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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 servitisation – 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 servitisation literature, we argue that further contextualisation 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; PSI; servitisation; performance.

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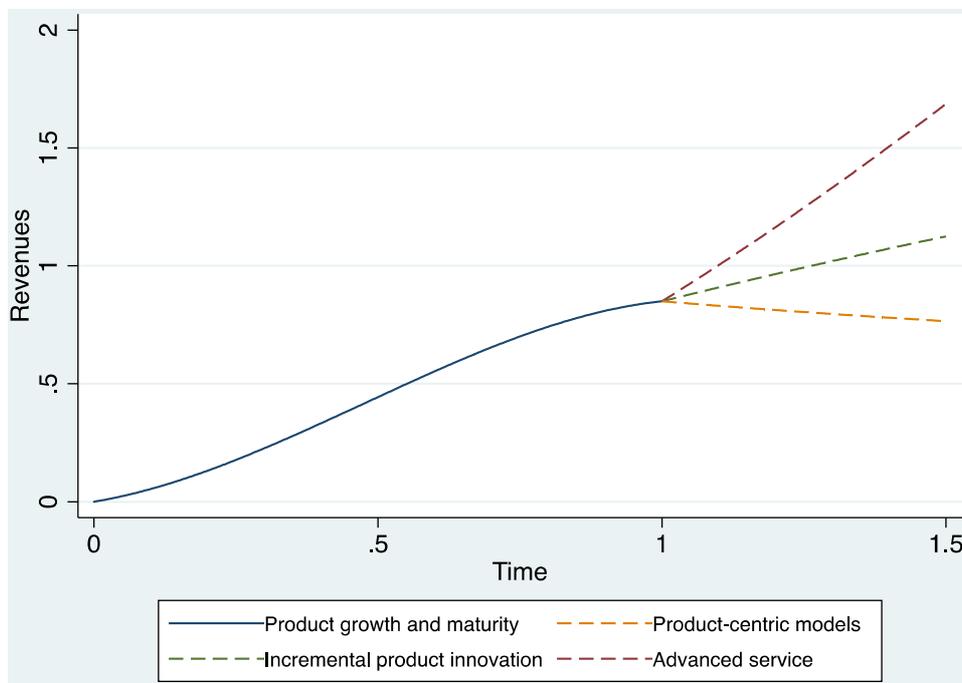
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## 1 Introduction

Product-service innovation (PSI) – or *servitisation* – has become a critical innovation strategy impelling firms to readjust their competitive edge and rearrange their organisational structure. Since Vandermerwe and Rada (1988, p.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”, analysis of the servitisation 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 have realised the importance of adding service business models to capture

additional value at the end of the value chain (Wise and Baumgartner, 1999). Some manufacturers (e.g., IBM) avoided being limited to cost strategies by shifting from selling products to services, while others (e.g., Roll-Royce) 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 lifecycle of the product and ultimately, to 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 competitors' offerings begin to be more attractive to consumers. To remain competitive at this point, firms must either implement incremental product innovations or embark on advanced services (ADS), the latter being seen as the winning strategy in terms of revenue growth (Bustinza et al., 2017a; Wang et al., 2018).

**Figure 1** The service implementation dilemma (see online version for colours)



Overall, PSI is a specific type of innovation. From this standpoint, it “is conceived as a means of changing the organisation, either as a response to changes in the external environment or as a pre-emptive action to influence the environment” [Damanpour, (1996), p.694]. Like any innovation, PSI seeks to create market-driven products or services (Plessis, 2007), acting either as a response to external environmental pressures (reactive PSI) or as a means to facilitate new market strategies (proactive PSI). In general terms, therefore, PSI affects producers in manufacturing sectors and in other industries that offer fuller market packages of customer-oriented goods and services in order to recover or achieve better 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 to contextualise and identify the complexities of the relationship

between PSI and performance in order to shed light on the servitisation-deservitisation debate (Kowalkowski et al., 2017) and contribute to strengthening consensus on the positive effect of PSI strategies on performance.

We provide a general overview of the various contexts affecting PSI-performance relationships by analysing the different quantitative approaches to collecting data and measuring PSI, following the linear and nonlinear relationships between PSI and performance in the literature. Next, we contextualise the PSI-performance relationship in different industry 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 to collecting data**

Originally, PSI was analysed primarily through case studies, both inductive (to develop theory) and deductive (to put theory into effect). From these studies, PSI typologies were described – see the seminal papers by Mathieu (2001), Oliva and Kallenberg (2003), Davies (2004) and Tukker (2004) – drivers and challenges analysed (Baines et al., 2009; Martinez et al., 2010) and implementation issues studied (i.e., Cenamor et al., 2017). Although relevant literature reviews have adapted the topic repeatedly (Baines et al., 2009, 2017), 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 must be resolved using data-driven analysis, in which the data required are similar to other quantitative analysis in the field of economics and business.

Two fundamental types of data exist: primary and secondary. Primary data are collected primarily by surveys and the link to the theoretical framework operationalised by constructs and the relationships between them (Forza, 2002). The target sample is then defined and the data collection method selected. Following data collection, measurement quality must be verified, the data analysed and hypotheses tested. Three constructs of PSI (i.e., operational definitions of a variable) are the variables most cited in the literature. First, Partanen et al. (2017) developed a multidimensional scale that includes five constructs for operationalising PSI in industrial contexts: pre-sales, product support, product lifecycle, R&D and operational services. Second, Bustinza et al. (2017b) operationalised PSI through two dimensions: product-service development and customer engagement. Third, Sousa and da Silveira (2017) differentiated between base and ADS dimensions.

These studies use survey data, but operationalising PSI through primary data collection requires to interesting and different approach. One example is the study by Visnjic and Van Looy (2013), who focus analysis on 44 national subsidiaries of a global manufacturing company transitioning to PSI at different speeds during period 2001–2007. 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 are basically obtained through worldwide company databases such as Capital IQ, ORBIS and Thomson ONE. These databases mostly report extensive margin (whether a resource is utilised or applied). Other databases, such as Compustat, include both extensive and intensive margins (the degree to which a resource is utilised or

applied, in our context usually characterised by the percentage of service sales in product firms). Extensive margin in PSI can be identified by analysing keywords (Neely, 2008), a useful tool for identifying the resources behind the PSI-performance relationship. Intensive margin is more suitable for analysing tendencies and measuring intensity of resources to explain the PSI-performance relationship over time (Suarez et al., 2013). Finally, various national-level databases on innovation prove useful for unpacking the PSI-performance relationship: community innovation survey (CIS) in Europe, business R&D and innovation survey (BRDIS) in the USA, etc. Although these surveys are popular for analysing 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

This section scrutinises the different types of PSI-performance relationships identified in the literature, considering only studies that measure intensive margin for PSI, through either latent or observed metrics. This exercise is important because it attempts to provide some nuance in the implementation of PSI (the so-called service journey or service infusion). This section deliberately omits models proposing a negative relationship between PSI and performance, as they do not match existing theoretical predictions and empirical evidence.

Figure 2 summarises the various relationships observed between PSI and performance. Figure 2(a) shows a positive and linear relationship between these variables (Belvedere et al., 2013; Bustinza et al., 2015; Crozet and Milet, 2017; Opazo et al., 2018; Szász et al., 2017), indicating a similarly proportional 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 on 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 embarking on the service journey is higher than the benefit obtained once the firm has some PSI experience. This relationship is depicted in Figure 2(b).

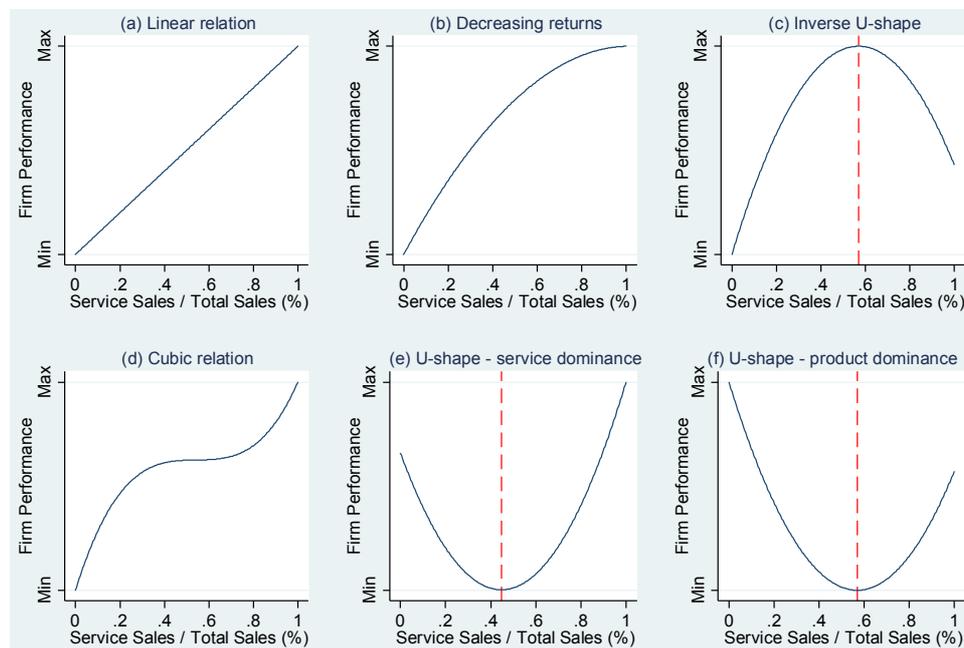
Testing the decreasing returns hypothesis requires introducing a quadratic term in the regression model and obtaining a positive parameter for the linear effect and a negative coefficient for the quadratic term. Under the assumptions that the PSI variable ranges from 0 and 1 (as shown in Figure 2) and the estimated model takes the form  $performance = \alpha + \beta_1 * PSI + \beta_2 * PSI^2 + \varepsilon$ , the decreasing returns to PSI hypothesis will be confirmed if:

- 1  $\beta_1 > 0$
- 2  $\beta_2 < 0$
- 3  $\beta_1 > 2 * (-\beta_2)$ .

If only (1) and (2) hold [(3) does not hold], we have a specific case of decreasing returns termed inverse U-shape [Figure 2(c)]. This situation indicates an optimum point beyond which it is advisable not to increase PSI. No empirical evidence demonstrates this type of relationship, but the 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 (e.g., TV) and others based on business-to-business (B-to-B) contracts that offer solutions rather than products (e.g., trains). Another case of decreasing returns is provided by Visnjic and Van Looy (2013), whose results are depicted in Figure 2(d). These authors find that PSI has decreasing returns up to a certain point, beyond which the benefits of PSI grow exponentially. Estimating this equation (i.e., cubic relationship) accurately requires a cubic term for PSI.

**Figure 2** Models of the relationship between psi and firm performance (see online version for colours)



Note: Min. and max. denote the maximum and minimum performance points.

Figures 2(e) and 2(f) depict other relationships between PSI and performance. Figure 2(e) presents a quadratic (U-shape) relationship between PSI and performance, suggesting 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  $\beta_2 > 0$ . Two variations of this relationship exist and they differ essentially based on whether maximum performance is obtained when the firm is selling only services [Figure 2(e)] or only products [Figure 2(f)]. The literature has identified cases for these two types of relationships. Suarez et al. (2013) show that information technology (IT) companies maximise their profitability by selling only products, whereas Kohtamäki et al. (2013) and Vendrell-Herrero et al. (2018a) find, for the machinery and the music industry, respectively, that companies maximise their profits by selling only services, in other words, selling the product through outcome-based contracts or streaming business models.

## 4 PSI-performance methods and metrics

### 4.1 Performance in servitisation (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 summarises the PSI constructs found in the literature. In doing so, it contextualises the research according to quantitative approach used and industry analysed. To help to elucidate the complexities, existing studies are grouped according to the performance outcome analysed. Some of the relevant literature reviews detail the possible outcomes suitable for measuring PSI processes. For instance, through a systematic literature review, some authors explain the service-related performance variables suitable for measuring servitisation efforts, particularly in the case of performance-based contracts (Glas et al., 2018), in which the service provider is paid according to service performance and in contexts of ADS (Bigdeli et al., 2018), in which the final service business models can be achieved during the servitisation journey. In the context of product-service systems (PSS) – an alternative definition of servitisation – Mourtzis et al. (2016) develop a map of PSS evaluation approaches. Rabetino et al. (2017) define a strategy map of servitisation that details key performance indicators (KPIs) suitable for benchmarking servitisation processes. In their analysis of the effect of these KPIs, Pan and Nguyen (2015) use a similar approach to measure PSI and achieve customer satisfaction.

### 4.2 Customer perspective

In addition to the literature reviews analysed, some authors have studied PSI strategies potentially conducive to superior performance. This is the case of Ambroise et al. (2017), who clarify that successful servitisation strategies related to customer satisfaction must take into account both value-adding services and appropriate activities, as well as business model reconfiguration. In this research line, authors measure PSS strategies using Likert scales that are quantitatively linked to performance. Structural equations models are used to evaluate whether those successful strategies are responsible for 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 this function measures customer experience before, during and after service encounters. Finding that customer satisfaction is nonlinear and follows decreasing returns, the authors argue that customer satisfaction is a variable needed to provide feedback on present and future PSS.

Bustinza et al. (2015) find that customer satisfaction is responsible for achievement of competitive advantage in servitising manufacturing multinational enterprises (MMNEs). The authors also analyse the servitisation continuum (e.g., Baines et al., 2017) as a product-service configuration using the following sequence: base service (BAS) (service parts sales and extended warranty contracts), intermediate service (cost-plus service contracts and performance-based contracts) and ADS (value-added services). The authors find that appropriate organisational structures are useful for achieving different performance objectives, their results complementing previous studies that indicate the need to create a separate service unit to increase service performance (Oliva et al., 2012). Finally, Bustinza et al. (2015) show that firms must consider their position in the

value chain before implementing PSI strategies and that these strategies yield different outcomes based on the aforementioned positions.

### *4.3 General performance: market, financial, operational, etc.*

The servitisation continuum from base to ADS via intermediate (Baines et al., 2017) is a framework commonly used in PSI-performance analysis to explain how different value-adding services affect different performance outcomes. Sousa and da Silveira (2017), for example, validate the constructs of product-oriented services (BAS) and co-creating value-in-use product-service (ADS), as well as their effects on performance. The authors find a nonlinear relationship in which BAS do not have a positive effect on financial performance. Szász and Seer (2018) use a similar approach to analyse the role of sustainability pressure in the PSI-performance relationship, as do Li et al. (2018a), finding a positive and linear relationship between PSI and performance in which organisations' decision-making features act as moderators. Tukker (2004) analyses the base-intermediate-ADS framework from a different perspective, in which the service continuum is considered as product-oriented–use-oriented–result-oriented services. Building on this framework, Li et al. (2015) find a nonlinear relationship (U-shape) between servitisation and product-per-capita, in which service intensity (level of service reached) acts as a moderator in the relationship. Interestingly, this study measures service intensity through manufacturing industry codes. This methodological approach to measuring PSI by industry codes has been used in recent work, including Gomes et al. (2018), who study the capacity of regions to servitise; Opazo et al. (2018), who analyse digital and green servitisation; Crozet and Milet (2017) who evaluate industry heterogeneity and the positive effect of servitisation on profitability, employment and total sales; and Szász et al. (2017) who find a linear relationship between PSI and performance with service provision acting as moderator.

Other moderators found in the literature are knowledge-intensive services (KIBS) and R&D intensity, proposed by Bustinza et al. (2017b) in their structural equations modelling (SEM) analysis. These authors also assess performance via financial and organisational 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. Ceci and Masini (2011) use operational environment variables as moderators in the PSI-performance relationship, employing productivity as the performance outcome. Belvedere et al. (2013) analyse the moderating effect of information and communication technology in the linear relationship between PSI and performance using a SEM approach. Finally, Valtakoski and Witell (2018) consider firm age as moderator using a service continuum categorisation of back-office vs. front-office services.

Finally, studies analysing the PSI-performance relationship in specific industries include Suarez et al. (2013), who find 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. Visnjic and Van Looy (2013) find a cubic relationship between PSI and performance. The same study analyses the servitisation journey of a global manufacturing firm contextualised among its 44 national subsidiaries and finds increasing-decreasing-increasing returns during the 2001–2007 period. Interestingly, the study also finds that customer proximity moderates in the relationship, highlighting the

importance of customer orientation in successful PSI implementation. It uses the outcome (performance) variable profitability. Although this type of performance is widely used in prior work, other authors employ different performance variables (e.g., productivity, innovation performance, survival or exports).

#### 4.4 Productivity

Sustainability has attracted the interest of PSI research, specifically in Scandinavian schools, which consider PSS analysis as understood in the context of sustainability and the impact of servitisation on 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 – *green servitisation*. As in 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) find 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) measure the effect of service innovation on new product performance, considering two moderators (market linking capabilities and market turbulence) that increase the positive effect of service innovation. In contrast, Kroh et al. (2018) consider PSI as a moderator that enhances the positive relationship between IT and market knowledge. These authors innovate in providing an index to calculate degree of servitisation by using the mean-centred average scores across all services provided by the focal industry to calculate the relative intensity of servitisation in a particular organisation.

**Table 1** PSI-performance relationship and metrics

		<i>Type of relationship</i>		
		<i>Linear</i>	<i>Nonlinear</i>	<i>Contextual</i>
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

The work by Ariu (2016a) opened interesting research avenues in two main directions. On the one hand, the authors analysed how PSI increased resilience in manufacturing firms during the 2008–2009 collapse. Böhm et al. (2017) also analyse this positive effect of PSI to show that PSI is a valuable option for manufacturing firms with deteriorating financial performance. On the other hand, Ariu (2016b) and more recently, Li et al. (2018b) analyse how PSI increases manufacturing exports. This research line opens an interesting approach to contextualising PSI within international business, where

Vendrell-Herrero et al. (2018b) demonstrate how cross-border strategic alliances increase the positive PSI-performance relationship. Further, Kamp and Ruiz de Apodaca (2017) find evidence that KIBS benefit international business performance. Finally, the role of KIBS in understanding the complexities of the PSI-performance relationship is a topic of increasing interest that has inspired recent study (Bustinza et al., 2017b; Gomes et al., 2018; Lafuente et al., 2017).

## 5 Illustrating some contextual nuances

The previous section emphasised the importance of contextualising the relationship between PSI and performance. Although contextualisation is frequently analysed at industry level, results may 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) and type of service provided (i.e., green vs. digital). The section seeks to illustrate graphically a number of these context specificities.

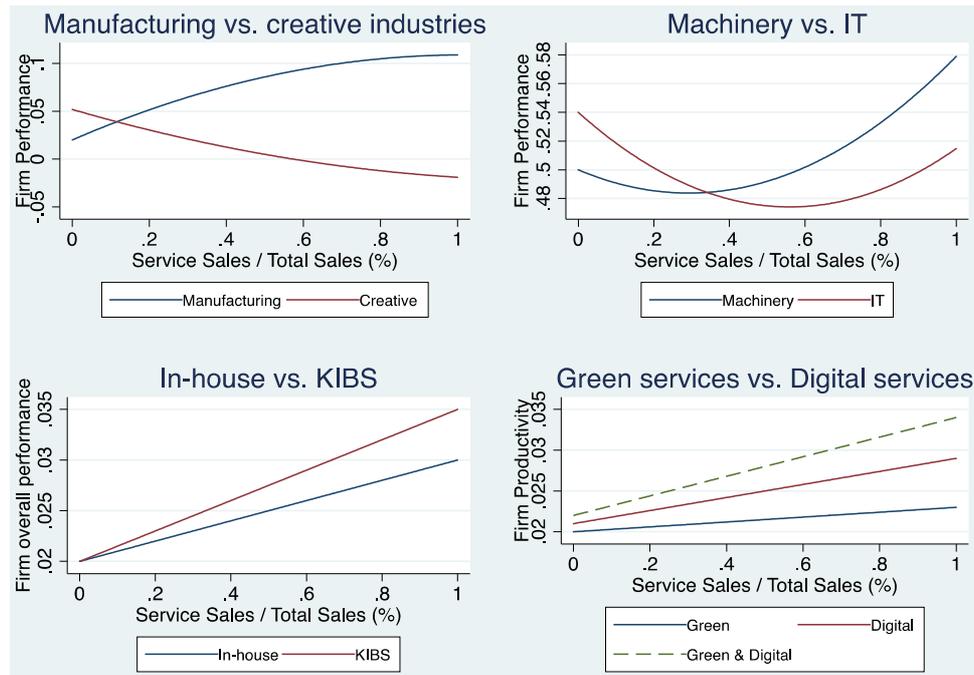
Figure 3 presents four contextual relations identified in the literature. Figure 3(a) compares the evolution of revenues from two types of product-centred industries moving into services. Most of the narrative explaining the PSI-performance link with manufacturing seems to suggest a positive relation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

Another contextual difference emerges from the comparison of Suarez et al. (2013) and Kohtamäki et al. (2013). Figure 3(b) represents the relationship between performance and service-to-total sales in both articles. The two studies analyse different industries and countries. Whereas Suarez et al. (2013) focus on IT firms from the USA and Kohtamäki et al. (2013) study machinery manufacturers in Finland. Both articles report a U-shape relationship between PSI and performance, but the resulting trajectories are considerably different. We propose two arguments to explain the dissimilar patterns. First, while the optimal decision for firms in the IT industry is to remain product sellers, the best decision for firms in the machinery industry is to sell the use of the product/machine (service) rather than the product itself (product). The second, very closely related difference in these curves is the point at which they reach minimum profit. For firms in the machinery industry, this point occurs when the firms sell 25%–0% of services. Firms in the IT industry seem, however, to have a negative relation between PSI and performance until service sales represent 55%–60% of their revenues.

Figure 3(c) presents an example of the strategic contextualisation by comparing the PSI-profit relationship for firms developing the service function in-house vs. through concentric partnerships with KIBS. The recent study by Bustinza et al. (2017b) 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 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 types of contextualisation by industry and strategy (see online version for colours)



Type of service commercialised is another context-specific setting, illustrated in Figure 3(d). We examine specifically the research conducted by Opazo et al. (2018), which distinguishes between digital services (digital platforms for premium customer experience, digital prototyping to optimise decision-making, etc.) and green services (eco-driving service, sustainability recognition service, etc.) in the automotive industry, linking these two types of services to labour productivity at the firm level. Interestingly, green services do not increase firm productivity<sup>1</sup>, but digital services have a positive impact on productivity. These two types of service seem to have synergetic effects, however, leading to higher productivity levels when firms offer both services together. Figure 3(d) represents this effect by a steeper slope in the positive relationship between PSI and productivity.

## 6 Conclusions

### 6.1 Theoretical contributions

This study proposes that there is no ‘general theory’ to explain the relationship between PSI and performance but argues that there is a way to reveal the complexities underlying this relationship. The study presented here improves framing and measurement of the

PSI-performance relationship from a methodological perspective by synthesising the available constructs, as well as the moderating and mediating variables found in the literature. The overwhelming majority of empirical work on the PSI-performance relationship is cross-sectional, highlighting the need to develop this research stream further through longitudinal studies that incorporate control variables and analyse changes in performance outcomes over time.

Methodological issues are not the only aspect of PSI-performance analyses in need of improvement. Solid configuration-based theories must also be advanced through research that enhances the fit between theory and measurement. Such analysis will help to integrate theory and empirical research and to consolidate the broad patterns of the PSI-performance relationship. The resource-based view (RBV) theory of the firm focuses on how exploitation of unique resources, such as those generated by PSI, contributes to producing 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 service – development or by managing strategic alliances – see, for example, Bustinza et al. (2017b), who show how KIBS alliances increase PSI-performance outcomes. Transaction cost theory analyses the cost of the increasingly complex process of information management that plagues servitising manufacturers. Finally, service-dominant logic helps to advance understanding of the increasing contextual variety generated as manufacturers move from base to ADS value propositions (Smith et al., 2014). These and other theories have been shown to be related to PSI and analysis of PSI through the lenses of these theoretical approaches can help to shed light on the complexities inherent in the relationship between PSI and performance.

Finally, this study provides novel approaches to understanding the PSI-performance relationship by uncovering proximal and distal outcomes related to market, operational, financial and customer performance. The study also opens interesting avenues connected to other PSI-performance outcomes, including, for example, innovation, market knowledge, exports and firm survival. This contribution will help businesses to improve benchmarking of their PSI objectives according to context and to understand the risks associated with this type of innovation, which is being implemented increasingly in different industries.

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## **Notes**

- 1 Note that the parameter estimated in the article is positive and thus shows an upward-sloping curve for green services [Figure 3(d)].