SERVITISATION AND EXPORTING IN MANUFACTURING FIRMS

Preliminary version

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Abstract

The aim of this study is to explore the impact of servitisation on firms' export behaviour. Using firm-level data from a rich sample of Spanish manufacturing companies in the period 1991-2014, we estimate the effect of producing and selling both manufactures and services on the probability of entry into and exit from export markets. In order to control endogeneity and reverse causality problems, we develop a double methodological strategy: an instrumental variables (IV) model with firm fixed effects, which allows us to control for observable and unobservable firm characteristics, and weighted matching techniques that estimate less biased probabilities of servitisation. Our findings show that servitised firms are more likely to start to export and to continue exporting than pure manufacturing firms, mainly when the firms are small, which suggests an enhancing effect of servitisation on export performance, particularly for smaller firms. These results support the idea that servitisation upgrades manufacturing firms' ability to attract foreign clients and to maintain them by further differentiation of their products through the offering of services that meet customers' needs. Moreover, since they are often highly customised services, consumers' loyalty increases and so does the ability of servitised firms to resist replacement by competitors.

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1. INTRODUCTION

In recent decades, services have become crucial for manufacturing competitiveness. This can be explained by the process of globalisation and the fierce competition that companies face in the global market. International fragmentation of production and the expansion of global value chains (GVCs) have allowed advanced countries' firms to reduce cost, obtain gains in efficiency and improve their competitive position. When a production process is broken up into tasks within a GVC, efficient and high-quality services in transportation, communications, logistics and other services linked to coordination and management are required for global value chains to function properly. Access to services is essential to participating in manufacturing value chains, exploiting economies of scale and efficiently managing inventories. In a GVC world, the quality and prices of services are determining factors of international competitiveness in manufacturing (Nordas and Kim, 2013).

Additionally, the growth of low-cost competition from emerging and developing countries has forced companies of advanced countries to reshape their competitive strategies accordingly. Product differentiation has been a frequent response to the increasingly competitive pressure, and some services such as design, branding, marketing or engineering are often used as instruments for distinguishing a product from competitors' products (Wolfmayr, 2012).

Consequently, nowadays, manufacturing and services are inextricably intertwined. Manufactures need more and more services to produce goods, and their competitiveness depends on how efficient those services are. This interaction between both is, namely, servicification of manufacturing, which means that manufacturing industries are relying on services more, whether as inputs (services outsourcing), activities within firms (in-house services) or sold output bundled with goods (National Board of Trade, 2016; Mirodout and Cadestin, 2017). In the present work, we are interested in the last one, manufacturing firms that are also services providers, which is specifically known as servitisation of manufacturing (Vandermerwe and Rada, 1988)[1].

Servitisation is not a new strategy. Services like installation, repair or maintenance have usually been coupled with complex capital goods to make them more attractive for consumers. However, servitisation goes further than merely adding services. It means a new business model for manufacturing firms that shift their objective from selling products to providing solutions and selling product-service systems[2] (Neely, 2008). Servitisation has changed the way manufactures create value: manufacturing firms compete by offering solutions that complement, and sometimes even substitute, their products.

[1] In related studies, servicification and servitisation are often used as synonymous terms (Lodefalk, 2013).
[2] Neely (2008) describes a product-service system as an integrated product and service offering that delivers value in use.

There are several reasons for providing services: (i) to better sell products by helping consumers to buy and use them (complementary services such as financing, insurance, maintenance or repair), (ii) to enhance a product's functionality by adding new uses and (iii) to increase a consumer's satisfaction by adapting products to changing customers' needs and tastes (Cusumano et al., 2015). In all the cases, servitisation can be considered to be a source of product differentiation that allows firms to face competitive pressure.

The offering of services by manufacturing firms is a global trend which has been accelerated by digital technologies, since they facilitate the flow of information between clients and providers to develop integrated solutions.

The literature reveals a high prevalence of servitisation. Miroudot and Cadestin (2017) review firm-level evidence on manufacturing firms which sell services, and document the extent of services sold and bundled with goods using data from the ORBIS database. They estimate the share of firms involved in manufacturing and in both manufacturing and services activities, and show the prevalence of manufacturing activities that are linked with the provision of a service. Neely et al. (2011) focus on data on supply of services, using an international sample of large manufacturing companies in 2007, 2009 and 2011. They find evidence of two facts regarding the share of firms offering services: it is unevenly spread across countries, although there are significant differences in the extent of servitisation in different countries, and it was stable throughout those years. Pilat and Wölfl (2005) examine the interaction between services and manufacturing using several types of data (aggregate and firm-level data). One of them is micro data which allow us to look at the composition of turnover within manufacturing enterprises by focusing on secondary products such as services products. Their analysis for four countries (Finland, Japan, New Zealand and Sweden) suggests that manufacturing firms appear to derive a growing share of turnover from services between 1997 and 2002 (the average share is around 10 per cent), notably in countries such as Finland and Sweden.

The aim of this paper is to explore the impact of servitisation on firms' export behaviour. Using firm-level information from a representative sample of Spanish manufacturing companies, we estimate the effect of producing and selling both manufactures and services on the probability of entry into and exit from export markets over two decades, 1994-2014. Our hypothesis is that being a servitised firm increases the probability of a firm's entering export markets and reduces its probability of exiting these markets.

While there is ample literature on the link between servicification and export performance, almost all studies focus on services content of manufacturing. The findings from industry-level analysis show, for different countries and periods, that the use of services inputs is positively correlated with export performance, whatever indicator is used (Wolfmayr, 2012; Francois and Woerz, 2008; Landesmann et al., 2015; Díaz-Mora et al., 2018). Firm-level studies are scarcer, but with similar findings about the positive linkage between servicification and export performance (Lodefalk, 2014; Hoeckman and Shepherd, 2017; Liu et al., 2019).

Less academic attention has been given to the impact of the sale of services by manufacturing firms on export performance. It is quite expected that servitisation will be related to manufacturing export performance in the same way that services content is. Offering services may have a positive impact on export performance through several channels. Firstly, when providing services, manufacturing firms seek to introduce elements that increase product attractiveness by extending their functionalities and responding to specific customer needs. Thus, bundling services with goods allows firms to increase perceived product quality and to differentiate their offerings from competitors. It is a way to strengthen competitiveness and, more specifically, to improve access to foreign markets. Consequently, we expect servitised firms to present a higher probability of exporting.

Secondly, a successful implementation of servitisation requires high skills and capabilities, which cannot be easily acquired by competitors, to provide highly customised services. In this respect, Dachs et al. (2014) find that the extent of servitisation is positively related to innovation intensity at both the sectoral and the firm level. One explanation suggested by the authors is that innovation capabilities are not restricted to technological innovation that may enable new products but may also be applicable to defining and offering new types of services in manufacturing firms. Thus, servitisation might act as a barrier to entry that restricts competition from new entrants. Therefore, servitisation not only helps manufacturing firms to start exporting but also contributes to preserving their exporter status.

Lastly, services bundled with goods increase consumers' loyalty. When manufacturing firms provide goods and services jointly, long-lasting relationships with customers are frequently established. Complementary services that guarantee the uptime and availability of goods usually tie suppliers and customers in long-term relationships because they reduce consumer uncertainty about the purchase and future usage of the product. Adapting services that customise products involves complex interdependence between consumers and providers. Supply of these services requires thorough knowledge of the manufactured product and very detailed information about clients' preferences and needs. Customers will be interested in a long-term commitment for a customised product which fulfills their requirements. The strength of the relationship between supplier and client matters for export survival, particularly in foreign markets, where uncertainty is higher than in domestic ones. Thus, we expect servitised firms to show a lower probability of quitting export markets than non-servitised firms.

Although they are small in number, the papers that focus on the impact of servitisation on export performance support our hypotheses. Ariu et al. (2020) investigate, from a theoretical and empirical perspective, the effect of selling both products and services abroad (what they call a bi-exporting firm) on the performance of goods exports. They propose a model of oligopolistic competition with imperfect substitutability between the good alone and the good provided jointly with the service, where goods and services are complements and consumers value variety. Focusing on Belgian manufacturing firms, they find that the provision of services boosts the demand for goods and

increases exports values and market shares since services increase the perceived quality of the good. Hence, the authors provide empirical evidence of the quality-enhancing effect of services for goods.

Aquilante and Vendrell-Herrero (2019) study the effect of bundling products and services in the same commercial offer on export performance for German firms. They focus on small and medium firms (SME) and find that selling solutions that integrate goods and services is positively linked with export intensity. This is an interesting outcome, since previous studies had shown that the smaller the firm is, the lower (higher) the likelihood of export entry (exit) is. Moreover, Dachs et al. (2014) find a non-linear relationship between firm size and servitisation. Smaller firms present high degrees of servitisation, which suggests that this type of firm uses the advantage of its flexibility to specialise in the needs of a few key customers. Therefore, the provision of services with goods could be a way to overcome some of the constraints faced by small firms to promote internationalisation, in short, an opportunity to improve export performance. In the same line are the results of Cassiman and Golovco (2011), who highlight the importance of product innovation in the decision to export by small and medium Spanish manufacturing firms. As servitisation is related to product innovation, a higher influence on export performance in SME than in other firms could be expected.

Our contribution to the literature is threefold. First, the present study contributes to a better understanding of the influence of a business model increasingly applied in manufacturing firms such as servitisation on trade competitiveness. This topic is hardly investigated in the literature regarding servitisation (Baines et al., 2017). Second, to the best of our knowledge, this is the first work that explores the effect of servitisation on export entry and exit. Third, in order to control endogeneity and reverse causality problems that occur when exports and servitisation are introduced in the same equation, we develop a double methodological strategy: an instrumental variables (IV) model with firm fixed effects, which allows us to control for observable and unobservable firm characteristics, and weighted matching techniques that estimate less biased probabilities of servitisation. Our results show a positive and significant effect on access to export markets. Moreover, we find that the effect of servitisation is higher for small firms. Regarding export survival, our findings suggest that servitisation plays an important role in continuing to export, and again this impact is higher for smaller firms.

The paper is structured as follows. After this introduction, in Section 2 we explain how servitisation is measured and offer a descriptive analysis about its relevance and connection to firm export activity. Section 3 explains the estimation strategy used to empirically analyse the effect of firm servitisation strategies on the export dynamics of the company. Section 4 presents the results of the empirical model, and Section 5 concludes.

2. DESCRIPTIVE ANALYSIS.

Data for this investigation come from the Survey on Business Strategies (*Encuesta sobre Estrategias Empresariales*, initialled ESEE in Spanish) for the period 1991-2014. It is a representative sample of

Spanish manufacturing firms with 10 or more employees, including the entire sample of large firms (more than 200 employees) and random sampling criteria for small and medium-sized firms. The ESEE includes around 2,000 firms every year and it provides establishment-level data on many of the firm characteristics[3]. The database allows us to distinguish small firms (between 10 and 49 employees) from all other firms[4].

We consider a manufacturing firm to be servitised when it offers services or related-activities apart from manufacturing. The ESEE allows us to identify whether a manufacturing firm supplies services and provides information on the percentage which it represents on total sales. However, it is quadrennial information starting in 1994 and, consequently, we only have six years of survey data on servitisation.

The prominence of servitisation in Spanish manufacturing firms is clear from Table 1. We find that almost half of them sell services and, on average, 24 per cent of the sales come from services. The percentage of servitised manufacturing tends to increase with the size of the company. It is not as frequent in small firms (41 per cent in 2014) as in medium-large firms (53 per cent). Moreover, the share of services in total sales for larger firms is significantly higher than the corresponding share for small firms. However, small firms are actively involved in this strategy, accounting for 44 per cent of manufacturing firms that produce services.

Table 1: Servitised firms and export, 2014.

	All firms	**Small firms**	**Medium & large firms**
SERVITISED FIRMS			
No. of firms	721	316	405
Share of total firms (%)	47.3%	41.3%	53.3%
Share of exporting firms (%)	81.7%	64.2%	95.3%
Export intensity (% on sales)	36.1%	27.6%	40.5%
Servitisation intensity (% on sales)			
Median	10.0%	10.0%	9.0%
Mean	24.7%	19.0%	24.8%
PURE MANUFACTURING (not servitised firms)			
No. of firms	804	449	355
Share of total firms (%)	52.7%	58.7%	46.7%
Share of exporting firms (%)	64.6%	45.7%	88.5%
Export intensity (% on sales)	39.6%	27.6%	47.4%

Source: Own elaboration from data of the Survey of Business Strategies

[3] Detailed information about the ESEE is available at https://www.fundacionsepi.es/investigacion/esee/spresentacion.asp
[4] Given the low number of large firms that start or stop exporting in our sample, we group all firms with more than 50 employees into one category: medium & large firms.

Table 1 also provides the mean and median values of the servitisation intensity (measured as the share of services on sales). The disparity between both statistical measures shows that wide differences exist in the degree of manufacturing servitisation among the sample of firms. The median is substantially smaller than the mean, which indicates that distribution is skewed towards firms with a low level of servitisation. However, this finding should be considered carefully because many services are sold in a package deal with the product and they are not charged for directly (National Board of Trade, 2016). Thus, share of revenues from services may not be a reliable measurement of servitisation intensity. Therefore, we do not consider intensity in our empirical model.

As shown in Table 1, servitised firms are more export-oriented than other firms are. Most of them are exporters (82 per cent) compared with those which offer only goods (65 per cent). As expected, medium-large servitised firms have a higher share of exporters than small ones (64%), and both of them are more involved in exporting than non-servitised companies. However, there are no significant differences in export intensity between servitised and non-servitised firms.

Here, the transition probabilities matrix, which shows the probabilities of changing the export status from time T to T+4 for servitised and pure manufacturing firms and size (Table 2), can help us to identify the underlying relation between servitisation and exports.

Table 2: Transition probabilities (in %)

t / t+4		Servitised firm		Pure manufacturing firm	
		Do not export (t+4)	Export (t+4)	Do not export (t+4)	Export (t+4)
All firms	Do not export (t)	78.3***	21.8***	83.0	17.0
	Export (t)	5.0	95.1***	6.8	93.2
Medium and large firms	Do not export (t)	58.1***	41.9	67.1	32.9
	Export (t)	2.4	97.6***	2.9	97.1
Small firms	Do not export (t)	83.3***	16.7***	86.5	13.5
	Export (t)	12.2**	87.8***	13.4	86.6

Notes: Four-year periods (t and t + 4) are considered that correspond with quadrennial information about servitisation. The Wald test is used to test the statistical significance of the differences between the values of the matrices of servitised firms compared to those of pure manufacturing firms. ***, ** and * indicate statistical significance at 1%, 5% and 10%, respectively.

Source: Own elaboration from data of the Survey of Business Strategies

First, the probability of starting to export is higher for manufacturing firms which are involved in providing services (22 per cent) than for pure manufacturing firms (17 per cent). This outcome is common for small and medium firms and large firms. As expected, for both types of firms, the probability of becoming an exporter tends to increase with size. Second, as previous studies show, exporting is a persistent activity. Once a firm has started to export, the probability of preserving its export status is higher for services supplier manufacturing firms (95 per cent). The difference in the

probability of remaining in export markets between manufacturing firms that sell services and those that do not is small, but it is statistically significant.

It is interesting to note that these results support our hypothesis that servitisation facilitates manufacturing firms' entry into export markets and plays an important role in preventing exit from exporting. However, the results could be influenced by the existence of firms'characteristics that distinguish servitised from non-servitised firms. To empirically investigate these issues, we propose to estimate two models, which are explained in the next section.

3. ESTIMATION STRATEGY

As already explained, the aim of this paper is to analyse the effect of firm servitisation strategies on the export dynamics of the company. In econometric terms, we define two different duration models with 'export entry' and 'export exit' hazard rates as dependent variables. We can define 'entry export' hazard as the complement to the survival function of remaining without exporting. Similarly, the 'exports exit' hazard rate is the complementary survival function of continuing exporting. In formal terms:

$$\Phi_{startX}(t) = Pr(T_{noX} = t / T_{noX} \geq t) = \frac{Pr(T_{noX})}{Pr(T_{noX} \geq t)} \quad (1)$$

$$\Phi_{exitX}(t) = Pr(T_X = t | T_X \geq t) = \frac{Pr(T_X)}{Pr(T_X \geq t)} \quad (2)$$

Considering T_{noX} as the duration of the non-exporting spell, $\Phi_{startX}(t)$ is the hazard rate of entry to exporting, defined as the probability of starting to export in t $(Pr(T_{noX}))$, conditional on non-exporting during the previous years $(Pr(T_{noX} \geq t))$. Moreover, considering T_X as the duration of the exporting spell, $\Phi_{exitX}(t)$ is the hazard rate of exiting from exporting, defined as the probability of stopping exporting in t $(Pr(T_X))$, conditional on having exported during the previous years $(Pr(T_X \geq t))$. In discrete terms, $\Phi_{startX}(t)$ and $\Phi_{exitX}(t)$ will take the value 1 if the firm starts to export in the former case, and if the firm stops exporting in the latter case, and zero otherwise including the right-censored observations.

We estimate the next two duration models. Model (3) and model (4) link the probability of export entry and export exit, respectively, with their determinants, including the servitisation ($Servit_{it}$) as a as a main independent variable.

$$\Phi_{startX}(t) = f\left(Servit_{it}; Import_{it}; Inn_{prod_{it}}; Inn_{proc_{it}}; Skill1_{it}; Foreign_{sh_{it}}; Product_{it}; Size_{cat._{it}}; Long_{no\_exper_{i_T}}; Medium_{no\_exper_{i_T}}; Age_{it}; Sector_j; Year_t\right) \quad (3)$$

$$\Phi_{exitX}(t) = f\left(Servit_{it}; Import_{it}; Inn_{prod_{it}}; Inn_{proc_{it}}; Skill1_{it}; Foreign_{sh_{it}}; Product_{it}; Size_{cat._{it}}; Long_{exper_{it}}; Medium_{exper_{it}}; Age_{it}; Sector_j; Year_t\right) \quad (4)$$

Following the literature, we include a number of relevant variables that may have an effect on the decision either to start or stop export activities. Most of them are firms' characteristics such as size ($Size_{it}$), product and process innovation (Inn_{prod} and Inn_{proc}), foreign ownership ($Foreign_{sh}$), skilled labour ($Skill1_{ij}$), productivity ($Product_{it}$) and age (Age_{it}). Table A1 in the appendix provides definitions and measurements of all the variables used in the empirical analysis.

Here, firm size is measured by a dummy variable that takes the value 1 for small firms and 0 otherwise, i.e., it identifies small firms ($Size_{cat.ij}$). This allows us to investigate possible heterogeneous effects for small versus medium-large firms when we introduce in both equations an interaction between servitisation probability and size ($Servit_{it}\#Size_{it}$).

We also include being an importer as an explanatory variable ($Import_{it}$). The connection between being an importer and export performance finds support in theoretical and empirical works (Impullitti et al., 2013; Aristei et al., 2013; Lo Turco and Maggioni, 2013; Díaz-Mora et al., 2015). According to these studies, three reasons (the higher productivity of firms that both import and export, the complementary nature of sunk costs firms have to incur and the less uncertainty they face in their activity abroad) would explain firms' greater durability as exporters.

Moreover, related research highlights the role of previous export experience in current export behaviour due to the existence of sunk and fixed costs of exporting (Albornoz et al., 2012). Past export experience increases the probability of starting to export for current non-exporters and decreases the probability of exiting from exporting for current exporters. To capture this, dummy variables for being regular exporters are constructed. Furthermore, we distinguish medium- and long-term export experience within regular exporters. We define regular exporters with medium-term experience as firms that have been exporting more than five consecutive years and less than twelve. Long-term export experience is defined as more than twelve consecutive years exporting. The variables $Long_{exper}$ and $Medium_{exper}$ take the value 1 for each of these two types of regular exporters and 0 otherwise. In a similar way, we construct dummy variables ($Long_{no\_exper}$ and $Medium_{no\_exper}$) to capture "regular non-exporters" with no previous export experience in the medium term (more than five and less than twelve consecutive years without exporting) and in the long term (more than twelve consecutive years without exporting). These dummy variables for being regular non-exporters and being regular exporters are included in the duration models to analyse the impact of servitisation on export entry or exit, respectively.

One issue that deserves particular attention is the possible existence of endogeneity of the servitisation variable**,** which would bias the estimates. Endogeneity problems may arise from two

main sources (Aquilante and Vendrell-Herrero, 2019; Crozet and Millet, 2017): (i) omitted variables, and (ii) reverse causality. Biases may result from omitted variables when unobservable firm-level characteristics are simultaneously correlated with both the servitisation status and the export entry or export exit decision. Additionally, reverse causality may occur since export entry and exit could also be a determining factor for servitisation.

In order to deal with these problems, this paper follows a double estimation strategy following prior related-literature[5]. We use an instrumental variables (IV) model to estimate the probability of servitisation as an instrumental variable of servitisation and we employ different matching methods to obtain a more robust estimation of the probability of servitisation.

3.1.Instrumental variables (IV) model

For the first approach, we estimate the probability of servitisation from the predicted probability of a random-effects probit model, considering the servitisation variable (*Servit*.) as the endogenous variable. In formal terms, the probability of servitisation (*Probservit*) will be:

$$Probservit^{*}_{it}=prob(Servit._{it}=1)=f(Export_{it-1};\ Capacity_{it-1};\ Skill2_{it-1};\ Inn_{prod\ it-1};\ Inn_{proc\ it-1};\ ForeignK_{it-1};Size_{it-1};\ (K/L)_{it-1};\ Industry_{j};\ Year_{t}) \quad (5)$$

where *Servit* is equal to 1 if company (i) performs servitisation in year t and zero otherwise. *Export* is a dichotomous variable that indicates whether the company exports. Note that this variable is different from the endogenous variables of the main models (3) and (4), which measure firm export dynamics (entry or exit). The variable *Capacity* measures the use of the company standard production capacity. *ForeignK* is a dichotomous variable that reports whether or not foreign capital participates in firms. *Size* denotes the firm's size, and here it is measured as the number of employees in logarithms. (*K / L*) is the capital-labour ratio measured as the value of the capital stock at constant 1990 prices, divided by total employment, in logarithms. *Industry* and *Year* are dummy variables to control for the industry heterogeneity and macroeconomic conditions of all firms, respectively. Additionally, all variables are lagged one year to further mitigate possible endogeneity problems. The results from model (3) are reported in Table A2 in the appendix[6]. According to them, firms that are more likely to become servitised are firms that are exporters, are larger, are more skill-intensive, have foreign ownership and do product innovation

[5] Bandick and Görg (2010) and Bandick (2020) use an instrumental variable and a propensity score matching approach in their models to investigate factors that affect plant survival and export survival, respectively. Crozet and Millet (2017) choose to estimate a lagged dependent variable (LDV) model (as a robustness check, they also estimate a fixed effects regression) as well as an instrumental variable model. Aquilante and Vendrell-Herrero (2019) opt for estimating a panel data model with firm fixed effects and, as a robustness check, implementing several (double robust) propensity score matching techniques.

[6] As a robustness check, we also estimate alternative specifications of equation (5), including additional firm characteristics. The results (available upon request) are quite similar; that is, the results are robust to changes in the variables that are included in the probit.

Although the ESEE provides servitisation data only every four years, the estimated probability of servitisation reports annual data, since all the explanatory variables of model (5) are also annual. This allows us to use the entire length of the sample (1991-2014). The next step is to introduce *Probservit** in duration models (equations (6) and (7)), which are estimated using a random effects probit. The complete specification of the models will be as follows:

$$\Phi_{startX_{it}}=\beta_1 Probservit^{*}_{it}+\beta_2 Import_{it}+\beta_3 Inn_{prod_{it}}+\beta_4 Inn_{proc_{it}}+\beta_5 Skill_{it}+$$
$$+\beta_6 Foreign_{sh_{it}}+\beta_7 Product_{it}+\beta_8 Size_{cat._{it}}+\beta_9 Long_{no\_exper_{i_T}}+ +\beta_{10} Medium_{no\_exper_{i_T}}+\beta_{11} Age_{it}+\beta_{12} Sector_j$$
$$+\beta_{13} Year_t+\varepsilon_i+\varepsilon_t+\mu_{it} \quad (6)$$

$$\Phi_{exitX_{it}}=\beta_1 Probservit^{*}_{it}+\beta_2 Import_{it}+\beta_3 Inn_{prod_{it}}+\beta_4 Inn_{proc_{it}}+\beta_5 Skill_{it}+$$
$$+\beta_6 Foreign_{sh_{it}}+\beta_7 Product_{it}+\beta_8 Size_{cat_{it}}+\beta_9 Long_{exper_{i_T}}+ +\beta_{10} Medium_{exper_{i_T}}+\beta_{11} Age_{it}+\beta_{12} Sector_j$$
$$+\beta_{13} Year_t+\varepsilon_i+\varepsilon_t+\mu_{it} \quad (7)$$

In a context of high firm heterogeneity, firm characteristics could affect each explanatory variable of the model in a different way (Arroyabe and Schumann, 2019). The error terms (ε_i and ε_t) in equations (4) and (5) of the random effects model would not fully capture the entire unobservable heterogeneity, and the estimated parameters will be inconsistent (Wooldridge, 2005). In that case, firm fixed effects would have to be introduced to control for individual unobservable heterogeneity. In non-linear models, such as probit, the standard fixed effects estimator leads to the well-known 'incidental parameter problem' (Neyman and Scott, 1948), which reports biased results. Recent studies, which are surveyed in Arellano and Hahn (2007), show different techniques for correcting this bias in both its temporal (*T*) and cross-section (*N*) component.

As a robustness test, in this paper we re-estimate models (6) and (7), which consider a time and firm-fixed effects probit, by using the jackknife bias correction proposed by Fernández-Val and Weidner (2016). This technique is especially suitable for moderately large N and T, similar to those used here[7].

3.2.Matching methods estimation

In this alternative method, we try to obtain a more precise measure of the probability of servitisation by distinguishing between companies that report servitisation data (treated group) and companies without data on servitisation (control group). Assuming that group membership is independent of the level of servitisation, the main idea of the matching techniques is to assign, to each company in the control group, a servitisation probability equal to that of the firm or firms with the most similar characteristics in the treated group. Regarding the IV model, we would therefore expect a significant

[7]To estimate it, we use the Stata command "probitfe", developed by Cruz-González *et al.* (2017).

reduction in the differences in the servitisation probability between firms with and without servitisation data.

When a servitisation probability has been assigned to all firms, we introduce the new variable in equations (6) and (7). Since probability of the treated group can determine the probability of more than one company in the control group, and an estimated probability of the control group could be the combination of several probabilities of the treated group, each observation is weighted by its relative participation in the whole sample. Previous literature highlights the importance of introducing weights in estimates when variables extracted from matching methods are considered (Busso et al, 2014; Li et al., 2018).

There are many different matching estimation methods that differ in the way they calculate the level of similarity between subjects. In order to evaluate how robust the results are to different methods, this work uses three of them: one-nearest neighbour matching, propensity score matching by 5-nearest neighbours (NN5), and matching by inverse probability weighting (IPWRA). In all cases, the unmatched observations are eliminated from the sample.

Firstly, the one-nearest neighbour method calculates the similarity between the control and the treated group from a weighted function of the covariates for each observation. In practical terms, it is calculated using the weighted means of the explanatory variables used in the servitisation model (equation 3). Each observation from the control group is matched with one observation from the treatment group. Furthermore, each observation of the treatment group can be matched with more than one observation from the control group.

Propensity-score matching techniques calculate the similarity between the control and the treated group from estimated treatment probabilities, known as propensity scores. In this paper, propensity scores are the predicted probabilities obtained in the probit model of servitisation (equation 3). Each observation from the control group is matched with the five most similar observations from the treated groups in terms of its propensity score.

Finally, the inverse probability weighted matching method calculates the similarity between the control and the treated group from an inverse-probability-weighted regression adjustment (IPWRA), where weights are the estimated inverse probabilities of treatment. It is a combination of the two techniques: estimated probabilities and average weights. Therefore, IPWRA estimators have the doubly-robust property.

Table 3 shows the average value of the estimated servitisation probability with both IV and matching techniques, distinguishing between companies with and without information on servitisation. As we expected, the variables estimated by matching techniques do not show significant differences between firms that belong to the control and the treatment group.

Table 3. Average of estimated servitisation propability

	Treated Servit. info	Control No servit. Info.	t-test*
IV	0.5397	0.5773	12.40***
One nearest-neighbor matching	0.5475	0.5460	0,38
Propensity score 5-nn	0.5475	0.5466	0,25
Inverse-probability-weighted	0.5486	0.5516	-1,05

Notes: *Significance test: *** p<0.01, ** p<0.05, * p<0.1

4. ESTIMATION RESULTS

In this section**,** we present the regressions results. We begin by examining the impact of servitisation on export entry decisions. The results from probit model (6) are shown in Table 4. Columns (1) and (2) display the results when the predicted probability of a firm's being servitised is calculated using an IV approach. The second column differs from the first in that it includes an interaction between servitisation and size variables in order to capture possible heterogeneous effects for small firms. Columns (3) and (4) replicate the estimates using a time and firm-fixed effects probit as a robustness test. The remaining columns (from 5 to 10) report results using the three chosen matching estimation methods.

Irrespective of the econometric approach used, we find that the estimated coefficient for the servitisation variable is positive and mostly statistically significant. Thus, servitised firms are more likely to start to export than pure manufacturing firms are. Our results suggest that being a servitised firm is associated with an increase in the likelihood of starting to export of between 10.0 and 24.3 per cent. With respect to the other firm characteristics, most estimates suggest that importing firms are more likely to enter into exporting whereas small firms and firms without previous export experience are less likely to. Moreover, the longer the prior period without exporting, the lower the probability of starting to export will be.

In order to investigate how the probability of entering the export market is affected by firm size, we estimate equation (6) adding an interaction term between the servitisation and small firms dummies. The results are presented in columns (2), (4), (6), (8) and (10). Only in two of them (in 4 when we use a correction for individual and time fixed effects and in 10 when the inverse probability weighted matching method is used to obtain a firm's servitisation probability), the coefficient for the interaction term is statistically significant. This means that the effect of servitisation on the probability of starting to export is significantly different for medium-large and small firms. Its positive sign would indicate the positive effect is stronger for small firms. This result seems not to be strongly robust according to the lack of significance in several estimates.

Table 4. Servitisation effect on starting exports (random effects probit model).

	IV approach				Matching approach					
	(1)	(2)	Correction for individual and time fixed effects		One-neighbour matching		PS matching: NN5		IPWRA matching	
			(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$Probservit^{*}_{it}$	0.243***	0.267***	0.100***	0.002	0.124***	0.133**	0.062	0.013	0.203***	0.113*
	(0.044)	(0.049)	(0.548)	(0.756)	(0.044)	(0.053)	(0.041)	(0.056)	(0.053)	(0.068)
$Probservit^{*}_{it}\#Size_{cat.it}$		-0.051		0.098***		-0.020		0.099		0.204**
		(0.046)		(0.849)		(0.057)		(0.070)		(0.085)
$Import_{it}$	0.043***	0.043***	0.080**	0.094**	0.053***	0.053***	0.048***	0.048***	0.049***	0.048***
	(0.008)	(0.008)	(0.120)	(0.120)	(0.011)	(0.011)	(0.010)	(0.010)	(0.009)	(0.009)
$Inn_{prod_{it}}$	0.012	0.012	0.025	0.030	0.020	0.020	0.022*	0.023*	0.011	0.011
	(0.010)	(0.010)	(0.133)	(0.134)	(0.013)	(0.013)	(0.012)	(0.012)	(0.012)	(0.012)
$Inn_{proc_{it}}$	0.012	0.012	0.005	0.010	0.014	0.014	0.016	0.016*	0.017*	0.018*
	(0.008)	(0.008)	(0.099)	(0.099)	(0.010)	(0.010)	(0.010)	(0.010)	(0.009)	(0.009)
$Skill1_{it}$	0.032	0.032	0.106***	0.065***	0.041	0.041	0.029	0.029	0.033	0.035
	(0.022)	(0.022)	(0.376)	(0.376)	(0.030)	(0.030)	(0.029)	(0.028)	(0.027)	(0.027)
$Foreign_{sh_{it}}$	-0.008	-0.013	0.036*	0.025**	-0.005	-0.006	0.008	0.014	-0.020	-0.007
	(0.016)	(0.017)	(0.359)	(0.357)	(0.021)	(0.022)	(0.020)	(0.020)	(0.021)	(0.022)
$Product_{it}$	0.013**	0.012**	-0.007	-0.005	0.001	0.001	-0.003	-0.003	0.001	0.001
	(0.006)	(0.006)	(0.092)	(0.092)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
$Size_{cat.it}$ [1]	-0.016	0.006	0.07	-0.287**	-0.027**	-0.018	-0.031***	-0.076**	-0.023**	-0.103***
	(0.010)	(0.023)	(0.211)	(0.429)	(0.012)	(0.028)	(0.011)	(0.035)	(0.011)	(0.035)
$Medium_{no\_exper_{iT}}$ [2]	-0.044***	-0.044***	-0.216***	-0.190***	-0.043***	-0.043***	-0.044***	-0.043***	-0.040***	-0.039***
	(0.012)	(0.013)	(0.115)	(0.116)	(0.011)	(0.011)	(0.011)	(0.011)	(0.010)	(0.010)
$Long_{no\_exper_{iT}}$ [2]	-0.056***	-0.056***	0.309***	0.566***	-0.075***	-0.075***	-0.073***	-0.074***	-0.067***	-0.065***
	(0.017)	(0.017)	(0.298)	(0.300)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Age_{it}	0.000	0.000	-0.002***	-0.001**	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.015)	(0.015)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Baseline	-0.374***	-0.384***	--	--	-0.254***	-0.258***	-0.215***	-0.192***	-0.261***	-0.223***
	(0.043)	(0.044)	--	--	(0.051)	(0.052)	(0.045)	(0.047)	(0.044)	(0.047)
Year control	Yes	Yes	--	--	Yes	Yes	Yes	Yes	Yes	Yes
Sector control[3]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,071	7,071	2,498	2,498	6,795	6,795	6,794	6,794	6,795	6,795
Firms	1,432	1,432	394	394	1,422	1,422	1,422	1,422	1,422	1,422

Notes: Average marginal effects. Standard errors in parentheses. References: [1]Large and medium firms. [2] $Short_{no\_exper_{iT}}$. [3] Clustered at the 2-digit NACE industry-level. *** p<0.01, ** p<0.05, * p<0.1.

Next, we turn to the analysis of the impact of servitisation on exiting from exporting. The results of estimating model (7) are shown in Table 5. Again, columns (1) to (4) list the estimation results using an IV procedure to obtain a firm's servitisation probability, the last two including a correction for individual and time fixed effects. Columns (5) to (10) offer results using matching estimation methods.

All estimates find a negative, significant causal impact of servitisation on the probability of exiting from export markets. The magnitude of the effect of servitisation on export exit is quite similar in the different estimates; the likelihood of exiting is reduced between 4.5 and 12.9 per cent. This is a more statistically significant impact although, on average, it is smaller in magnitude than the impact on export entry. The likelihood of export exit is also lower for importers, small firms and firms with prior export experience. The longer that experience is, the lower the probability of stopping exporting. Although with less robust results, product innovation and productivity also seem to have a negative effect on ceasing exports.

To examine whether the impact of servitisation on export survival differs between medium-large and small firms, we incorporate an interaction with firm size in equation (7). The results, which are displayed in the even columns (2, 4, 6, 8 and 10), suggest that the role of servitisation in the interruption of exporting activity is even stronger for small firms.

To conclude, our paper provides empirical evidence on the existence of a significant connection between servitisation and export performance. In particular, servitisation enhances exporting especially for small firms by increasing their export entry probability and reducing their probability of exiting from exporting.

Table 5. Servitisation effect on exit from exporting (random effects probit model).

	IV approach				Matching approach					
	(1)	(2)	Correction for individual and time fixed effects		One-neighbour matching		PS matching: NN5		IPWRA matching	
			(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$Probservit^{*}_{it}$	-0.129***	-0.113***	-0.049***	-0.038***	-0.082***	-0.076***	-0.045***	-0.039***	-0.120***	-0.101***
	(0.019)	(0.020)	(0.541)	(0.666)	(0.014)	(0.016)	(0.012)	(0.015)	(0.016)	(0.019)
$Probservit^{*}_{it}\#Size_{cat.it}$		-0.034**		-0.017**		-0.014		-0.014		-0.043*
		(0.014)		(0.784)		(0.017)		(0.020)		(0.026)
$Import_{it}$	-0.012***	-0.011***	0.005	0.010	-0.010***	-0.010***	-0.010***	-0.010***	-0.009***	-0.009***
	(0.003)	(0.003)	(0.138)	(0.138)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
$Inn_{prod_{it}}$	-0.001	-0.001	-0.008	-0.011	-0.007**	-0.007**	-0.008**	-0.008**	-0.003	-0.003
	(0.002)	(0.002)	(0.126)	(0.126)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
$Inn_{proc_{it}}$	-0.003	-0.003	-0.013***	-0.020***	0.001	0.001	-0.001	-0.001	-0.000	-0.001
	(0.002)	(0.002)	(0.102)	(0.101)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
$Skill1_{it}$	-0.002	-0.002	-0.006*	-0.006*	-0.013	-0.013	-0.016*	-0.016*	-0.007	-0.007
	(0.007)	(0.007)	(0.377)	(0.379)	(0.009)	(0.009)	(0.009)	(0.009)	(0.008)	(0.008)
$Foreign_{sh_{it}}$	0.007*	0.005	0.000	-0.000	-0.002	-0.003	-0.005	-0.005	0.010**	0.008
	(0.004)	(0.004)	(0.264)	(0.265)	(0.005)	(0.005)	(0.004)	(0.004)	(0.005)	(0.005)
$Product_{it}$	-0.005***	-0.005***	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.002	-0.002
	(0.002)	(0.002)	(0.089)	(0.089)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$Size_{cat.it}$ [1]	0.013***	0.031***	-0.002	0.148**	0.016***	0.023**	0.021***	0.028**	0.014***	0.036***
	(0.003)	(0.008)	(0.214)	(0.482)	(0.003)	(0.009)	(0.003)	(0.011)	(0.003)	(0.013)
$Medium_{exper_{iT}}$ [2]	-0.023***	-0.023***	-0.028***	-0.042***	-0.034***	-0.034***	-0.036***	-0.036***	-0.031***	-0.031***
	(0.004)	(0.004)	(0.129)	(0.129)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
$Long_{exper_{iT}}$ [2]	-0.025***	-0.025***	0.571***	0.682***	-0.042***	-0.042***	-0.042***	-0.042***	-0.038***	-0.038***
	(0.004)	(0.004)	(0.231)	(0.231)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)
Age_{it}	-0.000**	-0.000**	0.003	0.003	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(3.878)	(3.815)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Baseline	0.032**	0.022	--	--	-0.022	-0.026*	-0.053***	-0.056***	-0.013	-0.022
	(0.015)	(0.016)	--	--	(0.015)	(0.015)	(0.013)	(0.013)	(0.014)	(0.015)
Year control	Yes	Yes	--	--	Yes	Yes	Yes	Yes	Yes	Yes
Sector control[3]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	20,640	20,640	2,464	2,464	20,483	20,483	20,483	20,483	20,468	20,468
Firms	2,590	2,590	331	331	2,587	2,587	2,587	2,587	2,587	2,587

Notes: Average marginal effects. Standard errors in parentheses. References: [1]Large and medium firms. [2] $Short_{exper_{iT}}$. [3] Clustered at the 2-digit NACE industry-level. *** p<0.01, ** p<0.05, * p<0.1.

5. CONCLUDING REMARKS

Although there is ample literature on the increasing role of services in manufacturing activities, the relationship of this role to export performance at the firm level is a topic that has hardly been investigated. Most of these studies have focused on the services content of manufacturing, while servitisation consisting of manufacturing firms that are also service providers has been even less explored.

In this paper, we contribute to the literature by studying the effect of servitisation, understood as the sale of services by manufacturing firms, on firm export dynamics using a rich dataset of Spanish manufacturing firms from 1991 to 2014. Specifically, we analyse the interplay between being a servitised manufacturing firm and the probability of both export entry and exiting from exporting. This study adds further knowledge about the factors that may facilitate entry and retention in export markets. Prior literature on export behaviour highlights the difficulties of accessing foreign markets and, once the firm starts to export, the difficulties of surviving, so many of these firms do not last long as exporters. Hence, increasing the probability of becoming a regular exporting firm is an important issue for improving competitiveness.

Based on information from the descriptive analysis, manufacturing firms are actively involved in the strategy of servitisation according to the high share of servitised firms (around half of all firms), a share that is 12 percentage points higher for medium and large firms than for small firms. We also observed that servitised firms are more export-oriented than pure manufacturing firms, a feature that is more noticeable in small firms.

The results of the empirical analysis point to a robust association between servitisation and export dynamics, which holds after controlling for several observed and unobserved firm characteristics and reverse causality by using a two-way methodological approach (an IV model with firm fixed effects and matching and propensity score matching techniques). In particular, we find that the probability of export entry and export survival is systematically larger for manufacturing firms that sell both goods and services. These results suggest that servitisation may upgrade the ability of manufacturing firms to attract foreign clients and maintain them by further differentiation of their products through the offering of services that meet customers' needs. Moreover, since they are often highly customised services, consumers' loyalty increases and so does the ability of servitised firms to resist replacement by competitors. Both factors, which are crucial for operating in foreign markets, contribute to preserving their status as exporting firms.

Additionally, our estimates show that, although export entry and export survival probabilities are lower for small firms, the impact of servitisation on both entry and survival is stronger for those small firms. That is, manufacturing firms that also sell services are more likely to start to export and continue exporting than pure manufacturers, mainly when the firms are small, which suggests an enhancing effect of servitisation on export performance, particularly for smaller firms.

Our research provides important implications for managers and policymakers. As for the managers, servitisation seems to play an essential role for export entry and export survival mainly for small and medium firms, which face more difficulties accessing and staying in export markets, according to empirical evidence. Hence, smaller manufacturing firms in particular should increase efforts to integrate services in their offer. From a policy-making perspective, actions specifically designed to help small manufacturing firms engage and stay in exporting should consider measures which facilitate and encourage servitisation processes. Our recommendation would be to add those measures to policy measures aimed at broadening a country's base of exporting companies and ensuring their consolidation as regular exporters.

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Statistical appendix

Table A1. Variables definitions

Variable	Definition	Obs.	Mean	Std. Dev.
Variables used in equation (5)				
$Servit._{it}$	Dichotomous variable indicating whether or not the firm does servitisation. 1=Yes, 0=No	15,453	0.427	0.495
$Export_{it}$	Dichotomous variable indicating whether or not the firm does export. 1=Yes, 0=No	47,420	0.622	0.485
$Capacity_{it}$	Average use of the firm' standard production capacity.	46,453	0.793	0.167
$Skill2_{it}$	Percentage of graduated, engineers and qualified assistants over total employment (in logarithms)	34,676	2.328	0.876
$ForeignK_{it}$	Dichotomous variable indicating if the firm is participated by foreign capital. 1=Yes, 0=No	47,375	0.192	0.394
$Size_{it}$	Total employment of the firm (in logarithms)	47,428	4.196	1.514
$(K/L)_{it}$	Value of the capital stock, at constant 1990 prices, divided by total employment (in logarithms)	46,180	10.972	1.366
Variables used in equations (6) and (7)				
$\Phi_{startX_{it}}$	Dichotomous variable indicating if the firm does not export in *t-1* and exports in *t*. 1=Yes, 0=No	17,913	0.071	0.257
$\Phi_{exitX_{it}}$	Dichotomous variable indicating if the firm exports in *t* but does not export in *t+1*. 1=Yes, 0=No	29,507	0.033	0.178
$Probservit^*_{it}$	$Probservit^*_{IV_{it}}$ Estimated probability of servitisation in IV model	29,387	0.576	0.193
	$Probservit^*_{1NM._{it}}$ Estimated probability of servitisation with one-neighbor matching method.	28,471	0.543	0.195
	$Probservit^*_{NN5_{it}}$ Estimated probability of servitisation with NN5 propensity score matching method.	28,469	0.541	0.128
	$Probservit^*_{IPW._{it}}$ Estimated probability of servitisation with 'inverse probability weighted' matching method.	31,913	0.538	0.156
$Import_{it}$	Dichotomous variable indicating whether or not the firm imports. 1=Yes, 0=No	47,417	0.619	0.486
$Skill1_{it}$	Percentage of employees over total employment	47,230	0.304	0.191
$Foreign_{sh_{it}}$	Share of foreign capital over total social capital	47,375	0.165	0.357
$Product_{it}$	Labor productivity: Added value over total employment (in logarithms)	40,857	3.526	0.715
$Size_{cat._{it}}$	Dichotomous variable indicating the firm size: 1=Small firm (10-49 workers); 0=Medium or large firm (more than 50 workers).	47,428	0.505	0.500
$Long_{no\_exper_{iT}}$	Dichotomous variable indicating if the firm registers more than 12 consecutive years without exports. 1=Yes; 0=No	17,913	0.103	0.304
$Medium_{no\_exper_{iT}}$	Dichotomous variable indicating if the firm does not register exports during 6-12 consecutive years. 1=Yes; 0=No	17,913	0.264	0.441
$Short_{no\_exper_{iT}}$	Dichotomous variable indicating if the firm does not register exports for 5 years or fewer consecutive years. 1=Yes; 0=No	17,913	0.634	0.482
$Long_{exper_{iT}}$	Dichotomous variable indicating if the firm registers exports during more than 12 consecutive years. 1=Yes; 0=No	29,507	0.170	0.376
$Medium_{exper_{iT}}$	Dichotomous variable indicating if the firm registers exports during 6-12 consecutive years. 1=Yes; 0=No	29,507	0.308	0.462
$Short_{exper_{iT}}$	Dichotomous variable indicating if the firm registers exports for 5 years or fewer consecutive years. 1=Yes; 0=No	29,507	0.522	0.500
Age_{it}	Variable indicating the firm age	47,157	26.838	21.733
Variables used in equations (5), (6) and (7)				
$Inn_{prod_{it}}$	Dichotomous variable indicating whether or not the firm registers product innovation. 1=Yes, 0=No.	47.411	0.225	0.418
$Inn_{proc_{it}}$	Dichotomous variable indicating whether or not the firm registers process innovation. 1=Yes, 0=No.	47,412	0.327	0.469
$Sector_j$	Categorical variable identifying the manufacturing sector for each firm: 1 Meat products; 2 Food and tobacco; 3 Beverage; 4 Textiles and clothing; 5 Leather, and footwear; 6 Timber; 7 Paper; 8 Printing; 9 Chemicals and pharmaceuticals; 10 Plastic and rubber products; 11 Non-metal mineral products; 12 Basic metal products; 13 Fabricated metal products; 14 Machinery and equipment; 15 Computer products, electronics and optical; 16 Electric materials and accessories; 17 Vehicles and accessories; 18 Other transport equipment; 19 Furniture; 20 Other manufacturing.			
$Year_t$	Categorical variable identifying the current year. Values 1991-2014.			

Source: Survey of Business Strategies.

Table A2. Estimated servitisation probability: Random-effects probit to estimate *Probservit* from equation (5). Average marginal effects.

	(1)
$Export_{it-1}$	0.152***
	(0.026)
$Capacity_{i,t-1}$	-0.150***
	(0.058)
$Skill2_{i,t-1}$	0.029**
	(0.012)
$Inn_{prod}{}_{i,t-1}$	0.066***
	(0.021)
$Inn_{proc}{}_{i,t-1}$	-0.012
	(0.019)
$Foreign1_{sh}{}_{i,t-1}$	0.143***
	(0.027)
$(K/L)_{i,t-1}$;	-0.032***
	(0.011)
$Size_{i,t-1}$ (logs)	0.037***
	(0.010)
Industry dummies	Yes
Year dummies	Yes
Observations	6,683
Number of firms	2,790

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1