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Product-service innovation and performance: The role of collaborative partnerships and R&D intensity

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Abstract

Treating the intersection of the strategic partnerships, R&D intensity and servitization literatures, this study explores empirically whether external collaborative service development and provision, and industrial R&D intensity help to unpack the complex relation between product-service innovation (servitization) and performance. We argue that manufacturing firms implementing services benefit from strategic partnerships with Knowledge-Intensive Business Service (KIBS) firms. KIBS partnering provides opportunities for downsizing, externalising risks and sharing knowledge. Additionally, manufacturers in R&D-intensive industries are more likely to benefit from implementing service provision than firms in other sectors because of industry dynamics and reduced customer uncertainty. The study surveys executives in 370 large manufacturers worldwide. Results reinforce the importance of concentric strategic partnerships to successful product-service innovation in high-R&D industries.

Key words: Service innovation, performance, strategic partnership, R&D intensity

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Product-service innovation and performance: The role of collaborative partnerships and R&D intensity

Abstract

Treating the intersection of the strategic partnerships, R&D intensity and servitization literatures, this study explores empirically whether external collaborative service development and provision, and industrial R&D intensity help to unpack the complex relation between product-service innovation (servitization) and performance. We argue that manufacturing firms implementing services benefit from strategic partnerships with Knowledge-Intensive Business Service (KIBS) firms. KIBS partnering provides opportunities for downsizing, externalising risks and sharing knowledge. Additionally, manufacturers in R&D-intensive industries are more likely to benefit from implementing service provision than firms in other sectors because of industry dynamics and reduced customer uncertainty. The study surveys executives in 370 large manufacturers worldwide. Results reinforce the importance of concentric strategic partnerships to successful product-service innovation in high-R&D industries.

Key words: Service innovation, performance, strategic partnership, R&D intensity

1. Introduction

In industries with fast-changing technologies, strategic alliances are primary in product innovation (Visnjic et al., 2016), value creation and competitive advantage (Gomes et al., 2011; Torres-Barreto et al., 2016). Collaborative product innovation strategies and R&D cross-fertilisation (Faems et al., 2005; Cloodt et al., 2006; Colombo and Rabbiosi, 2014) enable firms to modify or develop new products to meet continuously changing customer needs and preferences (Utterback and Abernathy, 1975; Krzeminska and Eckert, 2015). Development and provision of combined product-service offers enhance manufacturers' product innovation and differentiation (Zhang et al., 2016). Manufacturers' capability to provide customer-specific or industry-specific product-

service "solutions" (Cusumano et al., 2015) through close product manufacturer-client relationships (Neely, 2008; Vargo and Lusch, 2008) has been termed *servitization*[1] (Baines and Lightfoot, 2013). Large manufacturers servitise through internal development (Bustinza et al., 2015), since they usually have financial resources and lack adequate open innovation processes (Keupp and Gassman, 2009). We argue that specific strategic alliances (concentric) permit alternative development of such value-adding, innovative, integrated product-service solutions (Love et al., 2014). This study integrates the servitization and strategic alliances literatures to compare firm performance levels achieved through internal greenfield and external collaborative service development and provision.

As servitization is a complex process, the link between implementation of services and firm performance is still unclear. Previous studies view this relationship as non-linear (Suarez et al., 2013; Visnjic Kastalli and Van Looy, 2013) and dependent on external variables such as value chain position (Bustinza et al., 2015). To fill the research gap on this relationship and the importance of contingent variables, our paper aims to better understand the link between service implementation and firm performance in manufacturers. Our analysis of this relationship is important in light of two key moderating variables: strategic partnerships and R&D industrial intensity.

Although previous studies note the importance of strategic partnerships in product innovation and servitization (Paiola et al., 2013; Kohtamäki and Partanen, 2016), evidence on technological strategic collaborations' impact on firm performance is inconclusive and contradictory (Cassiman et al., 2005). Some studies demonstrate empirically positive effects of intra-organisational collaborative innovation arrangements (Colombo and Rabbiosi, 2014); others demonstrate that this relationship depends on type and nature of partnership (Nieto and Santamaria, 2007; Faems et al., 2005). Cloodt et al. (2006) find that innovative performance declines when firms are too similar or too unrelated, characteristics that reduce potential synergetic and complementary effects.

More importantly, although some evidence shows that large manufacturers have begun servitization through transactional relations and strategic partnerships (Bustinza et al., 2015), no studies assess the impact of specific types of collaboration known as

[1] The present research is focused exclusively on manufacturing sectors. The terms servitization and service business models are synonymous in this context (Visnjic-Kastalli and Van Looy, 2013) and therefore in this study they are used interchangeably.

concentric alliances. Concentric alliances, like conglomerate alliances, occur when firms move into different areas, adding new products/services to their operations. However, concentric alliances share some related elements -input or output factors- (Gomes et al., 2011) typical of servitization. The omission is intriguing, as previous studies demonstrate negative impact in increased likelihood of bankruptcy of servitization through internal development (Benedetti et al., 2015). This evidence recommends investigating the role and impact of servitization through external strategic partnerships with Knowledge-Intensive Business Service (KIBS) providers. We believe this approach is important because KIBS firms serve as bridges for knowledge transfer (Junni et al., 2015; Kohtamäki and Partanen, 2016), innovation (Czarnitzki and Spielkamp, 2003; Amara et al., 2009), and growth (Muller and Zenker, 2001). Our second contribution is to clarify the impact of concentric partnerships as alternatives to in-house service provision. This is important because the literature on mergers and acquisitions and strategic alliances tends to focus on horizontal or vertical (Quintana-García and Benavides-Velasco, 2005) collaborative arrangements, hence the need to understand the role and impact of collaboration in concentric partnerships.

As successful implementation of services is contingent on industry characteristics (Bustinza et al., 2015; Cusumano et al., 2015), our third contribution is the exploration of the idiosyncratic effect of servitization on manufacturers in high R&D-intensity industries, where firms face more technological disruptions (Christensen et al., 2003). This observation is valuable because we investigate the firm performance-servitization relationship in the context of strategic partnerships and because successful implementation of innovative changes in collaborative agreements tends to vary substantially between high-tech and more traditional industries (Weber et al., 2015).

In addition to these theoretical contributions, this study contributes empirically with a unique, robust survey dataset collected from 370 senior executives from large corporations. All sample firms are undergoing product-service innovation (servitization) through in-house development or external collaborative agreements with KIBS. The model is tested with Structural Equation Modelling (SEM), a method that provides more generalizable results for analysis of study variables by hypothesising several relationships simultaneously (Feldman and Bolino, 1996).

2. Theoretical framework and hypotheses

Concentric alliances involve a process of related diversification, as partnering firms are involved in different products/services but have similar input or output factors. Such firms can collaborate in upstream functional activities such as R&D and production, or downstream activities like marketing or distribution. By entering areas related to their current business, partners can use their unique resources and competencies to develop complementary synergies to achieve competitive advantage (Gomes, Barnes and Mahmood, 2016). This is particularly true of KIBS partnerships, where manufacturers can achieve product service innovation by partnering with service firms. KIBs partnerships help manufacturers to manage the paradox of focusing on core manufacturing activities while diversifying and differentiating their products by developing complementary innovative services (Einola, Rabetino and Luoto, 2016).

2.1. Product-service innovation

Standard product innovation models identify three motivations for developing and implementing enhanced offerings: quality, variety and cost (Utterback and Abernathy, 1975). When manufacturers introduce service business models (servitization), product innovation models extend Utterback and Abernathy's standard model, in which firms increase product variety (product/service bundles) among products that are already high quality to adapt increasingly to customers and engage them (Vandermerwe and Rada, 1988; Baines et al., 2016).

Like previous models, ours conceptualises *product-service innovation* as a continuum where two interacting dimensions determine the innovation level achieved by servitised manufacturers. First, firms aim to maintain, and if possible increase, supply quality through product-service development (Product innovation and Updated product lifecycle). Continuous product improvement through innovation helps extend product lifecycle and achieving economies of scale (Ulaga and Reinartz, 2011). Second, firms want to lock in existing customers and, if possible, add new ones through customer engagement (Product-service alignment and Service feedback & analytics). Product-service alignment, required to manage integrated offerings and respond effectively to customer's requests (Martinez et al., 2010), is an important capability enabling firms to compete through product-service offerings (Matthyssens and

Vandenbempt, 2008). For manufacturers, alignment prioritises product/service enhancement processes, decreasing the cost of designing new products/services, reducing time-to-market for new products/services, enhancing product-service quality, and supporting product/service innovation (Tallon, 2007). Service feedback & analytics facilitate leveraging knowledge, skills and resources between providers and customers, maximising value creation (Vargo and Lusch, 2008) with tools useful for analysing individual customers' preferences and behaviour (Bustinza et al., 2013). Such tools capture and assess information to support key decisions in the product-service lifecycle (McFarlane and Cuthbert, 2012).

2.1.1. Product-service innovation and performance

The resource-based view establishes how firms' performance varies depending on their resources and capabilities (Barney, 1991). Product service innovation requires introducing paradoxical capabilities such as maintaining traditional product-identity while developing a new integrated solutions identity (Einola, Rabetino and Luoto, 2016). Precisely these contradictory capabilities suggest that the link between servitization and firm performance is not yet well defined.

Two studies make serious attempts to clarify the servitization-performance link quantitatively. Suarez et al. (2013) design a longitudinal analysis of 464 US software firms during 1990-2006. Their model takes percentage of service revenue as a measure of the service business model, related to profit margin as a measure of firm performance. They find a U-shaped relationship, where minimum profit occurs when service revenues are 56% of total revenue. Visnjic-Kastalli and Van Looy (2013) analysed 44 subsidiaries of Atlas Copco during 2001-2007. They measure firm performance and service implementation by the ratio of subsidiary profits over subsidiary sales and total subsidiary sales in service, respectively, and find a cubic relationship. These studies demonstrate that the decline or stagnation of performance is partly due to higher product-service development costs that servitising firms are more likely to incur when adopting new innovative processes.

Visnjic et al. (2016) attempt to unpack the complex relationship between product-service innovation and firm performance by exploring the effects of combinatory variables. They propose coupling service business models with product innovation processes to enhance profit margin. Servitization increases product range by combining

products with varying service bundles, enhancing differentiation (Bustinza et al., 2015). Despite the undefined results in quantitative studies, most (if not all) qualitative studies analysing this link suggest that manufacturers obtain explicit benefits from implementing service business models -see Baines et al. (2016) for a summary. Therefore, we hypothesise that:

Hypothesis 1: Product-service innovation is positively associated with manufacturers' performance.

2.2. Strategic partnerships with KIBS and product innovation outcomes

To remain competitive in high-R&D-intensity industries and fast-changing technologies, firms must develop strong product/service innovative capabilities. Although some authors argue that in-house innovation is important (Veugelers and Cassiman, 1999), it is no longer sufficient to respond rapidly and maintain cutting-edge sophistication. This observation is particularly important when in-house development and implementation of innovation coerce the organisation's internal functioning, ultimately affecting firm bankruptcy (Miller, 1992), which recent studies claim may occur in servitised manufacturers. Analysing a sample of 129 manufacturers that went bankrupt, 75 of which had servitised, Benedetti et al. (2015) suggest that service provision leads to more failures in manufacturing contexts due to greater internal risks, such as excessive time and cost of introducing services and internal constraints on restructuring. Alghisi and Saccani (2015) corroborate this view by showing that internal cooperation and alignment between organisational units involved in service development and delivery are critical success factors for servitised manufacturers.

An alternative to in-house product service innovation is external collaboration between organisations operating at different stages of the value creation process (Nieto and Santamaria, 2007). Although different collaborative arrangements, such as vertical alliances with suppliers and buyers or horizontal alliances with competitors may be required (Faems et al., 2005; Quintana-García and Benavides-Velasco, 2005), we focus on concentric partnerships between manufacturers and KIBS firms. Such concentric product-service innovation alliances form to develop and introduce new services or improve existing ones significantly. Partnerships generally offer different advantages

than in-house development (e.g., firm downsizing, risk of externalisation, knowledge sharing).

Thus, the opportunities and risks associated with growth through product-service innovation differ from those for tangible products (European Commission, 2007). Product development requires more fixed capital investment but offers more opportunities for developing economies of scale and scope, and make-or-buy decisions are made differently (Carman and Langeard, 2006). Whereas the need for achieving synergies and economies of scale and scope increase the need for collaborative partnerships in product development (Gomes et al., 2011), the importance of knowing customers' needs and behaviour to develop appropriate service (Bustinza et al., 2013) increases the need for strategic KIBS partnerships to foster product-service innovation (Paiola et al., 2013; Kohtamäki and Partanen, 2016). We thus view strategic alliances as manufacturers' preferred method of product-service innovation development, ahead of organic growth.

Servitization through KIBs partnerships may be valuable in overcoming and managing paradoxes involving growth and diversification (Einola et al., 2016). Such concentric alliances permit partnering firms to enhance their resource base, achieve higher product service innovation and provide integrated solutions whilst enabling manufacturers to maintain their traditional product-identity by focusing on their unique resources and core competences. These alliances also reduce risks by distributing research and development costs associated with service innovation and other benefits that enhance firm performance (Sampson, 2007). For instance, firms attempting to strengthen competitive position by establishing a monopsony on service distribution (Vendrell-Herrero et al., 2016), or firms forced to introduce service offerings because of market pressures and disruptive innovations (Bustinza et al., 2013), may have to resort to strategic alliances. Truck manufacturers who lack access to the enabling technology (Bustinza et al., 2015) might partner strategically with telematics service providers (KIBS). Alliances can also enhance innovation and firm performance through access to new knowledge (Mauer et al., 2011) and complementary capabilities required to transform innovation into commercial products and bring them successfully to markets (Teece, 1986; Nieto and Santamaria, 2007).

Make, buy, or ally decisions are common moderators in the literature on performance. Geyskens et al. (2006) find strong support for "make versus buy and ally versus buy decisions" (p. 519). Our research analyses whether servitization affects

performance, and whether firms that servitise by making service in-house perform differently from those that establish KIBS partnerships. We thus test the moderating effect of make (R&D expenditures, used by Xu [2015], among others, as moderator) versus ally decisions –knowledge transfer through KIBS, used by several authors, e.g., Denicolai et al. (2014). Firm`s choice of knowledge governance is a critical determinant for superior innovation performance (Lakemond et al., 2016). By collaborating through KIBS, manufacturers can experiment with service provision without fully internalising the risks and costs of service implementation (e.g., Cusumano et al., 2015). KIBS firms have expertise to minimise crucial costs, as they reduce allocation of "sticky" information between manufacturers and end customers (Shah, 2000). KIBS firms can thus be "bridges for innovation" (Czarnitzki and Spielkamp, 2003, p. 3) and play an important role in product-service innovation (Amara et al., 2009), economic performance and firm growth (Muller and Zenker, 2001). Based on these arguments, we hypothesise that:

Hypothesis 2a: Strategic partnership with KIBS positively moderates the relationship between product innovation through service implementation and firm performance.

2.3. Industrial R&D intensity and product innovation outcomes

Cusumano et al. (2015) examine types of services provided by manufacturers during a product lifecycle. They suggest that both incumbents and new entrants in high-tech industries with high R&D investments focus more on product innovation than industries with less R&D and are more prone to technological disruptions (Christensen et al., 2003).

Significant technological disruptions likely change how firms compete in the marketplace and re-establish power relations between incumbents and new entrants (Roy and Cohen, 2015). This dynamism in high-R&D-investment industries fosters continuous rivalry for technological superiority between incumbents and new entrants, periodically reigniting rivalry. In the mobile phone, aircraft, pharmaceutical and medical equipment industries, completing a new project/product does not stop innovation processes, which are continuous. As Suarez (2004) argues, R&D-intensive industries are prone to experience "battle for dominance" between two or more rival technologies.

Industries in which firms invest large amounts in R&D also tend to re-establish new ferment phases in the product lifecycle due to frequent technological disruptions, increasing uncertainty, product variation and investment in product innovation (Grodal et al., 2015). Implementing services can alleviate customer uncertainty concerning new generations of technology, as services support customers who lack confidence to engage with product complexities and remain reluctant to purchase the latest generation (Cusumano et al., 2015).

What then is the firm's position in the supply chain, and how does this position help the firm face consumer uncertainty? For Bustinza et al. (2015), service innovation processes differ for industries with B2B and B2C orientation. Delivering services to end consumers differs from delivering them to other firms. Firms selling new pharmaceutical or electronic products must handle end-consumer uncertainty differently than, for example, aircraft manufacturers handle flight operators. Implementing services in product firms reduces customer uncertainty, regardless of proximity to customers. Providing optimisation services through software and big data technologies, for example, gives product firms valuable feedback about product use and customer needs (Opresnik and Taisch, 2015). This information feeds new product development and supports product innovation (Visnjic et al., 2016).

R&D intensity seems to be a central moderator in the context of innovation effects (De Luca et al., 2010). Service innovation in manufacturing may provide more economic value to industries with high R&D intensity than to low- or medium-intensity industries. High-R&D-intensity industries continuously develop new complex products, and related services can reduce customer uncertainty and increase firms' resilience (Ariu, 2016), giving them more opportunities to capture economic value through implementation of services. From these arguments, we construct the following hypothesis:

Hypothesis 2b: Industrial R&D intensity positively moderates the relationship between product-service innovation and firm performance.

Figure 1 presents the hypotheses formulated in a relationship model. The next section presents the study methodology.

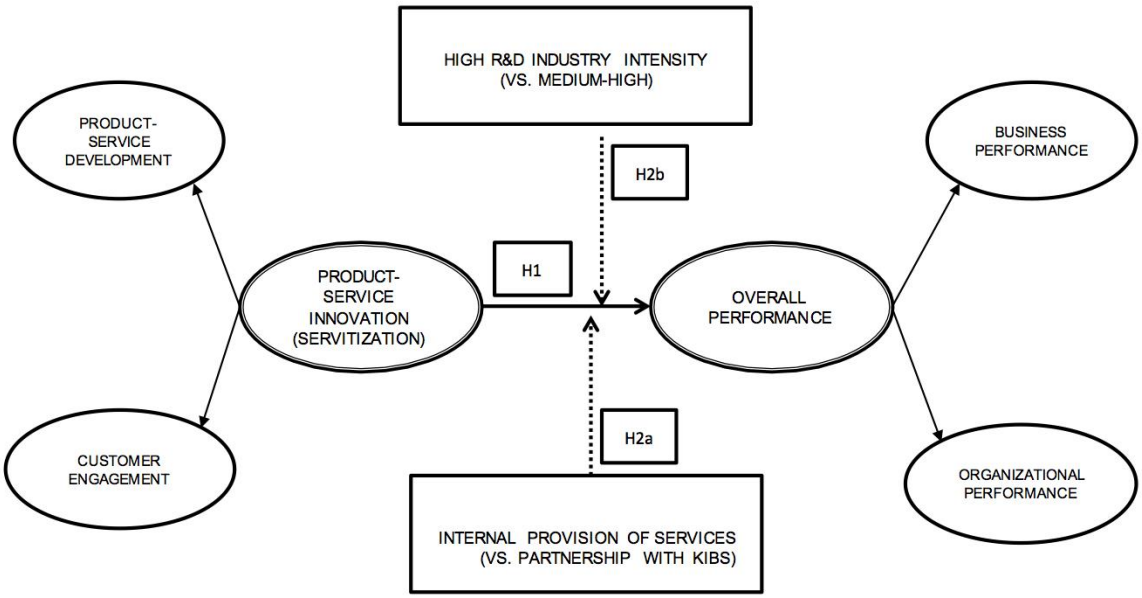

Figure 1. Relationship model

3. Methodology

3.1. Sampling procedures

Empirical investigation to verify the hypotheses was based on an international survey of manufacturing practice conducted by a U.S. industry partner specialising in service management solutions in partnership with a global advisory firm established in Oxford, UK. The sample contains a representative selection of manufacturers currently investing in service innovation. The survey, which defined the target sample and was validated by an advisory board prior to administration, defined services as "all processes and services surrounding a product from initial sale to conclusion of customer use". Industry experts reviewed all findings and validated them by teleconference and a physical workshop.

The survey questioned 370 services executives (VPs for Services, 10.8%; Directors, 45.9%; Chief Managers, 43.3%) worldwide. Harman's one-factor test (Hair et al., 2001) to exclude possible respondent bias due to different firm profiles yielded several factors, detecting no spurious correlations and indicating that results are not biased towards response styles. Nor were significant differences found in the sample regarding company's industry segment or size. We can thus exclude common method biases (Podsakoff et al., 2003). Table 2 summarises the data-set.

Table 2. Data set: Technical specifications

Geographical Headquarter	North America (22.97%), Europe (44.86%), and Asia (32.16%)		
Service Unit Location	North America (37.57%), Europe (35.13%), and Asia (27.30%)		
Methodology	Structured questionnaire		
Sample Size	N=370 Manufacturing firms offering advanced services		
Industry Segments	High R&D intensity	Aerospace and Defence	13.25%
		Electronics and High-Tech Equipment	15.68%
		Medical Devices and Equipment	13.79%
	Medium-High R&D intensity	Automotive and Transportation	14.32%
		Commercial or Cargo Airlines	14.05%
		Heavy and Industrial Equipment	14.32%
		White Goods Manufacturing	14.59%
Collaborative Partnership	In-House (85.95%)		
	KIBS partnership (14.05%)	North America	Outsourced (70%)
			Offshored (30%)
		Europe	Outsourced (30%)
			Offshored (70%)
		Asia	Outsourced (52.94%)
			Offshored (47.06%)
Data collection period	September 2013 – February 2014		

Sample selection targeted companies in North America, Europe and Asia with over $1 billion total revenues. Interestingly, most of the Asian companies' service units were located in the same region, while 22% of European firms preferred to offshore service units to North America. Moreover, for partnership with KIBS, 70% of European firms prefer a North American partner; only 30% of KIBS chose European firms. Offshoring decreases to almost 50% and to just 30% for Asian and North American firms, respectively.

3.2. Main scales

3.2.1. Product-Service innovation (Servitization)

This four-item scale is included in a questionnaire using a 5-point Likert scale (1=Total disagreement, 5=Total agreement) to assess product-service innovation. Principal component analysis (Hair et al., 2001) with Varimax rotation—Kaiser-Meyer-Olkin test, 0.54 (>0.5); Bartlett's test of sphericity χ^2=87.192 (p=0.000); Total Variance Extracted 66.06%—validated the second-order dimensions (Figure 1): a) *Product-*

Service development dimension with two items, *Product innovation* and *Updated product lifecycle* and b) a *Customer engagement* dimension with two items, *Product-service alignment*, and *Service feedback & analytics*. As all firms offer product-service innovations, a discrimination index is produced. A subset of criterion-referenced tests (firms at extremes of the service continuum) enables analysis of the scale's internal consistency, showing a Cronbach's alpha value of α=0.89 (Cronbach, 1951). Scale reliability measures are 0.88 for Composite Reliability and 0.56 for Average Variance Extracted. Lagrange multiplier did not suggest model changes. These values validate this original scale's internal consistency and reliability. Servitization is thus a second-order construct composed of two dimensions, Product-Service development and Customer engagement.

3.2.2. Overall business performance

A 5-point Likert scale (1=Total disagreement, 5=Total agreement) is developed to collect the main performance indicators. This scale is a second-order construct containing two dimensions (see Figure 1) found in (Bustinza et al., 2010), organisational performance (competitive advantage, higher customer satisfaction) and business performance (profit level, profit level change, increased profitability). Principal components analysis indicated these two dimensions—Kaiser-Meyer-Olkin test=0.55, Bartlett's test of sphericity χ^2=255.344 (p=0.000), Total Variance Extracted=58.57%. Analysis of the scale's internal consistency with the discrimination index explained above produces a Cronbach's alpha of α=0.91. Composite Reliability (0.87) and Average Variance Extracted (0.52) show the scale to have internal consistency and reliability. The next section analyses the relationship between this variable and product-service innovation.

4. Results and discussion

Structural Equations Modelling (SEM) to test the model hypotheses, following Robust Maximum Likelihood estimation, calculated the parameters for Hypothesis 1 (Figure 2), the relationship between product-service innovation and overall performance (β_1=0.339; p-value<0.001). The estimation included appropriate indicators of the model's goodness

of fit (Hair et al., 2001) through three kinds of indicators (Table 3)—absolute, incremental and parsimony—all of whose values obtain satisfactory levels.

Table 3. Goodness-of-fit indicators of constructs and relationship model

TYPE OF FIT	INDICATOR	NOMENCLATURE	ACCEPTANCE RANGE	VALUE
ABSOLUTE	Chi-Square Likelihood	CMIN	Significance test	58.723 (p=0.035)
	Goodness-of-Fit Index	GFI	> 0.900	0.950
	Root Mean Square Error	RMSEA	0.050-0.080	0.070
	Root Mean Residual	RMR	< 0.050	0.032
INCREMENTAL	Compared Fit Index	CFI	> 0.900	0.962
	Normed Fit Index	NFI	> 0.900	0.951
	Tucker-Lewis Index	NNFI	> 0.900	0.943
	Adjusted Goodness Fit	AGFI	> 0.900	0.941
PARSIMONY	Normed Chi-square	CMINDF	Range (1-5)	2.581

The role of collaborative partnership and R&D intensity as moderators of the relationship between product-service innovation and performance was also analysed using SEM. The sample was divided through median multi-group analysis and the two moderators using the same process. Firstly, parameters were restricted and the model's goodness-of-fit estimated (χ^2 Satorra-Bentler 58.723) and restricted to equality in the different subsamples, resulting in changes in χ^2 Satorra-Bentler (66.285 and 69.731, respectively). A χ^{2-}difference test shows significant differences between the models, verifying that collaborative partnership and R&D intensity moderate the relationship between product-service innovation and overall performance. In estimating the model in Figure 2 for subsamples with collaborative partnership (H2a) and R&D intensity (H2b), the parameter decreased from β1=0.339 to β1=0.306 (βMod=-0.033, p-value<0.001) for collaborative partnership, and increased from β1=0.339 to β1=0.376 (βMod=+0.037, p-value<0.001) for R&D intensity. These results indicate that the effect of product-service innovation on performance is significantly lower with internal provision of services than in collaborative KIBS partnerships and significantly higher for firms in high-R&D-intensity environments (Figure 2), supporting Hypotheses H2a and H2b.

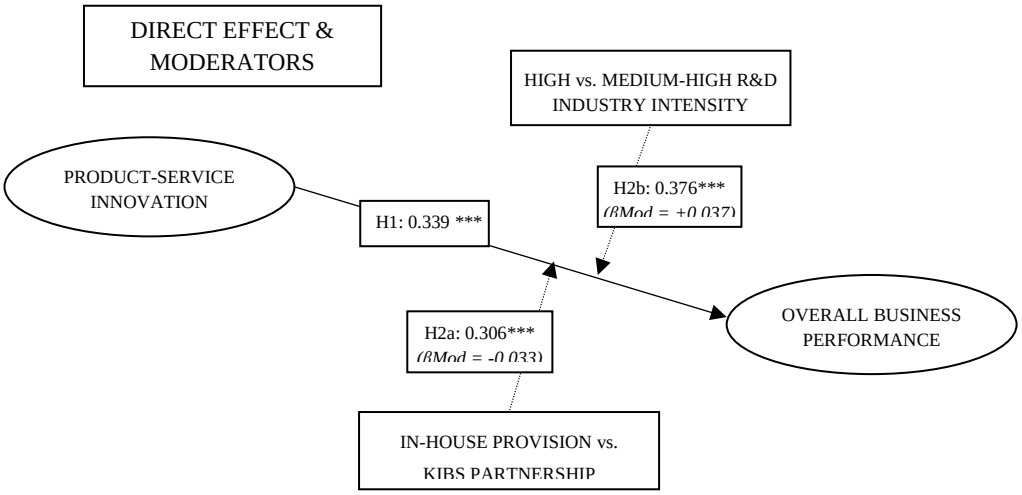

Figure 2. Parameter estimation

4.1. Discussion

This study aims to examine crucial variables that affect the relationship between product-service innovation and performance. In contrast to previous studies' different methodological approach (Visnjic-Kastalli and Van Looy, 2013; Suarez et al., 2015; Visnjic et al., 2016), our study pioneers in applying a second-order SEM model to a sample of large companies worldwide. Results on the relationship between product-service innovation and performance reinforce those of Visnjic et al. (2016), who propose coupling servitization with product innovation processes to enhance long-term profitability. Our results also support Bustinza et al. (2015), who argue the relationship between servitization and competitive advantage through differentiation, linking servitization business and organisational performance outcomes.

The study validates an original scale measuring product-service innovation that shows the importance of analysing servitization throughout product lifecycle (Neely, 2008). Servitization fundamentals suggest that new business models from the entire value chain maximise profit capture (Wise and Baumgartner, 1999). They also demonstrate the role of product-service alignment in product-service configuration, promote integration of product-service offerings and provide a useful tool for fulfilling customers' requests (Martinez et al., 2010). Analysing customers as part of product-service innovation processes supports the importance of customers' engagement in successful addition of services in product firms (Vargo and Lusch, 2008).

The results confirm that collaborative partnership increases the positive effect of product-service innovation in overall performance measures. Product innovation is closely related to technological innovation, but service innovation cannot be reduced to technological innovation. Collaborative KIBS partnership extends the positive effect of innovation development to six forms of innovation—strategic, managerial, marketing, etc. (Amara et al., 2009), making KIBS an innovation catalyst (European Commission, 2007) that help manufacturers overcome product-service innovation paradoxes (Einola et al., 2016).

Strategic innovations involve new or modified business strategies that incorporate service into traditional product offerings (Baines et al., 2016). Our results support this argument, as collaboration through KIBS increases strategic outcomes such as competitive advantage. Managerial and marketing innovations are associated with new or significantly modified business and marketing strategies (Amara et al., 2009). Collaborative partnerships with KIBS thus increase performance outcomes such as profit and customer satisfaction, variables traditionally related to servitization strategies (Bustinza et al., 2015).

Finally, the results help to clarify the moderating role of R&D industry intensity. Industries with high R&D intensity are more prone to disruptive technologies (Christensen, 2003) and thus to returning product lifecycle to the ferment phase (Grodal et al., 2015). Including services in firm offerings that sell products in the ferment phase may reduce consumer uncertainty regarding unknown technology, facilitating customer engagement and value capture (Bustinza et al., 2015; Cusumano et al., 2015) and increase firm resilience (Ariu, 2016). Our results empirically validate this theoretical argumentation, showing that high-R&D industry intensity increases product-service innovation's positive impact on performance.

5. Conclusions and future research avenues

5.1. Theoretical implications

This article contributes to theory by reinforcing assumptions about the servitization-performance relationship and providing a new perspective by analysing the roles of strategic partnerships and R&D intensity. Our first theoretical contribution is the

construction of an empirical measure of product-service innovation (servitization) composed of different elements. Service innovation favours customer engagement. As a strategic tool for locking in customers (Vandermerwe and Rada, 1989), it benefits performance outcomes such as customer satisfaction (Bustinza et al., 2015). Servitization opens continuous dialogue with customers, creating channels to boost value-in-use contexts (Bustinza et al., 2013). Customer engagement & service feedback analytics leverage resources and knowledge, maximising value creation (Vargo and Lusch, 2008). Finally, product-service alignment maximises this value creation process (Martinez et al., 2010). Our study shows how such alignment as an organisational capability influences superior performance.

Our research shows how KIBS partnerships provide firms with strategic knowledge to lock competitors out through services (Vandermerwe and Rada, 1989), achieving superior performance by providing specialised knowledge, downsizing opportunities and increased organisational flexibility. Since competitive risk is higher in services than in products (Carman and Langeard, 2006; Benedetti et al., 2015), KIBS minimises risks associated with service implementation internally.

The alliance and M&A literatures traditionally analyse vertical and horizontal relationships (Faems et al., 2005; Quintana-García and Benavides-Velasco, 2005Gomes et al., 2011) but remain silent on economic assessment of concentric partnerships. This article advances knowledge by providing evidence of the benefits of implementing service business models in manufacturing through establishment of concentric partnerships with KIBS firms.

Another important academic contribution to knowledge of servitization is our study's response to increasing interest in understanding industry-specific factors that enhance or diminish returns on product-service strategies (Bustinza et al., 2015; Cusumano et al., 2015). Our study examines different levels of industrial R&D intensity more specifically, concluding that, the higher the R&D intensity level, the higher the potential profits for manufacturers implementing service business models. Companies operating in high R&D industries generally require a combination of unique products, services and knowledge to out-perform competitors (Osborn and Baughn, 1990). Servitization, by definition, develops demand-driven "bundles" of knowledge, products and services to appropriately satisfy customer needs (Vandermerwe and Rada, 1998). Our research shows that product-service innovation is a successful strategy in high R&D intensity contexts. This novel finding corroborates previous arguments suggesting

that, in changing business environments, product-service innovation reduces consumer uncertainty in facing new technologies (Christensen, 2003; Suarez, 2004), informs product developers (Visnjic et al., 2016) and increase firm resilience (Ariu, 2016).

5.2. Managerial and policy implications

Our results have important practical implications for firms and managers. First, they provide evidence that non-servitised manufacturers can enhance organisational and strategic performance through business model innovation (Amit and Zott, 2012). Our factor analysis demonstrates that product-service innovation is composed of two constructs: technical development of products/services, and customer engagement. Accurate implementation of service business models requires not only designing and delivering a novel, distinctive service, but also understanding consumers and meeting their demands quickly. While some studies acknowledge significant internal risks in implementing services in-house (Alghisi and Saccani, 2015; Benedetti et al., 2015), our evidence suggests that KIBS partnerships can externalise those risks and increase firm performance.

Our study also demonstrates that high-R&D-intensity industries enhance servitization benefits. Since R&D intensity is related to the degree of customization of production processes in a particular industry (Lepak et al., 2003), product-service innovation enhances customization and is suitable to high-R&D-intensity industries. Combined with the strategic role of KIBS in firms' economic development of firms, regions and countries, this finding has implications for policy. KIBS firms play an important role in the creation, transfer and diffusion of knowledge, and high value-adding services for partner organisations, and facilitate learning and improvement of innovation outcomes (Love et al., 2014). As recent evidence from Ariu (2016) finds that services are more resilient than products, KIBS firms may be more resilient than product firms, with important theoretical implications, as these results suggest that resilience may be transferred from KIBS to product firms through long-term partnerships.

Moreover, geographical proximity between KIBS and product firms is a variable of great interest. Analysis would clarify the importance of policy incentives for KIBS allocation, linking service innovation in managerial (servitization) and economics (servinomics) perspectives. Since high-R&D-intensity industries require a highly skilled

employees policy makers may try to boost territorial servitization (Lafuente et al., 2016) through KIBS allocation incentives. Recent research findings showing that product and service firms' co-location and service reforms (Arnold et al., 2016) in a specific geographical area enhance territorial competitiveness, suggest the need for research inquiry into how industrial clusters with a multi-sector (i.e., product and service) approach provide more additionalities than traditional industrial clusters centred exclusively in one sector.

5.3. Limitations and future research avenues

Like most survey-based studies, our analysis is cross-sectional. As such, the results do not capture the dynamic processes that build the relationships identified between the variables. This limitation is especially important in R&D partnerships, as building innovation partnerships can be a long, costly process (Amara et al., 2009), and manufacturer-KIBS partnerships are unlikely to differ from other collaborative partnerships. While we observe successful partnerships in our sample, our evidence is silent on how the partnerships are formed, obstacles overcome, and partnership profits obtained. Therefore, future research analysing open innovation as a driver of partnership and product-service business model development is warranted.

This article uses manufacturers as its unit of analysis. Future studies could examine how KIBS managers perceive both partnerships with manufacturers and the economic outcome of such long-term relationships. Choice of unit of analysis advances the M&A literature. Modern industry dynamics go beyond Schumpeter's assumption of small technological new entrants competing with large manufacturing incumbents. In the current economic scenario, large technology companies like Google threaten to enter the automotive industry by acquiring incumbent firms (Schulze et al., 2015). Analysing who acquires whom contributes to understanding the role and power of KIBS firms in their economic ecosystems. Finally, user-centric innovation could play an important role as user-centric communities could become important players in the market. Hence, future studies may consider users as their unit of analysis.

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