ABSTRACT

This paper contributes to the literature on firm internationalization by exploring how the decision of manufacturing firms to bundle product and services, *servitization* or *advanced services*, affect their competitiveness in international markets. Using a unique sample of German SMEs, we show that servitization is a relatively rare activity which is strongly associated to firm-level export intensity. We account for endogeneity by exploiting the panel structure of the data and by implementing several doubly-robust propensity score matching (DR-PSM) techniques to address reverse causality concerns. Interestingly, the effect of servitization on exporting is larger for firms that sell all their products in combination with services in relation to firms that bundle services only with some of products sold.

KEYWORDS: Servitization, innovation, export, SMEs.

JEL Classification Codes: D22, F10, F14, F23, L80.

INTRODUCTION

The third industrial revolution is based on the growing use of information and communication technologies (ICT) that produce a transformation in businesses and society, and ultimately underpins the way manufacturing firms compete in local and global markets (Alcacer, Cantwell and Piscitello, 2016; Dosi, Galambos, Gambardella and Orsenigo). Through IT, product firms are able to adopt, design and deliver smart and connected products that transform their differentiation (Porter and Heppelman, 2014), internationalization (Brouthers, Dung, Geisser and Rothlauf, 2016) and global production (Laplume, Petersen and Pearce, 2016) strategies.

The broad debate on the industrial revolution has various ramifications, being one of the most significant the implementation of services in manufacturing firms, or *servitization*. This growing field of research was initiated with the seminal works of Vandermerwe and Rada (1988) and Wise and Baumgartner (1999) and consolidated more recently with the contributions of Cusumano, Kahl and Suarez (2015), Crozet and Millet (2017) or Visnjic Kastalli and Van Looy (2013). By borrowing from current trends in international business, international trade and operations management, this study aims to evaluate the relationship between servitization and internationalization through exports, a relevant issue but yet underexplored (Bustinza, Vendrell-Herrero and Baines, 2017a).

Manufacturing firms increasingly deploy new business-to-business approaches that create value to their corporate clients by leveraging on technological improvements and outcome base mechanisms (Kowalkowski, Gebauer and Oliva, 2017). This enhanced offer is based on integrated solutions (also referred to advanced services), in which bundles of products and services are sold together (Baines and Lightfoot, 2013; Tukker, 2004; Zeithaml, Brown, Bitner, and Salas, 2014). Integrated solutions
require a long-term relationship between the manufacturer and the corporate client (Visnjic, Jovanovic, Neely and Engwall, 2016a).

Consistent with the product life cycle (Cassiman and Golovko, 2011; Vernon, 1979) and self-selection theories (Mayer, Melitz and Ottaviano, 2014; Melitz, 2003), recent research has shown that whilst the percentage of firms selling products and services in international markets (bi-exporters) is relatively small (8%), their presence in international markets is notorious as they account for more than 30% of total exports (Ariu, 2016).

The strategy of adding services to product offerings in manufacturing firms is known as servitization (Vandermerwe and Rada, 1988; Wise and Baumgartner, 1999) or product-service innovation (Bustinza, Gomes, Vendrell-Herrero and Baines, 2017b). The core issue analysed in servitization research is the process of value creation underlying service implementation in product firms (Baines, Lightfoot, 2013; Brax and Visintin, 2017; Rabetino, Kohtamäki and Gebauer, 2016). To this extent servitization can be considered as a mode of innovation.¹ As such, it may increase firm productivity and home-country market share, which makes the firm better prepared to compete in international markets. In particular, integrated solutions improve customer understanding through the addition of advanced services that will ultimately set entry barriers (Nalebuff, 2004; Zhou, 2017), locking in customers and boosting exports (Vandermerwe and Rada, 1988). We test the proposed relationships between servitization and exporting using a unique dataset including information on more than 4,000 German manufacturing small and medium enterprises (SMEs) for the years 2010 and 2013. Our findings show that after controlling for productivity and product innovation there is a causal association between integrated solutions and exporting intensity.

Our study contributes to the literature in three ways. First, we uncover the link between servitization and firm internationalization. By doing this our study adds to the understanding of export antecedents and the role of service business model innovation in boosting international competitiveness. Previous research has highlighted how various forms of product innovation (Altomonte, Aquilante, Bekes and Ottaviano, 2013; Cassiman and Golovko, 2011) or outsourcing strategies (Bertrand, 2011) are linked to internationalization through exporting, but no research to date has looked at the specific relationship between servitization and exports.

¹ The use of sensors, the exponential rise of data availability, and the increased capacities to store and analyse information have allowed product firms to better visualize their own value chain from production to maintenance, and can achieve a better comprehension of their suppliers’, customers’ and competitors’ underlying strategies and needs (Alcacer, Cantwell and Piscitello, 2016; Dosi, Galambos, Gambardella and Orsenigo, 2014). Manufacturers worldwide are leveraging their business strategies on this enhanced information that allow a better engagement with clients and suppliers through the implementation of services in addition to product offerings (Cusumano, Kahl, and Suarez, 2015). The main innovation in the servitization process relies on bundling products and services to stimulate long-term relationships with industrial clients (Kowalkowski, Gebauer and Oliva, 2017). This process of bundling is recognized in the literature (almost interchangeably) as advanced services (Baines and Lightfoot, 2013) or integrated solutions (Tukker, 2004; Zeithaml, Brown, Bitner, and Salas, 2014). Integrated solutions can either take the form of sensors and network that enhance product usage (Bigdeli et al., 2017) or outcome-based contracts in which firm sells the use rather than the ownership of the product (Visnjic et al., 2016a).
Second, we connect two bodies of literature (international business/trade and operations management) without much overlap but dealing with similar questions such as firm innovation and its effects on global markets. From the studies in international business we build on the product life cycle (Vernon, 1979; Cassiman and Golovko, 2011) and self-selection (Mayer, Melitz and Ottaviano, 2014; Melitz, 2003) theories to provide a robust theoretical underpinning in the relationship between servitization and exports. From the studies on operations management we draw on the product upgrading based on adding advanced services in product firms (Baines and Lightfoot, 2013; Cusumano, Suarez and Kahl, 2015; Tukker, 2004; Zeithaml et al., 2014; Visnjic, Jovanovic, Neely and Engwall, 2016a).

Third, the focus on SMEs rather than large multinational enterprises (MNEs) is another important contribution of this study. From an international business standpoint exporting is a priority entry mode to foreign markets for SMEs, as in comparison with foreign direct investment it involves low levels of commitment, resources, risk and complexity (Leonidou and Katsikeas, 1996; Sui and Baum, 2014). Exporting per se is much less relevant for MNEs. Second, the evidence in servitization comes mostly from large corporations and therefore we uncover a research gap by looking at smaller firms (Lafuente, Vaillant and Vendrell-Herrero, 2016).

The paper proceeds as follows. In the next section the paper develops the theoretical underpinning on the relationship between innovation, productivity and exporting, as well as develops the empirical hypothesis. The third section describes the data and the empirical model. Fourth section presents the results and various empirical exercises to show results robustness. Following this, paper closes with discussion and conclusions.

**Servitization and exporting**

As mentioned before, servitization can be considered as a form of innovation that firms use to differentiate their products and increase foreign sale, at home and abroad. Innovation drives and is driven by productivity; both drive exports. Building on Melitz (2003), a large strand of the international trade literature shows that these relationships are driven by a self-selection mechanism (see for example Altomonte et al., 2013; Becker and Egger, 2013; Wagner, 2007) whereby the ability of firms to enter and compete in international markets depends on their level of productivity: only the most productive firms will enter the export market. The key idea is that whilst some strategic decisions (i.e. entering industry or undertaking innovation projects) are the result of endogenous choices of firms, firms base their decision on exporting on how their productivity level compare with international competitors (Costantini and Melitz, 2008).

Another body of literature builds on the so called learning-by-exporting hypothesis: exporters increase their productivity because they learn from the exposure to international trade (see, e.g., Van Biesebroeck, 2005; Solomon and Shaver, 2005; De Loecker, 2007). Whilst some empirical evidence seems to go in favour of this relationship (i.e. Bratti and Felice, 2012; Vendrell-Herrero, Gomes, Melahi and Child, 2017), the learning-by-exporting hypothesis does not shed light on why firms decide to export in the first instance.

Both the self-selection and the learning-by-exporting literatures implicitly assign a role to innovation. In the first case, firms may deploy innovation to boost productivity and increase international competitiveness. In the second, they can increase their know-how and innovation outcomes might rise as a result of selling abroad.
The product life cycle developed in the international business literature (Vernon, 1979) sits somewhere in between the two hypotheses outlined above: innovative firms boost their domestic competitiveness through innovation, which in turn increases the capacity to sell in foreign markets, whereas non-innovators need to raise productivity before exporting. The empirical work of Cassiman and Golovko (2011) exemplifies this rationale. Using a sample of approximately 1,000 Spanish firms over the period 1990-1998, Cassiman and Golovko concluded that the self-selection into exporting only apply to non-innovators. This result suggests that innovative need a lower level of productivity to start exporting relative to non-innovative ones: the exported product itself differentiates the firm from the competitors in international markets.2

Whilst there is a huge debate in the literature on the link between innovation, productivity and exporting, not much attention has been devoted to the effect of specific modes of product and process innovation on firms’ internationalization. The main contribution of this paper is to look at the link between servitization and exporting.

Firms are selling the use of their products (leasing) rather than selling their products in transactional operations. For instance, Rolls Royce is selling the hourly use of their engines rather than selling the engines themselves. Another example is the train manufacturer Alstom which has introduced ‘train life services’, offering maintenance and parts supply services to transport companies. One of the reasons for service implementation detected in the literature is to better engage with customers (Vandermerwe and Rada, 1988; Wise and Baumgartner, 1999), and ultimately recover competitiveness in Western manufacturing industries (Crozet and Millet, 2017). By relying on more business-to-business relational governance structures, trust and knowledge exchange enable firms to be more competitive in international markets (Styles, Patterson and Ahmed, 2008; Wu, Sinkovics, Cavusgil and Roath, 2007; Zhang, Cavusgil and Roath, 2003).

Recent research has shown that servitization can have positive effects on operative margin (Crozet and Millet, 2017; Suarez et al., 2013; Visnjic Kastalli and Van Looy, 2013), employment (Crozet and Millet, 2017), sales growth (Kohtamäki, Partanen, Parida and Wincent, 2013; Sousa and da Silveira, 2017) and key performance indicators (Bustinza et al., 2017b), whereas servitization also has underlying commercial and operational risks (Hou and Neely, 2017) that condition product’s firms decisions of implementing services (Bigdeli, Bustinza, Vendrell-Herrero, Baines, 2017) and rises the probability of default for those firms embarking in the servitization journey (Benedettini, Neely and Swink, 2015).

To date, no research has tested the main hypothesis investigated in this paper, i.e. the effect of implementing integrated solutions on exporting exports. Closely related to our work is Ariu (2016) who finds that Belgian firms that export both products and services are very rare (less than 10% of total exporters) but account for more than 30% of total exports. More recently, Ariu, Mayneris and Parenti (2016) use the same data to show that (foreign) demand complementarities might lead firms to combine product and services when they sell abroad. Although related to our paper, these studies do not focus on integrated solutions, which is the focus of our paper.

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2 This hypothesis is also related to the growing importance of the ‘born global’ phenomenon (Knight and Cavusgil, 2004): new firms that are unaware of their productivity type can export as they bring differentiated goods to the international markets. Another research strategy to analyse the role of product innovation in exporting firms is to understand the internationalization practices of multi-product firms. Mayer, Melitz and Ottaviano (2014) show that when international competition gets tougher, a multi-product firm will skew its export sales towards its best performing product, normally the one that differentiates better from the competitors (innovation advantage) or the one that has a cost advantage (productivity advantage).
More specifically in this paper we seek to empirically test the export effect of bundling products and services in business to business contexts. Our central hypothesis is that by adding services into the product offering the manufacturer builds onto relational governance structures with corporate clients, setting entry barriers and to locking in customers (Nalebuff, 2004; Zhou, 2017), and ultimately enhancing export performance (Styles, Patterson and Ahmed, 2008; Wu, Sinkovics, Cavusgil and Roath, 2007; Zhang, Cavusgil and Roath, 2003).

DATA AND METHODS

The context: German manufacturing SMEs

Our analysis is based on survey data on German manufacturing SMEs, provided by the Cologne Institute for Economic Research (CIER). These firms are essentially leading the journey to the third industrial revolution and provide thus a particularly relevant context for analysing service innovation (Czarnitzki and Spielkamp, 2003; Muller and Zenker, 2001) and exporting (Marin, Schymik and Tschkeke, 2015). In fact, Germany’s service jobs in the manufacturing industry grew by 30% since 1975 (Boddin and Henze, 2014). Jobs directly linked to the implementation of digital and service business models in the manufacturing sector are expected to generate economic growth of around 75 billion of Euros until 2025 (van Ackern, & Schröder, 2016), and recent trends of Chinese firms acquiring Germany manufacturing SMEs in order to embark on the servitization ladder (Xing, Liu, Tarba and Cooper, 2016).

The sample

To conduct our analysis, we use a unique survey of manufacturing firms conducted by the Cologne Institute for Economic Research. The survey was implemented in two waves (2011 and 2014) and contains a repeated cross-section of 4,287 product firms (all the firms in the sample contain a positive value for product sales). The 2011 wave contains information on 2,787 firms whereas the 2014 one includes 1,500. There were 428 firms that appeared in both waves giving the possibility to conduct longitudinal analysis for a subsample of firms (we will call this set the panel). The sample contains a representative selection of German manufacturing SMEs. The survey was validated by a panel of industry experts prior to administration. Special care was taken to assure that respondents were in key managerial decisions and have a good understanding of innovation practices and firm strategy. The survey was conducted in German to assure respondents were able to provide precise answers.

Key variables

Export intensity: Export intensity is calculated as the ratio between exports (sales foreign markets over turnover. On average exporting firms in our sample sells abroad 30% of their total turnover.

Integrated solutions intensity (IS): This variable measures the degree of product-service innovation of the firm. It is measured with the ratio between revenues obtained from integrated solutions over total turnover. This way of measuring servitization is consistent with Suarez et al. (2013). One fifth of firms surveyed offer ISs. Among those firms, integrated solutions account roughly of 40% of their total revenue.
Labour productivity (LP): This control variable is measured through turnover over employees. This measure has been used previously in international business studies (Luo and Bu, 2016). This variable is entered into the model in logarithms and lagged one year. The average is of 4.94. In our sample, 46% of firms are exporters. On average they sell abroad 30% of their total turnover.

**Empirical approach**

To look at the relation between export and servitization intensities, we start by estimating linear models of the following form:

$$\text{Export}_{it} = g(IS_{it}, X_{it}, \omega_i, \vartheta_k, \varphi_s, \delta_t) + \varepsilon_{it}$$ (1)

Where the subscript $i$ identifies firms, while the subscript $t$ indicates the time period. $IS_{it}$, the regressor of interest measures the firm-level servitization intensity. Since servitization is a form of innovation, based on previous literature, we expect the coefficient on $IS_{it}$ to be positive and significant. $X_{it}$ is a set of time-varying firm level controls (LP and/or PI depending on the versions of the model estimated). In fact, higher-productivity firms have been found to export and servitize more. At the same time, firms doing product innovation might be more likely to export and implement ISs. So, including LP and PI in the regressions allow us to control for two important firm-level characteristics that could be correlated both with exporting and servitization. Importantly, $\omega_i$ refers to firm fixed-effects. As mentioned in the previous section, a subset of the surveyed firms (428) appear in both the years of our sample. For them we create a panel that allows us to test our main hypothesis after controlling for any unobserved firm-level time-invariant characteristics (firm fixed-effects) that could be correlated both with servitization and exporting. Finally, $\vartheta_k$, $\varphi_s$ and $\delta_t$ indicate sector, size and time fixed-effects and $\varepsilon_{it}$ is the error term.

**Endogeneity concerns**

The relation between exporting and servitization could be affected by the presence of omitted variables and reverse causality. On the one hand, there could be unobserved firm characteristics that, even after controlling for productivity, could cause exporting and servitization. On the other hand, causality could run from exporting to servitization: exporters could servitize to meet foreign demand.

We attempt to control for possible estimation biases in the export decision in two ways. First, we exploit the panel structure of our data and control for time-invariant unobserved firm heterogeneity (firm fixed-effects, $\omega_i$). Second, both to address the reverse causality issue, and as a robustness check on the regression analysis, we implement several doubly-robust propensity score matching (DR-PSM) procedures (Busso, Di Nardo and McCrary, 2014; Deheija and Wahba, 2002; Lechner, 2002; Uysal, 2015). To do that we need to look at the difference between $\gamma^1_{ist}$ and $\gamma^0_{ist}$, where $\gamma_{ist}$ is the outcome (exporting) for firm $i$ in sector $s$ at time $t$ and the superscripts denote the servitization behaviour. The key problem is related to the fact that $\gamma^0_{ist}$ is not observable: we do not know what would have happened to the exports of servitized firms had they not servitized. This boils down to building a counterfactual starting from the definition of the average effect of servitization on exporting:

$$E(\gamma^1_{ist} - \gamma^0_{ist}) = E(\gamma^1_{ist}) - E(\gamma^0_{ist})$$ (2)

The probability model of servitizing (the propensity score) can then be estimated as follows:

$$\text{Pr}(\gamma^0_{ist} = 1) = \Phi(h(IS_{it}, X_{it}, \omega_i, \vartheta_k, \varphi_s, \delta_t))$$ (3)
Once the counterfactual has been recovered, we use it to calculate the average treatment effect of servitization on exporting. However, both regression and PSM methods rely on the (unverifiable) assumption that the model is correctly specified. Implement a DR-PSM estimator gives us an additional possibility to satisfy this assumption: if one of the two models (regression or PS) are correctly specified and there are no omitted confounders, the effect of servitization on exporting will be correctly estimated. In this case, the estimator of the causal effect for firm $i$ becomes:

$$\zeta_{DR} = E(Y_{ist,DR}^1) - E(Y_{ist,DR}^0) =$$

$$n^{-1} \sum_{i=1}^{n} \left[ \frac{s_i Y_{ist}^1}{\lambda(X_{it}, \theta_k, \varphi_z, \delta_t \beta)} - \frac{[s_i - \lambda(X_{it}, \theta_k, \varphi_z, \delta_t \beta)]}{\lambda(X_{it}, \theta_k, \varphi_z, \delta_t \beta)} \chi_1(X_{it}, \theta_k, \varphi_z, \delta_t; \hat{\alpha}_1) \right] -$$

$$n^{-1} \sum_{i=1}^{n} \left[ \frac{(1-s_i) Y_{ist}^1}{1-\lambda(X_{it}, \theta_k, \varphi_z, \delta_t \beta)} - \frac{[s_i - \lambda(X_{it}, \theta_k, \varphi_z, \delta_t \beta)]}{1-\lambda(X_{it}, \theta_k, \varphi_z, \delta_t \beta)} \chi_0(X_{it}, \theta_k, \varphi_z, \delta_t; \hat{\alpha}_0) \right]$$

(4)

**FACTS**

Figure 1: Fact 1 – IS is less frequent than and exporting

![Lorenz curve](image1.png)

Concentration of service innovation and exporting

Figure 2: Fact 2 – Servitized firms are more productive and export more

![Lorenz curve](image2.png)

Lorenz curve

Concentration of service innovation and exporting
RESULTS

Table 1: Descriptive statistics

<table>
<thead>
<tr>
<th></th>
<th>Observations</th>
<th>Mean</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Export</td>
<td>3,821</td>
<td>15.24</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integrated Solutions</td>
<td>4,217</td>
<td>9.46</td>
<td>0.06</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labour productivity</td>
<td>4,039</td>
<td>4.84</td>
<td>0.17</td>
<td>0.05</td>
<td>1.00</td>
<td></td>
</tr>
</tbody>
</table>

In **bold** denotes that the correlation is significant at 1%

Table 2: The effect of servitization on exporting (OLS)

<table>
<thead>
<tr>
<th></th>
<th>Repeated cross-section</th>
<th>Panel</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Export_{it}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS_{it}</td>
<td>0.0510***</td>
<td>0.0508**</td>
</tr>
<tr>
<td></td>
<td>(0.0177)</td>
<td>(0.0200)</td>
</tr>
<tr>
<td>LPI_{it-1}</td>
<td>1.679***</td>
<td>1.746***</td>
</tr>
<tr>
<td></td>
<td>(0.433)</td>
<td>(0.438)</td>
</tr>
</tbody>
</table>

Sector FE Yes Yes Yes Yes No No No No
State FE Yes Yes Yes Yes No No No No
Time dummies Yes Yes Yes Yes No Yes No No
Firm size dummies Yes Yes Yes Yes No No Yes Yes
Sector-time FE No No Yes Yes No No Yes Yes
State-time FE No No Yes Yes No No Yes Yes
Firm size-time dummies No No Yes Yes No No Yes Yes
<table>
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<tr>
<th>Firm FE</th>
<th>No</th>
<th>No</th>
<th>No</th>
<th>No</th>
<th>Yes</th>
<th>Yes</th>
<th>Yes</th>
<th>Yes</th>
</tr>
</thead>
</table>

| Observations | 3749 | 3165 | 3749 | 3165 | 797 | 719 | 797 | 719 |
| $R^2$     | 0.159 | 0.169 | 0.165 | 0.175 | 0.045 | 0.060 | 0.093 | 0.110 |

Dependent variable: Export intensity.
Standard errors in parentheses
Level of statistical significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure 3 – Total servitization vs. partial servitization

Predictive Margins of focus with 95% CIs

Servitize to some products — Servitize to all products
Matching results

Table 4: The effect of servitization on exporting (Doubly-robust propensity score matching)

<table>
<thead>
<tr>
<th></th>
<th>ATE Doubly Robust</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1) (2) (3) (4) (5) (6)</td>
</tr>
<tr>
<td></td>
<td>NN Radius Kernel</td>
</tr>
<tr>
<td>IS</td>
<td><strong>3.531</strong> (t=3.21) <strong>2.403</strong> (t = 3.06) <strong>2.275</strong> (t = 2.98)</td>
</tr>
<tr>
<td>Controls</td>
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<tr>
<td>Firm FE</td>
<td>No No No No No No</td>
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<tr>
<td>Year FE</td>
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<td>State FE</td>
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</tr>
<tr>
<td>Observations</td>
<td>1,061 3,438 3,564</td>
</tr>
</tbody>
</table>

DISCUSSION AND CONCLUSION

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