Product-service innovation and performance

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Product-service innovation and performance: unveiling the complexities

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Abstract: The purpose of this paper is to unveil the existing complexities in the relationship between Product-Service Innovation (*PSI*) –or servitization– and firm performance that arise from the mismatch between theoretical predictions and empirical evidence. Whilst theoretical work suggests that there are a number of advantages for implementing PSI, quantitative firm-level evidence is not conclusive about the positive effects of this type of innovation on firm performance. By reviewing the relevant publications dealing with the PSI-performance relationship, their methodological approach, the novel constructs validated, and the role of mediators/moderators found in the servitization literature, we argue that further contextualization is needed to solve this puzzle. Additionally, this work systematically organises the different methods and variables used to assess the PSI-performance link, guiding scholars on the choice between different methods and measures. This work enumerates various streams of future research to discover unexplored fields to better ground this relationship, including the development of solid configurational theories, appropriate fit between theory and measurement techniques, and new sampling strategies for performing longitudinal studies.

Keywords: Product-service innovation, Servitization, Performance.

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Abstract: The purpose of this paper is to unveil the existing complexities in the relationship between Product-Service Innovation (*PSI*) –or servitization– and firm performance that arise from the mismatch between theoretical predictions and empirical evidence. Whilst theoretical work suggests that there are a number of advantages for implementing PSI, quantitative firm-level evidence is not conclusive about the positive effects of this type of innovation on firm performance. By reviewing the relevant publications dealing with the PSI-performance relationship, their methodological approach, the novel constructs validated, and the role of mediators/moderators found in the servitization literature, we argue that further contextualization is needed to solve this puzzle. Additionally, this work systematically organises the different methods and variables used to assess the PSI-performance link, guiding scholars on the choice between different methods and measures. This work enumerates various streams of future research to discover unexplored fields to better ground this relationship, including the development of solid configurational theories, appropriate fit between theory and measurement techniques, and new sampling strategies for performing longitudinal studies.

Keywords: Product-service innovation, Servitization, Performance.

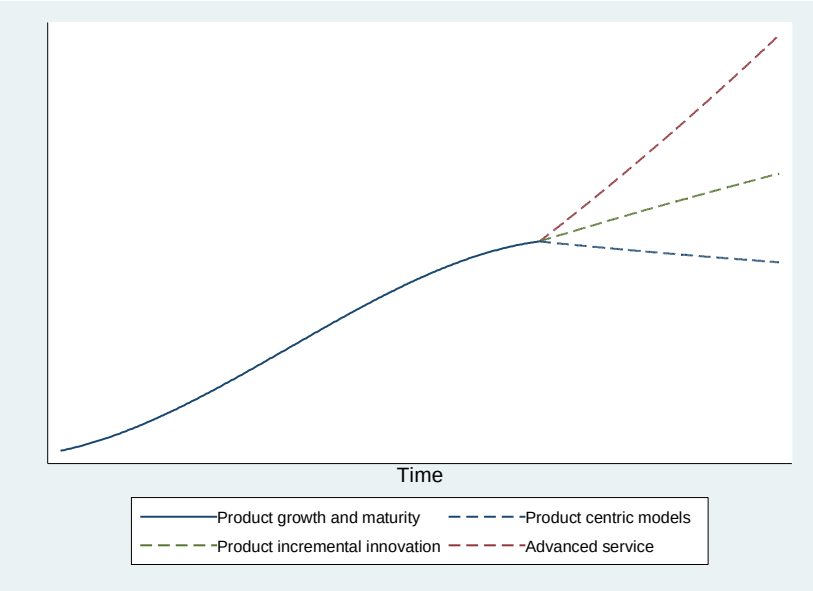
1 Introduction

Product-Service Innovation (PSI) –or *servitization*– has become a critical innovation strategy that is impelling firms to readjust their competitive edge and rearrange their organizational structure. Since Vandermerwe and Rada (1988, pp. 314) defined PSI as the increased "offerings of fuller market packages or bundles of customer-focussed combinations of goods, services, support, self-service, and knowledge", the analysis of the servitization phenomenon has proliferated in parallel with its increased presence in business reality (Baines et al. 2017; Oliveira and Azevedo, 2018). Since the late 1980s, firms realized the importance of adding service business models in order to capture additional value at the end of the value chain (Wise and Baumgartner, 1999). Some manufacturers such as IBM escaped from cost strategies by shifting from selling products to services, while others, such as Roll-Royce, have changed from transactional relationships to outcome-based contracts (Rabetino et al., 2018). By developing technology-enabled services and business models, firms want to see in their cash flows the value generated during the entire life cycle of the product and, ultimately, generate a long-term competitive advantage (Bustinza et al., 2015). The theoretical argument is presented in Figure 1. Products' market share may shrink once the product lifecycle matures and competitor's offer starts to be more attractive to consumers. At this point, to remain competitive, firms either implement incremental product innovations or embark on advanced services, the latter seen as the winning strategy in terms of revenues growth (Bustinza et al., 2017a; Cusumano et al., 2015).

Overall, PSI is a specific type of innovation and, from this standpoint, "is conceived as a means of changing the organization, either as a response to changes in the external environment or as a pre-emptive action to influence the environment" (Damapour, 1996, pp. 694). As any innovation, PSI seeks to create market driven products or services (Pleiss, 2007), either acting as a response to external environmental pressures (reactive

PSI) or to facility new market strategies (proactive PSI). Therefore, in general terms PSI affects producers, in manufacturing sectors and in other industries that offer fuller market packages of customer-oriented goods and services, with the objective to recover or achieve superior performance than competitors (Vendrell-Herrero et al., 2017). Bearing in mind the different research fields and industry contexts covered by PSI, this paper addresses the need of contextualizing and unveiling the complexities of the relationship between PSI and performance with the objective to shed light on the servitization-deservitization debate (Kowalkowski et al., 2017), and contribute to increase the consensus about the positive effect of PSI strategies on performance.

Figure 1. The service implementation dilemma



We provide a general overview of the different contexts affecting PSI-performance relationships by analysing the different quantitative approaches for collecting data and measuring PSI, following the linear and nonlinear relationships between PSI and performance found in the literature. Next, the PSI-performance relationship will be contextualized to different industries contexts, analysing a number of variables that may mediate or moderate this relationship. The article concludes by presenting a discussion and various proposals for future research.

2 Measuring PSI: quantitative approaches for collecting data

Originally, PSI was primarily analysed through the analysis of both inductive (to develop theory) and deductive (to put theory into effect) case studies. From these studies, PSI typologies were described –see the seminal papers by Mathieu (2001), Oliva and Kallenberg (2003), Davies (2004), or Tukker (2004), drivers and challenges analysed (Baines, 2009, Martinez et al., 2010), and implementation issues studied (i.e., Cenamor et al., 2017). Relevant literature reviews have repeatedly adapted the topic (Baines et al., 2009, 2017); however, the specific analysis of the PSI-performance relationship has gained increased scholarly attention during the last decade, and the results of these recent

research efforts are inconclusive. This debate has to be solved upon data-driven analysis, being the data requested similar to other quantitative analysis in the field of economics and business.

Basically, there are two types of data: primary and secondary. Primary data is mostly collected by surveys, where the link with the theoretical framework is operationalized by constructs and the relationships between them (Forza, 2002). Then, the target sample is defined and the data collection method selected. Following the data collection process, a verification of measurement quality is required, the data can be analysed, and hypotheses can be tested. Regarding PSI constructs (i.e. operational definitions of a variable), three are the most cited variables found in the literature. First, Partanen et al. (2017) developed a multidimensional scale that includes five constructs for operationalizing PSI in industrial contexts: Pre-sales, Product support, Product life-cycle, R&D, and Operational services. Second, Bustinza et al. (2017) operationalized PSI through two dimensions: Product-service development and Customer engagement. Third, Sousa and Silveira (2017) differentiate between Base and Advanced services' dimensions.

These studies used survey data, but there is an interesting and different approach to operationalize PSI through primary data collection. One example is the work of Visnjic and Van Looy (2013) who focus their analysis on forty-four national subsidiaries of a global manufacturing company transiting to PSI at different speeds during the 2001-2007 period. This unique approach adds a longitudinal perspective rarely seen in studies using primary data, but very popular in studies based on secondary data.

Secondary data is basically obtained through worldwide company databases such as Capital IQ, ORBIS, or Thomson ONE. These databases mostly report extensive margin (whether a resource is utilized or applied), while other databases, such as Compustat, include both extensive and intensive margins (the degree to which a resource is utilized or applied, in our context normally characterized by the percentage of service sales in product firms). Extensive margin in PSI can be identified by analysing keywords (Neely, 2008), which constitutes a useful tool for identifying those resources behind the PSI-performance relationship. Intensive margin is more suitable to analysing tendencies and measuring the intensity of resources for explaining PSI-performance relationship over time (Suarez et al., 2013). Finally, various national-level databases on innovation have proved themselves useful for unpacking the PSI-performance relationship: CIS (Community Innovation Survey) in Europe, BRDIS (Business R&D and Innovation Survey) in USA, etc. Although these surveys are popular to analyse product and process innovation (Cassiman et al. 2010), the specific analysis of service innovation in product firms based on these datasets remains largely unaddressed in academic research.

3 Linear and nonlinear relationships between PSI and performance

In this section we scrutinise the different types of PSI-performance relationships identified in the literature. In doing this we consider only studies that measure the intensive margin for PSI, either through latent or observed metrics. This exercise is important as it attempts to provide some nuances towards the gradual exposition to PSI (the so-called service journey or service infusion). Additionally, this section voluntarily neglects models proposing a negative relationship between PSI and performance as they do not match existing theoretical predictions and empirical evidence.

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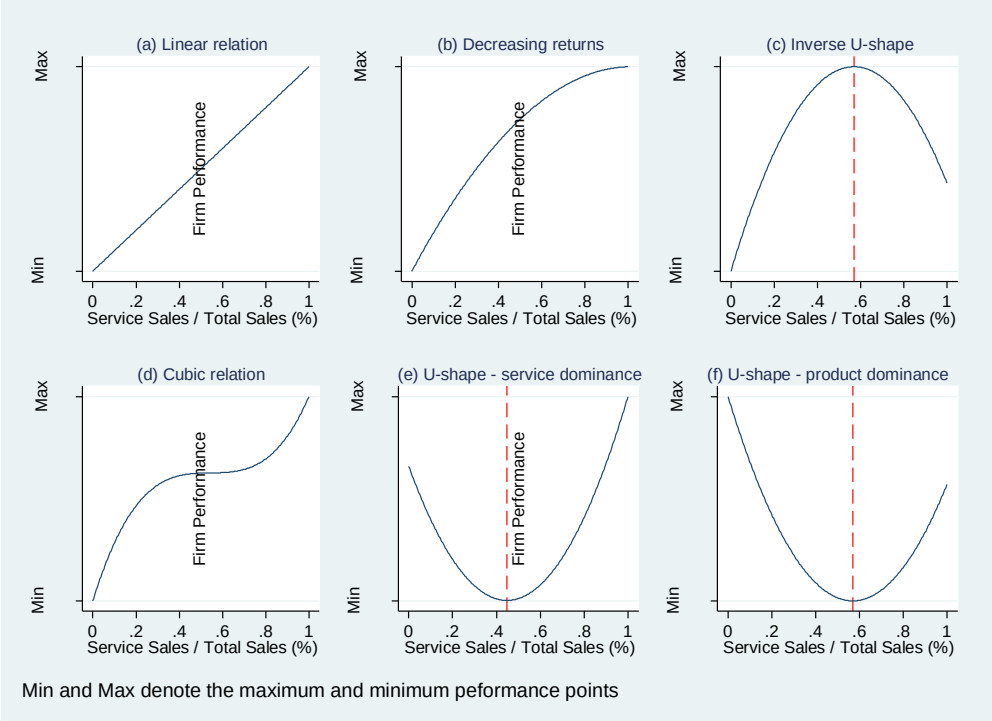
More concretely, Figure 2 summarizes the various relationships that can be observed between PSI and performance. Exhibit (2a) shows a positive and linear relationship between these variables (Belvedere et al., 2013: Bustinza et al., 2015; Crozet and Millet, 2017; Opazo et al., 2018; Szász et al., 2017), which points to an equally proportionate effect of service sales on performance, regardless the business' current service sales. One way of relaxing this assumption is to test for the presence of decreasing returns to PSI. This hypothesis has not been tested before but would be consistent with the learning curve view (Argote and Epple, 1990). The initial benefit of entering the service journey is higher than the benefit obtained once the firm has certain PSI experience. This relationship is depicted in Exhibit (2b).

Figure 2. Models of the relationship between PSI and firm performance.



To test the decreasing returns hypothesis is necessary to introduce a quadratic term in the regression model, and to obtain a positive parameter for the linear effect and a negative coefficient for the quadratic term. Under the assumptions that the PSI variable ranges from 0 and 1 (as shown in Figure 2) and that the estimated model has the following form: $Performance = \alpha + \beta_1 * PSI + \beta_2 * PSI^2 + \varepsilon$, the decreasing returns to PSI hypothesis will be confirmed if (i) $\beta_1 > 0$; (ii) $\beta_2 < 0$; and (iii) $\beta_1 > 2*(-\beta_2)$. If only (i) and (ii) hold ((iii) does not hold) we have a particular case of decreasing returns called inverse U-shaped (see Exhibit (2c)). In this situation there is an optimum point beyond which it is advisable not to increase PSI. There is no empirical evidence showing this type of relationship, but this effect is consistent with multi-product firms like Hitachi that serve a number of markets, some based on business-to-consumer (B-to-C) contracts that require little servicing if any (i.e. TV), while others are based on business-to-business (B-to-B) contracts that offer solutions rather than products (i.e. train). Another case of decreasing returns is provided by Visnjic and Van Looy (2013). Their results are

depicted in Exhibit (2d). These authors identify that PSI has decreasing returns up to a certain point beyond which the benefits of PSI grow exponentially. To accurately estimate this equation (i.e., cubic relationship) a cubic term for PSI is required.

Exhibits (2e) and (2f) depict other relationships between PSI and performance. On the hand, Exhibit (2e) presents a quadratic (U-shaped) relationship between PSI and performance, meaning that it is better to focus on either product-centric or service-centric business models. Mathematically this relationship will become evident if $\beta_1<0$ and $\beta_2 >0$. There are two variations of this relationship, and they basically differ on whether maximum performance is obtained when the firm is selling only services (Exhibit 2e) or only product (Exhibit 2f). Existing literature has identified cases for these two types of relationships. Suarez et al. (2013) show that IT companies maximize their profitability by selling only products, whereas Kohtamäki et al (2013), for the machinery industry, and Vendrell-Herrero et al. (2018a), for the music industry, find that companies maximize their profits by selling only services, or in other words selling the product through outcome base contracts or streaming business models.

4 PSI-performance methods and metrics

4.1 Performance in servitization (reviews)

After detailing quantitative approaches to evaluate the PSI-performance relationship and the plausible types of (linear and nonlinear) relationships that can arise, this section is devoted to recapitulate the PSI constructs found in the literature. In doing so, research is contextualized according to the quantitative approach used and the industry analysed. To help unveiling the complexities, research is grouped according to the analysed performance outcome. In this vein, some of the relevant literature reviews detailed the possible outcomes suitable to measure PSI processes. For instance, throughout a systematic literature review, some authors explain the service-related performance variables suitable to measure servitization efforts, particularly in the case of performance-based contracts (Glas et al., 2018) in which the service provider is paid according to the service performance, or in contexts of Advanced services (Bigdeli et al. 2018) in which the final service business models can be reached during the servitization journey. In the context of Product-Service Systems (PSS), an alternative definition of servitization, Mourtzis et al. (2016) develop a map of PSS evaluation approaches. Rabetino et al. (2017) define a strategy map of servitization that details Key Performance Indicators (KPI) suitable for benchmarking servitization processes. A similar approach was used by Pan and Nguyen (2015) in their analysis of the effect of these KPIs to measure PSI and achieve customer satisfaction.

4.2 Customer perspective

Besides the analysed literature reviews, some authors have analysed PSI strategies that are potentially conducive to superior performance. This is the case of Ambroise et al. (2017) who clarified that successful servitization strategies related to customer satisfaction have to take into account both value-adding services, appropriate activities as well as business models reconfiguration. In this tradition, authors measure PSS strategies using Likert scales that are quantitatively linked to performance. Structural equations models are used to evaluate if those successful strategies are responsible of the

relationship between PSI and financial performance. Kimita et al. (2009) incorporate customer satisfaction as a prerequisite for successfully designing PSS. For these authors, customer satisfaction with PSI is a mathematical function determined by Expectation, Quality, and Satisfaction, and measure customer experience before, during and after service encounters. The authors found that customer satisfaction is nonlinear and follows decreasing returns, and argued that customer satisfaction is a variable needed to feedback present and future PSS.

Bustinza et al. (2015) found that customer satisfaction is responsible of competitive advantage achievement for servitizing Manufacturing Multinational Enterprises (MMNEs). Additionally, the authors analysed the servitization continuum (e.g., Baines et al., 2017) as a product-service configuration with the following sequence: Base service (Service parts sales, and Extended warranty contracts), Intermediate service (Cost-plus service contracts, and Performance-based contracts), and Advanced services (Value-added services). These authors found that appropriate organizational structures are useful to reach different performance objectives, complementing previous studies that pointed out the necessity of creating a separate service unit for increasing service performance (Oliva et al., 2012). Finally, Bustinza et al. (2015) show that firms need to consider their position in the value chain before implementing PSI strategies, and that these strategies yield different outcomes according to the aforementioned positions.

4.3 General performance: market, financial, operational…

The servitization continuum framework from Base to Advanced services transiting by Intermediate services (Gebauer et al., 2005; Baines et al., 2017) is quite usual in the PSI-performance analysis as a way to explain that different value-adding services reflect different performance outcomes. That is the case of Sousa and da Silveira (2017). The authors validated the constructs of product-oriented services (BAS, base services) and co-creating value-in-use product-service (ADS, advanced services) and their effects on performance. They found a nonlinear relationship where BAS does not have a positive effect on financial performance. A similar approach was used by Szász and Seer (2018) to analyse the role of sustainability pressure in the PSI-performance relationship, and by Li et al. (2018) who found a positive and linear relationship between PSI and performance where organizations' decision-making features act as moderators. Tukker (2004) analyse the Base—Intermediate—Advanced services framework from a different perspective in which the service continuum is considered a product-oriented—use-oriented—result-oriented services. Building on this framework, Li et al. (2015) found a nonlinear relationship (a U-shape) between servitization and product-per-capita, in which service intensity (level of service reached) acts as moderator of the relationship. Interestingly, service intensity was measured through manufacturing industry codes. This methodological approach to measure PSI by industry codes has been used in recent work, including Gomes et al. (2018) who study the capacity of regions to servitize, Opazo et al. (2018) who analyze Digital and Green servitization, Crozet and Milet (2017) who evaluate industry heterogeneity and the positive effect of servitization in profitability, employment and total sales, and Szász et al. (2017) who found a linear relationship between PSI and performance with service provision acting as moderator.

Other moderators found in the literature are the role of knowledge-intensive services (KIBS) and R&D intensity, as proposed by Bustinza et al. (2017) in their Structural Equations Modelling (SEM) analysis. Additionally, they assessed performance

via financial and organizational measures, and validate a PSI construct incorporating a set of items related to the product-service continuum: Product innovation, Updated product lifecycle, Product–service alignment, and Service feedback and analytics. Other authors using moderators in the relationship between environmental variables and strategic choices are Ceci and Masini (2011) who use productivity as performance outcome. Belvedere et al. (2013) analysed the moderating effect of Information and Comunication Technology (ICT) in the linear relationship between PSI and performance using a SEM approach. Finally, Valtakoski and Witell (2018) considered firm age as moderator using a service continuum categorization of Back-office vs. Front-offices.

Finally, studies analysing the PSI-performance relationship in specific industries include Suarez et al. (2013) who found a U-shape relationship in the software industry and the highest performance in pure product or pure service offerings, that is, at each end of the product-service continuum. Also, Visnjic and Van Looy (2013) found a cubic relationship between PSI and performance. Visnjic and Van Looy (2013) analysed the servitization journey of a global manufacturing firm contextualized to its 44 national subsidiaries. They found increasing-decreasing-increasing returns during the 2001-2007 period. Interestingly, they found that customer proximity acts as moderator of the relationship, highlighting the importance of customer orientation on PSI successful implementation. The outcome (performance) variable is profitability and though this type of performance is widely used in prior work, others authors employ other performance variables (e.g., productivity, innovation performance, survival, or exports).

4.4 Productivity

Sustainability has attracted the interest of PSI researches, specifically in the Scandinavian schools that consider PSS analysis contextualized to sustainability and the impact of servitization in the environment (Baines et al., 2009). In this tradition, and as explained above, Opazo et al. (2018) contribute by introducing an interesting variable related to the impact of PSI on the environment, namely *Green servitization*. Similar to Gomes et al. (2018), this variable is measured through the classification used to identify manufacturers' sustainable activities: NAICS codes 56 "Administrative and Support and Waste Management and Remediation Services" and 811 "Repair and Maintenance". Opazo et al. (2018) found a linear relationship between PSI and performance, using a novel and interesting outcome variable: Productivity.

4.5 Other outcome variables: innovation performance, market knowledge, survival, and exports

Chen et al. (2016) measured the effect of service innovation in new product performance considering two moderators (i.e., market linking capabilities and market turbulence) that increase the positive effect of service innovation. On contrary, Kroh et al. (2018) consider PSI as a moderator that enhances the positive relationship between Information Technology (IT) and market knowledge. As a novelty, these authors offers an index to calculate the degree of servitization by using the mean-centred average scores across all the services offered by the focal industry to calculate the relative intensity of a particular organization.

The work by Ariu (2016a) opened interesting research avenues in two main directions. On one hand, the authors analyse how PSI increases resilience on

manufacturing firms during the 2008-2009 collapse. This positive effect of PSI is also analysed by Böhm et al. (2017) who showed how PSI is a valuable option for manufacturing firms with deteriorating financial performance. On the other hand, Ariu et al. (2016a) and more recently Li et al. (2018), analyse how PSI increases manufacturing exports. This research line opens an interesting approach to contextualize PSI within the International Business field, where Vendrell-Herrero et al. (2018b) demonstrated how cross-border strategic alliances increase the positive PSI-performance relationship. Also, Kamp and Ruiz de Apodaca (2017) found evidence that KIBS are beneficial to international business performance. Finally, the role of KIBS in understating the complexities behind PSI-performance relationship is a topic of increased interest that has inspired recent work (Bustinza et al., 2017; Gomes et al., 2018; Lafuente et al., 2017).

Table 1. PSI-performance relationship and metrics

		Type of relationship		
		Linear	*Non-linear*	*Contextual*
Type of performance	*Financial*	Yes	Yes	Yes
	Productivity	Yes	No	No
	Survival	Yes	No	No
	KPI	Yes	No	Yes
	Patents	No	No	No
	Exports	Yes	No	No

5 Illustrating some contextual nuances

The previous section emphasized the importance of contextualizing the relationship between PSI and performance. In many occasions this contextualization is analysed at industry level; however, contextual results may well be found at other levels of analysis, including firm size (i.e. MNEs vs. SMEs), country characteristics (i.e. Developed vs. Emerging economies), firm strategy (i.e. Make vs. Buy) or type of service offered (i.e. Green vs. Digital). The section seeks to illustrate graphically a number of these context specificities.

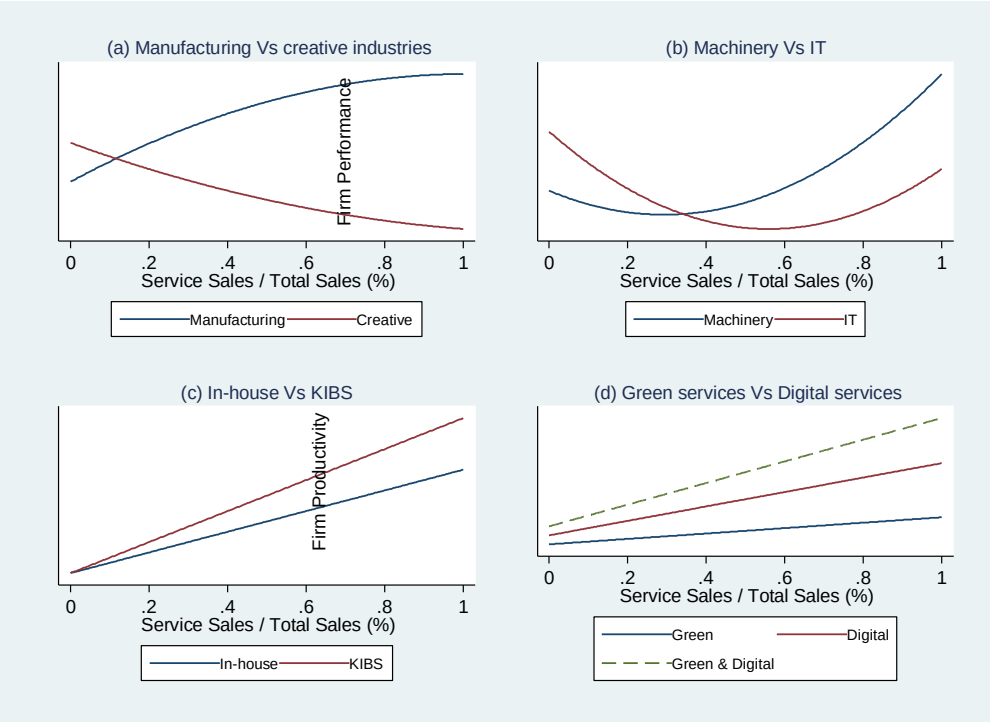
Figure 3 presents four contextual relations identified in the literature. Exhibit (3a) compares the evolution of revenues of two types of product-centred industries moving into services. Most of the narrative explaining the PSI-performance link with manufacturing seems to suggest that there is a positive relation (represented in the figure with decreasing returns), whereas this relation takes the opposite sign when is explored in creative industries, such as the music and publishing industries in which firms have moved from selling products (i.e CDs or books) to selling services (i.e. streaming or ebooks). In these sectors, the results of this transition have found to be very negative (Bustinza et al, 2013; Liebowitz, 2008; Myrthianos et al., 2014; Vendrell-Herrero et al., 2017). This is reflected in exhibit (3a) with a downward (concave) curve.

Another contextual difference emerges from the comparison of the work by Suarez et al. (2013) and Kohtamäki et al. (2013). Exhibit (3b) replicates the relationship between performance and service-to-total sales found in both articles. The two studies analyse different industries and countries: whilst Suarez et al., (2013) focuses on IT firms from the US; Kohtamäki et al. (2013) study firms producing machines in Finland. Both articles report a U-shaped relationship between PSI and performance but the resulting trajectories are considerably different. We propose two arguments to explain

the dissimilar trajectory patterns. First, whilst for firms in the IT industry the optimal decision is to stay as product sellers, the best decision for firms in the machinery industry is to sell the use of the product/machine (service) rather than to sell the product itself (product). In a closely related manner, the second difference in these curves is the point in which they reach the minimum profit: for firms in the machinery industry this occurs when firms sell 25-30% of services, whereas firms in the IT industry seem to have a negative relation between PSI and performance until service sales represent 55-60% of their revenues.

By comparing the PSI-profit relationship for firms developing the service function in-house or through concentric partnerships with Knowledge Intensive Business Services (KIBS), Exhibit (3c) shows an example of the strategic contextualization. The recent work by Bustinza et al. (2017) shows the moderating role of the Make-or-Buy decision in a model that considers a linear relationship between PSI and profits. Although both strategic options are positively related to performance, the authors' core finding is that partnering with KIBS outperforms the development of the service function in-house. This finding is important because it reveals that the role of KIBS in the economy goes beyond the black box, and that KIBS firms have the capacity to influence territorial economic development (Lafuente et al., 2017).

Figure 3. Illustration of some industry and strategy types of contextualization



The type of service commercialized is another context specific setting that we illustrate in Exhibit (3d) in Figure 3. In particular, we look at the research conducted by Opazo et al (2018). This work distinguishes between digital (i.e. digital platforms for premium customer experience, digital prototyping to optimize decision making…) and green (i.e. eco-driving service, sustainability recognition service…) services in the automotive industry, and link these two types of services to labour productivity at the

firm level. Interestingly, green services do not increase firm productivity[1], whereas digital services do have a positive impact of productivity. However, both types of services seem to have synergetic effects, and when both services are jointly offered firms seem to have higher levels of productivity. This effect is presented in exhibit (3d) with a steeper slope in the positive relationship between PSI and productivity.

6 Conclusions

6.1 Theoretical contribution

In this study, we propose that there is no "general theory" that explains the relationship between PSI and performance; however, we argue that there is a way for unveiling the complexities underlying this relationship. This study presented in this research helps to better frame and measure the PSI-performance relationship from a methodological perspective by reporting available constructs, as well as moderating and mediating variables found in the literature. The overwhelming majority of empirical work on the PSI-performance relationship is cross-sectional in nature, which highlights the need to further develop this research stream through longitudinal studies that incorporate control variables and analyse changes in performance outcomes over time. But methodological issues are not the only aspect of PSI-performance analyses that has to be improved.

The development of solid configuration-based theories is an aspect that deserves further attention by researchers interested in enhancing the fit between theory and measurement issues. This type of analysis will help to integrate theory and empirical research and to consolidate broad patterns of the PSI-performance relationship. The resource-based view (RBV) theory of the firm focuses on how the exploitation of unique resources, as those generated by PSI, contributes to produce a hard-to-imitate competitive advantage in the long run. The dynamic capabilities view explains how firms achieve superior performance by promoting specific dynamic capabilities such as new product –or services– development or by managing strategic alliance –see, e.g., Bustinza et al. (2017) who show how KIBS alliances increase PSI-performance outcome. Transaction Cost Theory deals with the cost of increasing process of information management suffered by servitizing manufacturers. Finally, the service-dominant logic helps to understand the increasing contextual variety produced as manufacturers move from base to advanced services value propositions (Smith et al., 2014). These, and other theories, have shown to be related to PSI, and the analysis of PSI through the lenses of these theoretical approaches can help to shed light on the complexities inherent to the relationship between PSI and performance.

Finally, this study offers novel approaches to understanding the PSI-performance relationship by uncovering proximal and distal outcomes related to market, operational, financial and customer performance; while opening interesting avenues connected to other PSI-performance outcomes, including, for example, innovation, market knowledge, exports, and firm survival. This contribution will help businesses to better benchmark their PSI objectives according to the context, and understand the risks associated with this type of innovations that is increasingly implemented in different industries.

[1] It must be noticed that the parameter estimated in the article is positive and therefore we represent an upward sloping curve for green services in exhibit (3d).

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