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Bundling and exporting: Evidence from German SMEs

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ABSTRACT

Drawing on the disciplines of operations management and international business theories, this paper evaluates the effect of bundling products and services on a firm's export intensity. After surveying more than 4,000 German SMEs, we report several findings. First, bundling is a relatively rare activity, which is unevenly spread over sectors. Second, SMEs that bundle products and services are more productive than those selling products and services separately. Third, using regression analysis and matching techniques, we find that product–service bundling is strongly associated with higher levels of export intensity. Lastly, the competitiveness-enhancing effect of bundling goes beyond manufacturing, affecting non-manufacturing firms as well.

1. Introduction

Exporting is by far the most prominent mechanism for firms to engage with international markets. In fact, at present, exporting accounts for more than 29% of the gross domestic product in the OECD countries (World Bank, 2020). Thus, any comprehensive answer to the increasingly important question of what drives firms' international competitiveness must include the factors that affect a firm's ability to compete in export markets. With this in mind, international business scholars and trade economists have been exploring the drivers of export performance for nearly 50 years (Leonidou & Katsikeas, 2010).[1] Within this stream of research, previous studies have highlighted the importance of the link between a firm's innovation and its export performance, but for product and service firms separately (Falk & de Lemos, 2019; Lejpras, 2019). The goal of the present paper is to assess the exporting outcomes of hybrid firms (Ulaga & Reinartz, 2011), that is, firms that sell bundles of products and services in the form of integrated solutions (Davies, 2004). Previous studies have analysed conceptually (Vandermerwe & Rada, 1988) and empirically (Ariu, Mayneris, & Parenti, 2020) the positive relation between selling products and services abroad and a firm's export performance (e.g. bi-exporting). However, to the best of our knowledge, this is the first study to consider how bundling products and services in the same offering affects the export intensity of small and medium-sized enterprises (SMEs).[2]

The path followed by a firm to implement an integrated solution depends on its primary sector. For example, manufacturers normally servitize by offering the use rather than the ownership of their products (e.g. outcomes-based contracts) to their clients (Baines et al., 2017; Crozet & Milet, 2017; Rabetino, Harmsen, Kohtamäki, & Sihvonen, 2018). (Knowledge-based) service firms, in contrast, package their services by adding tangible products to their offerings, including embedded sensors or other forms of hardware–productization (Harkonen, Haapasalo, & Hanninen, 2015; Rajanna, 2013). We argue that selling products and services as a package is positively associated with export intensity, irrespectively of the firm's primary sector. In light of the existing literature, our argument can be rationalized in two ways. First, integrated solutions are described as an innovation outcome (Bustinza, Lafuente, Rabetino, Vaillant, & Vendrell-Herrero, 2019; Vendrell-Herrero, Bustinza, & Opazo-Basaez, 2021) because customization provides an opportunity to differentiate the offering. By enhancing the customer's understanding, product–service bundling ultimately increases firms' competitiveness in foreign markets (Aw, Chen,

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[1] Based on this definition, our study uses 'product–service bundling' (or, for short, 'bundling') and 'integrated solutions' as synonymous and interchangeable.

[2] Ariu (2016), for example, examining whether manufacturing firms have positive sales for services but cannot tell whether both goods and services are sold to the same buyer in a given market.

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& Roberts, 2001; Bughin, 1996; Cassiman & Golovko, 2011). Second, integrated solutions can lock customers in to long-term agreements (Vargo & Lusch, 2008; Wise & Baumgartner, 1999). In line with this argument, more than 90% of the firms in our sample declare that bundling is indeed a way to increase customer loyalty. Consolidating such loyalty is likely to generate stable revenue streams, leading firms to increase their engagement in specific foreign markets (Teece, 2014; Vahlne & Johanson, 2017).

We analyse the relation between product–service bundling and export intensity using a unique dataset that includes information about more than 4000 German SMEs for the years 2011 and 2014. Our focus on Germany is important empirically, as Germany is leading the way to the fourth industrial revolution (Brouthers, Geisser, & Rothlauf, 2016; Gomes, Bustinza, Tarba, Khan, & Ahammad, 2019) and therefore constitutes an ideal setting to explore the implementation of SME's innovation practices (Mukherjee, Gaur, Gaur, & Schmid, 2013). The firms sampled operate in a wide range of industries, enabling us to study industry-level heterogeneities in the implementation of integrated solutions. Interestingly, we find that product–service bundling goes beyond the manufacturing and service industries. In fact, the percentage of firms in transportation, construction, professional services, and retailing (to name a few) that offer integrated solutions is not negligible. Ultimately, the findings in this study show that selling integrated solutions increases export intensity, a result that is robust across several specifications.

Our contribution to the literature is threefold. First, although previous research has assessed the impact on exporting of innovation in products (e.g. Cassiman & Golovko, 2011) and services (e.g. Ganotakis & Love, 2011), no research to date has analysed how product–service bundling affects a firm's export intensity. By uncovering a robust relationship between bundling and exporting, this study responds to recent calls for studies seeking to determine the relationship between servitization and firm internationalization (Bustinza, Vendrell-Herrero, & Baines, 2017; Knight & Liesch, 2016). Second, previous research has analysed servitization and productization separately. The present paper provides a comparison of performance-enhancement effects by industry, showing that the benefits of product–service bundling transcend industry boundaries. In doing this, we respond to calls for studies undertaking cross-industry comparisons within the context of exporting SMEs (Lahiri, Mukherjee, & Peng, 2020). Third, the study's focus on SMEs rather than large multinational enterprises (MNEs) makes another important contribution. From an international business standpoint, SMEs prioritize exporting as a way to enter foreign markets (Laufs & Schwens, 2014). Compared with foreign direct investment, exporting involves low levels of commitment, resources, risk, and complexity (Sui & Baum, 2014). Within the empirical literature on innovation, most studies of integrated solutions analyse large corporations (e.g. Kastalli & Van Looy, 2013; Suarez, Cusumano, & Kahl, 2013). Our paper takes a different approach by looking at smaller firms. This focus is important because SMEs face more difficult challenges than larger corporations when serving foreign markets (Paul, Parthasarathy, & Gupta, 2017).

This paper is organized as follows. The next section reviews the relevant literature and develops a conceptual framework for how integrated solutions and firm internationalization are connected, developing two hypotheses. The third section describes the data and the empirical model. The fourth section explains the empirical approach. The fifth section presents the results and various robustness checks. The paper then closes with a discussion and some conclusions.

2. Background literature

2.1. Product–service bundling

While products and services have conventionally been considered separately, evidence points to synergies between the two. The traditional product–services dichotomy does not fully capture the fact that some firms actually bundle products and services into an integrated solution (referred to as 'product–service bundling' or simply 'bundling' in contexts where no confusion can arise), generating an integrated revenue stream (Davies, 2004). This type of bundling goes beyond the conventional product bundle, which tends to be composed of standardized components (Nalebuff, 2004). Product–service bundling is a customized combination of products and services that are delivered and priced to fulfil a specific customer's needs and can potentially increase a firm's competitiveness (Cusumano, Kahl, & Suarez, 2015).

Integrated solutions share three fundamental characteristics with innovation.[3] Firstly, value creation is a pre-requisite for an innovation to exist, whereas as indicated by Brax and Jonsson (2009, p. 150), bundled products and services "provide more value than the parts alone". Secondly, innovation sets the grounding for firm differentiation, whilst integrated solutions are "unusually tailored to create outcomes desired by specific clients or client types" (Miller, Hope, Eisenstat, Foote, & Galbraith, 2002, p. 3), meaning that they are intrinsically different from the existing offers in the market and hence provide opportunities for enhanced differentiation. Lastly, product and service innovation are basically considered as technological innovations, whereas previous studies have found that product–service bundling is enhanced when it is combined with the use of digital technologies, such as sensors and predictive algorithms (Kohtamäki, Parida, Patel, & Gebauer, 2020). Hence, integrated solutions are associated with a larger degree of technological adoption than selling products and services separately (Davies, 2004; Ulaga & Reinartz, 2011). For all these reasons, the term 'product–service innovation' is increasingly popular in the various research streams that analyse product–service bundling (i.e. Bustinza et al., 2019; Vendrell-Herrero et al., 2021).

Product–service bundling can occur in two different scenarios, depending on the primary industry. Manufacturing firms implement services to boost the capabilities of the product, a phenomenon referred to as servitization (Crozet & Milet, 2017). Alternatively, service firms add tangible components to their offerings, a phenomenon termed productization (Harkonen et al., 2015). Despite sharing several features (e.g. in both cases, firms offer integrated solutions), servitization and productization differ in significant ways.

With servitization, industrial manufacturing firms upgrade their products by offering their customers outcomes-based contracts in order to generate revenues for the product's entire lifecycle (Baines et al., 2017; Rabetino et al., 2018). Outcomes-based contracts consist of selling the use of the products rather than the products themselves in a transactional operation. For instance, Rolls Royce sells the hourly use of its engines rather than the engines themselves; the French train producer Alstom has introduced train life services, offering maintenance and parts supply services to transport companies. This integral solution is particularly important for advanced economies, which are typically characterized by high wages, high skills, and high disposable income, since the offer permits such economies to resume growth in strategic industries and sustain long-term competitiveness (Aquilante, Bustinza Sánchez, Vendrell-Herrero, et al., 2016).[4]

With productization, in contrast, service companies embrace tangible products in order to standardize their offerings and enhance their overall efficiency through increased economies of scale (Harkonen et al., 2015). Productization of services usually focuses on packaging and delivering Information and Communication Technologies (ICT) services in an industrialized form (Spohrer, 2017). Examples of these strategies include embedding sensors in industrial equipment and

[3] See Baregheh, Rowley, and Sambrook (2009) for an extensive literature review on how innovation can be defined.

[4] For example, the most representative studies show that servitization can have positive effects on operating margins (Kastalli & Van Looy, 2013), employment creation (Crozet & Milet, 2017), and sales growth (Kohtamäki, Partanen, Parida, & Wincent, 2013; Sousa & da Silveira, 2017). However, no research to date has analysed whether servitization strengthens a firm's export capacity.

hand-held devices to provide more real-time and high-precision information (see e.g. Ziaee Bigdeli, Bustinza, Vendrell-Herrero, & Baines, 2018).

Also, firms selling digital services to final consumers might include a product in the offer to leverage their competitive advantage. The American company OnePeloton is a good example of this productization approach. The company offers exercise classes for members online and in a limited number of studios. Additionally, the company offers a robust and nicely designed exercise bike, which includes a screen connected to the handlebar. Consumers can pay a monthly fee to access classes online or in a studio (only a service), or alternatively purchase the bundle of bike plus classes (a larger monthly fee can include both). The model is very simple and successful, since no competitor is able to charge the same prices for the product or the service. All of the firm's competitive advantage is generated by the complementarity between the product and the digital service. The growth of the company has been boosted by the Covid pandemic, which has strictly limited social interaction in physical spaces.

The literature on integrated solutions and financial performance can be separated by the first industry of the firm. On the one hand, a growing literature assesses the financial benefits of servitization in advanced economies. According to a recent review, the relationship between servitization and financial performance is generally positive (Wang, Lai, & Shou, 2018). On the other end, the literature on productization and firm performance is very scarce. Suarez et al. (2013), the only existing study, analyses almost 400 firms in the US software industry for the period 1990–2006 and concludes that selling software as a product provides higher operating margins than selling software as a service. In sum, the literature on integrated solutions and profit margins (financial performance) is extensive, but the link between integrated solutions and exports (international performance) is still unexplored. Since the literature increasingly considers product–service bundling as a form of innovation (Bustinza et al., 2019; Vendrell-Herrero et al., 2021), we briefly review the literature on innovation and exporting to ground our theoretical arguments.

2.2. Innovation and exporting

A substantial body of literature suggests that there is a positive link between innovation and exporting. This is grounded theoretically in the underlying differentiation and competitive advantage obtained from improved products and processes (Cassiman, Golovko, & Martínez-Ros, 2010; Roper & Love, 2002; Wheeler, Ibeh, & Dimitratos, 2008). There is a broad consensus that innovative firms boost their domestic competitiveness through product and process innovation, which in turn increases their ability to sell in foreign markets, whereas non-innovators must increase productivity before exporting. The empirical research by Cassiman and Golovko (2011) exemplifies this rationale. Analysing a sample of Spanish manufacturing firms over the period 1990–1998, Cassiman and Golovko conclude that innovative firms can begin exporting at a lower level of productivity than non-innovative ones: the exported product itself differentiates the firm from competitors in international markets.

Along similar lines, Golovko and Valentini (2011) also find that product innovation and exporting are complementary in boosting an SME's growth. Using a slightly longer panel (1990–1999) for the same set of manufacturing companies analysed by Cassiman and Golovko (2011), Golovko and Valentini demonstrate through conceptual and empirical analysis that these business activities dynamically and mutually reinforce each other, enhancing the potential importance of exporting and innovation in isolation. Such reinforcement enables innovative firms to make exports more successful by selling better products, while exporting firms can similarly improve the quality of their products by selling their products abroad. This virtuous cycle enables manufacturing SMEs that export and innovate to grow faster than SMEs carrying out only one or none of these business activities.

Previous research has also examined the heterogeneity of innovation outcomes and its varied effects on exporting. For instance, Lewandowska, Szymura-Tyc, and Gołebiowski (2016) analyse complementarity between technological innovations. Their study uses a cross-sectional sample of 6855 Polish firms surveyed in 2011 to show that there is a complementarity between product innovation and process innovation. They report that product and process innovation in isolation enhance exporting intensity, but firms with combined product and process innovation have a larger export intensity than those firms having only one type of technological innovation (product or process). Using a different dichotomy, Saridakis, Idris, Hansen, and Dana (2019) analyse the different impact on exporting of incremental and radical innovations. Using a cross-sectional sample of 12,823 British SMES surveyed in 2015, they show that both incremental and radical innovations have a positive effect on exporting intensity when compared to non-innovating firms, but that the degree of novelty also makes a difference, i.e. compared to incremental innovation, the effect of radical innovation on exporting intensity is significantly higher.

A firm's innovation capability also underlies its internal capabilities. The previous literature agrees on a number of internal enablers of the linkage between innovation and exporting (Bianchi & Wickramasekera, 2016). For instance, the set of skills within the workforce is an important internal enabler of exports and innovation. Firms that employ skilled labour (Brambilla, Lederman, & Porto, 2012) and have more managerial education (Ganotakis & Love, 2010) are more likely to succeed at exporting, whereas firms that innovate and export require a wider set of skills within the workforce, including technical, creative, and commercial skills (Herrmann & Peine, 2011). Overall, there is a consensus that innovation and distinctive workforce knowledge-based capabilities lead to superior exporting outcomes due to a higher degree of product (or service) differentiation. The next subsection provides a series of arguments about how product–service bundling may (or may not) enhance a firm's export intensity.

2.3. Bundling and exporting

The near absence of literature on bundling and exporting is somewhat surprising, since initial conceptualizations of product–service bundling indicated a potential linkage between these two variables. For instance, the seminal paper on servitization posits that "because services are increasingly being embodied in and delivered by goods, it is easy to standardize core elements of services. It is also possible to trade these services without either the customer or the company having to leave home in the typical manufacturing export mode" (Vandermerwe & Rada, 1988, p. 321). This section provides a series of arguments on how product–service bundling should be connected to exporting.

Regardless of the primary sector, it seems logical to consider sales from product–service bundles as an independent source of revenue, different from sales generated by either products or services alone. We argue that bundling products and services is likely to yield foreign sales superior to those obtained by selling products and services separately, since it creates and captures more value. There are two major explanations for this argument: product differentiation and long-term commitment.[5]

First, integrated solutions enhance a firm's differentiation (Miller et al., 2002) through customer engagement and customization (Visnjic, Wiengarten, & Neely, 2016; Zhang, Gregory, & Neely, 2016). Entering export markets requires internalizing sunk costs (Melitz, 2003),

[5] Like any other organizational change, we acknowledge that some aspects of adopting integrated solutions can damage or possibly harm a firm's competitiveness, opposing our theoretical prediction. For instance, dividing resources in the spirit of achieving an integrated solution may lead to a mediocre offering, or at least to one less valuable than that based on product (or service) specialization (Schott, 2004). However, we believe that the advantages of adopting an integrated solution will on average overcome the disadvantages.

and overcoming these costs is challenging, as the competition with incumbent foreign firms quite often results in lower mark-ups than those obtained in domestic markets (Bughin, 1996). The attributes and quality of the product are the main determinants of a firm's capacity to increase profit margins abroad and strengthen its presence in foreign markets (Aw et al., 2001). Most differences in the ability to penetrate foreign markets or in organizational innovation can be explained by differences in product/service quality (Golovko & Valentini, 2011). By offering bundles of products and services, the firm probably moves towards selling more sophisticated packages that create additional value for foreign consumers, enabling a more sustainable stream of revenues from abroad. We can illustrate how bundling increase exports through differentiation using the example of OnePeloton. The company used their differentiated offer of online classes and exercise bikes to enter the markets of Canada, the UK, and Germany, in the years after its foundation. The company took advantage of the fact that no similar product–service bundles were offered in those countries, to quickly gain enough market share to set up a sustainable subsidiary.

Second, product–service bundling can lock in customers by signing long-term agreements with them (Ulaga & Reinartz, 2011; Wise & Baumgartner, 1999), enabling firms to obtain revenues over the entire product life span (Baines et al., 2017; Cusumano et al., 2015). According to the Uppsala model of firm internationalization, a firm's export capacity and underlying export performance are closely associated with the investment committed to serving foreign markets (Vahlne & Johanson, 2017). Securing stable market share and revenue streams in a given foreign market often provides the right incentives to increase the commitment to invest in that market (Skarmeas, Katsikeas, Spyropoulou, & Salehi-Sangari, 2008). By offering integrated solutions, firms may be able to lock in a foreign customer for a period of time. The promise of secured revenue streams is an incentive for allocating more resources to this market and eventually for increasing the firm's export intensity. The effect of locking in consumers is also relevant to the case of OnePeloton. Once consumers have made a financial commitment to purchase the bike, they are locked in to the relationship. In this regard, the consumer commits to continue paying for the streaming services indefinitely, which assures a stable revenue stream over the years, which in turn can justify additional efforts in escalating the business in foreign markets. After the success of its exercise bike, the company released a treadmill to have the capacity to lock in more consumers.

In sum, we add to the existing literature by showing that SMEs that bundle products and services into one commercial offering increase their competitiveness in foreign markets relative to firms that export only products, only services, or products and services separately. We argue that bundling products and services increases a firm's ability to differentiate its export offerings, ultimately increasing its export intensity. We thus hypothesize:

Hypothesis 1. Firms bundling products and services exhibit higher export intensity than firms selling products and services separately

While no previous study has tested this hypothesis, two related streams of the literature provide evidence consistent with our hypothesized relationship. The first examines bi-exporting firms, that is, firms that export both products and services, but as separate offerings. Ariu (2016) finds that bi-exporters are relatively rare (under 10% of all exporters), but account for over 30% of all worldwide exports. More recently, Ariu et al. (2020) show that Belgian bi-exporters can benefit from demand complementarities, which ultimately increase the firm's exporting capacity. The second examines the percentage of the labour force that works in services within manufacturing firms. Lodefalk (2014) shows that Swedish manufacturers with a higher percentage of labour in service jobs have higher export intensity.

The present study also seeks to explore the industry-specific effects of bundling. As mentioned earlier, manufacturing and service firms follow different pathways when implementing integrated solutions: manufacturers servitize (Baines et al., 2017) but service firms productize (Harkonen et al., 2015). So far, we have argued that the main advantages of bundling products and services (i.e. differentiation through customization and lock-in consumers) are independent of the firm's primary industry; however, productization has additional benefits. First, and as mentioned earlier, by including products in their offer, service firms could have a more standardized offer, which enables economies of scale and enhancing their competitive advantage (Harkonen et al., 2015). The previous literature has extensively discussed the importance of reaching a certain level of resources and employment in order to penetrate export markets (Melitz, 2003), and a consequent increase in export sales (Bonaccorsi, 1992; Verwaal & Donkers, 2002). Taken together, the increase in scale resulting from a process of productization might enable service firms to reach the necessary level of internal resources to successfully serve foreign markets, suggesting that the export-enhancement effect of bundling is stronger in service firms. Second, previous studies suggest that compared to manufacturing firms, service firms rely more on partners and intermediaries to establish export sales abroad (Doloreux & Laperrière, 2014; Lejpras, 2019). We argue that the increase of tangibility associated to the sale of product–service bundles experienced by service firms, might reduce their dependence on external partners and intermediaries, and hence might enable service firms to increase their presence in export markets. Altogether, we hypothesize:

Hypothesis 2. Being in a primary industry moderates the relationship between bundling and exporting. The export-enhancement effect of bundling is stronger in service firms.

The conceptual model assessed in this study includes two hypotheses, shown in Fig. 1. Additionally, our model includes a number of firm-level control variables that previous research has identified as explanatory factors for export intensity: these include firm size, productivity, R&D investment and investment abroad (Bandick, 2020; Ganotakis & Love, 2011; Melitz, 2003).

3. Data

Our analysis tests the hypothesis of interest in the context of German SMEs. Since German SMEs are essentially leading the European journey to the fourth industrial revolution (Czarnitzki & Spielkamp, 2003; Muller & Zenker, 2001), Germany is a particularly interesting country to investigate the implications of product–service bundling.[6]

We used the MARKUS dataset, a Bureau Van Dijk service that provide accounting and financial information for German firms, as a firm directory, and hence, a way of identifying a wide selection of German SMEs that will form the population of this study. The Cologne Institute for Economic Research (CIER) surveyed these firms. Prior to the administration of the survey, a panel of industry experts validated the questionnaire. In order to obtain a longitudinal setting, the survey was implemented in two waves (2011 and 2014).

The survey was conducted in German to ensure that the respondents were able to provide precise answers. In both waves of the survey, the questionnaire was sent by e-mail. The e-mail contained an individual link, username, and password to log in to an online platform. The first wave of the survey was sent in December 2010 and January 2011 to 35,730 recipients and the second wave was sent in July and August 2014 to 22,388 recipients. The answer rate obtained was 7.8% in the first wave and 6.7% in the second wave, which is not far from the 9.2% average rate across top journals in the field of international

[6] In fact, Germany's service jobs in the manufacturing industry have grown by 30% since 1975 (Boddin & Henze, 2014). Gomes et al. (2019) show that 10% of German manufacturing firms declare having a secondary industry code in services, much larger than, for example, the Spanish figure (4%).

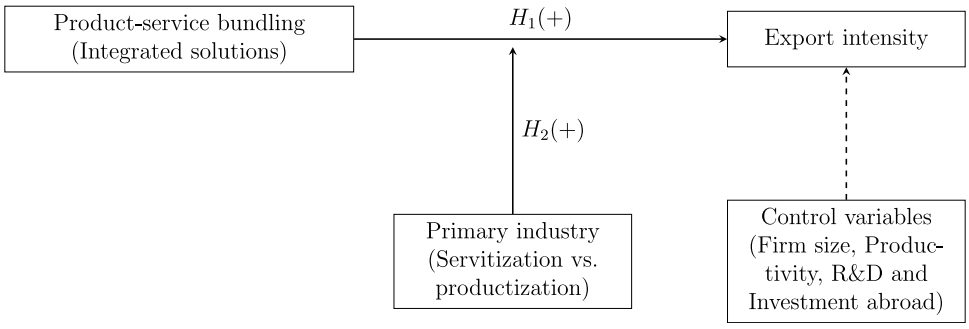

Fig. 1. Conceptual model.

Table 1
Size distribution of firms.

Class size	# of employees	# of firms	Percentage
Micro enterprises	[1–9]	3356	78.63
Small enterprises	[10–49]	738	17.28
Medium-sized enterprises	[50–249]	175	4.09
Total		4268	100

Firms are classified as being 'Micro', 'Small' and 'Medium-sized' enterprises according to the EUROSTAT definition. Observations are weighted using sample weights as computed in Appendix.

business (Chidlow, Ghauri, Yeniyurt, & Cavusgil, 2015).[7] Our working sample is a repeated cross-section of 4268 SMEs in different industries. The 2011 wave contains information about 3178 firms, whereas the 2014 one includes 1090 firms. There were 527 firms that appeared in both waves, providing the possibility of conducting a longitudinal analysis for a sub-sample of firms (we will call this sub-sample 'the panel'). The respondents were in key managerial decision-making positions and had a good understanding of innovation practices and the firm's strategy, i.e. directors, operations managers, and sales managers.

To ensure the representativeness of the sample, we have constructed size-sector weights which, when possible, will be used in the regressions and descriptive statistics.[8] Table 1 shows that the great majority of firms in our sample are micro enterprises (around 79% of the firms). The dependent variable, export intensity (e^f_{kjt}), is calculated as the ratio between sales in foreign markets and the total turnover of firm f in sector k and state j, at time t. As shown in Table 2, exporters (44% of the sample) derive on average 10% of their turnover from selling abroad.

Our variable of interest, s^f_{kjt}, is the ratio between revenues obtained from selling product–service bundles and total turnover. In particular, the managers were asked to split total revenues into products (only), services (only), and integrated solutions (product and service together). So, for example, if a firm sells a product and its related maintenance service, this would be considered an integrated solution if and only if both the product and its maintenance are part of the same offer. If the maintenance service is offered independently of the product, then it will be part of the service revenues, and the product will contribute to the product revenues.[9] Table 2 shows that 22% of the firms sell integrated solutions. The distribution of sales generated by bundling in each German state is provided in Fig. 2. Given the cross-state variation in bundling activities, it is important to control for the characteristics of the state, as we do in the empirical analysis.

As discussed earlier in the conceptual framework, we introduce a number of firm-level control variables into the model that have been used extensively in the previous literature as explanatory factors of exporting intensity (see e.g. Bandick, 2020; Ganotakis & Love, 2011; Melitz, 2003).

- **Firm size**. Since larger firms are more likely to export, firm size is a frequently used variable in empirical studies analysing exports (Bonaccorsi, 1992). Following Altomonte, Aquilante, Békés, and Ottaviano (2013) we have used firm-size dummies based on the level of employment. Categories are exhibited in Table 1.
- **Labour productivity**. We include labour productivity because both the decision to export (see e.g. Altomonte et al., 2013; Altomonte, Aquilante, & Ottaviano, 2012; Bernard & Jensen, 1999; Melitz, 2003) and the choice to bundle products with services (see Ariu et al., 2020) are likely to be correlated with the productivity of the firm. lp^f_{kjt} is the logarithm of the turnover divided by the number of employees (labour productivity), which is a common way of defining productivity in both, the international trade (see e.g. Altomonte et al., 2012) and the international business (see e.g. Vendrell-Herrero, Gomes, Mellahi, & Child, 2017) literature streams.[10]
- **Investment abroad**. Investing abroad enables learning about how foreign markets operate (Mukherjee, Lahiri, Ash, & Gaur, 2019). According to Bertrand (2011) firms with investment links in foreign markets are more capable of exporting and hence it is important to control for the investment abroad status when accounting for export intensity. inv^f_{kjt} is a dummy variable equal to 1 if firm f is in sector k and state j reports at time t having investment abroad, and 0 otherwise. Clearly, the number of firms investing abroad is relatively small in our sample (9.4%), in line with the nature of the survey, which is focussed on SMEs (see Table 2).
- **R&D expenditure**. R&D and exports are highly interconnected. Firms that conduct more R&D are normally more innovative and as a result have higher export intensity (Di Cintio, Ghosh, & Grassi, 2017; Girma, Görg, & Hanley, 2008). Consistently with Ganotakis and Love (2011), we control for the fraction of exports that is explained by R&D by introducing the share of R&D expenditures on the turnover of the firm (rd^f_{kjt}). On average, firms in our sample invest in R&D the equivalent of 4.8% of their annual turnover (see Table 2).

[7] Note that these rates refer to the entirety of the sample, which also contains a small number of firms, 1% of the sample, with more than 249 employees that we excluded from the analysis, given the focus on SMEs.

[8] A detailed illustration of the way the weights were constructed can be found in Appendix.

[9] Suarez et al. (2013) measure servitization in a similar way (service sales as percentage of total assets). However, they do not observe sales generated by integrated solutions, i.e. sales generated by selling products and services bundled in one offer.

[10] In computing labour productivity we use GDP deflators (base year 2009) to deflate sales.

Table 2
Summary statistics.

Variable	Mean	Std. Dev.	Observations(%)
e^f_{kjt}	10.146	21.995	3881
# of exporters (%)			1724 (44)
s^f_{kjt}	8.627	23.367	4200
# of bundling firms (%)			913 (22)
lp^f_{kjt}	0.18	1.224	4140
inv^f_{kjt}	0.094	0.292	3891
rd^f_{kjt}	4.786	12.657	4102

e^f_{kjt} is the ratio between sales in foreign markets and the total turnover of firm f in sector k and state j at time t. s^f_{kjt} is the share of firm turnover generated by selling integrated solutions. lp^f_{kjt} is the logarithm of labour productivity of firm f in sector k and state j at time t. inv^f_{kjt} is a dummy equal to 1 if firm f belongs to sector k and state j and produces abroad at time t. rd^f_{kjt} is the share of R&D expenditure on turnover of firm f, in sector k and state j at time t.

4. Empirical approach

To investigate the relation between bundling and exporting (Hypothesis 1), we start by estimating linear models of the form

$$e^f_{kjt} = \alpha_0 + \alpha_1 s^f_{kst} + \boldsymbol{\Omega}^f_{kjt} + \vartheta_f + \vartheta_k + \vartheta_j + \vartheta_m + \vartheta_t + \varepsilon^f_{kjt} \quad (1)$$

where e^f_{kjt} is the export intensity of firm f in sector k and state j, at time t, computed as the ratio between sales in foreign markets and total turnover (as in the previous section). s^f_{ijt} is the variable of interest, i.e. the share of firm turnover generated by selling integrated solutions: we expect α_1 to be positive and significant. $\boldsymbol{\Omega}^f_{kjt}$ is a vector of time-varying firm characteristics which have been shown to be export determinants in the literature (i.e. lp^f_{kjt}, inv^f_{kjt} and rd^f_{kjt}). ϑ_f are firm fixed-effects (FEs). ϑ_k indicates sector dummies/FEs. ϑ_j refers to state dummies/FEs. ϑ_m are size dummies/FEs. ϑ_t are time dummies/FEs. ε^f_{kjt} is the error term.

We then challenge the results in two ways. First, we exploit the panel structure of our data and control for time-invariant unobserved firm heterogeneity (firm fixed-effects, ϑ_f in Eq. (1)). As mentioned in the previous section, a subset of the surveyed firms appears in both the years of our sample. So, 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 bundling and exporting.

Second, we implement several doubly-robust propensity score matching (DR-PSM) procedures (Busso, DiNardo, & McCrary, 2014; Dehejia & Wahba, 2002; Lechner, 2002; Uysal, 2015). To do that we need to look at the difference

$$[\eta^{1,f}_{kjt} - \eta^{0,f}_{kjt}] \quad (2)$$

where $\eta^{1,f}_{kjt}$ ($\eta^{0,f}_{kjt}$) is the outcome (exporting) for firm f in sector k and state j, at time t that sells (does not sell) product–service bundles. Note that $\eta^{0,f}_{kjt}$ is not observable: we do not know what would have happened to the exports of firms that sell product–service bundles had they not chosen to do it. This boils down to building a counterfactual starting from the definition of the average effect of bundling on exporting, $\eta^{1,f}_{kjt} - \eta^{0,f}_{kjt}$. Defining the average effect of bundling on exporting as

$$E[\eta^{1,f}_{kjt} - \eta^{0,f}_{kjt}] = E[\eta^{1,f}_{kjt}] - E[\eta^{0,f}_{kjt}] \quad (3)$$

the probability model of bundling (the propensity score) can be written as

$$Pr[\eta^{0,f}_{kjt} = 1] = \Phi[g(\boldsymbol{\Omega}^*)] \quad (4)$$

where $\boldsymbol{\Omega}^*$ is a vector of firm, sector and state characteristics covariates. Imposing common support, if the balancing property holds, in each block the average propensity score is not different for treated and untreated.[11] Within each sub-sample, we can then analyse the data as if they came from a randomized experiment. Defining $\eta^{1,f,DR}_{kjt}$ and $\eta^{0,f,DR}_{kjt}$ as the counterfactual responses (DR stands for doubly robust) we can then evaluate

$$\begin{aligned}\zeta_{DR} &= E[\eta^{1,f,DR}_{kjt}] - E[\eta^{0,f,DR}_{kjt}] = \\ &= \frac{1}{f}\sum_f \left(\frac{s^{f,DR}_{kjt}\eta^f_{kjt}}{\lambda(\boldsymbol{\Omega}^*;\hat{\beta})} - \frac{s^{f,DR}_{kjt} - \lambda(\boldsymbol{\Omega}^*;\hat{\beta})}{\lambda(\boldsymbol{\Omega}^*;\hat{\beta})} \times \chi_1(\boldsymbol{\Omega}^*;\hat{\gamma}_1) \right) - \\ &- \frac{1}{f}\sum_f \left(\frac{(1 - s^{f,DR}_{kjt})\eta^f_{kjt}}{1 - \lambda(\boldsymbol{\Omega}^*;\hat{\beta})} - \frac{s^{f,DR}_{kjt} - \lambda(\boldsymbol{\Omega}^*;\hat{\beta})}{1 - \lambda(\boldsymbol{\Omega}^*;\hat{\beta})} \times \chi_0(\boldsymbol{\Omega}^*;\hat{\gamma}_0) \right)\end{aligned} \quad (5)$$

where f indexes firms as before; $\lambda(\boldsymbol{\Omega}^*;\hat{\beta})$ is a postulated model for the true propensity score; $\chi_0(\boldsymbol{\Omega}^*;\hat{\gamma}_0)$ and $\chi_1(\boldsymbol{\Omega}^*;\hat{\gamma}_1)$ are postulated regression models for the true relation between the vector of covariates ($\boldsymbol{\Omega}^*$) and the outcome within each stratum of treatment.

Since bundling is not a characteristic that is randomly assigned to firms but a strategy they choose to increase their competitiveness, the matching procedure relies on conditional independence: the treatment (bundling product and services) is as good as randomly assigned after conditioning on a set of covariates. In other words, we will have to show (as we do in Section 5) that after conditioning on those covariates, the treatment does not affect the means of the potential outcomes.

In Section 5, where we will present the DR-PSM results, we will show that this is the case and provide the details of how the procedure is practically implemented. This procedure provides us with two possibilities to assess the robustness of the relation between product–service bundling and a firm's exporting: either by matching and eliminating any association between the covariates and bundling, or by regressions that control for other factors that are correlated with the treatment. In the latter case, we will essentially estimate weighted linear regressions where we use the weights

$$\frac{s^{f,DR}_{kjt}\eta^f_{kjt}}{\lambda(\boldsymbol{\Omega}^*;\hat{\beta})}; \qquad \frac{(1 - s^{f,DR}_{kjt})\eta^f_{kjt}}{1 - \lambda(\boldsymbol{\Omega}^*;\hat{\beta})}$$

recovered from the PSM procedure.

Finally, our multi-industry data provides the opportunity to test whether the primary sector the firm belongs to plays a role in moderating the effect of bundling on exporting, hence to test Hypothesis 2. To do this, we first restrict the sample to firms in 'Manufacturing' and 'Services' industries.[12] The rationale behind this exercise is that when firms servitize, their primary sector is manufacturing, while in the case of productization, their primary sector is services. Restricting to these two sectors thus provides us with a relatively homogeneous group of service firms, more than if we included all non-manufacturing firms in one group. To corroborate Hypothesis 2 we expect that the effect of bundling will be stronger in service industries.

5. Results

The results section is divided into three parts. In Section 5.1, we establish several facts about the performance of firms that sell integrated solutions, including their higher propensity to export relative to firms that sell products or services separately. In Section 5.2, we present the results of the regressions that test for Hypotheses 1 and 2. Finally, in Section 5.3, we implement a robustness check on the regression

[11] Note that this affects the set of covariates that one can include when estimating the effect of bundling on exporting. More details will be provided in Section 5.3.

[12] Here we define the services industry as firms belonging to either ICT, Professional, scientific and technical services or wholesale and retailing. To ensure the robustness of the results, other classifications of service industries have been used (e.g. only ICT), but the results reported in Table 5 are qualitatively the same.

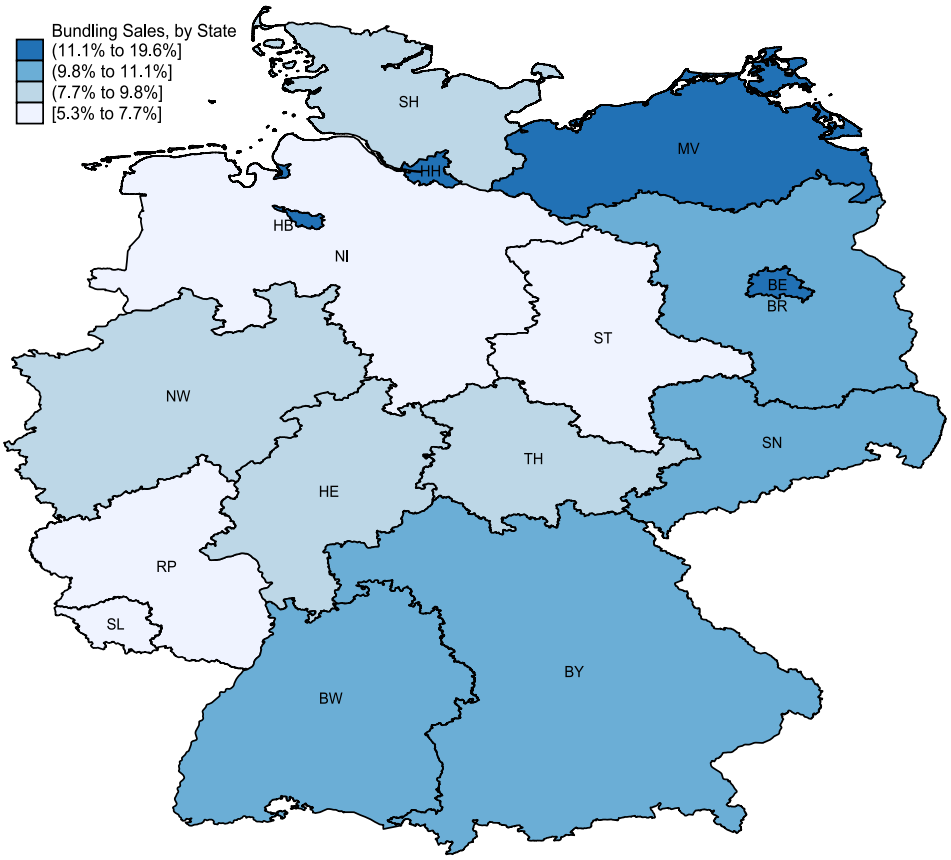

Fig. 2. Sales generated by bundling, by German state. **Notes:** The 2-digit state codes appearing in the map correspond to the following names: Baden-Württemberg (BW) Bavaria (BY) Berlin (BE) Brandenburg (BB) Bremen (HB) Hamburg (HH) Hesse (HE) Lower Saxony (NI) Mecklenburg-Vorpommern (MV) North Rhine-Westphalia (NW) Rhineland-Palatinate (RP) Saarland (SL) Saxony (SN) Saxony-Anhalt (ST) Schleswig-Holstein (SH) Thuringia (TH).

analysis. Concretely, we present the results of several doubly-robust propensity score matching models that strength the validity of the test of Hypothesis 1.

5.1. Descriptive analysis

In this section, we present two facts about the firms that sell integrated solutions. First, their presence varies considerably from sector to sector. In particular, in our sample, on average only 22% sell product–service bundles (Table 3), ranging from 7.92% for 'Transportation and storage' to 37.48% for 'Information and communication'. However, the share of product–service sales does not necessarily increase proportionally with an increase in the number of bundling firms. In the manufacturing sector, for example, around 21.44% of the firms generate 8.89% of the bundling sales. A slightly higher percentage of firms in Electricity (22.67%) generates instead a much larger share of sales (12.29%).[13]

Second, we show that SMEs which sell integrated solutions are more productive than those selling products alone or services separately (Fig. 3, Panel A). Third, firms that sell integrated solutions exhibit larger exports (Fig. 3, Panel B). Since our sample consists of SMEs, this is particularly interesting, as it suggests that product–service bundling benefits are not exclusive to large corporations (as argued for instance in Ariu et al. (2020)).

[13] In the category 'Other' in Table 3 we group 11 firms from the following sectors: 2 firms from 'Accommodation and food service activities'; 1 firm from 'Agriculture, forestry and fishing'; 1 firm from 'Education'; 1 firm from 'Human health and social work activities'; 2 firms from 'Mining and quarrying' and 4 firms from 'Other service activities'.

5.2. Regression analysis

We start the regression analysis by estimating linear models of the type indicated in Eq. (1). We thus begin with a parsimonious specification (first column of Table 4), where e^f_{ist} is regressed only on s^f_{kst} and a set of industry, state, size and time dummies. We subsequently include lp^f_{kjt}, inv^f_{kjt} and rd^f_{kjt} in columns 2–4. We then restrict the sample to only those firms that were surveyed in both years and estimate more demanding regressions that include firm, industry–time and size–time FEs in column 5 and firm, industry–time, size–time and state–time FEs in column 6.

Irrespective of the econometric specification used, we find that the estimated coefficient for the variable s^f_{kjt} is always positive and highly significant. Thus, firms that bundle products and services into integrated solutions are more likely to have larger exports than firms that sell goods and services separately. Moreover, the magnitude of the coefficient of interest varies little between the specifications, ranging from 7 to 9 percentage points. Importantly, we show that even after controlling for observed firm characteristics such as labour productivity (lp^f_{kjt}), investment in $R\&D$ (rd^f_{kjt}) and whether the firm invests abroad (inv^f_{kjt}), there is still a positive association between bundling and exporting. The same is true when we restrict the sample to only those firms that were surveyed in both years and estimate more demanding regressions that include firm, industry–time and size–time FEs in column 5 or firm, industry–time, size–time and state–time FEs in column 6. Overall, this result supports Hypothesis 1.

As explained before, in order to test Hypothesis 2, we restrict the sample to 'Manufacturing' and 'Services' industries and use the interactive term between bundling and industry to corroborate the hypothesis.

Table 3
Bundling by sector.

Sector	Description	Share of firms	Share of sales	Observations
58–63	Information and communication	39.20	16.54	432
35	Electricity, gas, steam, etc...	27.25	12.29	128
10–33	Manufacturing	23.34	8.89	1744
45–47	Wholesale and retail trade, repair	20.96	7.32	265
69–75	Professional, scientific and technical	18.98	7.77	818
64–66	Financial and insurance activities	14.12	4.86	19
77–82	Administrative and support service	14.55	6.04	353
68	Real estate activities	11.02	2.19	35
37–39	Water supply, sewerage, waste	10.56	1.32	18
41–43	Construction	8.42	1.46	227
49–53	Transportation and storage	8.67	3.98	150
	Other	22.95	4.29	11
	Aggregate	21.81	8.63	4200

Authors' calculation from CIER data. Observations are weighted using sample weights as computed in Appendix.

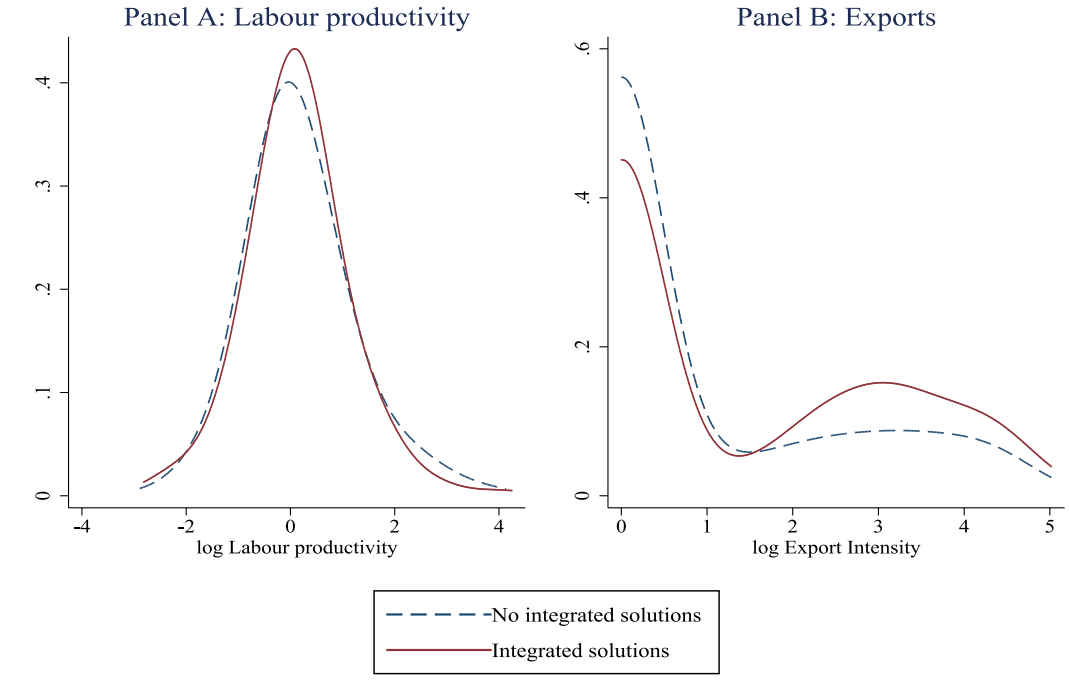

Fig. 3. Productivity, bundling and exporting. **Notes:** Panel A (Panel B) shows the distribution of firm-level labour productivity (export intensity), distinguishing between those selling integrated solutions and those which sell products alone or services alone. The distributions in the two panels are statistically different at 1%. Variables are in logarithms. Observations are weighted using sample weights as computed in Appendix.

The results are shown in Table 5, where σ^f_{kjt} is a dummy equal to 1 if the firm's primary sector is 'Services' and the coefficients of interest are those on s^f_{kjt} and the interaction $\sigma^f_{kjt} \times s^f_{kjt}$. The coefficient on $\sigma^f_{kjt} \times s^f_{kjt}$ is not significant while the one on s^f_{kjt} is, suggesting that bundling is per se what matters for exporting, rather than the sector the firm belongs to. This result does not support Hypothesis 2, meaning that the export-enhancing effect of bundling transcends industry boundaries.

All in all, the results reported in Tables 4 and 5 are in line with previous research, but there are at least three important novelties.

First, we go beyond what most of the existing literature focuses on, the effect of servitization on manufacturers' exports, showing that product–service bundling is export-enhancing also for non-manufacturing firms.

Second, as mentioned earlier, bundling is likely to increase a firm's competitive advantage either through product differentiation or by locking in customers in long-term agreements, or through a combination of the two. Our data allow us to look more closely into what leads firms to bundle. As we show in Table 6, 91% of firms sell integrated solutions to increase customer loyalty and 80.06% to acquire new customers. In other words, as postulated also by Ariu et al. (2020) for (relatively large) bi-exporters, bundling is primarily a strategy to capture demand. However, supply-side motives are also important, as 70% (68%) of firms declare that bundling is implemented to increase sales (earnings) per customer. To the best of our knowledge, this is the first paper to show that bundling is not only a strategy for large firms, but can actually be viable also for very small firms.

Third, since the firms in our sample are directly asked what share of their sales originate from selling products and services as a bundle (integrated solutions), we can be confident that our measure of bundling, although at the firm level, stems from bundles of product and services demanded by the same client (this is not the case in, for example, Ariu et al., 2020).

5.3. Matching analysis

The results in the previous section point to a robust positive association between bundling and export intensity, which holds after controlling for several observed and unobserved firm characteristics. In this section we further study our results about Hypothesis 1 by implementing propensity score matching techniques, as described in Section 4. To do this, we first compute the propensity score using a

Table 4
Bundling and exporting.

e^f_{kjt}	OLS (Full sample)				OLS (Fixed-effects)	
	(1)	(2)	(3)	(4)	(5)	(6)
s^f_{kjt}	0.088***	0.093***	0.085***	0.079***	0.069***	0.089**
	(0.010)	(0.010)	(0.012)	(0.012)	(0.020)	(0.035)
lp^f_{kjt}		−0.002	−0.003**	−0.002**		
		(0.002)	(0.001)	(0.001)		
inv^f_{kjt}			21.398***	21.072***		
			(2.426)	(2.328)		
rd^f_{kjt}				0.177***		
				(0.049)		
Observations	3829	3736	3726	3626	994	994
R^2	0.064	0.064	0.143	0.152	0.044	0.094
$\vartheta_k, \vartheta_j, \vartheta_m, \vartheta_t$	Yes	Yes	Yes	Yes	No	No
$\vartheta_f, \vartheta_{k\times t}, \vartheta_{m\times t}$	No	No	No	No	Yes	No
$\vartheta_f, \vartheta_{k\times t}, \vartheta_{m\times t}, \vartheta_{j\times t}$	No	No	No	No	No	Yes

Estimates of linear regressions. Significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors, in parentheses, are clustered at the 2-digit NACE industry level. s^f_{kjt} is the share of firm turnover generated by selling integrated solutions. e^f_{kjt} is the ratio between sales in foreign markets and the total turnover of firm f in sector k and state j at time t. lp^f_{kjt} is the logarithm of labour productivity of firm f in sector k and state j at time t. inv^f_{kjt} is a dummy equal to 1 if firm f belongs to sector k and state j and produces abroad at time t. rd^f_{kjt} is the share of R&D expenditure on turnover of firm f, in sector k and state j at time t. ϑ_k, ϑ_j, ϑ_m and ϑ_t are sector, state, size and time dummies/FEs. Observations are weighted using sample weights as computed in Appendix.

Table 5
Manufacturers vs. Services firms.

e^f_{kjt}	(1)	(2)	(3)	(4)
s^f_{kjt}	0.095**	0.099**	0.084**	0.086*
	(0.013)	(0.014)	(0.015)	(0.023)
σ^f_{kjt}	−3.135	−6.180**	−4.890	−6.550*
	(1.435)	(1.114)	(1.797)	(1.830)
$\sigma^f_{kjt} \times s^f_{kjt}$v	−0.023	−0.014	−0.001	−0.013
	(0.012)	(0.013)	(0.012)	(0.016)
lp^f_{kjt}		−0.003	−0.003*	−0.002**
		(0.001)	(0.001)	(0.000)
inv^f_{kjt}			21.056**	20.708**
			(3.259)	(3.137)
rd^f_{kjt}				0.182***
				(0.013)
Observations	2938	2874	2864	2785
R^2	0.033	0.053	0.135	0.145
$\vartheta_k, \vartheta_j, \vartheta_m, \vartheta_t$	Yes	Yes	Yes	Yes

Estimates of linear regressions. The sample is restricted to firms in 'Manufacturing' and 'ICT'. Significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors, in parentheses, are clustered at the 2-digit NACE industry level. s^f_{kjt} is the share of firm turnover generated by selling integrated solutions. e^f_{kjt} is the ratio between sales in foreign markets and the total turnover of firm f in sector k and state j at time t. σ^f_{kjt} is a dummy equal to 1 if firm f is in state j and belongs to the service sector at time t. lp^f_{kjt} is the logarithm of labour productivity of firm f in sector k and state j at time t. inv^f_{kjt} is a dummy equal to 1 if firm f belongs to sector k and state j and produces abroad at time t. rd^f_{kjt} is the share of R&D expenditure on turnover of firm f, in sector k and state j at time t. ϑ_k, ϑ_j, ϑ_m and ϑ_t are sector, state, size and time dummies/FEs. Observations are weighted using sample weights as computed in Appendix.

logit model where the treatment is a dummy which takes the value 1 if the firm sells integrated solutions and 0 otherwise: the sample is split between 876 treated and 3202 untreated. In computing the propensity score, we use lp^f_{kjt}, size and 1-digit NACE dummies as covariates and always allow replacement.

We impose common support in two ways. One is by discarding firms that sell integrated solutions whose propensity score is higher than the maximum or less than the minimum propensity score of firms that do not sell integrated solutions. The propensity score is then estimated using the 3679 on-support observations (69 are off support). By splitting the sample into 6 blocks, we make sure that the average propensity score is not different for treated and untreated, i.e. we make sure that the balancing property is satisfied. This is clear in Fig. 4, where we compare the propensity score of treated and untreated firms (those that sell integrated solutions and those that do not) in the unmatched and matched samples.

While the propensity scores for the two sub-samples are different from each other in the unmatched sample (top left hand side panel of Fig. 4), for all the three matching techniques we use, i.e. 1:1 Nearest Neighbour Matching (1:1), Radius Matching, and Local Linear Regression, the scores are not statistically different from one another (top right hand side and down panels of Fig. 4).

Table 6
The drivers of bundling.

Objective	Percentage
Acquisition of new customers	80.06%
Increase in sales per customer	70.46%
Increase in earnings per customer	68.22%
Increase in customer loyalty	91.75%

As an alternative way to impose common support, we trim 5% and 10% percent of the treatment observations at which the propensity score density of the control observations is the lowest. For conciseness, we do not show the propensity scores computed on the trimmed sample, but only the baseline estimates of the Average Treatment Effect (ATE). The ATE of bundling on export intensity ($ATE^{s,f}_{kjt}$) is estimated using the three techniques mentioned above. When we trim the sample, the ATE is indicated by $ATE^{s,f,5}_{kjt}$ and $ATE^{s,f,10}_{kjt}$. The results are shown in Table 7.

Irrespective of the matching technique used, the results from both PSM and DR-PSM strongly confirm the findings of the regression, with the export intensity of firms that sell integrated solutions being systematically larger than for those that sell only products or only services. However, the point estimates of the regression results are much larger than those of the matching results. This is because in the latter case, s^f_{kjt} is defined as a dummy equal to 1 if the firm sells bundles of product and services and 0 otherwise, thus capturing the effect of bundling vs. the effect of not bundling. In Section 5.2, s^f_{kjt} is instead a continuous measure of bundling intensity and captures what the effect of higher or lower bundling intensity is on exporting. Overall, the matching analysis confirms Hypothesis 1.

Note also that the set of covariates we include in the PSM procedure (columns 1–3) is different than the one we include in the DR-PSM (columns 4–6). In the former case, achieving the balancing property requires a parsimonious specification, which only includes lp^f_{kjt}, size and 1-digit NACE dummies. The aim is to match and eliminate any association between the covariates and bundling. In the latter, we use weighted regressions to control for further causes of the exporting that are correlated with bundling and thus include a richer set of covariates.

6. Discussion and conclusion

6.1. Academic implications

There is an ample literature on the interplay between innovation, productivity and exports (see e.g. Aghion, Bergeaud, Lequien, & Melitz, 2018; Altomonte et al., 2013; Cassiman & Golovko, 2011). However, to what extent innovation paradigms are transforming the ways SMEs internationalize remain under-explored. This is particularly important in light of the hybridization underlying the fourth industrial revolution, which is transforming the competition in international markets (Alcacer, Cantwell, & Piscitello, 2016). In this paper, we contribute to filling this gap by studying the effect of developing hybrid product–service bundles (Ulaga & Reinartz, 2011), also referred to as integrated solutions (Davies, 2004) and considered as a new form of innovation (Bustinza et al., 2019; Vendrell-Herrero et al., 2021), on the exporting intensity of German SMEs.

The present study accounts for the competitiveness-enhancing effect of product–service bundling in two mutually reinforcing ways. First, firms selling integrated solutions gain an international competitive advantage by differentiating their offers through increased customization (Golovko & Valentini, 2011). Such customized and upgraded offers can then provide the opportunity to lock in foreign customers for a longer period of time (Vargo & Lusch, 2008), giving the incentive to increase commitment in foreign markets and eventually increase a firm's export capacity (Skarmeas et al., 2008; Vahlne & Johanson, 2017).

Based on unique survey data, we have found a robust positive relation between bundling and exporting. In particular, our results hold after controlling for firm productivity and R&D investment as well as firm-level unobservable heterogeneity and to the implementation of several DR-PSM procedures, which leave the results qualitatively unchanged. The strength of this result is an important contribution to our understanding of innovation and exporting in the context of the fourth industrial revolution, i.e. the fact that incorporating hybrid bundles of products and services increase significantly a firm's exports.

While most of the literature on hybridization focuses on large manufacturing corporations (Gebauer, Paiola, Saccani, & Rapaccini, 2021), our research shows that much smaller firms sell integrated solutions too, and that a wide spectrum of industries are selling hybrid product–service bundles, including firms in retailing or construction. Related to this, we also find that the benefits of product–service bundling transcend industrial boundaries, and therefore product and service firms can benefit equally by offering complementarities.

This result also seems to suggest that service firms cannot use bundling as a way to exploit economies of scale or as a mechanism to reduce the dependency on exporting partners and intermediaries; leaving the underlying reasons for the export-enhancement effect of bundling on exporting found in service firms to the same as those identified for the rest of the firms in our sample, i.e. differentiation and locking in customers.

This study contributes to the literature on international business, as it expands our understanding of factors that enhance export performance (Leonidou & Katsikeas, 2010). Previous research has studied export intensity by analysing product and service firms independently (Falk & de Lemos, 2019; Lejpras, 2019), or analysing bi-exporting firms, which can sell products and services but do it in separate offerings (Ariu et al., 2020). The present study moves a step forward and examine firms with a multifaceted industrial activity that can offer products and services in the same offer. Additionally, the analysis addresses a call made by Knight and Liesch (2016), who argued that since hybridization 'engenders superior mutual value by shifting from selling product to selling product–service systems' (p. 100), it is necessary to examine how offering product–service bundles optimize international performance.

Our research also contributes to the literature on operations management. To the best of our knowledge, it is pioneering in various ways. For one thing, our survey provides a breakdown of the bundling-generated sales, which differs from selling products or services separately, which is all that has been considered in previous empirical research (Ariu et al., 2020; Kastalli & Van Looy, 2013; Suarez et al., 2013). This ensures that the revenues come from product–service bundles demanded by the same client. Second, whilst previous studies have analysed multiple outcomes of hybridization (e.g. Crozet & Milet, 2017), this is the first study analysing the exporting-enhancement effect of selling bundles of products and services. This addresses a call made by Bustinza et al. (2017), who pointed out that 'to date the operations management literature is silent on the internationalization of the service function by product firms, an issue we consider of vital importance to better understanding the organizational transformation of many industrial companies' (p. 7). Third, this study is among the first to merge servitization and productization, two things which, up till now, have been treated by two independent streams of the literature that need to converge, as they analyse the same type of business practice, i.e. product–service bundling, differing only in the firm's primary industry (Leoni, 2019).

6.2. Managerial implications

Our research also provides important managerial implications. First, exporting SMEs and firms seeking to participate in foreign markets can improve their export intensity by understanding the mechanisms that enable them to bundle products and services. As stated before, combining products and services in the same offer upgrades a firm's ability to differentiate its offers and might open the door to increased foreign market penetration. Importantly, this result transcends industrial boundaries. Second, evidence suggests that integrated solutions are particularly significant for those firms that need to increase consumer loyalty. This means that this business practice might be especially attractive for firms seeking to increase repeat purchases. Finally, our analysis finds that a number of control variables, including R&D investment and production abroad, also influence export intensity. The effect on exporting of employing integrated solutions assumes that those control variables are at their means, implying that integrated solutions should not work in isolation from other business practices that enhance exporting.

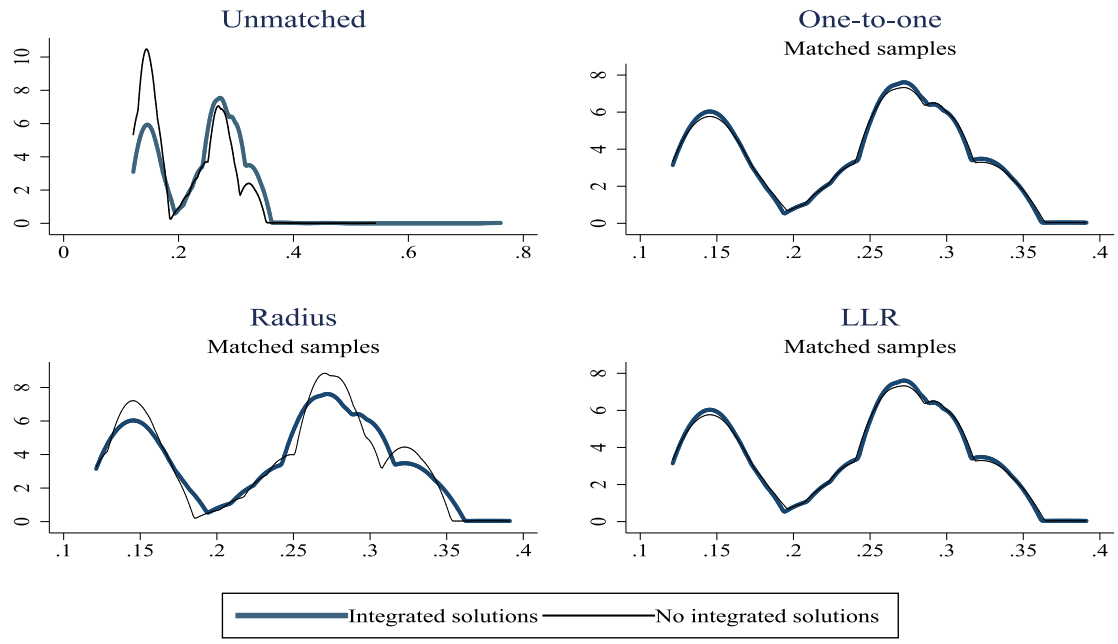

Fig. 4. Propensity score: Matched vs. unmatched sample (baseline).

Table 7
Doubly-robust propensity score matching.

e^f_{kjt}	*PSM*			*DR-PSM*		
	(1)	(2)	(3)	(4)	(5)	(6)
	1:1	Radius	Kernel	1:1	Radius	Kernel
$ATE^{s,f}_{kjt}$	5.31***	5.48***	5.16***			
ζ_{DR}				2.51**	3.84***	2.21**
Observations	3679	3679	3679	3573	3570	1127
R^2				0.19	0.17	0.19
	Sample trimmed at the 5th centile					
$ATE^{s,f,5}_{kjt}$	5.64**	6.18**	6.34***			
$\zeta_{DR,5}$				2.56***	4.29***	2.56***
Observations	3561	3561	3561	3460	3452	1067
R^2				0.25	0.16	0.24
	Sample trimmed at the 10th centile					
$ATE^{s,f,10}_{kjt}$	6.36**	6.61***	6.71**			
$\zeta_{DR,10}$				3.40**	4.44***	2.95***
Observations	3374	3374	3374	3267	3269	962
R^2				0.26	0.16	0.26
lp^f_{kjt}	Yes	Yes	Yes	Yes	Yes	Yes
inv^f_{kjt}	No	No	No	Yes	Yes	Yes
rd^f_{kjt}	No	No	No	Yes	Yes	Yes
ϑ_k, ϑ_m	Yes	Yes	Yes	Yes	Yes	Yes
ϑ_j, ϑ_t	No	No	No	Yes	Yes	Yes

Estimates of the ATE of bundling on export intensity in columns 1–3 and coefficients of weighted linear regressions in columns 4–6. Significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. In columns 1–3 observations are weighted using sample weights as computed in Appendix. In columns 4–6 observations are weighted using PSM weights. Standard errors are clustered at the 2-digit NACE industry level in columns 4–6. lp^f_{kjt} is the logarithm of labour productivity of firm f is sector k and state j at time t. inv^f_{kjt} is a dummy equal to 1 if firm f belongs to sector k and state j and produces abroad at time t. rd^f_{kjt} is the share of R&D expenditure on turnover of firm f, in sector k and state j at time t. ϑ_k, ϑ_j, ϑ_m and ϑ_t are sector, state, size and time dummies.

6.3. Limitations and further research avenues

This study is a first step towards studying the links between selling integrated solutions and exporting performance. As such, it leaves ample room for further research. For example, our data does not distinguish product–service bundles by their level of technology or the type of service. Future research might expand our analysis by examining the heterogeneities within product–service bundles, and disentangling the technological and the service elements that enhance a firm's exporting capacity (La, Patterson, & Styles, 2005). For example, our data consists of only two waves and a reasonably large proportion of firms were surveyed twice, which provides the opportunity to control for firm-level unobservable factors. However, a longer time span would allow a deeper understanding of how bundling affects a firm's export performance over time, not least because it would allow for the implementation of a wider range of causal methods.

Empirically, if firm- and transaction-level data were to increasingly include longitudinal information on product–service bundling, one could, for instance, borrow from the international trade literature and study whether bundling has larger effects on the intensive margin

or on the extensive margin of trade. Moreover, having information about the buyers of the integrated solutions could help the theoretical characterization of this strategy in a buyer–seller repeated interaction setting. This would be particularly interesting in light of the emerging industrial organization literature, which shows that a seller's reputation is key to keeping demand when negative shocks hit (Macchiavello & Ameet, 2015).

Finally, while Germany is an ideal context for analysis, as it is one of the leaders of the fourth industrial revolution and in the implementation of hybrid offerings, future research should analyse bundling in a cross-country perspective that can extend our understanding of how business and institutional environments affect the relation between the employment of integrated solutions and export intensity. Again, if data were available, a lot could be borrowed from the international trade literature also in this case. Similarly, it is important to analyse whether other firm- and industry-level factors moderate or mediate this relation.

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Appendix. Weights

A weighting scheme has been set up to ensure the representativeness of the sample. We constructed the dataset for the German population of firms from the *Unternehmensregister*. For each wave we sampled firms based on classes of size and sectors. Following Altomonte and Aquilante (2012), two types of weights (relative and absolute) have been constructed. For each wave, the relative (rw) and absolute (aw) weights for the firms in sector j and size class m were built as follows.

$$rw^{km} = \frac{\frac{\varphi^{km}}{\varphi}}{\frac{\rho^{km}}{\rho}} \qquad aw^{km} = \left(\frac{\frac{\varphi^{km}}{\varphi}}{\frac{\rho^{km}}{\rho}}\right)\left(\frac{\varphi}{\rho}\right) \tag{A.1}$$

Here, φ^{km} is the number of firms in industry k and size class m for the population of German firms in a given wave and ρ^{km} is the number of firms in industry k and size class m in our sample. φ and ρ are the numbers of firms in the population and our sample, respectively.

The essential difference between relative and absolute weights is that for relative weights, the sum of the weights over the firms is equal to the total number of firms in the sample by wave, whereas for the case of absolute weights, the sum of the weights over the firms is equal to the total number of firms in the reference population. By construction, firms belonging to the same size/sector cell will share the same weights.

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