbacks (Fifarek et al., 2008; Kotabe et al., 2008; Lampel and Bhalla, 2011), offshoring arises as a particularly relevant strategy that might positively impact firm innovation, as it allows knowledge accumulation and creation (Kenney et al., 2009). On the one hand, offshoring implies the international relocation of value chain activities (Mihalache and Mihalache, 2016), therefore widening the geographical scope of the firm. This, in turn, allows firms to access either more diverse knowledge, or one that is simply not available within their national borders (Chung and Alcacer, 2002). On the other hand, value chain activities may be either assigned to the firm's own subsidiaries overseas (captive offshoring), to external providers in foreign countries (offshore outsourcing) or to strategic partners abroad (e.g. via international alliances and joint ventures) (Jahns et al., 2006). Whatever the case, the variety of knowledge sources that firms may tap into subsequent to offshoring is likely to increase. For example, in captive offshoring firms may take advantage of pools of well-trained, highly-qualified local individuals hired for their foreign subsidiaries (Lewin et al., 2009), whereas in offshore outsourcing and strategic partnerships they may benefit from the tacit knowledge, expertise and technological advancement of foreign suppliers and partners (Ferdows, 1997; Kedia and Mukherjee, 2009).

All in all, offshoring potentially increases both the variety and breadth of available knowledge, which constitutes a fundamental input for the innovation process. Moreover, offshoring also facilitates innovation as a consequence of the organizational learning that derives from firm participation in international networks.

Consistent with the aforementioned arguments, some scholars have provided evidence that supports the notion that offshoring positively impacts firm-level innovation performance (Kotabe, 1990; Valle et al., 2015). However, the association between offshoring and innovation might be more nuanced than the offshoring literature to date has indicated. As recent research in the international business and strategy literature has started to suggest, country, industry and, overall, firm characteristics might influence the ability of firms to learn in international markets (García et al., 2012; Salomon and Jin, 2010) and from foreign companies (Blalock and Gertler, 2009; Zahra and Hayton, 2008). Nevertheless, whether and how the aforementioned heterogeneity may influence the (innovation) outcomes experienced by firms that pursue an offshoring strategy has remained barely unexplored in the offshoring literature (Mihalache et al., 2012 is a notable exception). Therefore, we still know little about whether some firms are better suited than others to reap the benefits of offshoring. Yet examining the role of context-specific factors stands to yield greater insight into the phenomenon, aiding our understanding of the underpinning mechanisms that shape the connection between offshoring and firm-level innovation.

With all that in mind, we aim to analyse whether and how firm heterogeneity in terms of technological capabilities moderates the association between offshoring and firm-level innovation. In this vein, we do not expect all firms to benefit equally from offshoring. Capabilities arguments suggest that technological leaders (i.e. firms endowed with superior technological capabilities) should be better equipped than technological laggards (i.e. firms that lack or fall short of those capabilities) to source, integrate and exploit the new knowledge that offshore operations and/or international supply relations and partnership is likely to generate. In other words, technologically leading firms should learn more from offshored activities, and consequently experience higher improvements in their innovative performance, than their technologically lagging counterparts.

To assess these arguments, we focus on intermediate manufacturing offshoring (i.e. products or services that will subsequently be transformed in the firm's production process), an area in which empirical research is still scarce (Mihalache et al., 2012). We believe this type of offshoring provides an adequate setting for our study, since not only it is frequently used by companies worldwide but, more importantly, production is one of the primary "business functions that provide direct knowledge inputs for innovation" (Mihalache et al., 2012: 1480). We perform empirical analyses using a panel dataset of 1,359 Spanish manufacturing firms for the period 2006-2011. Our results provide empirical support for our arguments, indicating that offshoring positively impacts firms' innovative output, but more so for technological leaders than for their technologically lagging counterparts. This hints at the importance of heterogeneity in firm-specific characteristics when it comes down to benefitting from offshoring. All things considered, these findings help expand our understanding of the offshoring phenomenon and, particularly, of the factors that underlie its effect on firms' innovative outcomes.

The remainder of the paper is structured as follows. Section 2 reviews the literature on the offshoring-innovation relationship, discusses how technological capabilities can moderate the impact of offshoring on firms' innovative performance and proposes hypothesis. Section 3 describes the data, variables and methods. Section 4 presents results. Finally, Section 5 concludes, discussing the results, as well as the implications of the study.

2. Theoretical background and hypothesis

2.1. Offshoring and firm innovation

Innovation, knowledge and organizational learning inevitably go hand in hand. There can be no innovation without knowledge. Knowledge is central to generate innovation and is one of its key inputs. Learning is the means that allows creating, managing and making use of that knowledge (Theodorakopoulos et al., 2012). Thus, firms' innovation capability depends on the amount and variety of knowledge they are able to accumulate, but also on their capacity for developing organizational learning dynamics that enable them to effectively manage all that knowledge.

In view of the complexity and speed of technological change today, it is becoming increasingly difficult for a firm to generate all the knowledge it needs alone. Firms need to use a wide variety of sources (Doz and Wilson, 2012; Kafouros and Forsans, 2012; Leiponen and Helfat, 2010; Svetina and Prodan, 2008), many of which may be beyond their national borders. That is, firms must be able to use information, knowledge and ideas from any agent in their value chain (suppliers, partners, distributors, customers…), regardless of their location across the globe. Only if knowledge inputs come from a wide range of sources may firms quickly develop technologies and achieve important progress (Chesbrough and Teece, 1996). Additionally, only by building an appropriate organizational learning environment will they be able to manage those knowledge inputs in such a way that they create value.

In this puzzle, offshoring becomes a fundamental piece. As Mihalache and Mihalache (2016: 1105) point out, "offshoring is a resource-seeking mechanism". When a firm resorts to offshoring and transfers activities from its value chain to other countries, either to subsidiaries (captive offshoring), by subcontracting from local suppliers (offshore outsourcing) or through collaborative agreements, it gains access to valuable, strategic resources that are available in those countries[1]. Most of those resources are useful ingredients for the firm's innovation processes (e.g., Berger, 2005; Kedia and Mukherjee, 2009; Kenney et al., 2009; Leonard-Barton, 1992; Venkatraman, 2004). Specifically, by resorting to offshoring, firms can access one of the key inputs for innovation, namely, knowledge (Tarn, 2015). By transferring activities to other countries, firms can take advantage of the varied, specialist and sometimes idiosyncratic knowledge available in those locations, which allows them to develop new capabilities (Cantwell, 1994; Chung and Alcacer, 2002). In the case of offshore outsourcing, this new knowledge comes from subcontracted foreign suppliers, who may share their know-how, experience and technological advances with the firm. The same occurs in the case of strategic alliances with foreign partners. In the case of captive offshoring, access to new knowledge is achieved via hiring local employees for the subsidiaries abroad. In many countries there are highly-skilled, specialized workers who are often cheaper than those in the firm's home country (Lewin et al., 2009; Manning et al., 2008). This combination of top-notch skills and low cost allows firms to access knowledge in a cheaper, faster and less risky fashion than in-house (Chung and Yeaple, 2008).

In sum, since offshoring allows firms to access a wide range of knowledge and know-how that can be added to their own knowledge bases, expanding them in both quantity and variety, it can clearly be considered a mechanism through which firms may improve their innovation processes (Kenney et al., 2009; Leonard-Barton, 1992; Mihalache et al., 2012; Venkatraman, 2004). The deeper firms' knowledge base, the greater their innovation capability will be (Pennings and Harianto, 1992). The same is true for the breadth of their knowledge base (Kotabe et al., 2007).

Integration of offshore knowledge with existing knowledge plays a key role in the process described above. In this respect, the fundamental tools that allow firms to match new knowledge with existing one are fourfold: the training of employees, the development of an optimal information management process, the building of knowledge brokering activities and the use of information technologies. First, employees must be trained so that they develop the motivation, mindset and skills that are necessary to integrate external with internal knowledge (Un, 2017). In this vein, it is fundamental to create an organizational context where sharing and collaboration play a central role. Human resource management policies (Davenport and Prusak, 1998; Matsuo, 2015) and organizational culture (Beckman, 1999) are crucial in this respect. Second, as of information management, combining and integrating external with internal knowledge requires communication, diffusion and systematization of such knowledge. As Nonaka and Takeuchi (1995) point out, the reconfiguration of externally acquired knowledge is what allows firms to develop new knowledge. Third, knowledge integration may also be facilitated by using so-called knowledge brokers (i.e., actors that connect knowledge producers and users), whose primary mission is to combine their knowledge of technologies and the market for application in unexplored areas (Castro, 2015). Lastly, the combination and integration of offshore and internal knowledge is greatly facilitated by the utilization of information technologies that gather, process, and store data, and support knowledge flows –e.g., intranets, databases, electronic document management, knowledge maps (Theodorakopoulos et al., 2012; Tyndale, 2002; Marwick, 2001). All in all, the simultaneous implementation of these four elements constitutes a knowledge management model that contributes to firm innovation performance (Gloet and Terziovski, 2004).

In sum, through offshoring firms can increase innovation by mobilizing and exploiting internationally disseminated knowledge and capabilities (Berger, 2005; Kedia and Mukherjee, 2009; Leiponen and Helfat, 2010; Slepniov et al., 2014).

In addition, offshoring implies to globally and strategically distribute firm's value chain activities and, consequently, to start participating in international production systems or networks (Slepniov et al., 2010). From then on, firms are forced to develop inter-organizational relations. Being based on information sharing and, in most cases, on close collaboration, this kind of relations will lead to sound organizational learning (Jensen, 2009; Kedia and Mukherjee, 2009), which will doubtlessly promote innovation-oriented initiatives. It is this group and collaboration methodology, essential for any innovation process, which will facilitate the development of relations among the different parties involved, combining internal and external knowledge, sharing experiences and connecting minds. The learning and mutual enrichment that arise in this scenario will allow new knowledge to be generated and new ideas and opportunities to be capitalized on.

In summary, through offshoring firms can increase their innovation capability thanks to the organizational learning they obtain from actively participating in international modular networks.

In conclusion, despite the fact that expectations for cost reductions is still the dominant perspective related to offshoring (Stentoft et al., 2015), by offshoring firms can access greater knowledge and achieve sound organizational learning, all of which improves their capacity to develop innovative solutions in a speedy fashion. This logic is valid for the international transfer of all value chain activities that can provide knowledge to the innovation process. Among those activities, one of the most essential in this respect (Mihalache et al., 2012), and the one on which our study focuses, is production (specifically, the manufacture of parts and components). In this vein, by offshoring intermediate manufacturing, firms can gain access to production techniques and technologies, as well as to special components, that they would not be able to obtain alone or, at least, to control and/or standardize so skilfully (Valle et al., 2015). Similarly, the resulting close interaction with foreign agents, constantly collaborating and sharing information, leads firms to learn more about the production process and allows them to improve both the process itself and the products resulting from it (Slepniov et al., 2014).

2.2. The moderating effect of technological capabilities

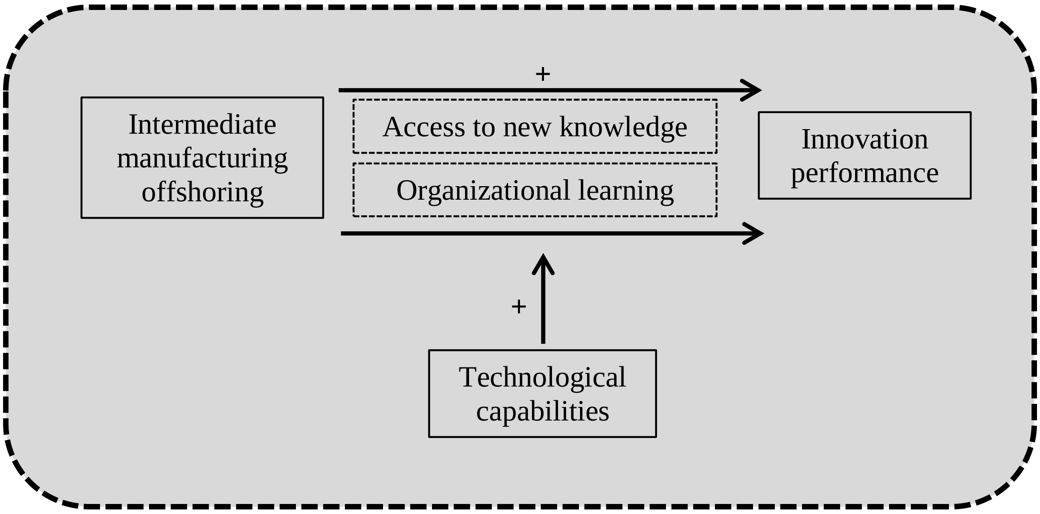
Albeit we have argued that offshoring can have a positive effect on firm innovation via access to new knowledge and organizational learning, this does not necessarily mean that all firms will benefit equally from this leverage effect. As some scholars have suggested, a firm's endowment of resources and capabilities can determine its ability to access and use sources of valuable resources (particularly knowledge) in foreign countries (García et al., 2012; Salomon and Jin, 2010). In line with this argument, we do not expect all firms that transfer value chain activities abroad to be equally suited to acquire and utilize external knowledge, as well as to learn from their interactions with foreign partners. As we will argue below, firms' technological capabilities may lie at the heart of such differences.

Technological capabilities of the firm refer to the capabilities it possess that allow it to identify and take advantage of different sources of learning, as well as to assimilate, adapt, use, combine, create and improve any type of technological knowledge, achieving its embeddedness in the organization as a whole (Westphal et al., 1990; Bell and Pavitt, 1995; Martínez-Noya and García-Canal, 2011; Zhou and Wu, 2010). The key aspect, therefore, is the creation and exploitation of knowledge (Acosta-Prado et al., 2014), coupled with its use in developing the firm's ability to exchange and transfer information with external agents – e.g., suppliers, technological and R&D centres, universities (Lall, 1992). In sum, these are a set of capabilities that allow firms' to effectively use available knowledge of a scientific and technological nature.

Innovation today not only increasingly depends on new knowledge from a wide range of sources, but also on the experience and ability in grasping that new knowledge produced elsewhere and integrating it within the firm in combination with existing knowledge. Put differently, a firm's capacity for recognizing the value and usefulness of external knowledge, as well as to assimilate it, integrate it, transform it and exploit it becomes a crucial factor to succeed in innovating (Castro and Cepeda, 2016; Cohen and Levinthal, 1990; Stock et al., 2001). This internal ability, commonly known as “absorptive capacity” (Cohen and Levinthal, 1989, 1990), depends on the existing knowledge base within the firm (especially of related knowledge), as well as on its skills and technical experience. Therefore, it also depends on the firm’s own research and development capability (Cohen and Levinthal, 1990). In other words, the ability to absorb external, complementary knowledge is contingent on a firm’s history of technological accumulation, which is partly a result of its internal R&D efforts (Castellani and Zanfei, 2007). It is not simple to assimilate and use any new knowledge without related prior one –know-how, shared language and technical knowledge– and, therefore, without R&D investments that would have allowed the firm to accumulate such knowledge and boost its technological development.

In accordance with the above, it is reasonable to expect the potential benefits of offshoring in terms of innovation (i.e. access to new knowledge and learning) to be contingent on the firm’s degree of technological development. If a firm lacks sufficient capability to assimilate the knowledge that comes from offshore locations and to integrate it into its existing knowledge base, or to develop the necessary ability to learn from interaction, the transfer of offshore knowledge will be inhibited and the firm’s capacity to transform new knowledge into innovations will decrease.

Figure 1. Conceptual model



For all these reasons, and given the limited empirical evidence in this regard, in this study we argue that firms' technological capabilities play a moderating role in the relationship between offshoring and innovation, determining to what extent offshoring has a positive effect on firms' innovation performance. Thus, as Figure 1 depicts, even when offshoring may increase the flow of knowledge and learning for firms that resort to it, it will be those with the strongest technological capabilities that will be able to take advantage of its learning benefits more effectively and thus achieve better innovation performance. Firms with greater technological capabilities possess the specific skills for learning and benefiting from what they learn. Conversely, firms with weak technological capabilities will be less skilled to identify and recognize the value of new technologies and knowledge, as well as to assimilate, exploit and transform them with sufficient speed into innovations (Berger, 2005; Cohen and Levinthal, 1989).

Furthermore, technological capabilities may also allow firms to be in a more favourable position to counteract or minimize one of the main risk that offshoring entails as far as innovation is concerned; namely, excessive dependence on external knowledge sources. Firms that, on a regular basis, transfer part of their value chain activities overseas might find themselves relying on offshore knowledge sources more than it would be advisable. As a consequence, they might neglect the preservation and development of their own knowledge stock in-house. Since the ability to detect and materialize new product and technological opportunities tightly relies on firms' existing knowledge base and technical expertise, this would clearly hamper and slow down their innovative processes (Berger, 2005; Cohen and Levinthal, 1990). In this vein, it is reasonable to assume that the more technologically advanced firms will be better suited to face the aforementioned risk thanks to their ongoing R&D investments and, consequently, their constant knowledge accumulation. On the contrary, those other firms that do not take proper care of their own technological capabilities as they reduce and slow down their R&D investments, will also likely neglect in-house development of the knowledge and competencies associated to offshored activities, and will therefore start depending excessively on their foreign partners' knowledge.

If we apply all the aforementioned arguments to the context of our study (i.e. intermediate manufacturing offshoring), it is reasonable to assume that, among the firms that transfer their intermediate production internationally, the ones endowed with superior technological capabilities will be able to identify, understand and make use of all relevant production techniques and technologies accessed via offshoring much more effectively than those others lacking such capabilities. The former will also be the ones better able to take advantage of the talent, specialization, know-how and technical skills of the foreign manufacturers to whom they have transferred production. Moreover, it is also reasonable to expect that technologically leading companies will likely be the most interested in maintaining in-house investment on their own stocks of manufacturing knowledge and competencies, therefore avoiding the gradual loss or deterioration of the skills, know-how and knowledge linked to the production of parts and components they have offshored. According to all the above, we argue that firms endowed with stronger technological capabilities will obtain better innovation performance from offshoring of intermediate manufacturing than their technologically weaker counterparts. In other words, we expect a firm's degree of technological development to positively moderate the favourable influence exerted by the offshoring of intermediate manufacturing on its innovation performance. Hence, we propose the following hypothesis:

> **H1:** Technological capabilities will positively moderate the favourable impact of offshoring of intermediate manufacturing on firm innovation performance. Increases in innovation will be larger for firms endowed with stronger technological capabilities than for those with weaker technological capabilities.

3. Data and methods

3.1. Sample

In order to test our hypothesis, we used the *Encuesta Sobre Estrategias Empresariales* (Survey on Business Strategy; ESEE onwards). The ESEE contains primary data from an annual survey conducted by the SEPI (National Bureau of Industrial Activity) Foundation with the support of the Spanish Ministry of Industry. The survey collects data from a representative sample (by size and industry) of the population of Spanish manufacturing companies that employ 10 or more workers. The survey has been annually performed since 1990, when the initial sample of participating firms was 2,188. Over the years, some of these firms have dropped out of the sample, while others have been included in the database. Given entry and exit dynamics, the ESEE is therefore an unbalanced panel of firms. We have been able to gather access to the ESEE data since the initial year (1990) until 2011, when the number of participating firms was 5,040. However, data for the independent variables in this study are only available as from 2006. In addition, the econometric technique we use requires data for at least two consecutive years for the variables of interest. Also, we were unable to determine an exact match between some industries in the ESEE data and the other data used in the study (this is detailed below). Finally, some data are missing for some of the other variables included in our estimates. Hence, the final usable sample comprises 1,359 firms.

In addition to the ESEE, we use the STAN (STructural ANalysis) database, published annually by the OECD (Organization for Economic Cooperation and Development), which compiles various industry-level macroeconomic indicators for the organization's member countries. For our study, we have extracted annual R&D expenditures and gross production data by industry for 22 of the 34 OECD member countries[2] (Spain included). With these data, plus those taken from the ESEE[3], we have built our measure of relative technological capabilities. As we will explain in the variables section, this measure allows us to classify firms in our sample in two categories: technological leaders and laggards.

Table 1 presents some descriptive statistics of the final sample divided by industry.

*** Insert Table 1 here ***

3.2. Variables

3.2.1. Dependent variable

In this study, we use two different measures of innovation. Following prior literature (e.g., Beneito, 2006; Jin et al., 2018; Lew and Liu, 2016; Salomon & Shaver, 2005; Torres-Barreto et al., 2016), we rely on patent and utility model counts as proxies for firm innovation. To the extent that each of these variables capture different elements of firms' innovative efforts, accounting for both allows us to provide a more complete picture of the influence of offshoring on firm innovation outcomes.

Despite known limitations (e.g. Kotabe, 1990), patents have been long regarded as a useful and reasonably good proxy for innovative activity (Basberg, 1987; Acs et al., 2002) and, as such, have been widely used in extant empirical research (e.g., Aghion et al., 2009; Almeida and Phene, 2004; Fifarek et al., 2008; García et al., 2013; Lew and Liu, 2016; Kim and Song, 2007; Salomon and Jin, 2008; Valle et al., 2015). Patents tend to express new technological knowledge and creation in an explicit fashion, representing a direct and observable measure of the innovation process (Archibugi and Pianta, 1996). Even when not all innovations are patentable (or will be patented), patents tend to indicate a firm's expectation about the utility, marketability and commercial impact of the innovations it has developed (Griliches, 1990). Therefore, patents may serve as a fairly good indicator of firm innovation, particularly in industries of a high technological content (Fifarek et al., 2008; Phene and Almeida, 2008).

Utility models, with some exceptions (notably, Beneito, 2006; Lew and Liu, 2016; Torres-Barreto et al., 2016), have not received as much attention in the literature. Similarly to patents, utility models are an indicator of the creation of new technology. However, utility models are used to protect less innovative inventions than patents; that is, minor innovations that may not satisfy the criteria and requirements to be patented (Boztosun, 2010). In this vein, utility models are regarded as particularly suitable for SMEs and those firms that favor the introduction of minor improvements or adaptations in their existing product line, rather than innovations of a more radical nature (Beneito, 2006). For this and other reasons, utility models tend to be useful indicators of a firm's innovative outcomes in less research-intensive and technologically advanced industries (Milesi et al., 2013; Neuhäusler, 2012), as well as in those with shorter product life cycles (Chen et al., 2014).

All things considered, and in line with Beneito (2006), we believe that patents and utility models nicely complement each other, since they speak to different traits and types of firm innovations. By considering both measures we are therefore able to cover a wider range of firms' innovative outcomes. Accordingly, we include "Patent applications" and "Utility models" as dependent variables in our study. These two variables, respectively, measure the number of patents and utility models filed for by a given firm in each year of the sample period.

3.2.2. Independent variables

One of the main ways in which extant research empirically measures production offshoring is by using indicators of foreign-origin, intermediate inputs that firms import to be incorporated in its home-based production. The use of this sort of imports in the literature as a proxy for production offshoring dates back to the work of Feenstra and Hanson (1996, 1999), but has since been commonly used in more recent research (e.g., Amiti and Wei, 2005; Falk and Koebel, 2002; Fariñas and Martín-Marcos, 2010; Geishecker and Görg, 2005; Hijzen et al., 2005).

In this study, we follow the aforementioned literature to proxy for the offshoring of intermediate manufacturing. Specifically, we use the yearly data that the ESEE gathers on firms' imports of intermediate products or services (as stated above, this is only available as from 2006). More specifically, the ESEE data allows us to use two different variables. Firstly, a dummy variable taking value 1 if the firm imports products or services that are then transformed in the production process in a given year, and value 0 otherwise. We label this variable "Offshoring (0/1)". Secondly, the ESEE also allows us to know the percentage of imports of this type of products or services (that is, those that are subsequently transformed in the firm's production process) relative to the firm's total imports in a given year. We label this variable (expressed in decimals points) "Offshoring (%)". This variable is an indicator of the intensity with which the firm transfers its intermediate manufacturing to other countries. By using these two variables, we can gain a broader view of the effect that the offshoring of intermediate manufacturing can have on firm innovation performance.

We lag the two independent variables in order to take into account that the effect of offshoring on firm innovation may not be immediate and may take some time to materialize. Based on the size of our panel, we include a one-year lag of both independent variables in all estimates of our model.

3.2.3. Control variables

Since a firm's innovation activity may be influenced by factors other than offshoring, we include a set of control variables in our estimates.

Firstly, market structure may affect firms' incentives to innovate (van Cayseele, 1998). However, it is not clear whether such incentives are greater in monopolistic/oligopolistic structures or in those others closer to perfect competition. In any case, following prior studies (e.g., Kotabe, 1990), we include the "Concentration ratio" variable in our estimates. This is defined as the concentration ratio of the four firms with the largest market share in the firm's main market.

Secondly, the literature has extensively studied the role played by firms' intangible capabilities on their innovation activity (e.g., Cohen and Levin, 1989). These capabilities are usually proxied by firms' investments in R&D and advertising (e.g., Andras and Srinivasan, 2003; Connolly et al., 1986; Gelb, 2002; Pearl, 2001). The former is commonly regarded as an indicator of firms' technical expertise and know-how, while the latter is so for market sophistication and consumer orientation (Morck and Yeung, 1991). We therefore include "R&D intensity" and "Advertising intensity" as additional control variables in our model. These are defined as expenditures in R&D and advertising, respectively, over the firm's total sales in a given year. Consistent with extant literature, we expect both variables to positively influence firm innovation. While R&D spending may increase a firm's capability to innovate –being a valuable input in the innovation process that, for instance, allows knowledge creation and utilization (Becheikh et al., 2006; Cohen and Levinthal, 1989)–, advertising expenditures may enhance a firm's incentives to innovate by increasing consumer orientation (Morck and Yeung, 1991; Salomon and Jin, 2008), as well as the firm's ability to appropriate the profits generated by its innovations (Acs and Audretsch, 1988; Comanor, 1967).

Additionally, innovation activity may be affected by ownership structure. For example, prior research indicates that family, as well as foreign, ownership may influence firms' strategic choices such as innovation. Accordingly, we control for these factors in our specifications. Firstly, we expect familiness to negatively influence firm innovation activities. Since family wealth is tightly linked to firm wealth, decision-making in family firms tends to be more conservative and exhibit higher risk-aversion profiles than in their non-family counterparts (e.g., Nieto et al., 2015; Munari et al., 2010). This may greatly limit family firms' willingness to pursue innovations, particularly of a radical nature, as these are normally risky and uncertain activities (Muñoz-Bullón and Sánchez-Bueno, 2011). Secondly, extant literature predicts contrasting effects of foreign ownership on firm innovation. On the one hand, firms' innovation activities may be positively affected by the presence of foreign investors in the firm's capital, as these may provide valuable resources to innovate, such as know-how or funding (Phene and Almeida, 2008). On the other hand, foreign investors are in a position to direct the innovative activities of the local affiliates they own (Chung et al., 2003; Kokko, 1994). For example, foreign owners might decide to transfer all or most innovation activity from the local affiliate to the parent company in their home country or to other subsidiaries in other countries (García et al., 2013), thus negatively affecting innovation in the local (in our case, Spanish) subsidiary. All things considered, we include two different control variables largely used in the literature to account for the influence of the type of ownership structure on firm innovation; namely, a dichotomous variable labelled "Family firm" that takes value 1 if a family group is actively engaged in the control or management of the firm, and value 0 otherwise (e.g., Fernández and Nieto, 2006; Nieto et al., 2015); and a variable labelled "Foreign capital", which accounts for the percentage of foreign capital participation in the firm in a given year, expressed in decimal points (e.g., Salomon and Jin, 2008, 2010; Valle et al., 2015).

There is also debate in the literature on whether larger or smaller firms are better equipped to innovate. In principle, larger firms possess more resources (of all types) than smaller ones, while the latter normally have more flexible organizational structures, which may greatly facilitate innovation. Whatever the case, we control for firm "Size", measured by the firm's total number of employees in a given year (in natural logarithm).

Innovation activity may also vary depending on the industry. Specifically, we expect firms in high-technology industries to have a greater propensity to innovate than those in low-technology industries, since technological dynamism makes innovation a much more relevant competitive variable in the former than in the latter. We separate firms in our sample in those two types of industries on the basis of the OECD classification of manufacturing sectors according to their technological advancement (OECD, 2011). Therefore, in our estimates we use a dummy variable taking value 1 if the firm belongs to a high-technology industry and value 0 if it belongs to a low-technology industry.

Finally, innovation may vary over time due to changes in the macroeconomic environment that are not observable by researchers. Therefore, to avoid the potential bias in research results that these unobservable may cause, we follow standard practice in the literature and include year dummies in all estimates of our econometric model as additional controls (e.g., Nieto et al., 2015; Salomon and Jin, 2008, 2010). These annual dummies allow us to account and control for year-specific events or other external shocks that might systematically influence firm innovation.

3.2.4. Moderating variable

Our aim in this study is to determine whether firms' technological capabilities moderate the influence of intermediate manufacturing offshoring on their innovative performance. We argue that technologically advanced firms will benefit more from the offshoring of their intermediate manufacturing activities than their technologically lagging counterparts.

As will be detailed below, to empirically assess this argument we follow prior research and proxy a given firm’s technological capabilities through its relative R&D expenditures (e.g., Chung and Alcacer, 2002; García et al., 2012). As extant literature suggests, there is a direct relation between a firm’s investment in R&D and the development of its capacity to assimilate, combine and use knowledge (Cohen and Levinthal, 1989, 1990; Griffith et al., 2004). As Kafouros and Forsans (2012) point out, R&D intensive firms are likely to be better able to exploit external ideas and technologies. A firm’s investments in R&D result in an increased technological capability that facilitates the understanding of the discoveries of others, as well as the assimilation and absorption of new technologies. Not in vain, R&D investments are commonly used as a proxy for this type of technological capabilities (Chung and Alcacer, 2002).

Moreover, the more complicated a firm’s learning environment is, the greater the marginal effect of R&D on its ability to absorb external knowledge (Cohen and Levinthal, 1990). In this sense, it seems reasonable to assume that accessing new knowledge and organizational learning will be more complicated in an international setting, which is precisely the context in which offshoring takes place. These difficulties are mainly due to the barriers created by the geographic, cultural and social differences between the domestic and foreign markets that the firm has to deal with, which make interorganizational relationships more complex. Therefore, in offshoring, investments in R&D play an even more relevant role in achieving effective learning and knowledge transfer between geographically and culturally distant agents.

In view of all the above, we turn to R&D expenditures to build a measure that accurately reflects the level of technological capabilities of the focal firm. Specifically, we follow Salomon and Jin (2008; 2010) and construct an index that allows us to classify firms in our sample as technological leaders or laggards based on their relative investments in R&D

(in comparison with average R&D expenditures in their same industry in other OECD countries). That is, we distinguish technological leaders from technological laggards based on their proximity to their industry global technological frontier. For this purpose, we use the ESEE firm-level data and the industry-level data from the STAN database. On the one hand, we calculate R&D intensity of firms in the ESEE sample for each year; that is, we divide R&D expenditures of firm *i* in sector *j* in year *t* by its sales in that year. By doing this we eliminate the influence of firm size on the firm's capacity to invest in R&D. On the other hand, using the STAN database, we calculate average R&D intensity in year *t* for each industry *j*, taking into account all the OECD countries for which we have data (except Spain). That is, for each country *k* other than Spain, we divide R&D expenditures each year *t* for each sector *j* by the gross production in that country in that industry and that specific year. We then calculate the average value of this measure across all those OECD countries, excluding Spain. By doing so, we approximate the global technological frontier for each industry in our sample. Finally, we subtract this average R&D intensity of the OECD for industry *j* from the R&D intensity calculated for each ESEE firm operating in that industry *j*. In this way, we obtain a time-varying, firm-specific R&D index (which we label RDI^{OCDE}), which is consistent with prior research (e.g., Chung and Alcacer, 2002; Salomon and Jin, 2008, 2010; Jin et al., 2018). This index is a proxy of the firm's technological position in comparison with the average R&D intensity from its corresponding industry in other developed countries and, therefore, allows us to gauge the proximity (or distance) of firms in our sample from their relevant industry technological frontier. Thus, increasing values of this index indicate that a given firm is technologically advanced, whose R&D expenditures put it closer to the global technological frontier. Conversely, decreasing values of the RDI index indicate that a firm can be considered technologically backward, placed further from the global technological frontier. Equation (1) formally expresses how this index is calculated:

$$RDI_{ijt}^{OCDE} = [RD_{ijt} / Sales_{ijt}] \times 100 - \left[\sum_{k=1}^{n} (RD_{jkt} / GP_{jkt}) \right] \times \frac{1}{n} \times 100 \quad (1),$$

where RDI_{ijt}^{OCDE} is our R&D index, which represents relative expenditure on R&D by firm *i* in sector *j* in year *t* in comparison with the average expenditure in its same industry in other OECD countries (excluding Spain); RD_{ijt} measures R&D expenditure by firm *i* in industry *j* in year *t*; $Sales_{ijt}$ captures total sales by firm *i* in industry *j* in year *t*; RD_{jkt} measures R&D expenditure in industry *j* in country *k* in year *t*; GP_{jkt} is gross production in industry *j* in country *k* in year *t*; and *n* is the total number of OECD countries, excluding Spain (n=21).

To analyse the potential moderating effect of technological capabilities on the offshoring-innovation relation, we split our sample into two groups based on this R&D index. We use the median of RDI^{OCDE} as the cut-off point for defining the group of technologically leading firms (those with RDI^{OCDE} values equal to or above the median) and the group of technologically lagging firms (those with RDI^{OCDE} values below the median). By performing this sub-sample analysis, we can understand the relation between offshoring and innovation in each sub-group of firms, as well as the extent of the moderating effect.

3.3. Econometric technique

The characteristics of our dependent variables (the number of patent and utility model applications are count variables that take non-negative integer values, many of which are zero or close to zero) lead us to use a negative binomial model in our estimates. This type of model can be considered a generalization of Poisson models, although it has some advantages over these. Essentially, in the presence of overdispersion, negative binomial models are more accurate than Poisson models (Cameron and Trivedi, 1998).

In addition, and taking into account the structure of our data, we introduce a dynamic specification in these negative binomial models. Following Salomon and Jin (2008, 2010), we incorporate an auto-regressive process that includes lagged values of the dependent variable as regressors[4]. Specifically, we include one lag of the dependent variable in the estimates of our model. Dynamic models allow to control for: 1) endogeneity in offshoring decisions, as these may be influenced by prior firm innovation; 2) firm-specific effects (Greene, 2003) and, consequently, serial correlation which might arise from having data with several observations for each firm if such observations are not mutually independent.

Equation (2) represents the general model described above:

$$\lambda_{it} = \exp(\rho_1 y_{i,t-1} + \beta_1 x_{ij,t-1} + \beta_2 W_{it} + \varepsilon_{it}) \qquad (2),$$

where λ_{it} represents the expected number of patent or utility model applications for firm i in year t, $y_{i,t-1}$ is the lag of the dependent variable for firm i, $x_{ij,t-1}$ represents, alternatively, each of the two measures of offshoring for firm i in year $t-1$, W_{it} is a vector of control variables, and ε_{it} is an error term. The rhos and betas represent the estimates of coefficients.

4. Results

4.1. Descriptive statistics and correlations

Table 2 presents the matrix of correlations and some descriptive statistics for the two groups of firms into which the sample is split (using the RDI^{OCDE} index).

*** Insert Table 2 here ***

As expected, technologically more advanced firms show, on average, greater innovation activity than technologically less advanced firms: they not only apply for more patents and utility models than the latter, but also invest more in R&D. The former are also larger and invest more in advertising. Finally, intermediate manufacturing offshoring is greater for technological leaders than for technological laggards.

If we focus on correlations, we note that these are positive between the lag of the two offshoring variables (the dummy and the percentage) and the two dependent variables (patent applications and utility models) for both technological leaders and laggards. Also, correlation coefficients are generally larger for the group of leading firms, which suggests that technological capabilities have a positive moderating effect on the relation between offshoring and innovation.

4.2. Results

Tables 3 to 6 present the results for the negative binomial regressions for different model specifications. Tables 3 and 4 present results for “Patent applications”, whereas Tables 5 and 6 do so when the dependent variable is “Utility models”. In each of these two sets of results, the first table (i.e., Tables 3 and 5) presents results using “Offshoring (0/1)” as the independent variable, whereas the second table in the set (i.e., Tables 4 and 6) presents results for the “Offshoring (%)” independent variable. In all these tables, the sample is divided into technologically leading and technologically lagging firms in terms of median RDIOECD.

In addition to the coefficients and statistics for each variable, all results tables include marginal effects, calculated as partial derivatives with respect to the mean of the variable in question. The marginal effects measure the increase in the dependent variable when there is a one unit increase in the mean of the independent variable.

In Table 3 to Table 6, columns 1 and 3 present the base model, in which only the control variables are included. Columns 2 and 4 present the results of the regressions after including the respective independent variables. Therefore, columns 2 and 4 in those tables present results meant to test our hypothesis.

As we have indicated, Tables 3 and 4 present results using “Patent applications” as the dependent variable. In Table 3 the independent variable is “Offshoring (0/1)”, whereas in Table 4 this is “Offshoring (%)”.

*** Insert Tables 3 and 4 here ***

The results reported in both Table 3 and Table 4 indicate that, for both groups of firms, the lagged value of the number of patent applications has a positive and significant effect on its contemporary value, suggesting persistence in firms' patent behaviour; that is, applying for patents in a given year increases the likelihood of doing so the following year. For the control variables, we find that neither the degree of concentration in the market in which the firm competes, nor investments in advertising, nor belonging to high or low technology sectors influence the innovation performance of the two groups of firms. Conversely, and consistent with our expectations, we find familiness to negatively and significantly affect patenting. Moreover, firm size does have a positive and significant influence on firm innovation. This result is in line with prior empirical evidence, suggesting that, as firm size grows, so do the resources and capabilities available to innovate.

For the remaining control variables, however, the effects vary for the two groups of firms. Investing in R&D is positively and significantly related to the number of patent applications filed by technologically leading firms, but does not have a significant effect on their technologically lagging counterparts. Finally, participation by foreign investors in the firm's capital only has a significant effect for the technological leaders in our sample. It is of interest to note that this effect is negative, a result that is in line with prior studies (García et al., 2013) and that might indicate that foreign investors decide to use the acquired firm's technological capabilities to innovate in their home country, rather than in Spain.

Regarding the independent variables –"Offshoring (0/1)" and "Offshoring (%)"–, we find that offshoring (regardless of the proxy we use) is positively and significantly related to subsequent patent applications for both technologically leading and lagging firms. This suggests that offshoring intermediate manufacturing activities implies improvements in the innovation performance of firms that adopt such a strategy. When the two groups of firms (i.e., technological leaders and laggards) are compared, we find that the marginal effects of offshoring on innovation are greater for technologically leading firms than for technologically lagging ones. More specifically, comparison of the marginal effects for the

"Offshoring (0/1)" variable between the two sub-samples (columns 2 and 4 in Table 3) indicates that, as a consequence of their offshoring activities, technological leaders apply for 0.0731 (0.1059 – 0.0328) more patents than technological laggards. Similarly, the difference in the marginal effects for the "Offshoring (%)" variable in columns 2 and 4 in Table 4 shows that, for an equivalent level of increase in the percentage of imports of intermediate products, technological leaders apply for 0.0565 (0.0865 – 0.0300) more patents than technological laggards. Taken together, these results provide support for our hypothesis and imply that firms' technological capabilities have a positive moderating effect on the offshoring-innovation relation. That is, firms endowed with superior technological capabilities benefit more from offshoring activities than those others with weaker technological capabilities.

Tables 5 and 6 present the results of the negative binomial regressions with "Utility models" as the dependent variable, respectively using "Offshoring (0/1)" and "Offshoring (%)" as the independent variable.

*** Insert Tables 5 and 6 here ***

As was the case with patents, results presented in these tables indicate persistence in utility model applications. Similarly, the results for R&D and advertising intensity, as well as for firm size, are largely consistent with those obtained for patents. For the remaining control variables, results slightly vary. Market concentration is now positively and significantly related to firm innovation for the group of technological leaders. For the proxies of capital structure, we now find that neither foreign capital participation nor familiness is significantly related to utility model applications. Finally, results for the industry dummy indicate that belonging to a high technology industry is negatively related to filing for utility models, at least for technologically leading firms. We interpret these results as a reflection of the specific characteristics of utility models. For example, the risk aversion that characterizes family firms might not be so critical when it comes down to developing minor or incremental innovations such as the ones that utility models represent. Moreover, results for the industry dummy are consistent with findings in the literature suggesting that utility models are more common in low technology industries (Milesi et al., 2013).

Turning to our two independent variables –“Offshoring (0/1)” and “Offshoring (%)”–, and the moderating effect of technological capabilities, results in Tables 5 and 6 are consistent at large with those presented in Tables 3 and 4. That is, our results indicate that the offshoring of intermediate manufacturing is positively and significantly related to utility model applications by both technological leaders and laggards (with the only exception of column 4 in Table 5, where the coefficient is directionally consistent but does not statistically differ from zero). In addition, and similarly to the results for patents, we note that the statistical relationship between offshoring and utility model applications is stronger in the leader condition than the laggard condition. That is to say, when we compare column 2 to column 4 for both independent variables, we find a difference in marginal effects of 0.0872 (0.0904 – 0.0032) in Table 5 and 0.0830 (0.0877 – 0.0047) in Table 6. These results indicate that, subsequent to offshoring of intermediate manufacturing, technological leaders file for more utility models than technological laggards. These results provide further support for our hypothesis.

Taken together, the results from Tables 3 to 6 confirm our hypothesis, hinting at a positive moderating role played by technological capabilities when it comes down to benefitting from offshoring activities.

4.3. Robustness tests

In addition to the results reported in Tables 3 to 6, we have performed several other tests to confirm that the results obtained are robust to different model specifications5.

First, although relative R&D expenses have been commonly used to proxy for firms’ technological capabilities, there may be other possible ways to measure this sort of firm capabilities. Therefore, we assess the robustness of our findings to alternative proxies for our moderating variable. Specifically, we focus on firms' technological collaboration with third parties, since these may constitute valuable avenues for knowledge acquisition and skill building and, consequently, may enhance firm capabilities (e.g., Beldervos et al., 2004; Caloghirou et al., 2004; Cantwell and Colombo, 2000). In this vein, empirical findings in the literature support the notion that firms can build and expand their technological capabilities via cooperation with competitors, customers, suppliers and universities, as well as by participating in collaborative agreements such as joint ventures (e.g. Iammarino et al., 2012; Prahalad and Hamel, 1990; Schildt et al., 2012). With this in mind, we take advantage of the ESEE data and build a categorical a variable that measures whether the focal firm collaborates with any of those agents (competitors; suppliers; customers; Universities and/or technological centres) and/or maintains technological cooperation agreements in a given year. We then split our sample into the technologically leading and lagging categories based on the industry average number of collaborations that the focal firm maintains in a given year, and rerun our analyses. Results using this alternative proxy for firms' technological capabilities as a moderator (in lieu of RDI) are largely consistent with those presented in Tables 3 to 6.

Additionally, to test that the positive moderating effect of firms' technological capabilities on the offshoring-innovation relation is not affected by the criterion used to classify firms as technological leaders and laggards, we ran additional regressions using a different index to split our sample.

Since many industries in Spain lag behind other industrialized countries with regard to technological development, comparing firms in our sample with those of other OECD countries might affect our results in that firms in our sample might be systematically treated by the RDI^{OCDE} index as technological laggards. Hence, it might be more appropriate to compare them with the average firm in their industry in Spain. In line again with previous studies (Salomon and Jin, 2008, 2010), we built a new index (labelled RDI^{Spain}) to classify firms in our sample into technologically leading or lagging according to these considerations. This new index is built in a similar way to RDI^{OCDE}, except that, in this case, from the R&D intensity of firm *i* in industry *j* in year *t*, we subtract average R&D intensity in industry *j* in Spain, instead of the average for the OECD. Equation (3) formally expresses this new index:

$$RDI_{ijt}^{Spain} = [RD_{ijt} / Sales_{ijt}] \times 100 - \left[RD_{jt}^{Spain} / GP_{jt}^{Spain}\right] \times 100 \qquad (3),$$

where variables definitions follow those in equation 1.

As with RDI^{OCDE}, firms are classified as technological leaders and laggards based on median RDI^{Spain}. Results using this new index do not vary with regard to the main results of the study presented herein.

We also reran all regressions using mean, instead of median, RDI^{OCDE} and RDI^{Spain} to separate leaders and laggards. Results remained unchanged once again.

Finally, there is an extensive literature arguing that firms can access new knowledge in foreign markets by exporting (e.g., Bernard and Jensen, 1999), which can lead to improvements in their innovation performance (Salomon and Shaver, 2005). Therefore, in order to ensure that our results actually capture an increase in patent applications as a consequence of offshoring, rather than of learning from exporting, we reran our models including “Export intensity” as an additional control variable. This is measured as the firm’s export volume over total sales in a given year. Again, our results did not change.

Taken together, the results of all these robustness tests provide additional support for our hypothesis, reinforcing the notion that technological capabilities positively moderate the relationship between offshoring and firm-level innovation.

5. Discussion and conclusions

In this study, we aim to analyse the role played by firms' technological capabilities in the positive impact that offshoring may have on their innovation performance. Our results show that, while the offshoring of intermediate manufacturing is positively related to *ex-post* patent and utility model activity by Spanish firms regardless of their technological standing, however technological leaders apply for more patents and utility models than their technologically lagging counterparts subsequent to the transfer of intermediate manufacturing activities abroad. These findings allow us to confirm the positive moderating effect of technological capabilities on the offshoring-innovation relation proposed in the hypothesis, suggesting that not only is there substantial heterogeneity among firms in terms of their capabilities, but also that this plays a key role in their chances to obtain innovation benefits from production offshoring.

When the degree of technological development of firms is measured by their relative level of R&D investment, it can be interpreted that the more firms invest in R&D, the easier it will be for them to understand the knowledge generated by others and to assimilate and absorb it, especially in a complicated learning environment such as that of offshoring. In fact, the firms in our sample that have a stronger R&D position seem to have been able to learn more effectively from the knowledge, know-how and experience of the offshore suppliers, partners or subsidiaries to which they transferred the manufacture of parts and components, as well as to more optimally integrate such learning in their operations and production processes. So, greater technical skill and experience resulting from their R&D investments seem to lead to an enhanced ability for detecting and recognizing the value of new techniques, knowledge and production technologies, as well as for assimilating it all and transforming it effectively into innovations. In fact, the most technologically advanced firms in the sample, probably because of that capacity to learn more and to make better use of such learning, apply for more patents and utility models than their technologically lagging counterparts.

All in all, we believe our study makes important contributions to the literature. Firstly, our findings aid us gain a more profound understanding of the offshoring phenomenon and, particularly, of its impact on firm innovative outcomes. Given that innovation has been extensively regarded as a key driver of firm competitiveness (Afuah, 1998) and the long-term development of nations (Grossman and Helpman, 1994), this is relevant both at the firm level and from the point of view of economic growth. Moreover, and more importantly, our study stands to fill some gaps in the offshoring literature by analysing the conditions under which offshoring influences firm innovation. Extant research in this area has been mostly directed at exploring whether offshoring has any effect whatsoever on different firm performance indicators –e.g. costs, productivity and innovation. However, with very few exceptions, whether and how heterogeneity in firm-specific characteristics may moderate the impact of offshoring on firm performance, and particularly on innovative outcomes, has to date remained largely unexplored in the offshoring literature. Therefore, our findings yield relevant insights on the underlying mechanisms that shape the effect of offshoring on firm-level innovation.

Secondly, our results nicely complement previous findings in the international business and strategy literatures. Prior research has hinted at importance of firm capabilities when it comes down to benefiting from international expansion. Scholars have argued that technological leaders are better equipped than their technologically lagging counterparts to access and make use of valuable knowledge inputs available in other countries. Consequently, the former have been found to experience greater improvements in their performance and innovative outcomes subsequent to internationalization (e.g. García et al., 2012 and Salomon and Jin, 2010 for exporting; Zahra and Hayton, 2008 for international alliances and acquisitions). Our results, therefore, extend those findings highlighting that the positive moderating role of firms' technological capabilities in learning from, and innovating as a result of, international expansion is also relevant in the offshoring context and, thus, applies to an even wider spectrum of firms' internationalization activities.

Our findings also have important managerial implications. Albeit our results indicate that offshoring of intermediate manufacturing is positively related to firm innovation in general, managers should bear in mind that, as stated above, firms with the greatest technological capabilities are the ones that will benefit the most from the knowledge available abroad. Accordingly, our results suggest that managers should carefully plan ahead their firms' investments in building or expanding technological capabilities if they aspire to innovate on the basis of knowledge sourced from intermediate production offshoring. Only the development of these capabilities will allow them to identify potentially useful knowledge and turn it into specific product designs that would be the result of innovation. For example, firms' managers could be well served to devote part of their R&D investments to the development, accumulation and use of knowledge within the organization, to the assimilation of external knowledge, to technological learning and development, as well as to promoting employees' ability and behaviour oriented to these goals. Investing in technological capabilities, in sum, would mean doing so in the development of a set of abilities that will allow firms to take full advantage of one of the potential benefits that offshoring activities (in our case, of intermediate production) might have; that is, enhanced innovativeness.

Moreover, this practical implication sends a direct message to policymakers. These should design specific policies aimed at promoting the development of technological capabilities within firms and, particularly, in those firms that may lack the resources needed to enhance their technological development. Therefore, this type of resource limitations may at least partly be mitigated with public policies such as those aimed at providing financial aid or, above all, training –in terms of innovation and knowledge management– both for employees and intermediate managers.

Contributions notwithstanding, our study is not free of limitations. On the one hand, our findings are limited to Spanish manufacturing firms. It would be of interest to examine these relations in different contexts in order to account for industry- and/or country-specific heterogeneity. It would be interesting to know whether the moderating role of technological capabilities varies depending on the country of origin of the firms that offshore value chain activities (for example, whether the home country is relatively more or less technologically advanced than Spain), or whether this moderating role is equally relevant for non-manufacturing firms.

On the other hand, the level of technological development of host countries might not only influence the chances to learn from offshoring for the firms in our sample, but also how relevant their technological capabilities in this respect are. For example, in countries in which the technological gap relative to Spain is small, firms in our sample would find fewer possibilities of benefiting from offshoring in terms of innovation. Nevertheless, for this same reason, firms' technological capabilities would not be such a determining factor for identifying and integrating the (limited) new knowledge acquired in such countries. However, the ESEE does not provide annual data on the foreign countries from which the firms in the sample obtain their components. Therefore, we are unable to control for the effect of host country heterogeneity.

For all these reasons, we are cautious to generalize our findings. However, in spite of its limitations, we believe our study contributes to the field of international expansion and strategy.

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6. References

Acosta–Prado, J.C., Bueno–Campos, E. and Longo–Somoza, M. (2014) 'Technological capability and development of intellectual capital on the new technology based firms', *Cuadernos de Administración*, Vol. 27 No. 48, pp. 11–39.

Acs, Z.J., Anselin, L. and Varga, A. (2002) 'Patents and innovation counts as measures of regional production of new knowledge', *Research Policy*, Vol. 31 No. 7, pp. 1069–1085.

Acs, Z.J. and Audretsch, D.B. (1988) 'Innovation in large and small firms: An empirical analysis', *The American Economic Review*, Vol. 78 No. 4, pp. 678–690.

Afuah, A. (1998) *Innovation Management: Strategies, Implementation, and Profits*, Oxford University Press, New York.

Aghion, P., Blundell, R., Griffith, R., Howitt, P. and Prantl, S. (2009) 'The effects of entry on incumbent innovation and productivity', *The Review of Economics and Statistics*, Vol. 91 No. 1, pp. 20–32.

Almeida, P. and Phene, A. (2004) 'Subsidiaries and knowledge creation: The influence of the MNC and host country on innovation', *Strategic Management Journal*, Vol. 25 No. 8-9, pp. 847–864.

Al-Osh, M.A. and Alzaid, A.A. (1987) 'First-order integer-valued autoregressive, INAR(1)) process', *Journal of Time Series Analysis*, Vol. 8 No. 3, pp. 261–275.

Amiti, M. and Wei, S.J. (2005) 'Fear of outsourcing: Is it justified? ', *Economic Policy*, Vol. 20 No. 42, pp. 308–348.

Andras, T.L. and Srinivasan, S.S. (2003) 'Advertising intensity and R&D intensity: Differences across industries and their impact on firm's performance', *International Journal of Business and Economics*, Vol. 2 No. 2, pp. 81–90.

Archibugi, D. and Pianta, M. (1996) 'Measuring technological change through patents and innovation surveys', *Technovation*, Vol. 16 No. 9, pp. 451–519.

Basberg, B.L. (1987) 'Patents and the measurement of technological change: A survey of the literature', *Research Policy*, Vol. 16 No. 2–4, pp. 131–141.

Becheikh, N., Landry, R. and Amara, N. (2006) 'Lessons from innovation empirical studies in the manufacturing sector: A systematic review of the literature from 1993-2003', *Technovation*, Vol. 26 No. 5–6, pp. 644–664.

Beckman, T.J. (1999) 'The current state of knowledge management', in Liebowitz, J. (Ed.), *Knowledge Management Handbook*, CRC Press, Boca Raton, FL.

Belderbos, R., Carree, M. and Lokshin, B. (2004) 'Cooperative R&D and firm performance', *Research Policy*, Vol. 33 No. 10, pp. 1477–1492.

Bell, M. and Pavitt, K. (1995) 'The development of technological capabilities', in Irfan–ul–Haque, R. and Bell, M. N. (Eds.), *Trade, Technology, and International Competitiveness,* The World Bank, Washington, pp. 69–101.

Beneito, P. (2006) 'The innovative performance of in-house and contracted R&D in terms of patents and utility models', *Research Policy*, Vol. 35 No. 4, pp. 502–517.

Berger, S. (2005) *How We Compete –What Companies around the World Are Doing to Make It in Today's Global Economy*, Currency/Doubleday/Random House, New York.

Bernard, A.B. and Jensen, B.J. (1999) 'Exceptional exporter performance: Cause, effect, or both?', *Journal of International Economics,* Vol. 47 No. 1, pp. 1–25.

Blalock, G. and Gertler, P.J. (2009) 'How firm capabilities affect who benefits from foreign technology', *Journal of Development Economics,* Vol. 90 No. 2, pp. 192–199.

Boztosun, N.A.O. (2010) 'Exploring the utility of utility models for fostering innovation', *Journal of Intellectual Property Rights,* Vol 15, pp. 429–439.

Caloghirou, Y., Kastelli, I. and Tsakanikas, A. (2004) 'Internal capabilities and external knowledge sources: Complements or substitutes for innovative performance?', *Technovation,* Vol. 24 No. 1, pp. 29–39.

Cameron, A.C. and Trivedi, P.K. (1998) *Regression Analysis of Count Data*, *Analysis of Count Data*, Cambridge University Press, New York.

Cantwell, J.A. (1994) *Transnational Corporations and Innovation Activities*, Routledge, London.

Cantwell, J. and Colombo, M.G. (2000) 'Technological and output complementarities, and inter-firm cooperation in information technology ventures', *Journal of Management and Governance*, Vol. 4 No. 1–2, pp. 117–147.

Castellani, D. and Zanfei, A. (2007) 'Internationalisation, innovation and productivity: How do firms differ in Italy?', *The World Economy*, Vol. 30 No. 1, pp. 156–176.

Castro, L. (2015) 'Strategizing across boundaries: Revisiting knowledge brokering activities in French innovation clusters', *Journal of Knowledge Management*, Vol. 19 No. 5, pp. 1048–1068.

Castro, I. and Cepeda, G. (2016) 'Social capital: Absorptive capacity and entrepreneurial behaviour in an international context', *European Journal of International Management,* Vol. 10 No. 4, pp. 479–495.

van Cayseele, P.J.G. (1998) 'Market structure and innovation: A survey of the last twenty years', *De Economist*, Vol. 146 No. 3, pp. 391–417.

Chen, R., Feng, C.L. and Chen, K.W. (2014) 'Patent maintaining and premature expiration of utility models in Taiwan', *World Patent Information*, Vol. 38, pp. 57–61.

Chesbrough, H.W. and Teece, D.J. (1996) 'When is virtual virtuous? Organizing for innovation', *Harvard Business Review*, Vol. 74 No. 1, pp. 65–74.

Chung, W. and Alcacer, J. (2002) 'Knowledge seeking and location choice of foreign direct investment in the United States', *Management Science*, Vol. 48 No. 12, pp. 1534–1554.

Chung, W. and Yeaple, S. (2008) 'International knowledge sourcing: Evidence from U.S. firms expanding abroad', *Strategic Management Journal*, Vol. 29 No. 11, pp. 1207–

1224.

Chung, W., Mitchell, W. and Yeung, B. (2003) 'Foreign direct investment and host country productivity: The American automotive component industry in the 1980s', *Journal of International Business Studies*, Vol. 34 No. 2, pp. 199–218.

Cohen, W.M. and Levin, R.C. (1989) 'Empirical studies of innovation and market structure', in Schmalensee, R. and Willig, R.D. (Eds.), *Handbook of Industrial Organization*, Vol. 2, North Holland, New York, NY, pp. 1059–1107.

Cohen, W.M. and Levinthal, D.A. (1989) 'Innovation and learning: The two faces of R&D', *The Economic Journal*, Vol. 99 No. 397, pp. 569–596.

Cohen, W.M. and Levinthal, D.A. (1990) 'Absorptive capacity: A new perspective on learning and innovation', *Administrative Science Quarterly*, Vol. 35 No. 1, pp. 128–152.

Comanor, W.S. (1967) 'Market structure, product differentiation, and industrial research', *The Quarterly Journal of Economics*, Vol. 81 No. 4, pp. 639–657.

Connolly, R.A., Hirsch, B.T. and Hirschey, M. (1986) 'Union rent seeking, intangible capital, and market value of the firm', *The Review of Economics and Statistics*, Vol. 68 No. 4, pp. 567–577.

Davenport, T. and Prusak, L. (1998) *Working Knowledge*, Harvard University Press, Boston, MA.

Doz, Y.L., and Wilson, K. (2012) *Managing Global Innovation: Frameworks for Integrating Capabilities around the World*, Harvard Business School Press, Boston, MA.

Falk, M. and Koebel, B.M. (2002) 'Outsourcing, imports and labour demand', *Scandinavian Journal of Economics*, Vol. 104 No. 4, pp. 567–586.

Fariñas, J.C. and Martín-Marcos A. (2010) 'Foreign sourcing and productivity: evidence at the firm level', *The World Economy*, Vol. 33 No. 3, pp. 482–506.

Feenstra, R.C. and Hanson, G. (1996) 'Globalization, Outsourcing, and Wage Inequality', *American Economic Review*, Vol. 86 No. 2, pp. 240–245.

Feenstra, R.C. and Hanson, G. (1999) 'The impact of outsourcing and high-technology capital on wages: Estimates for the United States, 1970-190', *Quarterly Journal of Economics*, Vol. 114 No. 3, pp. 907–940.

Ferdows, K. (1997) 'Making the most of foreign factories', *Harvard Business Review*, Vol. March-April, pp. 73–88.

Fernández, Z. and Nieto, M. J. (2006) 'Impact of ownership on the international involvement of SMEs', *Journal of International Business Studies*, Vol. 37 No. 3, pp. 340–351.

Fifarek, B.J., Veloso, F.M. and Davidson, C.I. (2008) 'Offshoring technology innovation: A case study of rare-earth technology', *Journal of Operations Management*, Vol. 26 No. 2, pp. 222–238.

García, F., Avella, L. and Fernández, E. (2012) 'Learning from exporting: The moderating effect of technological capabilities', *International Business Review*, Vol. 21 No. 6, pp. 1099–1111.

García, F., Jin, B. and Salomon, R. (2013) 'Does inward foreign direct investment improve the innovative performance of local firms?', *Research Policy*, Vol. 42 No. 1, pp. 231–244.

Geishecker, I. and Görg, H. (2005) ‘Do unskilled workers always lose from fragmentation?’, *North American Journal of Economics and Finance,* Vol. 16 No. 1, pp. 81–92.

Gelb, D.S. (2002) ‘Intangible assets and firms' disclosures: An empirical investigation’, *Journal of Business Finance & Accounting,* Vol. 29 No. 3-4, pp. 457–476.

Gloet, M. and Terziovski, M. (2004) ‘Exploring the relationship between knowledge management practices and innovation performance’, *Journal of Manufacturing Technology Management,* Vol. 15 No. 5, pp. 402–409.

Greene, W.H. (2003) *Econometric Analysis*, 5th ed., Prentice Hall, Upper Saddle River, NJ.

Griffith, R., Redding, S. and van Reenen, J. (2004) ‘Mapping the two faces of R&D: Productivity growth in a panel of OECD industries’, *Review of Economics and Statistics,* Vol. 86 No. 4, pp. 883–895.

Griliches, Z. (1990) ‘Patent statistics as economic indicators: A survey’, *Journal of Economic Literature,* Vol. 28 No. 4, pp. 1661–1707.

Grossman, G.M. and Helpman, E. (1994) ‘Endogenous innovation in the theory of growth’, *Journal of Economic Perspectives,* Vol. 8 No. 1, pp. 23–44.

Hijzen, A., Görg, H. and Hine, B. (2005) ‘International outsourcing and the skill structure of labour demand in the United Kingdom’, *Economic Journal,* Vol. 115 No. 506, pp. 860–878.

Iammarino, S., Piva, M., Vivarelli, M. and Von Tunzelmann, N. (2012) ‘Technological capabilities and patterns of innovative cooperation of firms in the UK regions’, *Regional Studies,* Vol. 46 No. 10, pp. 1283–1301.

Jahns, C., Hartmann, E. and Bals, L. (2006) ‘Offshoring: Dimensions and diffusion of a new business concept’, *Journal of Purchasing and Supply Management*, Vol. 12 No. 4, pp. 218–231.

Jensen, P.D.Ø. (2009) ‘A learning perspective on the offshoring of advanced services’, *Journal of International Management,* Vol. 15 No. 2, pp. 181–193.

Jin, B., García, F. and Salomon, R. (2018) ‘Inward foreign direct investment and local firm innovation: The moderating role of technological capabilities’, *Journal of International Business Studies,* forthcoming.

Joubioux, C. and Vanpoucke, E. (2016) ‘Towards right-shoring: A framework for off-and re-shoring decision making’, *Operations Management Research,* Vol. 9 No. 3–4, pp. 117–132.

Kafouros, M.I. and Forsans, N. (2012) ‘The role of open innovation in emerging economies: Do companies profit from the scientific knowledge of others?’, *Journal of World Business,* Vol. 47 No. 3, pp. 362–370.

Kedia, B.L. and Mukherjee, D. (2009) ‘Understanding offshoring: A research framework based on disintegration, location and externalization advantages’, *Journal of World Business,* Vol. 44 No. 3, pp. 250–261.

Kenney, M., Massini, S. and Murtha, T.P. (2009) ‘Offshoring administrative and technical work: New fields for understanding the global enterprise’, *Journal of International Business Studies,* Vol. 40 No. 6, pp. 887–900.

Kim, C., and Song, J. (2007) ‘Creating new technology through alliances: An empirical investigation of joint patents’, *Technovation,* Vol. 27 No. 8, pp. 461–470.

Kokko, A. (1994) ‘Technology, market characteristics, and spillovers’, *Journal of Development Economics*, Vol. 43 No. 2, pp. 279–293.

Kotabe, M. (1990) ‘The relationship between offshore sourcing and innovativeness of U.S. multinational firms: An empirical investigation’, *Journal of International Business Studies*, Vol. 21 No. 4, pp. 623–638.

Kotabe, M., Dunlap-Hinkler, D., Parente, R. and Mishra, H.A. (2007) ‘Determinants of cross-national knowledge transfer and its effect on firm innovation’, *Journal of International Business Studies*, Vol. 38 No. 2, pp. 259–282.

Kotabe, M., Mol, M.J. and Ketkar, S. (2008) ‘An evolutionary stage model of outsourcing and competence destruction: A triad comparison of the consumer electronics industry’, *Management International Review*, Vol. 48 No. 1, pp. 65–94.

Lall, S. (1992) ‘Technological capabilities and industrialization’, *World Development*, Vol. 20 No. 2, pp. 165–186.

Lampel, J. and Bhalla, A. (2011) ‘Living with offshoring: The impact of offshoring on the evolution of organizational configurations’, *Journal of World Business*, Vol. 46 No. 3, pp. 346–358.

Leiponen, A. and Helfat, C.E. (2010) ‘Innovation objectives, knowledge sources, and the benefits of breadth’, *Strategic Management Journal*, Vol. 31 No. 2, pp. 224–236.

Leonard-Barton, D. (1992) ‘The factory as a learning laboratory’, *Sloan Management Review*, Vol. 34 No. 1, pp. 23–38.

Lew, Y.K. and Liu, Y. (2016) ‘The contribution of inward FDI to Chinese regional innovation: The moderating effect of absorptive capacity on knowledge spillover’, *European Journal of International Management*, Vol. 10 No. 3, pp. 284–313.

Lewin, A.Y., Massini, S. and Peeters, C. (2009) ‘Why are companies offshoring innovation? The emerging global race for talent’, *Journal of International Business Studies*, Vol. 40 No. 6, pp. 901–925.

Manning, S., Massini, S. and Lewin, A.Y. (2008) ‘A dynamic perspective on next-generation offshoring: The global sourcing of science & engineering skills’, *Academy of Management Perspectives*, Vol. 22 No. 3, pp. 35–54.

Martínez–Noya, A. and García–Canal, E. (2011) ‘Technological capabilities and the decision to outsource/outsource offshore R&D services’, *International Business Review*, Vol. 20 No. 3, pp. 264–277.

Marwick, A. (2001) ‘Knowledge management technology’, *IBM Systems Journal*, Vol. 40 No. 4, pp. 814–830.

Matsuo, M. (2015) ‘Human resource development programs for knowledge transfer and creation: The case of the Toyota Technical Development Corporation’, *Journal of Knowledge Management*, Vol. 20 No. 6, pp. 1186–1203.

Mihalache, M. and Mihalache, O.R. (2016) ‘A decisional framework of offshoring: Integrating insights from 25 years of research to provide direction for future’, *Decision Sciences*, Vol. 47 No. 6, pp. 1103–1149.

Mihalache, O.R., Jansen, J.J.J.P., van den Bosch, F.A.J. and Volberda, H.W. (2012) ‘Offshoring and firm innovation: The moderating role of top management team attributes’, *Strategic Management Journal*, Vol. 33 No. 13, pp. 1480–1498.

Milesi, D., Petelski, N. and Verre, V. (2013) ‘Innovation and appropriation mechanisms: Evidence from Argentine microdata’, *Technovation*, Vol. 33 No. 2–3, pp. 78–87.

Morck, R. and Yeung, B. (1991) ‘Why investors value multinationality’, *Journal of Business*, Vol. 64 No. 2, pp. 165–187.

Munari, F., Oriani, R. and Sobrero, M. (2010) ‘The effects of owner identity and external governance systems on R&D investments: A study of Western European firms’, *Research Policy*, Vol. 39 No. 8, pp. 1093–1104.

Muñoz-Bullón, F. and Sanchez-Bueno, M.J. (2011) ‘The impact of family involvement on the R&D intensity of publicly traded firms’, *Family Business Review*, Vol. 24 No. 1, p. 62–70.

Neuhäusler, P. (2012) ‘The use of patents and informal appropriation mechanisms—Differences between sectors and among companies’, *Technovation*, Vol. 32 No. 12, pp. 681–693.

Nieto, M.J., Santamaria, L. and Fernandez, Z. (2015) ‘Understanding the innovation behavior of family firms’, *Journal of Small Business Management*, Vol. 53 No. 2, pp. 382–399.

Nonaka, I. and Takeuchi, H. (1995) *The Knowledge–Creating Company*, Oxford University Press, New York.

OECD (2011) *ISIC Rev*. 3 *Technology Intensity Definition. Classification of Manufacturing Industries into Categories Based on R&D Intensities* [online]. OECD Directorate for Science, Technology and Industry.

Pearl, J. (2001) ‘Intangible investments, tangible results’, *MIT Sloan Management Review*, Vol. 43 No. 1, pp. 13–13.

Pennings, J.M. and Harianto, F. (1992) ‘Technological networking and innovation implementation’, *Organization Science*, Vol. 3 No. 3, pp. 356–382.

Phene, A. and Almeida, P. (2008) ‘Innovation in multinational subsidiaries: The role of knowledge assimilation and subsidiary capabilities’, *Journal of International Business Studies*, Vol. 39 No. 5, pp. 901–919.

Prahalad, C.K. and Hamel, G. (1990) ‘The Core Competence of the Corporation’, *Harvard Business Review*, Vol. 68 No. 3, pp. 79–91.

Revilla, E., Sáenz, M.J. and Knoppen, D. (2013) ‘Towards an empirical typology of buyer–supplier relationships based on absorptive capacity’, *International Journal of Production Research*, Vol. 51 No. 10, pp. 2935–2951.

Ribau, C.P., Moreira, A.C. and Raposo, M. (2019) ‘The role of exploitative and exploratory innovation in export performance: An analysis of plastics industry SMEs’, *European Journal of International Management*, Vol. 13 No. 2, pp. 224–246.

Salomon, R. and Jin, B. (2008) ‘Does knowledge spill to leaders or laggards? Exploring industry heterogeneity in learning by exporting’, *Journal of International Business Studies*, Vol. 39 No. 1, pp. 132–150.

Salomon, R. and Jin, B. (2010) ‘Do leading or lagging firms learn more from exporting?’, *Strategic Management Journal*, Vol. 31 No. 10, pp. 1088–1113.

Salomon, R.M. and Shaver, J.M. (2005) ‘Learning by exporting: New insights from examining firm innovation’, *Journal of Economics and Management Strategy*, Vol. 14 No. 2, pp. 431–460.

Schildt, H., Keil, T. and Maula, M. (2012) 'The temporal effects of relative and firm–level absorptive capacity on interorganizational learning', *Strategic Management Journal*, Vol. 33 No. 10, pp. 1154–1173.

Slepniov, D., Wæhrens, B.V. and Johansen, J. (2014) 'Dynamic roles and locations of manufacturing: Imperatives of alignment and coordination with innovation', *Journal of Manufacturing Technology Management*, Vol. 25 No. 2, pp. 198–217.

Slepniov, D., Wæhrens, B.V. and Jørgensen, C. (2010) 'Global operations networks in motion: Managing configurations and capabilities', *Operations Management Research*, Vol. 3 No. 3–4, pp. 107–116.

Stentoft, J., Mikkelsen, O.S. and Johnsen. T.E. (2015) 'Going local: A trend towards insourcing of production?', *Supply Chain Forum: An International Journal*, Vol. 16 No. 1, pp. 2–13.

Stock, G.N., Greis, N.P. and Fischer, W.A. (2001) 'Absorptive capacity and new product development', *The Journal of High Technology Management Research*, Vol. 12 No. 1, pp. 77–91.

Svetina, A.C. and Prodan, I. (2008) 'How internal and external sources of knowledge contribute to firms' innovation performance', *Managing Global Transitions*, Vol. 6 No. 3, pp. 277–299.

Tarn, D.D.C. (2015) 'Integrated decision model for knowledge offshoring and outsourcing', *Knowledge Management Research & Practice*, Vol. 13 No. 1, pp. 1–16.

Theodorakopoulos, N., Patel, C. and Budhwar, P. (2012) 'Editorial: Knowledge flows, learning and development in an international context', *European Journal of International Management*, Vol. 6 No. 1, pp. 1–9.

Torres-Barreto, M.L., Mendez-Duron, R. and Hernandez-Perlines, F. (2016) 'Technological impact of R&D grants on utility models', *R&D Management*, Vol. 46 No. S2, pp. 537–551.

Tyndale, P. (2002) 'A taxonomy of knowledge management software tools: Origins and applications', *Evaluation and Program Planning*, Vol. 25 No. 2, pp. 183–190.

Un, C. A. (2017) 'Absorptive capacity and R&D outsourcing', *Journal of Engineering and Technology Management*, Vol. 43, pp. 34–47.

Valle, S., García, F. and Avella, L. (2015) 'Offshoring intermediate manufacturing: Boost or hindrance to firm innovation?', *Journal of International Management*, Vol. 21 No. 2, pp. 117–134.

Venkatraman, N.V. (2004) 'Offshoring without guilt', *Sloan Management Review*, Vol. 45 No. 3, pp. 14–16.

Westphal, L.E., Kritayakirana, K., Petchsuwan, K., Sutabutr, H. and Ythavong, Y. (1990) 'The development of technological capability in manufacturing: Macroscopic approach to policy research', in Evenson, R. and Ranis, G. (Eds.), *Science and Technology: Lessons for Development Policy*, Intermediate Technology Publications, London, pp. 81–134.

Zahra, S.A. and Hayton, J.C. (2008) 'The effect of international venturing on firm performance: The moderating influence of absorptive capacity', *Journal of Business Venturing*, Vol. 23 No. 2, pp. 195–220.

Zhou, K.Z. and Wu, F. (2010) ‘Technological capability, strategic flexibility, and product innovation’, *Strategic Management Journal*, Vol. 31 No. 5, pp. 547–561.

[1] For example, Joubioux and Vanpoucke (2016) found that the main motivation for offshoring in the aeronautic industry is to access new resources and capacities in developing countries, rather than cost-cutting considerations.

[2] Because of missing data during the period for which we use the ESEE data, we have had to exclude the following countries from the sample: Chile, Czech Republic, Estonia, Hungary, Ireland, Israel, Luxembourg, Poland, Slovak Republic, Slovenia, Switzerland and Turkey.

[3] We have combined the ESEE and STAN data using industry equivalences, but we were unable to find a suitable match for firms belonging to the “Non-metallic mineral products” and “Other manufacturing industries” sectors, so these were excluded from the final sample.

[4] Although this type of auto-regressive model was initially proposed for continuous dependent variables, Al-Osh and Alzaid (1987) argue that it can also be applied to count data.

[5] The results reported in this section are available from the authors upon request.

Table 1: Industry breakdown (final sample)

Industry	Firms (%)	Employees (average)	RDI^{OECD} (average)	Patent Applications (average)	Firms (%) offshoring intermediate manufacturing	Intermediate imports over total imports (average %)
1. Meat products	3.67	256.93	-0.30	0.03	28.81	15.67
2. Food and tobacco	11.44	179.17	-0.14	0.14	39.23	27.38
3. Beverages	2.52	185.06	0.51	0.05	31.82	26.62
4. Textiles and wearing apparel	8.06	59.11	-0.24	0.32	37.98	29.46
5. Leather and footwear	3.09	32.56	-0.18	0.01	46.00	35.39
6. Wood	4.75	105.08	0.09	0.06	34.18	26.46
7. Paper	3.67	108.75	-0.35	2.12	55.74	44.81
8. Graphic arts	5.61	166.64	-0.04	0.05	33.33	20.13
9. Chemical and pharmaceutical products	6.83	317.86	-2.96	0.96	69.03	56.72
10. Rubber and plastic products	6.19	124.07	-0.70	0.38	52.00	41.41
11. Ferrous and non-ferrous metals	4.03	493.01	-0.20	0.09	45.59	34.16
12. Metal products	14.46	94.14	-0.04	0.04	32.29	27.70
13. Agricultural and industrial machinery	6.91	140.88	-0.06	0.24	53.85	40.33
14. Computer, electronic and optical products	2.37	569.85	-4.11	0.38	72.97	57.96
15. Electrical machinery and equipment	4.46	243.52	-3.85	0.27	54.93	35.10
16. Motor vehicles	5.18	952.82	-0.47	0.19	71.08	58.55
17. Furniture	6.76	72.35	0.46	0.04	35.45	24.92

Table 2: Descriptive statistics and correlations (sample split by median RDI^{OCDE})

Variable	Average	Std. Dev.	Min.	Max.	1	2	3	4	5	6	7	8	9	10	11	12	13
Technological leaders																	
1. Patent applications $_{(t)}$	0.58	4.48	0	113	1												
2. Patent applications $_{(t-1)}$	0.56	4.18	0	113	0.39	1											
3. Utility models $_{(t)}$	0.29	3.70	0	112	0.02	0.02	1										
4. Utility models $_{(t-1)}$	0.38	4.03	0	112	0.02	0.01	0.08	1									
5. Offshoring (0/1) $_{(t-1)}$	0.64	0.48	0	1	0.06	0.02	0.05	0.03	1								
6. Offshoring (%) $_{(t-1)}$	0.46	0.44	0	1	0.03	0.01	0.04	0.02	0.77	1							
7. Concentration ratio $_{(t)}$	0.43	0.36	0	1	-0.00	-0.02	0.05	0.03	0.05	0.01	1						
8. R&D intensity $_{(t)}$	0.03	0.05	0	0.97	0.15	0.15	0.03	0.04	0.03	0.07	-0.07	1					
9. Advertising intensity $_{(t)}$	0.02	0.03	0	0.32	0.05	0.06	0.04	0.02	-0.03	-0.07	0.03	0.01	1				
10. Foreign capital $_{(t)}$	0.21	0.40	0	1	-0.04	-0.04	0.02	0.01	0.16	0.10	0.12	-0.08	-0.05	1			
11. Family firm $_{(t)}$	1.57	0.50	0	1	-0.07	-0.06	-0.01	0.00	0.05	0.07	0.11	-0.10	-0.18	0.31	1		
12. Size (ln) $_{(t)}$	5.05	1.32	1.95	9.50	0.10	0.11	0.08	0.07	0.14	0.09	0.20	-0.09	0.15	0.38	0.17	1	
13. Industry (high-low technology) $_{(t)}$	0.42	0.49	0	1	0.06	0.08	0.01	0.02	0.13	0.08	0.03	0.27	-0.11	0.10	-0.00	0.05	1
Technological laggards																	
1. Patent applications $_{(t)}$	0.16	5.69	0	288	1												
2. Patent applications $_{(t-1)}$	0.17	5.72	0	288	0.01	1											
3. Utility models $_{(t)}$	0.04	0.75	0	25	0.00	0.01	1										
4. Utility models $_{(t-1)}$	0.04	0.62	0	20	0.00	0.01	0.86	1									
5. Offshoring (0/1) $_{(t-1)}$	0.37	0.48	0	1	0.03	-0.01	0.03	0.03	1								
6. Offshoring (%) $_{(t-1)}$	0.28	0.42	0	1	0.03	-0.01	0.02	0.02	0.88	1							
7. Concentration ratio $_{(t)}$	0.30	0.37	0	1	-0.01	-0.01	-0.02	-0.02	0.15	0.12	1						
8. R&D intensity $_{(t)}$	0.00	0.00	0	0.03	0.00	0.00	-0.01	-0.01	0.19	0.17	0.08	1					
9. Advertising intensity $_{(t)}$	0.01	0.02	0	0.27	-0.00	-0.00	0.02	0.04	0.07	0.04	0.10	0.03	1				
10. Foreign capital $_{(t)}$	0.10	0.30	0	1	-0.01	0.07	-0.01	-0.01	0.32	0.25	0.17	0.15	0.09	1			
11. Family firm $_{(t)}$	1.58	0.49	0	1	-0.02	0.02	0.02	0.02	0.04	0.04	0.06	0.05	-0.01	0.21	1		
12. Size (ln) $_{(t)}$	3.68	1.31	0	9.57	0.03	0.04	0.01	-0.00	0.37	0.30	0.29	0.22	0.19	0.47	0.12	1	
13. Industry (high-low technology) $_{(t)}$	0.20	0.40	0	1	-0.01	-0.01	-0.02	-0.02	0.26	0.22	0.15	0.39	0.02	0.33	0.10	0.25	1

Table 3: Negative binomial regressions (sample split by median RDI^{OCDE})
[Dependent variable: Patent applications $_{(t)}$; Independent variable: Offshoring (0/1) $_{(t-1)}$]

	Technological leaders		Technological laggards	
	1	2	3	4
Offshoring (0/1) $_{(t-1)}$		0.7559*** (2.94) [0.1059]		1.2813*** (2.64) [0.0328]
Patent applications $_{(t-1)}$	0.5912*** (7.35) [0.0955]	0.560*** (7.22) [0.0865]	0.7228** (2.16) [0.0159]	0.6126** (2.23) [0.0123]
Concentration ratio $_{(t)}$	-0.1058 (-0.29) [-0.0171]	-0.0788 (-0.22) [-0.0120]	-0.0256 (-0.04) [-0.0006]	0.0137 (0.02) [0.0003]
R&D intensity $_{(t)}$	6.7714** (2.29) [1.0938]	5.6709** (1.98) [0.8634]	215.8379 (1.08) [4.7513]	127.6586 (0.83) [2.5668]
Advertising intensity $_{(t)}$	1.0902 (0.27) [0.1761]	1.2435 (0.32) [0.1893]	4.3334 (0.33) [0.0954]	7.6837 (0.62) [0.1545]
Foreign capital $_{(t)}$	-1.2025*** (-3.31) [-0.1942]	-1.2461*** (-3.44) [-0.1897]	-1.0361 (-1.29) [-0.0228]	-0.8079 (-1.05) [-0.0162]
Family firm $_{(t)}$	-0.4475* (-1.77) [-0.0723]	-0.5209** (-2.08) [-0.0793]	-0.8802* (-1.77) [-0.0194]	-0.9603** (-2.03) [-0.0193]
Size (ln) $_{(t)}$	0.5442*** (5.58) [0.0879]	0.5202*** (5.37) [0.0792]	0.8502*** (4.30) [0.0187]	0.6714*** (3.40) [0.0135]
Industry (high/low technology) $_{(t)}$	0.0851 (0.33) [0.0138]	0.0691 (0.27) [0.0106]	-0.2626 (-0.36) [-0.0054]	-0.4602 (-0.68) [-0.0081]
Year Dummies	Included	Included	Included	Included
Constant	-4.7260*** (-7.38)	-4.9858*** (-7.74)	-5.4007*** (-4.50)	-5.0755*** (-4.38)
N	1060	1060	2585	2585
Log Likelihood	-592.3838	-588.1251	-323.9836	-318.7504
-2ΔL		8.5174**		10.4664***

* p<0.10; ** p<0.05; *** p<0.01 (two-tailed tests)
t-statistics appear in (parentheses); marginal effects in [brackets]

Table 4: Negative binomial regressions (sample by median of RDI^{OCDE})
[Dependent variable: Patent applications $_{(t)}$; Independent variable: Offshoring (%) $_{(t-1)}$]

	Technological leaders		Technological laggards	
	1	2	3	4
Offshoring (%) $_{(t-1)}$		0.5511** (1.98) [0.0865]		1.4723*** (2.67) [0.0300]
Patent applications $_{(t-1)}$	0.5912*** (7.35) [0.0955]	0.5946*** (7.48) [0.0933]	0.7228** (2.16) [0.0159]	0.6983** (2.27) [0.0142]
Concentration ratio $_{(t)}$	-0.1058 (-0.29) [-0.0171]	-0.0316 (-0.09) [-0.0050]	-0.0256 (-0.04) [-0.0006]	-0.0285 (-0.04) [-0.0006]
R&D intensity $_{(t)}$	6.7714** (2.29) [1.0938]	5.8478** (2.00) [0.9179]	215.8379 (1.08) [4.7513]	126.6484 (0.82) [2.5836]
Advertising intensity $_{(t)}$	1.0902 (0.27) [0.1761]	1.4768 (0.37) [0.2318]	4.3334 (0.33) [0.0954]	7.1037 (0.59) [0.1449]
Foreign capital $_{(t)}$	-1.2025*** (-3.31) [-0.1942]	-1.1543*** (-3.17) [-0.1812]	-1.0361 (-1.29) [-0.0228]	-0.6798 (-0.88) [-0.0139]
Family firm $_{(t)}$	-0.4475* (-1.77) [-0.0723]	-0.5278** (-2.07) [-0.0828]	-0.8802* (-1.77) [-0.0194]	-0.8908* (-1.89) [0.0182]
Size (ln) $_{(t)}$	0.5442*** (5.58) [0.0879]	0.5090*** (5.18) [0.0799]	0.8502*** (4.30) [0.0187]	0.6593*** (3.35) [0.0134]
Industry (high/low technology) $_{(t)}$	0.0851 (0.33) [0.0138]	0.1068 (0.42) [0.0169]	-0.2626 (-0.36) [-0.0054]	-0.3493 (-0.52) [-0.0064]
Year dummies	Included	Included	Included	Included
Constant	-4.7260*** (-7.38)	-4.7470*** (-7.45)	-5.4007*** (-4.50)	-5.0665*** (-4.37)
N	1060	1060	2585	2585
Log Likelihood	-592.3838	-590.4340	-321.9836	-318.6847
-2ΔL		3.8996		6.5978**

* p<0.10; ** p<0.05; *** p<0.01 (two-tailed tests)
t-statistics appear in (parentheses); marginal effects in [brackets]

Table 5: Negative binomial regressions (sample split by median RDI^{OCDE})
[Dependent variable: Utility models $_{(t)}$; Independent variable: Offshoring (0/1) $_{(t-1)}$]

	Technological leaders		Technological laggards	
	1	2	3	4
		1.5131***		0.6404
Offshoring (0/1) $_{(t-1)}$		(3.34)		(1.19)
		[0.0904]		[0.0032]
	0.6163***	0.6488***	2.5158***	2.3002***
Utility models $_{(t-1)}$	(3.41)	(3.82)	(3.02)	(2.91)
	[0.0496]	[0.0437]	[0.0116]	[0.0105]
	1.7895***	1.6257***	-1.1519	-1.0283
Concentration ratio $_{(t)}$	(2.90)	(2.67)	(-1.37)	(-1.26)
	[0.1439]	[0.1096]	[-0.0053]	[-0.0047]
	12.7879*	10.4322	-0.8963	-10.6553
R&D intensity $_{(t)}$	(1.73)	(1.48)	(-0.01)	(-0.08)
	[1.0284]	[0.7033]	[-0.0041]	[-0.0487]
	4.2938	5.2572	-1.5900	-2.1142
Advertising intensity $_{(t)}$	(0.53)	(0.70)	(-0.12)	(-0.16)
	[0.3453]	[0.3544]	[-0.0073]	[-0.0097]
	-0.4799	-0.7163	-1.1703	-1.3814
Foreign capital $_{(t)}$	(-0.90)	(-1.35)	(-0.96)	(-1.16)
	[-0.0386]	[-0.0483]	[-0.0054]	[-0.0063]
	-0.3060	-0.1721	-0.5007	-0.4001
Family firm $_{(t)}$	(-0.73)	(-0.42)	(-0.87)	(-0.70)
	[-0.0246]	[-0.0116]	[-0.0023]	[-0.0018]
	0.3180**	0.2290	1.0418***	0.9638***
Size (ln) $_{(t)}$	(2.02)	(1.48)	(4.08)	(3.78)
	[0.0256]	[0.0154]	[0.0048]	[0.0044]
	-1.1217**	-1.0269**	-1.0299	-0.9189
Industry (high/low technology) $_{(t)}$	(-2.32)	(-2.19)	(-1.10)	(-1.00)
	[-0.0873]	[0.0669]	[-0.0036]	[-0.0033]
Year Dummies	Included	Included	Included	Included
Constant	-4.7636***	-5.5405***	-7.6298***	-7.7737***
	(-4.27)	(-4.91)	(-5.59)	(-5.69)
N	1060	1060	2585	2585
Log Likelihood	-325.0756	-319.5242	-163.9953	-163.3070
-2ΔL		11.1028***		1.3766

* $p<0.10$; ** $p<0.05$; *** $p<0.01$ (two-tailed tests)
t-statistics appear in (parentheses); marginal effects in [brackets]

Table 6: Negative binomial regressions (sample by median of RDI^{OCDE})
[Dependent variable: Utility models $_{(t)}$; Independent variable: Offshoring (%) $_{(t-1)}$]

	Technological leaders		Technological laggards	
	1	2	3	4
Offshoring (%) $_{(t-1)}$		1.2034*** (2.63) [0.0877]		1.0820* (1.96) [0.0047]
Utility models $_{(t-1)}$	0.6163*** (3.41) [0.0496]	0.6305*** (3.66) [0.0460]	2.5158*** (3.02) [0.0116]	2.1999*** (3.01) [0.0095]
Concentration ratio $_{(t)}$	1.7895*** (2.90) [0.1439]	1.7395*** (2.87) [0.1268]	-1.1519 (-1.37) [-0.0053]	-0.9635 (-1.20) [-0.0042]
R&D intensity $_{(t)}$	12.7879* (1.73) [1.0284]	10.2676 (1.42) [0.7486]	-0.8963 (-0.01) [-0.0041]	-19.2504 (-0.14) [-0.0835]
Advertising intensity $_{(t)}$	4.2938 (0.53) [0.3453]	5.5395 (0.71) [0.4039]	-1.5900 (-0.12) [-0.0073]	-1.6850 (-0.13) [-0.0073]
Foreign capital $_{(t)}$	-0.4799 (-0.90) [-0.0386]	-0.6032 (-1.14) [-0.0440]	-1.1703 (-0.96) [-0.0054]	-1.4937 (-1.27) [-0.0065]
Family firm $_{(t)}$	-0.3060 (-0.73) [-0.0246]	-0.4028 (-0.99) [-0.0294]	-0.5007 (-0.87) [-0.0023]	-0.3178 (-0.56) [-0.0014]
Size (ln) $_{(t)}$	0.3180** (2.02) [0.0256]	0.2537 (1.63) [0.0185]	1.0418*** (4.08) [0.0048]	0.9392*** (3.81) [0.0041]
Industry (high/low technology) $_{(t)}$	-1.1217** (-2.32) [0.0873]	-0.8622* (-1.80) [-0.0607]	-1.0299 (-1.10) [-0.0036]	-0.7862 (-0.88) [-0.0028]
Year dummies	Included	Included	Included	Included
Constant	-4.7636*** (-4.27)	-4.9976*** (-4.56)	-7.6298*** (-5.59)	-7.9375*** (-5.77)
N	1060	1060	2585	2585
Log Likelihood	-325.0756	-321.6691	-163.9953	-162.1582
-2ΔL		6.8130**		3.6742

* p<0.10; ** p<0.05; *** p<0.01 (two-tailed tests)
t-statistics appear in (parentheses); marginal effects in [brackets]