Which Intermediate Import Source is Best for Innovation in MNEs?

Purpose

This paper explores the importance of the importing intensity for different intermediate inputs depending on their source (internal sourcing or intra-firm trade versus external sourcing or foreign suppliers) for different types of innovation (product and process innovation) and applied to MNEs (foreign versus domestic).

Design/methodology/approach

The sample contains 2,448 firm-year observations (2006-2016) of firms located in Spain that belong to an MNE group. We applied a conditional mixed process to a panel recursive bivariate probit model with robust standard errors.

Findings

We obtained three key results. First, intermediate imports do not always contribute to improving innovation, since their effects vary depending on their source. Second, intermediate imports from foreign suppliers (external source) are more advantageous for product innovation than those from intra-firm trade (internal source). Third, intermediate imports from intra-firm trade are more important for process innovation than those from foreign suppliers. Thus, the impact of importing intermediate inputs on innovation is contingent on the source of the imports, the ownership of the MNE and the type of innovation.

Originality

Our paper contributes to this topic with new insights and results for MNEs. It identifies which import source is best for innovation depending on the type of innovative result expected. Moreover, it helps to uncover simultaneity and causal relationships between product and process innovation, issues which have not previously been considered in the literature.

Keywords: Intermediate imports, importing source, innovation performance, multinationals

JEL: O14, O32, F20

1. Introduction

Innovation is a key factor in the economic development of markets and the improved competitiveness of firms, and even at times for their very survival. The health and financial crisis resulting from the Covid-19 pandemic has reinforced its importance.

Although all firms can innovate, evidence shows that most innovative firms are multinational enterprises (MNEs) since they can handle the complexity and high costs of engaging in innovation and can also benefit from the locational advantages of being in different markets. MNEs, with their global value chains, take advantage of creating and integrating sourcing activities around the world (Kotabe, 1990). These can act as diffusers of technologies and skills, contributing to developing productive capacities and enhancing the innovation process and success. Moreover, they can also benefit from being closer to a wide range of sophisticated suppliers.

In this environment, MNEs result in an important increase in the inter-firm and intra-firm trading of intermediate inputs. Unlike capital inputs (such as new machinery) or final products, intermediate inputs are combined with other inputs and are incorporated in the production process to produce goods. Thus, imports of intermediate inputs enable MNEs to tap into foreign knowledge resources, which subsequently boosts their innovation performance and competitive advantage (Valle *et al.,* 2015). This has led to studies on the role of imported intermediate inputs in promoting innovation performance (Bos and Vannoorenberghe, 2019), although as Chen *et al*. (2017) point out, such studies are still scarce. This paper offers new insights by examining the relationship between imports of intermediate inputs and innovation success.

An MNE has two different alternative sources for imports of intermediate inputs for its own production needs. *Importing via inter-firm* or external sourcing involves purchasing intermediate inputs from external foreign suppliers (Kotabe and Murray, 1990). *Importing via intra-firm trade* or internal sourcing involves purchasing intermediate inputs from foreign

subsidiaries of the MNE group.

While earlier studies have explored the factors determining the choice of foreign sourcing (e.g., Elia *et al*., 2014), few authors have evaluated the potential effect on an MNE´s innovation performance of sourcing via overseas subsidiaries or foreign suppliers, and the focus has mainly been on the offshoring of R&D services in all types of firms (e.g., Nieto and Rodríguez, 2011 and Steinberg *et al*., 2017) or in small and medium enterprises –SMEs (e.g. Rodríguez and Nieto, 2016). While service offshoring is clearly important, it represents only a small fraction of total offshoring (Valle *et al*., 2015). Moreover, there is limited knowledge about the relationship between the importing of intermediate inputs and innovation performance in manufacturing firms (e.g., Valle *et al*., 2015 study patents; or Mazzola *et al.,* 2019 focus exclusively on the number of new products).

Therefore, there is still a need to analyze the relationship between imports of intermediate inputs from internal or external foreign sources and innovation performance because each import source option may offer different advantages when it comes to accessing new knowledge, as well as advantages related to efficiency and flexibility, or knowledge spillovers, which may have different effects depending on a firm´s innovation performance (Steinberg *et al*., 2017).

To fill this gap, our main research question is how importing intermediate inputs is related to innovation performance in manufacturing firms belonging to MNE groups, depending on the sources of intermediate imports and the type of innovation performance. We focus on intermediate inputs because they constitute an information channel that stimulates the cross-border learning of production process and product design (Abubakar *et al*., 2019). We distinguish between two import sources, internal or intra-firm and external or foreign suppliers, as their use could be motivated by different causes and have different consequences. Firms that belong to MNEs are our target group, because they have the option of choosing between these different intermediate import sources. Moreover, they may belong to Spanish or foreign MNEs

and we also analyze the differences between them on this basis. Finally, we consider product and process innovation as innovation performance since they are closely related to the concept of technological development and reflect different innovation behavior (Hullova *et al.*, 2016). Our sample included around 2,500 firm-year observations of manufacturing firms belonging to MNEs located in Spain between 2006 and 2016.

By combining the theoretical perspectives of international business, transaction cost economics and the knowledge and resource-based view, this study contributes to the theoretical and empirical understanding of the role of foreign sourcing in innovation performance, an under-researched area that is crucial for understanding firm competitiveness. Our paper sheds light on the importance of considering the source of intermediate imports, since its impact on innovation performance may depend on the type of innovative result expected, at least in firms belonging to MNEs. In particular, our results show that the effect on innovation performance of importing intermediate inputs is contingent on the source of the imports (external versus internal), the ownership of the MNE (Spanish versus foreign MNE) and the type of innovation performance (product or process innovation). Thus, the decision to import intermediate inputs from external (foreign suppliers) or internal (intra-firm) sources could have important strategic implications for MNEs.

The importing of intermediate inputs is a growing trend, and it is therefore important to understand this phenomenon by providing empirical evidence of its implications for MNEs, a topic that has received scant attention in the literature. Indeed, as far as we are aware, the few published papers on the importing of intermediate inputs are macro- rather than micro-level studies that have no clear focus on MNEs (Abubakar *et al.*, 2019). Our paper contributes to this topic with new insights and results. Another contribution is that our analysis helps to uncover simultaneity and causal relationships between product and process innovation, which have not previously been considered in the literature. All the above is particularly important for MNEs

and their subsidiaries, as it can help company managers make better importing decisions. The results are underpinned by the literature on MNEs and innovation.

This study is structured as follows: Section 2 presents the theoretical arguments and research hypotheses; the database and methodological approach are described in Section 3; Section 4 discusses the main findings. The conclusions, implications and limitations are presented in Section 5.

2. Theoretical framework

The current globalization has made decisions on sourcing intermediate inputs more complex. Nowadays, the world provides importing firms (non-MNE or MNE) with many potential markets that can supply the best intermediate inputs. Importing these inputs leads to different kinds of opportunities and challenges related to innovation performance. Studies have shown that intermediate imports not only allow firms to obtain the inputs they need for their economic activities under better conditions (less expensive, better quality or products that are unavailable in the domestic markets), but also to acquire new and specialized knowledge from abroad (Almeida and Fernandes, 2008; Damijan and Kostevc, 2015), internalize host location-specific technological spillovers (Damijan and Kostevc, 2015) and accumulate learning effects (Acharya and Keller, 2009).

Moreover, importing intermediate inputs from foreign countries can help firms to tap into foreign embedded knowledge, so favoring the better internal allocation of resources (Grossman and Helpman, 1991; Bos and Vannoorenberghe, 2019) and helping build up a learning network that can exploit technological advantages for firms and their suppliers in international markets (Bertschek, 1995).

Thus, imports can drive a firm's innovation, because once they are incorporated into the production process they contribute to the creation of new products or to the improvement of processes (Cassiman and Golovko, 2011). Thus, imports emerge as an important channel for

introducing or improving innovation in firms (Bos and Vannoorenberghe, 2019).

These benefits from importing could be greater for firms forming part of a multinational network. The range of markets in which an MNE's subsidiaries operate offers the MNE group the opportunity to exploit several locational sourcing advantages. Additionally, unlike non-MNE firms, MNEs have two alternative or complementary ways to import intermediate inputs: 1) from foreign suppliers (inter-firm or external source) and 2) from inside the MNE group (intra-firm trade or internal source). Since transactions between an MNE's subsidiaries may have different consequences on their competitiveness than transactions with external suppliers (Kotabe and Murray, 1990), research should place more emphasis on explaining how inter- and intra-firm intermediate imports may be associated with MNEs' innovation performance.

In general, sourcing from foreign suppliers provides a greater variety of inputs (e.g., Amiti and Wei, 2009; Bos and Vannoorenberghe, 2019), the highest quality inputs (e.g. Aristei *et al*., 2013) and the latest technologies, but it can also transfer embedded technological knowledge not available domestically (Grossman and Helpman, 1991; Almeida and Fernandes, 2008). Importing firms could benefit from the reverse engineering of these suppliers' inputs, thereby obtaining a technological innovation advantage (Almeida and Fernandes, 2008). Moreover, the particular combination of importing and foreign suppliers promises to lead to significant cost advantages and efficiency gains (Bos and Vannoorenberghe, 2019). Foreign suppliers benefit from large scale economies (Barthélemy, 2003) because they can meet the demands of many firms and are often highly specialized in production. Moreover, selecting the most efficient supplier allows firms to dedicate internal resources to activities that are their core competencies (Jabbour, 2010; Mukherjee *et al.,* 2013), enhancing their flexibility (Di Gregorio *et al*., 2009), and leaving them better placed to focus on their value-adding activities (Mazzola *et al*., 2019), higher value-opportunities (Farrell, 2005) or innovation (Di Gregorio *et al*., 2009; Bertrand and Mol, 2013).

Since MNEs are formed by a network of subsidiaries in different markets, they may be closer to sophisticated suppliers and may have more information about the location of better suppliers, so achieving significant advantages. MNEs benefit from frequent contacts and connections with more specialized and knowledgeable suppliers (Almeida and Fernandes, 2008) and other upstream and downstream firms in the same supply chain (Pittiglio *et al.,* 2009), which may be essential in identifying foreign business opportunities. In this way, MNEs access a large flow of ideas[1] and suggestions (Pittiglio *et al.,* 2009; Jabbour, 2010) that can contribute to developing their innovation ability.

Moreover, as MNEs are less dependent on their suppliers, since the costs of changing supply must be low and suppliers face strong competition, they can easily switch between suppliers and create more flexible supply chains and reduce institutional uncertainty (Mukherjee *et al.,* 2013), thereby helping them to achieve competitive advantages.

However, there are also problems or risks that could impact negatively on an MNE's innovation performance. MNEs importing through foreign suppliers lose control over the imported intermediate input. Although partners in the importing relationship might engage in a long-term relationship based on detailed contracts specifying all the obligations and rights needed to reduce ex-post control problems, this is likely to increase initial transaction costs (Albertoni *et al*., 2019). According to other studies on transaction costs, this could lead to asymmetric information and opportunistic behavior from suppliers (Farrell, 2005; Jabbour, 2010; Elia *et al.,* 2014) that affects, for example, the quality of their intermediate inputs. Another potential negative consequence for MNE, as Kotabe and Murray (1990, p. 388) establish, is that MNEs "*tend to lose sight of emerging technologies and expertise which could be incorporated into the development of new manufacturing processes as well as new products* (Imai, 1986)".

[1] Both the quantity and variety of knowledge are central to innovation (Kotabe *et al.,* 2007).

The international flow of intermediate inputs between parent companies and their subsidiaries or among these subsidiaries (i.e., intra-firm trade or internal source) is another source of imports only available to MNEs and it is also an important source of innovation performance (Pittiglio *et al*., 2009). Recent studies have focused on the importance of international technology transfers in firms belonging to MNEs (e.g., Michailova and Mustaffa, 2012). A firm belonging to an MNE can access, internalize and exploit location-specific advantages in its host country (Frost, 2001) that are not available in the home-base market. Local knowledge can be transferred between the firm's headquarters and its overseas subsidiaries, thus improving the absorptive capacity of the firm. This absorptive capacity is important for transforming foreign knowledge into innovation performance (Alcácer and Chung, 2007). Moreover, this minimizes the risks of knowledge transfer (information leakage) to competitors (Alcácer and Chung, 2007) and knowledge loss (Gerbl *et al.,* 2014).

When MNEs engage in intra-firm trade, parent and subsidiary companies must be highly integrated and connected, implying better communication and more trust and commitment (Solberg and Nes, 2002) than is required in buyer-seller relationships. This promotes communication and reporting between units and increases the informational advantages of sourcing abroad (Bertrand, 2011). However, although transaction costs are reduced, coordination and control requirements are more complex in integrated firms (Jabbour, 2010). Moreover, MNEs have increased control and reduced risks in the supply chain, thereby making it easier to secure high quality intermediate inputs when importing through subsidiaries rather than foreign suppliers (Kedia and Mukherjee, 2009). Quality becomes more important than price in these firms, although there are also fewer price uncertainties in global firms.

However, this source of inputs also creates problems or risks that could negatively impact on a firm's innovation performance. Overseas subsidiaries are located in foreign countries with different environments, different degrees of uncertainty and different bundles of resources, thus

putting subsidiaries at risk when doing business in a foreign environment (Mukherjee *et al.,* 2013). Subsidiaries may therefore limit or downplay the use of the local knowledge or innovation advantages generated in the host country, thereby reducing the innovation capacity of the company. Moreover, MNEs are less flexible owing to their bureaucratic structures and hierarchical thinking (Di Gregorio *et al.,* 2009), which may harm the innovation process within overseas subsidiaries.

In summary, although both sources of intermediate inputs are associated with a series of costs and risks, their potential advantages and benefits could overcome these obstacles and may result in innovation performance and enhanced competitiveness.

On the basis of previous studies, we argue that the strategic decision of whether to import intermediate inputs from external (foreign suppliers) or internal sources (intra-firm trade) depends on innovation characteristics. Product and process innovations (the most common innovation outputs for firms) are different in nature, their development requires different knowledge inputs and organizational skills (Damanpour and Gopalakrishnan, 2001; Hullova *et al.,* 2016) and they have different strategic implications, such as a market focus (customer-driven) for product innovations and an internal focus (efficiency-driven) for process innovations (Utterback and Abernathy, 1975).

Importing from external sources is believed to be associated with more product innovations than importing from internal sources. The main argument that justifies this relationship is based on the "variety effect" since it provides a broader range of available intermediate inputs. The variety effect allows the creation of new products and an increase in the product portfolio through recombining of existing and new inputs (Castellani and Fassio, 2019). Foreign suppliers may especially increase the number of new intermediate input varieties available, which would provide importers with external learning (product upgrading, reverse engineering) that allows the importing firm to develop a broader knowledge base which in turn is useful for

product innovation. Thus, importing intermediate inputs from external sources is expected to have a positive impact on product innovation (Bos and Vannoorenberghe, 2019).

According to the Knowledge Based View and Transaction Cost Theory, in process innovation we would expect importing intermediate inputs from internal sources (intra-firm trade) to be more effective than importing them from external sources (foreign suppliers), given that process innovation requires a great deal of intangible know-how along the value-added chain (Kotabe and Murray, 1996). In process innovation, know-how is tacit, less codifiable and harder to teach (Kogut and Zander, 1993). For its diffusion, a technical infrastructure between the importing firm and its subsidiaries is crucial for effective knowledge transfer, as it allows employees to codify, store and access knowledge. Likewise, MNEs repeating the process of importing from their subsidiaries are more likely to acquire more intensive and direct information flows, and to leverage their own learning-by-doing and task-specific experience in subsequent importing activities. Moreover, they can nurture a learning process by leveraging their network of subsidiaries, which can transfer both their technological knowledge and their best organizational innovation practices directly to the headquarters and other subsidiaries through planning and training meetings. In contrast, accumulated experiential learning is expected to be weaker when importing from foreign suppliers rather than through subsidiaries, due to possible continuous changes of supplier, which might require a high level of adaptation of the import contract. Additionally, the foreign supplier might be reluctant to transfer its knowledge and best practices to the importer firm, while the importer subsidiary might have not sufficient absorptive capacities to learn from the foreign supplier (Albertoni *et al*., 2019).

Thus, intense collaboration between the importing firm and its overseas subsidiaries supports knowledge sharing processes within the organization by establishing routines for knowledge exchange (e.g. shared norms, Bresciani and Ferraris, 2016) that leave minimal space for causal ambiguity (Ambos and Ambos, 2009). Moreover, the degree to which importing parties share

the same organizational culture and value systems (i.e. norm distance) is likely to affect the success of any knowledge transfer in importing activities (Cummings and Teng, 2003). The greater level of understanding between parties required for process innovation will therefore result in a greater use of overseas subsidiaries for importing because of their smaller norm distance in comparison with foreign suppliers. Conversely, the involvement of foreign suppliers makes the transfer of knowledge in the importing activities of MNEs less immediate and less straightforward (Gao and Pan, 2010). Thus, the learning mechanism related to both the strengthening of existing technological capabilities and the development of new technological capabilities is likely to be less effective when importing through foreign suppliers than through subsidiaries. Moreover, as a result, MNEs could protect their knowledge from external appropriation and keep their new technologies to themselves without disseminating them to competitors (Kotabe and Murray, 1990) who would find it difficult to imitate or benefit from them (Ciabuschi and Martín, 2012).

We therefore propose the following hypotheses:

Hypothesis H1a: Firms that import intermediate inputs from external sources (foreign suppliers) are more likely to develop product innovation behaviour than those that import from internal sources (intra-firm).

Hypothesis H1b: Firms that import intermediate inputs from internal sources (intra-firm) are more likely to develop process innovation behaviour than those that import from external sources (foreign suppliers).

Given the importance of this area of research for the competitiveness of importing MNEs, this paper goes further in the study of the effect of the importing activities of subsidiary firms on innovation performance, taking into account that this relationship might be different depending on the ownership of the MNE (domestic versus foreign ownership).

MNEs design their organizational structures according to the needs arising from their activities

(including innovation) to construct a network of locational advantages for every activity in a different location, while taking into account the overall objectives of the firm (Bardhan, 2006). Location advantages could include the availability of resources (natural and strategic), the existence of sophisticated suppliers, lower production and transportation costs, market size, and/or the quality of institutions, among others, and these will be country-specific.

Thus, MNEs become knowledge-creating organizations due to their structural position that spans heterogeneous markets (Frost, 2001). Their foreign subsidiaries may provide new inputs and ideas and develop capabilities which contribute to generating innovations based on the locational advantages of host countries. The configuration of MNEs allows capabilities at the headquarters to be combined with locational innovation advantages from a different market, producing a competitive structure (Bardhan, 2006).

The previous arguments are valid for all MNEs regardless of their ownership, although nowadays it is common to find subsidiaries belonging to local MNEs coexisting with subsidiaries belonging to foreign MNEs that could seek different location factors and be created with different aims. For example, foreign subsidiaries aiming to acquire knowledge from sources external and distant from the headquarters would have difficulty implementing innovation strategies (Ayari, 2010). Therefore, subsidiaries belonging to domestic and foreign MNEs could differ in the configuration of their international and national capabilities, which could influence their ability to learn from and exploit their importing activity.

Therefore, the following hypothesis is proposed:

Hypothesis H2: The ownership of the MNE (domestic *versus* foreign) affects the relationship between imported intermediate inputs and innovation performance.

3. Sample, variables and methodology

To test the hypotheses, we used the Spanish Survey on Business Strategies (Encuesta sobre Estrategias Empresariales) compiled by a public institution (SEPI Foundation). This database

contains data on manufacturing firms with ten or more employees located in Spain[2]. It is especially suitable for our study because it provides annual information on innovation (i.e., R&D, product and process innovation), imports (i.e. intermediate inputs and their source: internal or intra-firm *versus* external or foreign suppliers) and other firm characteristics.

This database has been used by researchers studying the innovation process and its consequences (e.g. Damijan and Kostevc, 2015; Valle *et al.,* 2015) and it has been applied to all types of firm (e.g. Cassiman and Golovko, 2011 for SMEs or Ramírez-Alesón and Fernández-Olmos 2019, for family firms).

We selected firms belonging to an MNE since they have a choice between the two importing sources. Our final sample consisted of an unbalanced panel of 2,448 firm-year observations for 262 firms belonging to an MNE during 2006-2016 (with 2016 being the latest available year); with the required information for at least six consecutive years. This sample is split into two subsamples to differentiate between firms belonging to foreign MNEs (1,254 firm-year observations) and national or Spanish MNEs (906 firm-year observations).

Table 1 shows that 77.53% of the observations correspond to importers of intermediate inputs that import on average €4,300 million. Importers are more common than non-importers, which is consistent with the fact that they all belong to MNEs. Firms could import from both intra- and inter-firm sources at the same time, but most of them import mainly from suppliers, with less than half importing from their MNE network (intra-firm trade). Moreover, the spending in euro on intermediate imports from external sources is 30% higher than the figure from internal sources.

INSERT TABLE 1

On average, 58.66% of the observations in the sample achieved some level of product or process

[2] Firms with 10-200 workers are randomly sampled by industry and size strata and firms with more than 200 workers are surveyed on a census basis. See https://www.fundacionsepi.es/investigacion/esee/en/spresentacion.asp for more information.

innovation during the period. However, the results by type of innovation output are different. While 50.65% of firms in the sample engaged in process innovation, only 32.23% of them reported product innovation activities.

3.1 Variables: description and measurement

We used two dependent variables to measure innovation performance: product and process innovation. Each variable reflects a different innovation performance dimension and strategy (Hullova *et al.,* 2016). Product innovation performance (*PRODUCT*) is measured as a dummy variable that takes a value of 1 if the firm has reported a product or service which is either completely new or significantly improved with respect to its fundamental characteristics, technical specifications or components in a given year, and 0 otherwise. Process innovation performance (*PROCESS*) is a dummy variable that takes the value of 1 if the firm has reported new and significantly improved production technology, and/or new and significantly improved methods of supplying services or delivering products in a given year, and 0 otherwise.

The main independent variables are those related to the imported intermediate input and its source (internal/intra-firm, external/foreign suppliers). The intra-firm imported intermediate inputs variable (M_{int}^{Subs}) is measured as the logarithm of the volume of imported intermediate inputs (in millions of euro) per employee from other subsidiaries in the MNE group. Similarly, the inter-firm imported intermediate inputs variable ($M_{int}^{Supplier}$) is measured as the logarithm of the volume of imported intermediate inputs (in millions of euro) per employee from foreign suppliers. These measures are divided by the total number of employees in order to control for size effects and they follow a logarithmic transformation[3] to linearize them and reduce their skewness.

A number of control variables were included in the model. R&D intensity is measured as R&D

[3] These variables show zero-valued observations and since log (0) is undefined, we use the logarithm of each variable plus one.

expenditure in relation to the firm's total sales (R&D). The export activity of the firm was included as the ratio between exports and total sales (EXPORT). The size of the firm is captured by a dummy variable that differentiates between small and medium enterprises (SME) and large firms. In order to identify if the firms belong to a Spanish or foreign MNE group, we include a dummy variable that identifies foreign firms (FMNE) by assigning 1 if the firm has foreign capital equal to or greater than 50% (i.e. belongs to a foreign multinational) in a given year, and 0 otherwise. To capture industry effects, we assigned firms to industries based on their principal economic activity, which is listed in one of the two-digit manufacturing industries in the NACE-Rev.1 (Statistical classification of economic activities in the European Union). These are captured by eighteen dummy variables, one for each industry. Finally, time effects were included as yearly dummy variables.

Table 2 provides the main descriptive statistics of the variables, the correlation matrix and the variance inflation factor (with values very close to one) which does not show the presence of serious multicollinearity problems.

INSERT TABLE 2

3.2 Methodology

We used the conditional mixed process (*cmp*) estimators with multilevel random effects implemented by Roodman (2011). The main advantage of this methodology is that it allows us to jointly and simultaneously estimate both product and process innovation equations. Product and process innovation reflect different dimensions of innovation, but they are also complementary and interrelated because they share limited resources. Another advantage is that the estimators of the recursive simultaneous equations are efficient and consistent with systems in which the endogenous variables appear on the right-hand side (Roodman, 2011). This is especially suitable in our study as product and process innovations are positively associated (Damanpour and Gopalakrishnan, 2001) and interdependent (Kotabe and Murray, 1990;

Hullova *et al*., 2016). A product development subsequently triggers changes in process innovation. Indeed, the manufacturing of a new product will require or promote the implementation of a new technology (Abernathy and Utterback, 1978; Kraft, 1990; Hullova *et al*., 2016). Similarly, a process development subsequently results in changes in the characteristics of goods and the opportunity for the development of new products (Bratti and Felice, 2012; Hullova *et al*., 2016).

Thus, we applied *cmp* to a panel recursive bivariate probit model with robust standard errors. Independent and control variables are lagged one year, as is commonly done in similar studies (e.g., Damijan and Kostevc, 2015; Castellani and Fassio, 2019). The proposed model is as follows[4].

Equation 1: $y^{*}_{1,it} = x'_{1,it-1}\beta_1 + y_{2,it-1}\delta_1 + \alpha_{1,i} + \varepsilon_{1,it-1}$ for i: 1, …, N and t: 1, …, T and

Equation 2: $y^{*}_{2it} = x'_{2,it-1}\beta_2 + y_{1,it-1}\delta_2 + \alpha_{2,i} + \varepsilon_{2,it-1}$

$$y_{1,it} = 1 \text{ if} \left(y^{*}_{1,it} \geq 0\right) = \begin{cases} 1 \text{ if } y^{*}_{1,it} \geq 0 \\ 0 \text{ if } y^{*}_{1,it} < 0 \end{cases} \quad \text{and} \quad y_{2,it} = 1 \text{ if} \left(y^{*}_{2,it} \geq 0\right) = \begin{cases} 1 \text{ if } y^{*}_{2,it} \geq 0 \\ 0 \text{ if } y^{*}_{2,it} < 0 \end{cases} \qquad [1]$$

$$\text{where} \begin{cases} \varepsilon_{it} = \begin{pmatrix} \varepsilon_{1,it} \\ \varepsilon_{2,it} \end{pmatrix} \simeq \text{i.i.d.N} \left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}; \begin{pmatrix} 1 & \tau \\ \tau & 1 \end{pmatrix} \right] \\ \alpha_i = \begin{pmatrix} \alpha_{1,i} \\ \alpha_{2,i} \end{pmatrix} \simeq \text{i.i.d.N} \left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}; \begin{pmatrix} \sigma_1^2 & \rho\sigma_1\sigma_2 \\ \rho\sigma_1\sigma_2 & \sigma_2^2 \end{pmatrix} \right] \end{cases} \qquad [2]$$

where y_{it} is the outcome of interest ($y_{1,it}$ product innovation and $y_{2,it}$ process innovation) of firm i (i= 1 to 262) and period t (t= 2007 to 2016), β is a vector of coefficients, x'_{it-1} represents a vector of one-year lagged exogenous variables (i.e. $M_{int}{}^{Subs}{}_{it-1}$, $M_{int}{}^{Supplier}{}_{it-1}$, and control variables $R\&D_{it-1}$, $EXPORT_{it-1}$, SME_{it-1}, $FMNE_{it-1}$, industry and year dummies), and ε_{it-1} is the error term with standard normal distribution, a measure of unobservables associated with the

[4] We must stress that in this model no lagged dependent variable, which is used to capture the effects of omitted variables, is included. Thus, the process (product) innovation variables in the product (process) equation may capture the omitted lagged variable.

outcome y_{it} and assumed in this specification not to be correlated with the variables $M_{int}{}^{Subs}{}_{it-1}$ and $M_{int}{}^{Supplier}{}_{it-1}$; τ and ρ are correlations and σ_1 and σ_2 are variances, respectively.

Finally, the likelihood ratio test proposed by Buis (2011) was used to test for exogeneity (Atanhrho_12=0).

We estimated the same model with the same methodology for the subsamples of Foreign MNEs and Spanish MNEs (omitting the variable FMNE)

4. Results and discussion

Table 3 presents the results of the analyses for the total sample (Model 1: first and second column) and both subsamples (Model 2: foreign MNEs in the next two columns; Model 3: Spanish or domestic MNEs the last two columns). We checked full model fit using the Wald chi-squared which is statistically significant for each of the models. The correlation coefficient between the residuals from the two equations in each model (estimated atanhrho) was statistically significant in the three models. Thus, the two equations (product and process innovation) are not independent, and it is confirmed that panel recursive bivariate probit is more appropriate than univariate probit in all the models. Moreover, the analysis of the coefficient of the product innovation variable in the process innovation equation and the coefficient of the process innovation variable in the product innovation equation produces results that are consistent with an integrative view of the model that sees the two different types of innovation performance (product and process) as being positively interrelated. This is confirmed for both subsamples and the total sample.

INSERT TABLE 3

After checking the analyses, we first present the relationship obtained between imported intermediate inputs by source ($M_{int}{}^{Supplier}$ and $M_{int}{}^{Sub}$) and the likelihood of innovation performance (product and process). The estimated coefficients for the intermediate imports from an external source ($M_{int}{}^{Supplier}$) variable are positive and significant for product innovation

performance in the total sample model (model 1) and in the Foreign MNE subsample (model 2). This positive relationship is not found in the Spanish MNEs subsample (model 3), so we observe differences in the results depending on the ownership of the MNE group. The positive association between intermediate imports from foreign suppliers and the probability of obtaining product innovation performance for firms belonging to foreign MNEs was expected and would confirm the "variety effect" that allows importers to increase their product portfolio by recombining current or new inputs (Castellani and Fassio, 2019). However, the result observed in the Spanish subsample contradicts the previous literature. This result may imply that the subsidiaries of Spanish MNEs do not take advantage of the potential spillovers that imports can bring; or that they could have difficulties in searching for and/or entering into agreements with sophisticated suppliers in foreign countries (high transaction costs) that could favor product innovation; or even that they already have their specialist suppliers close to them in the home country (Spain).

Although in previous papers it has been argued that imports from foreign suppliers are associated with greater benefits for product innovation than for process innovation (Kotabe and Murray, 1990; Nieto and Rodriguez, 2011), we observe that firms from the Spanish subsample that import from foreign suppliers are positively associated with process innovation, while this association is not statistically significant for foreign MNEs. The results suggest that these imported intermediate inputs could transfer embedded technological knowledge not available domestically and be useful for process innovation especially for Spanish MNEs, while not being relevant for firms belonging to Foreign MNEs. Moreover, it could also be due to the characteristics of the technologies developed and their use. Those that are highly idiosyncratic or specific to the corporation, with high economic value to the firm and with an internal use, would source from inside the corporation to avoid their dissemination (Kotabe and Murray, 1990); however, those new technologies with other alternative uses could benefit from frequent

contacts and connections with more specialized and knowledgeable suppliers (Almeida and Fernandes, 2008), which is what could be happening in the Spanish subsample.

The coefficients for intermediate imports from the intra-firm trade variable (M_{int}^{Subs}) are significant for both types of innovation performance in all models, but this effect varies depending on innovation performance. The coefficient for M_{int}^{Subs} is significantly negative for product innovation, showing that importing from foreign suppliers reduces the likelihood of obtaining improved product innovation performance, regardless of MNE ownership. Being part of an MNE group may imply having a limited product portfolio or scope to focus only on products complementary to those produced in other subsidiaries of the MNE, and this could decrease the overall rate of development of new products (Castellani and Fassio, 2017). In contrast, the coefficient for M_{int}^{Subs} is significantly positive for process innovation. These results suggest that intra-firm trade is associated with process innovation performance, as predicted in the literature. Moreover, as our results show that both intermediate imports regardless of their source (i.e., M_{int}^{Subs} and $M_{int}^{Supplier}$) are positively associated with process innovation only in the subsidiaries of Spanish MNEs, we compare their coefficients with the Wald test in order to identify which has a greater effect. This test reveals that intermediate imports from an internal source exert a greater effect than those from external sources. This result may suggest that the international transfer of knowledge through the subsidiaries of Spanish MNEs is the most efficient method of achieving process innovation. Thus, we can conclude that firms belonging to Spanish MNEs that import intermediate inputs from internal sources (intra-firm trade) are more likely to develop process innovation behavior than those (Spanish MNEs) that import from external sources (foreign suppliers).

To check if the hypotheses are confirmed, we analyze all the results together. On the one hand, with respect to hypothesis H1a, our results show that importing intermediate inputs from an external source only has a positive association with product innovation performance for foreign

firms. Thus, H1a is only partially supported. However, it should be noted that in the case of the subsidiaries of Spanish MNEs it would be more advantageous to import from foreign suppliers than from other subsidiaries of the MNE group, to avoid the negative effect of intra-firm trade. On the other hand, our results do not reject hypothesis H1b and confirm that for both types of MNE (foreign and domestic), importing intermediate inputs from an internal source will be more valuable for achieving process innovation than importing from external sources. In general, process innovation is usually specific or highly idiosyncratic with limited alternative use as it must be efficiently integrated into the organizational structure. Moreover, it usually affects other systems and could require changes in organizational structure (Chesbrough and Teece 1996; Damanpour and Gopalakrishnan 2001). Importing from other subsidiaries allows the specific knowledge (mainly intangible know-how) to flow easily through the MNE network, due to its technical and communication infrastructure and to trained employees being able to codify, store and access knowledge. Since process innovations are characterized by the use of knowledge that is difficult to comprehend and cannot be easily understood by others, meaning that its successful application depends on widespread changes in organizational structure, importing from subsidiaries is more important for developing process innovations than importing from foreign suppliers.

To sum up, our results show that the effect of importing intermediate inputs on innovation performance is contingent on the source of the imports, the ownership of the MNE and the type of innovation.

With respect to the control variables, R&D intensity is confirmed as important for both types of innovation performance, as the previous literature establishes. It is known that MNEs improve their ability to absorb, evaluate and use external information when they allocate resources to research and development (Cohen and Levinthal, 1990). Contrary to our expectations, the export intensity effect differs according to the type of MNE. This coefficient

is positive and significant for subsidiaries of Spanish MNEs in both innovation outcomes, as predicted in the literature, but is not significant for foreign subsidiaries. This could be explained by the export intensity of the subsidiaries of foreign MNEs used in the sample, which on average export a larger percentage of their total sales than the subsidiaries of Spanish MNEs. An increase in the export rate probably has a greater effect on innovation performance when the MNE export rate is low; similarly, this effect would be less significant or even insignificant when the export intensity of the MNE is high. With respect to firm size, we find that the propensity to obtain process innovation is lower for SMEs (with a negative and significant coefficient) than it is for large firms, regardless of MNE ownership. In general, large firms are positively correlated to innovation performance, not only because they benefit from cost savings derived from economies of scale in the development of new technologies, but also because of positive knowledge spillovers (Almeida and Fernandes, 2008). Thus, the results show that SMEs have a size disadvantage in process innovation. However, with respect to product innovation, the size disadvantage is also observed for SMEs in the Spanish MNEs subsample, while for the Foreign MNEs subsample, there are no significant differences between SMEs and large MNEs. The variable FMNE (belonging to a foreign MNE) is included in the total sample and its coefficient is negative and significant in the product innovation equation. Thus, belonging to a foreign multinational group has less impact on product innovation than belonging to a Spanish MNE. This could be because innovative effort is usually expected to be made mainly in the home country of the MNE (De Beule and Van Beveren, 2019).

5. Conclusions

Nowadays, all firms, but particularly MNEs, are experiencing globalization and a constant need for rapid innovation; a situation that calls for research into how MNEs can improve their innovation success. Some authors have found strong evidence that international activities positively affect innovation performance. The notable growth of international trade over the

past few decades is increasingly linked to the generation and application of new knowledge (Acharya and Keller, 2009). However, there is little evidence of the effects of importing.

Importing can be important in stimulating the cross-border learning of production methods and product design (Abubakar *et al.,* 2019), particularly in the case of imported inputs incorporated into the production process (i.e., imported intermediate inputs). Importing intermediate inputs allows firms to acquire the new knowledge embedded in new products and new machinery and establishes channels of communication that help to achieve innovation.

Our study has shown which source of imports is best for product and process innovation using a large, updated sample of almost 2,500 year observations of manufacturing firms belonging to a Spanish or foreign MNE group over a long period (2006-2016).

From our results we observe that MNEs must understand the different effects of intermediate imports based on the source of the imports and the type of innovation. Not all intermediate imports have the same effect on innovation. While all intermediate imports from subsidiaries appear to be valuable for achieving process innovation, they could be disadvantageous for achieving product innovation. The ownership of the subsidiary is not relevant in these cases.

Moreover, not all imported intermediate inputs from suppliers contribute in the same way, with differences according to the ownership of the MNE. Importing intermediate imports from foreign suppliers has a positive impact on product innovation for foreign MNEs and a positive impact on process innovation for Spanish MNEs. The different inputs imported for each type of MNE and their transferability may be behind the different effects of importing on innovation.

In summary, we can draw three valuable conclusions. First, intermediate imports do not always contribute to improving innovation, since their effects vary depending on their source. Second, intermediate imports from an external source (foreign suppliers) are more advantageous for product innovation than those from an internal source (intra-firm trade). Third, intermediate imports from intra-firm trade are more important for process innovation than those from foreign

suppliers. The results show that the effect of importing intermediate inputs on innovation performance is contingent on the source of the imports, the ownership of the MNE and the type of innovation. Thus, the decision to import intermediate inputs from external or internal sources has important strategic implications for MNEs.

Implications and limitations

Based on our results, we can offer some recommendations for managers and policy makers. Our study adds to the evidence from prior studies investigating the effect of importing intermediate inputs through external or internal sources that focus on the distinction between product and process innovation. We show that it is important to consider this difference, because the contribution of intermediate imports varies depending on the type of innovation and the source of import. Thus, managers have new knowledge to better design their global supply chain and help improve innovation.

A second new insight for those responsible for innovation and international business is that importing intermediate inputs from internal sources (intra-firm trade) contributes to improving process innovation regardless of the ownership of the MNE. The role of importing intermediate inputs from internal sources has been considered only rarely in previous studies on innovation performance, but our findings suggest that such imports are important and that it is also important to consider the heterogeneity of importing sources. These can nurture a process of learning by leveraging their network of subsidiaries, which can transfer both their technological knowledge and their best organizational innovation practices directly to the headquarters and to the other subsidiaries through planning and training meetings. Moreover, if firms are in a position to choose, importing from foreign suppliers represents the most effective way of achieving product innovation, particularly for foreign MNEs. Investigating these questions is important, because the efforts of many policy makers devising and implementing importing policies that lead to innovation are often hindered by the dearth of empirically informed

knowledge as to whether or not these activities are appropriate.

A limitation of this study is that it relies on information on importing intermediate inputs from different sources without specifying their origin, that is, we do not know the location of the foreign suppliers or overseas subsidiaries. Our theoretical and empirical framework therefore considers the rationale for importing from different sources to enhance innovation performance from a strategic perspective, rather than focusing on the specific characteristics (e.g., duration, location, etc.) of individual importing relationships. As this information is currently not available, it could be an important subject for future research. Additionally, the study of external *versus* internal sources in the domestic market is not studied as the research focuses exclusively on how imported intermediate inputs from different sources are related to innovation performance in MNE groups. However, the analysis of the complete set of possible sources of intermediate inputs (external and internal) in both foreign and domestic markets deserve to be studied. Finally, the target firms are manufacturing firms belonging to an MNE group, so our results cannot be generalized to other types of firm such as service firms or domestic firms.

Despite these limitations, we believe that our paper contributes to the ongoing debate on the relationship between intermediate imports and innovation performance. In particular, it breaks down specific innovation performance, in terms of product and process innovation, for each type of importing firm, which helps to clarify the role of imports in improving the innovation performance of MNEs.

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Table 1. Description of the sample.

		Value[1]	Number	Percentage
Importers of intermediate inputs		4,303	1,898	77.53
Source	External or Foreign Suppliers	2,435	1,767	72.18
	Internal or Intra-firm	1,868	1,019	41.62
Non-Importers firms of intermediate inputs		--	550	22.47
With product and/or process innovation		--	1,436	58.66
	Product innovation	--	789	32.23
	Process innovation	--	1,240	50.65
Number of observations		2,448	2,448	100.00

(1) Millions of euros on average. Source: Compiled by author

Table 2. Descriptive statistics and Spearman correlations (*N*=2,448)

	1	2	3	4	5	6	7	8
Mean	0.3	0.5	0.9	0.5	0.0	0.5	0.6	0.6
Std. Dev.	0.5	0.5	0.9	0.9	0.0	0.3	0.5	0.5
Min	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Max	1.0	1.0	4.4	6.4	0.2	1.0	1.0	1.0
1 PRODUCT	1.00							
2 PROCESS	.34*	1.00						
3 $M_{int}^{Supplier}$	.01	.03	1.00					
4 M_{int}^{Subs}	-.09*	.07*	.32*	1.00				
5 R&D	.39*	.28*	.09	-.09*	1.00			
6 EXPORT	.02	.10*	.10*	.09*	.16*	1.00		
7 SME	-.09*	-.15*	-.05*	-.11*	-.18*	.01	1.00	
8 FMNE	-.13*	.00	.11*	.38*	-.16*	.05*	-.02	1.00
Variance inflation factor	1.16	1.11	1.19	1.27	1.48	1.22	1.16	1.28

*p-value<.05

Table 3. Panel Bivariate probit model with robust standard errors (cmp)

	MODEL 1 TOTAL SAMPLE		MODEL 2 Foreign MNE (FMNE)		MODEL 3 Spanish MNE	
	Product	**Process**	**Product**	**Process**	**Product**	**Process**
	Marginal Effects *dy/dx*	Marginal Effects *dy/dx*	Marginal Effects *dy/dx*	Marginal Effects *dy/dx*	Marginal Effects *dy/dx*	Marginal Effects *dy/dx*
PRODUCT$_{t-1}$	--	0.40*** (0.10)	--	0.26* (0.13)	--	0.51*** (0.14)
PROCESS$_{t-1}$	0.45*** (0.09)	--	0.27** (0.13)	--	0.57*** (0.14)	--
M$_{int}^{Supplier}{}_{t-1}$	0.07** (0.03)	0.00 (0.03)	0.17*** (0.05)	-0.04 (0.04)	-0.07 (0.06)	0.11* (0.06)
M$_{int}^{Subs}{}_{t-1}$	-0.17*** (0.04)	0.13*** (0.04)	-0.19*** (0.04)	0.12*** (0.04)	-0.19* (0.10)	0.25** (0.10)
R&D $_{t-1}$	13.49*** (1.65)	7.41*** (1.79)	13.27*** (2.00)	11.11*** (2.84)	14.66*** (3.48)	5.04* (2.82)
EXPORT$_{t-1}$	0.03 (0.11)	0.45*** (0.10)	-0.10 (0.15)	0.17 (0.14)	0.42** (0.19)	0.69*** (0.17)
SME $_{t-1}$	-0.09 (0.07)	-0.31*** (0.06)	-0.02 (0.09)	-0.39*** (0.08)	-0.19* (0.10)	-0.23** (0.17)
FMNE$_{t-1}$	-0.18*** (0.07)	-0.03 (0.06)	--	--	--	--
Industry Effects	Included		Included		Included	
Time Effects	Included		Included		Included	
N	2,186		1,254		906	
Log pseudolikelihood	-2,480.61		-1,384.97		-960.74	
Wald X2	402.19***		253.55***		296.34***	
Atanhrho_12	0.32***		0.39***		0.30***	
Comparison tests[1]	--		--		$\beta^{MintSubs}$ (process) > $\beta^{MintSupplier}$ (process): X^2=18.19***	

Note: Standard errors in parentheses. [1]Wald tests comparing the difference of coefficients estimates of M$_{int}^{Subs}$ vs M$_{int}^{Supplier}$ within Process equation in model Spanish MNE (model 3).
*** *P*-value<.01 ** *p*-value<.05 * *p*-value<.1