Digital service innovation

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Digital Service Innovation: A paradigm shift in technological innovation

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Abstract
Purpose – Existing innovation frameworks suggest that manufacturing firms have traditionally developed a complementary model of technological innovations comprising process and product innovations (e.g., Oslo Manual). This article presents digital service innovation as a novel form of technological innovation that is capable of enhancing the performance of firms in certain manufacturing industries.

Design/methodology/approach – Drawing on technological innovation and digital servitization fields of research, this study argues that digital service innovation, in manufacturing contexts, complements traditional sources of technological innovation, so increasing the profit margins of firms. This effect is significant in industries characterized by B2B contexts, high presence of link channels and long product life spans (e.g., manufacturing and computer-based industries). Predictions are tested on a unique sample of 423 Spanish manufacturing firms using parametric (t-test) and non-parametric (fuzzy-set qualitative comparative analysis, fsQCA) approaches.

Findings – The results of our analysis show that a necessary condition so that manufacturing firms can increase profits is the deployment of simultaneous process and product innovations. It also reveals that optimal configuration requires that digital service innovation be undertaken, particularly in machinery and computer-based manufacturing industries. Hence, all three sources of technological innovation are brought together in order to reach the highest levels of company performance. The evidence suggests that technological innovation and digital servitization are closely interrelated in highly innovative manufacturing contexts.

Originality - This study's originality and value reside in the fact that it reveals the existence of firms incorporating digital service innovation—a new, technological innovation dimension that challenges existing innovation frameworks—to complement traditional technological innovation sources, namely process and product innovation. Moreover, the study conceptualizes and empirically tests the value-adding role of digital services in firms' technological innovation portfolio.

Keywords - Technological innovation, Servitization, Digitalization, Fuzzy set, Oslo Manual.

Paper type – Research article.

1. Introduction

Services are becoming increasingly important in today's globalized manufacturing settings (Crozet and Milet, 2017). This becomes all the more significant as services form part of competitive advantages that incorporate organizational innovations such as outcome-based contracts (Batista *et al*., 2017), and marketing innovations such as product-service bundles (Aquilante and Vendrell-Herrero, 2021). In view of this, servitization has progressively become more technological and digitalized (Vendrell-Herrero *et al*., 2017). Within the boundaries of this (thereby created) model of digital servitization, a new form of innovation has emerged called digital service innovation. Digital service innovation refers to the development of new services by means of digital technologies (Setzke *et al*., 2021) that exploit product connectedness in order to create value via digitally enhanced provider-customer relationships (Tronvoll *et al*., 2020). Hence, as competitiveness intensifies, digital services are extended to all business demographic strata, not simply to large corporations. For instance, a recent study indicated that around 10% of SMEs offer digital services such as autonomous product operation (Vendrell-Herrero *et al*., 2021a).

We argue that this high degree of technological development and innovativeness in digital services transforms the way in which technological innovation in manufacturing has thus far been conceived. Technological innovation studies have traditionally focused on examining the dynamics of innovation deployment in manufacturing firms, and predominantly evaluated existing interactions between process and product innovations (e.g., Hullova *et al*., 2019). They have therefore neglected the increasingly important role of digital service innovation in manufacturing industries. The present article fills this gap in the literature by revisiting and updating the technological innovation typologies described in the Oslo Manual (OECD, 2018); the predominant framework for describing innovation typologies, and widely adopted by governments and statistical agencies to monitor innovation activities across the economy (Gault, 2018). We propose a triad of technological innovations, comprising product, process and digital service innovation, which can be adopted in isolation or simultaneously, so opening up to eight distinct configurational[1] approaches towards technological innovation, including non-technological innovation, or the simultaneous-in-time adoption of all three technological innovations—to name a couple.

[1] Our conceptualization of "configuration/configurational" is based on the Cambridge dictionary (2008), whose definition is: "the particular arrangement or pattern of a group of related things".

Based on this holistic model of technological innovation, this article sets three empirical objectives. First, it seeks to quantify the adoption of different technological innovations, both in isolation and in their different combinations. Second, it searches for the technological innovation configurations yielding the best performance. This objective is relevant because, while previous research has assessed performance advantage by adopting product and process innovation simultaneously (e.g., Prajogo, 2016), no study has examined the performance-enhancement effect of digital service innovation in isolation, or in tandem with other technological innovations. Lastly, an attempt is made to determine the manufacturing industries where digital service innovation is most important in order to achieve enhanced business performance. In this sense, it is argued that industries characterized by strong industrial focus, i.e., B2B contexts (Kreye *et al*., 2021), high presence of link channels (Bustinza *et al*., 2013), and long product life spans (Vendrell-Herrero *et al*., 2021b), possess greater potential to economically exploit digital services.

These three empirical objectives are validated by a purpose-built questionnaire issued to 423 medium-sized Spanish enterprises operating in processing, science, machinery and computer-based manufacturing industries. A non-parametric method is employed as an empirical approach to study the optimal technological innovation configurations, i.e., fuzzy-set qualitative comparative analysis (fsQCA). Analysis shows that, in processing and science-based industries (largely characterized by B2C markets, low presence of link channels and short product life span), the optimal configuration involves adopting product and process innovation. Conversely, in machinery and computer-based industries (largely characterized by B2B relations, high presence of link channels and long product life span), the optimal configuration contains all three forms of technological innovation. Thus, our findings show that firms deploying all three technological innovations in the latter industries yield a return on sales five percent higher than those deploying only product and process innovations.

This study makes three important contributions. First, it updates the innovation taxonomy proposed by the Oslo Manual (OECD, 2018) by offering a holistic view of innovation typologies in manufacturing that are in sync with current developments in the field of digital servitization. This updated model includes a new type of technological innovation in manufacturing (i.e., digital service innovation) and integrates non-technological service innovations into existing forms of marketing (product-service bundling) and organizational (contractual) innovations. This is of significance because the implementation of the framework proposed would enable servitization scholars to be represented in Community Innovation Surveys (CIS), thereby influencing the political debate more profoundly (Cirera and Muzi, 2020). Other communities such as Open Innovation and Global Value Chains have received such recognition in recent Oslo Manual updates. Meanwhile, growing communities such as public sector innovations are lobbying to be included (e.g., Gault, 2018; Arundel *et al.,* 2019). Second, given that previous service innovation studies have largely ignored digital service innovation, as demonstrated by the absence of this type of services in recent literature reviews (e.g., see Gallouj and Savona, 2009; Carlborg *et al*., 2014; Snyder *et al*., 2016; Witell *et al*., 2016), this study extends existing models of service innovation in manufacturing industries. Third, it responds to a call for studies to assess the simultaneous-in-time deployment of various technological innovation types (Damanpour, 2014), and shows that digital service innovation is a source of competitive edge that complements product and process innovations in manufacturing industries with strong industrial focus.

The paper is organized as follows: Introduction, Section Two, presenting a literature review; Section Three, which sets testable propositions; Section Four, describing the empirical research; Section Five, presenting the results; and Section Six, which discusses the conclusions and their implications.

2. Devising a new model of technological innovation

2.1. Digital servitization as a new innovative trend in manufacturing

Technological development and the globalization of economic production activities have been regarded as both drivers and enablers of servitization deployment by manufacturing firms aiming to achieve and maintain a competitive edge in increasingly globalized markets (Buckley *et al*., 2020; Crozet and Milet, 2017; Grandinetti *et al*., 2020). Servitization corresponds to the transition from selling products and post-sale services to offering extended life-span services in the form of customized, integrated solutions and product-service systems (Lafuente *et al*., 2017; Vendrell-Herrero *et al*., 2021b). This has also been denoted as product-service innovation (PSI) (Bustinza *et al*., 2019a), service infusion (Eloranta and Turunen, 2015) or the provision of industrial services (Kohtamäki and Helo, 2015), and has been ascribed as a crucial innovation strategy that enables manufacturing firms to gain a competitive edge by differentiating and integrating innovative services into the firm's traditional product offers (Benedettini and Neely, 2019). Concurrently, digital servitization, enabled by digital and information technologies, has surfaced as the convergence between product and service-growth strategies and the development of physical vs. digital (strategic) assets (Gebauer *et al*., 2020).

Digital servitization comprises the use of digital means to provide innovative, value-creating and revenue-generating opportunities to manufacturing firms in the service ecosystem (Sklyar *et al.*, 2019; Vendrell-Herrero *et al.*, 2017). Essentially, it utilizes the potentialities offered by adopting digital technologies such as the Internet of things, digital platforms, remote monitoring, big data analytics and artificial intelligence in operations to transition from stand-alone products to digital service solutions (Kohtamäki *et al.*, 2020; Naik *et al.*, 2020).

From a functional (back-end) perspective, digital servitization acts as a catalyst to nurture digital service innovation in operations, simplifying the sharing of information and knowledge across company divisions (Vendrell-Herrero *et al*., 2021c; Westerlund, 2020). This broadens opportunities to enhance operational efficiency, process redesign, resource allocation and transparency in supporting decision making (Coreynen *et al*., 2017). Conversely, from a relational (front-end) standpoint, and deeming that servitization is essentially an ecosystemic value co-creation process; digital servitization facilitates stronger relational interactions and closer integration among its actors (suppliers, intermediaries and customers) within the value-creation ecosystem (Story *et al*., 2017; Bailey *et al*., 2020). All of which enables firms to offer highly customized value propositions based on digitally enhanced services and relationships (Kowalkowski *et al*., 2013; Tronvoll *et al*., 2020).

As noted in the literature, such technological capacities may afford unprecedented possibilities for superior market differentiation (Kohtamäki *et al.*, 2018), enhanced customer engagement and collaboration (Sousa and da Silveira, 2017) —and for recognizing and grasping contextual opportunities to mitigate inherent risks in servitization (Dmitrijeva *et al.*, 2020).This may be achieved by expediting corrective actions or strategic adjustments (Coreynen *et al.*, 2020), and by developing more effective and efficient mechanisms for value creation and customer satisfaction (Cenamor *et al.*, 2017).

2.2. Innovation typologies and digital service innovation

Digital servitization strategy entails a significant degree of technological adoption in order to yield its expected benefits. Such capacities, however, have not thus far been integrated into standard models of innovation, especially in the case of manufacturing firms. This section reinterprets and expands existing categorizations so as to incorporate this growing practice through the lens of servitization and service innovation in manufacturing[2]. In particular, we focus on the definition of the Oslo Manual (2018).

The Oslo Manual, developed jointly by Eurostat and the Organization for Economic Co-operation and Development (OECD), describes the innovation activity of industrial firms as a multidimensional phenomenon that is contingent on technological types as much as it is on non-technological types (see Table 1). According to these typologies, technological innovations comprise product and process innovations; that is, introducing a new product or new production process into the firm. Conversely, non-technological innovations integrate organizational and marketing innovations. These involve the implementation of new organizational methods related to practices, the workplace or firm's external relations, in addition to new packaging, placement, promotion or price-setting criteria (Álvarez-Coque *et al*., 2017; Radicic and Djalilov, 2019).

--- Insert Table 1 hereabouts ---

In industrial sectors, technological innovation has predominantly focused on product and process innovations according to the notion that both innovation types possess meaningful strategic values so as to afford firms a competitive edge (Onufrey and Bergek, 2020). However, in so doing, service innovation has been overlooked despite the well-documented relevance of service transition in manufacturing industries (Eloranta and Turunen, 2015; Crozet and Milet, 2017). Consequently, existing OECD typologies fail to integrate service innovation (in itself) as a standard innovation category in manufacturing industries, making the classification of service innovation in industrial settings somewhat decontextualized, to date (Gustafsson *et al*., 2020; Kowalkowski and Witell, 2020). This is further intensified given that the progressive adoption of digital technologies in manufacturing firms enables the implementation of digital servitization (Kohtamäki *et al*., 2020). In turn, this exacerbates the incapability of current typologies to encompass and represent the entire realm of digital service innovation accurately in industry settings.

Recent studies on servitization provide clues to the presence of innovation dimensions contained in traditional typologies which partially explain the characteristics of service

[2] It is acknowledged that service innovation refers to a comprehensive concept encompassing the introduction of new or improved services irrespective of the implementation context. However, our analysis is built on the servitization literature, given that it represents a reference framework to investigate value creation by service innovations in manufacturing firms.

innovation in industrial settings. Nevertheless, it is argued that within the current nomenclatures, key aspects of service innovation in manufacturing such as outcome-based contracts (Batista *et al*., 2017) and bundling service offerings (Aquilante and Vendrell-Herrero, 2021) should be classified as non-technological innovations; to be more specific, 'External relations innovation' and 'Promotion/pricing innovation', respectively. This, on the one hand, indicates that traditional typologies largely conceive servitization as a non-technological innovation, and therefore classify it (inaccurately) as such and, on the other; the existing typologies (as stated) fail to capture a large share of service innovation reality in manufacturing, particularly with regard to digital servitization.

As a whole, we argue that the current typologies are insufficient because they fail to take the intrinsic technological features of service innovation in manufacturing into consideration, and therefore provide an impractical (narrow and limited) classification for this context. Table 1 addresses this issue by presenting a first attempt at extending the traditional OECD typologies by integrating a new technological innovation dimension called "Digital service innovation". This new type of innovation, conceived for manufacturing industries, relies on digital services as the main innovation vehicle to exploit technological knowledge emerging essentially from data analysis. Subsequently, the technological building blocks underpinning the service entity enable—based on analytical outcomes—the continuous re-configuration of the service to the benefit of producers and users (Chowdhury *et al*., 2021). In other words, the service itself becomes a technological innovation source insofar as the products or processes can be significantly improved in relation to the service's characteristics.

2.3. Holistic overview of technological innovations

Having stated our formulation, which essentially broadens the established innovation frameworks by embracing service elements related to the servitization of the manufacturing sector, we focus on defining the foundational constituents underlying so-called technological service innovation. Hence, Figure 1 shows the two constituents (spheres) bringing about this new dimension, comprising process innovation and product innovation (i.e., components of technological innovation), and external relations and promotion/pricing innovation (i.e., mainstream components of digital servitization). Digital service innovation is thus situated as a multifaceted construct that intersects the essential elements in the fields of technological innovation and digital servitization.

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Process innovation is regarded as the implementation of new or significantly enhanced production or delivery methods through the introduction of substantial changes in techniques, equipment and/or software (OECD, 2018).This type of innovation has proven to upgrade the operational processes of firms, leading to enhanced efficiency (e.g., time saving), quality (e.g., defect reduction) and production profitability (e.g., cost optimization) (Chai *et al.*, 2020). Firms accrue technology and knowledge through process innovation, which boosts the development of new products and thereby affords further opportunities to grow market share (Lisboa *et al.*, 2011). Furthermore, process innovation materializes at an internal level, making replication difficult, and erecting higher entry barriers for competitors, thus protecting the firm's market edge (Prajogo, 2016).

Product innovation, meanwhile, involves introducing technical specifications, components and materials, software technologies, or other functional features into products in order to satisfy market demands (OECD, 2018).This type of innovation has shown to enhance the value delivered by products in order to meet consumer needs (Sok and O'Cass, 2015), enhance consumer experience (Foroudi *et al.*, 2016), and thus achieve further product differentiation (Aliasghar *et al.*, 2019). By using new technologies and knowledge (or a combination of both), product innovation provides a consistent means of improving competitiveness, and of gaining higher profits and market shares (Martinez-Ros, 2019). Moreover, product innovation increases the potential of firms product portfolio, opens up possibilities to seize unexploited market niches (Cormican and O'Sullivan, 2004), and thus helps gain a competitive edge and superior growth in performance (Chapman and Hyland, 2004).

Digital service innovation refers to the development of new services and/or improvement of those existing through the use of digital technologies (Setzke *et al*., 2021). This new breed of technological innovation is primarily built on the ability to use connected products in order to provide highly customized service-oriented value propositions—via more direct and collaborative, digitally enhanced provider-customer relationships (Kowalkowski *et al*., 2013; Tronvoll *et al*., 2020). By accessing/acquiring valuable knowledge from customers, this type of innovation opens up the firm's innovation possibility frontiers in industrial services. On the one hand, by streamlining real-time customer data collection and integration in the firm's information system (Schroeder *et al*., 2019) and, on the other, by providing efficient tools to monitor, optimize and automatize the product's functions, remotely and globally (Beverungen *et al*., 2020). This promotes the development of innovative digital service offerings (based on consumer patterns) in industrial contexts, enabling manufacturing firms to align business model component configurations dynamically with customers' needs (Porter and Heppelmann, 2015; Helkkula *et al*., 2018; Kohtamäki *et al*., 2020).

The proposed definitions are compartmentalized[3]. However, technological innovations do, in fact, interrelate, and can influence each other. The following section theoretically analyzes how these types of technological innovations interact with one another and their relationship with business performance.

3. Developing an integrative model of technological innovations

Despite the fact that technological innovation has substantiated its positive effects on business performance (Damanpour, 2010), and both process and product innovations are considered equal drivers of innovation activities (Onufrey and Bergek, 2020), deployment of these innovations separately is considered insufficient to sustain competitiveness in well-positioned industries (Prajogo, 2016; Hullova *et al.*, 2019). This is partly due to the fact that their full benefit can only be fully achieved when both innovative activities are undertaken together (Hullova *et al.*, 2016), and partly because competitors can replicate product and process innovation far more rapidly than in the twentieth century (Graham and Nafukho, 2007). This has driven firms across different industries to pursue both innovation types simultaneously so as to reap the benefits of novelty and added value embodied in the complementarity of these innovations (Najafi-Tavani *et al.*, 2018), and compile more complex innovation portfolios. In other words, they are more valued and difficult to replicate (Rivkin, 2000). Hence, it has long been considered that process and product innovations in unison is the "single best complementarity strategy" (Damanpour, 2010), and the contemporary manufacturing archetype's "forefront strategy" (Cornelius *et al*., 2021).

In addition, existing research indicates that technological and non-technological innovations reinforce rather than replace one another (González-Blanco *et al*., 2019; Martin-Rios *et al*., 2019), which is further evidence of the existence of complementarity between these types of innovation (Arranz *et al*., 2019). Such results set out the relevance of the

[3]Well-known representatives of process innovation range from the introduction of modern manufacturing practices such as Lean or Just-in-Time techniques to the optimization of production processes. As for product innovation, noted archetypes include the development of hybrid or electric cars or trucks, smartphones or digital cameras, which significantly differ from their predecessors. While, in the case of digital service innovation, illustrative examples include digital/remote services such as the continuous condition/diagnosis monitoring of machinery, remote assistance, remote control and production optimization , updates/ upgrades, etc. Apple is a prime example of a company that deploys all three technological innovations simultaneously-in-time. Continuous improvement in global value chain operations represents process innovation, new developments/features in iPhones/iPads represent product innovations, and streaming services (e.g., Apple Music) represent digital service innovations.

symbiotic effects between innovation types, and thereby substantiate the reasoning behind adopting an integrative view in order to maximize innovation outcomes (Dammanpour, 2010). In line with the resource-based view (RBV), the integrative view is based on the notion that the multiple types of innovation are interdependent and their co-existence generates a synergistic effect on the performance of firms by increasing their competitive strategy's complexity. Both viewpoints therefore conceive innovation as a unique and heterogeneous set of resources which, in combination rather than separately, allow firms to build sustainable competitive advantages (Terziovski, 2010; González-Blanco *et al*., 2019).

3.1. Generic technological innovation configurations

Drawing on the integrative view of innovation (Dammanpour, 2010), the performance effects of combining technological innovations in two distinct manners is examined. The simultaneous-in-time process-product innovation strategy is first explored, then the added gains of including digital service innovation to this tandem assessed. In other words, all three innovations; product, process, and digital service innovation simultaneously combined. Moreover, the existence of sectoral heterogeneity among manufacturing firms (Pires *et al.*, 2008) suggests that there may be different optimal configurations according to the manufacturing industry.

Process innovation has proven to enhance a firm's ability to exploit, maximize and reconfigure resources and capabilities used in the production process (Chai *et al.*, 2020). Meanwhile, product innovation has been found to broaden the range of products to meet sales targets, market share goals, return on investment and customer satisfaction (Najafi-Tavani *et al.*, 2018). In parallel, both product and process innovations prove to have significant implications with regard to a firm's marketing and differentiation strategies (Lukas and Ferrell, 2000). Their simultaneous deployment therefore allows diverse assets to be integrated, and a coherent system of interrelated innovations constructed which mutually reinforce one another (Prajogo, 2016). The above enables firms to better adapt to market changes, with shorter, more rapid decision chains and greater flexibility (Hullova *et al.*, 2016), all of which leads to a solid strategic springboard for gaining competitive edge (Hullova *et al.*, 2019) and business performance (Damanpour, 2010). Such evidence upholds the positive effect of interplay between process and product innovations on business performance, and thus enables the following proposition to be put forward:

Testable proposition 1: In manufacturing firms, simultaneous-in-time deployment of product and process innovation is a necessary condition in order to achieve superior performance.

3.2. Exploring industrial heterogeneity

As stated, the argument that product innovation and process innovation constitute a necessary condition for the competitiveness of manufacturing firms applies to all product industries. However, we believe that this proposition may have nuances depending on the industrial sector/context (Pires *et al.*, 2008). The rationale behind this assertion follows from the literature on servitization which suggests that digital servitization is not a one-size-fits-all strategy, and that in certain industries with greater industrial focus there are more opportunities to benefit from such strategies (Bustinza *et al*. 2019b).[4]Hence, while digital service innovation may have differential value in certain industries, and almost negligible value in others, there are three key industry factors considered here which differentiate digital service innovation.

First, a firm's market orientation towards Business-to-Business (B2B) or Business-to-Consumer (B2C) is regarded a factor that influences its ability to profit from digital service innovation. In this vein, the recent literature states that consumer-oriented B2C manufacturing industries are less likely to benefit from services than industries oriented towards B2B markets (Kreye *et al*., 2021). It is therefore argued here that only industries with a total or partial orientation towards B2B markets are better positioned to benefit from including digital services in the product-process innovation tandem.

Second, the product's intrinsic characteristics determine the company's capability to interact with the customer through the actual product—*as link channels*[5]—using digital services (Bustinza *et al*., 2013). Therefore, it is argued that products/link channels such as processed food or medicines (pills/caplets) are incapable of generating data or interacting with the consumer in any way, so the value of digital service innovation in industries such as the food processing and pharmacy sectors will be residual. On the other hand, products/link

[4] Part of our argument is also based on the fact that most case-study servitization research has largely analyzed firms in metal, machinery and hardware industries (NAICS 33). However, there are practically no cases in textile, food processing, chemical or pharmaceutical firms (NAICS 31 and 32). There seems to be less implementation of service innovations in these industries, which we interpret as firms in these industries finding service innovation less financially attractive.

[5] Drawing on Bustinza *et al*. (2013), link channels are conceptualized as the physical platform (i.e., product, equipment, device, machinery, etc.) whereby information is transferred by means of sensors or other embedded systems.

channels such as machinery, hardware and electronics are highly capable of interacting with the consumer and exploiting the benefits of digital services, adding great value to the product-process innovation tandem.

Finally, industries with longer product life spans have more time to capitalize on their investment in digital services. In this sense, a recent article by Vendrell-Herrero *et al*. (2021b) shows that only companies with products with an extended life span (15 years onwards) can exploit advanced servitization models; those with a higher degree of digitalization. Hence, it is posited that industries with long life-span products will be more able to take advantage of digital service innovation. Taking all these arguments into consideration allows the following testable propositions to be formulated:

> **Testable Proposition 2a**: In industries characterized by B2C contexts, low presence of products/link channels and short product life spans (e.g., processing and science-based manufacturing industries), the simultaneous-in-time deployment of product and process innovation is a necessary and sufficient condition to achieve superior performance.
> **Testable Proposition 2b**: In industries characterized by B2B contexts, high presence of products/link channels and long product life spans (e.g., machinery and computer-based manufacturing industries), the simultaneous-in-time deployment of product, process and digital service innovation is a necessary and sufficient condition to achieve superior performance.

4. Data and Method

4.1. Database

In order to achieve the objectives set, this study analyzes innovation approaches in relation to a sample of Spanish manufacturers. Spain is deemed a relevant context as it has very few large corporations, and most private innovation takes place in medium-sized enterprises (Lafuente *et al*., 2019; Ortin-Angel and Vendrell-Herrero, 2014), which opens up the sampling to more firms, thus achieving greater heterogeneity. The SABI database is used to identify the population of firms, which is a service offered by Bureau Van Dijk (BvD) (http://sabi.bvdep.com), and provides an accurate representation of the entire Spanish business population's strata.

The study is limited to a population of firms with over 50 employees that operate in industries with NAICS manufacturing codes: 31, 32, 333, 334, 335 and 336. A population of 7,552 firms was identified. Firms were contacted via Computer-Aided Telephone

Interviewing following procedures supported by the literature. This method is cost-effective and can measure behavior of interest (Couper, 2000). During November and December 2018, companies were contacted by phone until 438 responses were obtained, 423 of which were answered in full. The respondent firms were found to be representative since the sectoral and size compositions approached to that of the total population. Once the survey had been completed, it was merged with the SABI database to ensure that the monetary values of interest including revenues and profits for the current (2018) and subsequent (2019) periods were completely objective.

4.2. Variables

Return on Sales: business performance is measured as profit margin (e.g., Suarez *et al.*, 2013; Visnjic-Kastalli and Van Looy, 2013; Sousa and da Silveira, 2017) and is operationalized as Returns on Sales (ROS), i.e., a firm's pre-tax earnings divided by the firm's annual revenues. As profitability varies significantly over the years, ROS was averaged for two years (2018-19) to provide a clearer picture of the normal profits obtained by the firm. The sample's mean ROS is 8.42%. This reveals that firms retain an average of 8.42 cents per euro in the form of profit. Standard deviation is 0.955. Figure 2 graphs data points in a probability density plot and relate it to a normal distribution with a 0.0842 mean and standard deviation of 0.955. ROS was calibrated using -5%, 0% and 5% thresholds for full non-membership (FNM), crossover point (CP) and full membership (FM), respectively (Frösén *et al.*, 2016). Relatively loose thresholds were used because this research does not intend to explain differentials between high (low)-performing and very high (low)-performing firms (Fiss, 2011). Calibration points are also shown in Figure 2.

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Innovation Configuration: This model considers three distinct forms of technological innovation, namely product, process and digital service innovation[6]. The same methodology is used as that employed by the CIS and World Bank Enterprise Survey in order to measure

[6] The rationale behind including the "digital" component in service innovation is due to the fact that the OECD Oslo Manual classifies (by definition) both product and process innovation as technological innovations, while it considers service innovation (in manufacturing) a non-technological form of innovation. However, the provision of services in manufacturing settings depends heavily on the adoption of digital technologies. In this context, the service entity cannot be decoupled from the technology used for its deployment. It is argued that it should therefore be classified as technological.

the constructs as dichotomous variables (Cirera and Muzi, 2020). To ensure that the innovations had a technological element, separate strategies were followed for product/process and digital services.

- *Product and Process Innovation*: Firms were asked: "*During the last three years, did your firm introduce any new or significantly improved product/process?*" To ensure that the innovation had a technological component, firms answering the first question affirmatively were asked: "*Was the product/process innovation a technological improvement on the existing product/process?*" All the firms answered affirmatively to this second question. These two variables were calibrated in binary, taking value '1' for full membership and '0' for non-membership.
- *Digital Service Innovation*: Firms were asked: "*During the last three years, did your firm introduce any new or significantly improved service innovation?*" To ensure that the innovation had a digital element, the firms answering the first question affirmatively were asked: "*Is the service innovation embedded in a digital component (i.e., sensors, streaming service, real-time data, etc.)?*" A firm is classified as a digital service innovator if both questions are answered affirmatively. This variable was calibrated in binary. Full membership takes value 1 and non-membership value 0.

Table 2 provides some descriptive statistics on the different innovation configurations produced after combining the membership and non-membership status of the different technological innovations. According to Table 2, just 6 (1.4%) of the 423 firms are non-innovators, revealing that manufacturing firms are increasingly reliant on certain forms of technological innovation. Of the 29 firms (6.8%) that have one single innovation, process innovation seems to be the most popular form (22 firms, 5.2%). Of the 296 firms (70%) that simultaneously deploy two types of innovation, 264 (62.4%) implemented "product-process" innovation. Finally, 92 firms (21.7%) simultaneously implement "product-process-service" innovation, implying that most firms in our sample (91.7%) simultaneously deploy two or more forms of technological innovation.

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Industrial composition: This research seeks to analyze the moderation role of industry in the relationship between innovation configuration and business performance by using subsamples. It considers four industries, listed below. According to Table 2, the proportion of firms in each innovation configuration is fairly similar.

- *Processing-based*: Industries such as food, beverages and textile included in NAICS 31. 123 firms comprise this industry.
- *Science-based*: Industries with a scientific component. These include chemical and pharmaceutical industries. It is considered that any firm in NAICS 32 can be included in this category. 121 firms comprise this industry.
- *Machinery-based*: Firms that build vehicles, machines, turbines or engines (NAICS 333/336) are included in this industry. 107 firms comprise this industry.
- *Computer-based*: Firms that produce hardware and electronics (NAICS 334/335) are included in this industry.72 firms comprise this industry.

4.3. Method

Testable propositions seek to reveal the optimal configurations for firms' necessary and sufficient conditions. To this end, a non-parametric technique, fuzzy-set Qualitative Comparative Analysis (fsQCA) is used, which helps analyze equifinality, that is, different variable combinations associated with the highest level of a selected outcome (Longest and Vaisey, 2008). In this research, a particular combination of technological innovations (process, product, and digital service) is expected to achieve the greatest impact on profits. In terms of innovation strategies, variables can only take two values; 0 if unimplemented or 1, when implemented. As profit margin is a continuous variable, the fsQCA technique is preferred in order to crisp the QCA, since the latter is only appropriate for dichotomous variables, not for continuous variables. In order to introduce continuous variables in fsQCA analysis, they first need to be calibrated through a transformation. The specific calibration strategies for performance and innovation variables have been described above in Section 4.2.

5. Findings

5.1. Necessary analysis

Consistency measures whether variables are necessary for the outcome to occur, that is, whether all firms with a certain causal variable–process innovation, product innovation or service innovation–present profits. A configuration is considered necessary when the consistency value is above the threshold value. In general, a "necessary" or "almost necessary" causal variable consistency value must be equal to or higher than 0.9 in order to be considered (Schneider and Wagemann, 2010). Table 3 reports consistency measures. Only product and process achieve a consistency score above the 0.9 threshold for the full sample, which is in line with our theoretical predictions. This result corroborates testable proposition 1. This analysis also reveals the coverage value–the proportion of cases where both the condition and result of interest emerge. For example, product innovation has a coverage value of 0.707, i.e., in 70.7% of the cases where this condition (product innovation) is present, the result of interest (high profits) is also present (Schneider and Wagemann, 2012). All technological innovations (product, process, and service innovation) are non-trivial conditions as their coverage score yields a value that is clearly distant from 0. Taking a value close to zero would have meant that conditions occurred in all cases, and would be theoretically and empirically considered trivial conditions (Schneider and Rohlfing, 2016).

--- Insert Table 3 hereabouts ---

5.2. *Sufficiency analysis*

A causal condition is (almost) sufficient for the result if, whenever present, the expected outcome (e.g., high profits) is also present. The usual sufficiency threshold is 0.8 for the Solution Consistency value, i.e., how many cases in a given category achieve the result of interest (Ragin, 2008), and is analyzed using the "Truth Table Algorithm", which is a method in fsQCA to reveal causal configurations that yield the highest outcome values (Ragin, 2008). Causal variable combinations exceeding a cut-off consistency score are considered sufficient (Schneider and Wagemann, 2012). fsQCA software provides three solutions: complex, intermediate, and parsimonious, the intermediate solution is recommended. It is the most parsimonious solution, and allows maximum complexity (Ragin, 2008). Table 4 shows the causal combinations of technological innovations leading to the highest profit margin, i.e., causal configurations with the highest raw and unique coverage.[7] Raw coverage indicates what proportion of cases leading to higher profit margins is explained by causal configurations. Conversely, unique coverage indicates that the proportion of cases leading to higher outcome levels is exclusively explained by this causal configuration, and by no other. Overall solution coverage scores assess the solution's explanatory power over the outcome, which is similar to *R*-squared in multivariate analysis.

[7]Table 4 only shows configurations with consistency values above threshold value 0.8.

--- Insert Table 4 hereabouts ---

The results show sectoral heterogeneity, since firms belonging to processing and science-based industries achieve the highest profit margin by combining "*process and product*" innovation. However, firms operating in machinery and computer-based industries also require digital service innovation in order to achieve the highest profit levels ("*process, product and digital service innovation*)". The results therefore support proposition 2a in that they suggest that deploying process and product innovations simultaneously is a necessary and sufficient condition for company profits in processing and science-based industries. The results also support proposition 2b in that they show that having all three technological innovations is the necessary and sufficient condition to achieve the highest profit margin in machinery and computer-based manufacturing industries.[8]

5.3. Comparative analysis of optimal configurations

The average performance for the two optimal configurations identified has been compared in order to better interpret the results, namely process and product innovation (according to proposition 2a), as well as all technological innovations, namely process, product, and digital service innovation (according to proposition 2b). Table 5 shows the mean ROS for these two configurations. In addition to the full-sample analysis, separate findings for each industry are given. The T-test informs on the probability of mean ROS values being equal for the analyzed configurations.

--- Insert Table 5 hereabouts ---

In the full sample, firms with product and process innovation achieve a mean ROS of 0.081, which is significantly lower than the mean ROS for firms with three technological innovations, equaling 0.104 (P-value < 0.1). Despite this statistical significance, the difference is not large enough for the fsQCA to determine that digital service innovation is a necessary and sufficient condition in order to reach maximum performance. One possible

[8] Smaller subsamples that consider other control conditions were analyzed. For instance, the optimal solution was tested for changes when the subsample was further divided into medium (less than 250 employees) and large (more than 250 employees) firms. The optimal solution does not change, so our results do not seem to be contingent on company size.

cause for this seemingly contradictory result between parametric and non-parametric methods could be the full membership threshold in the ROS calibration (0.05).

When analyzed at industry level, the t-test results are completely consistent with the fsQCA. On the one hand, in processing and science-based industries, the mean ROS is practically identical in both optimal configurations, suggesting that digital service innovation is not a necessary condition to achieve maximum profit in processing and science-based industrial contexts. Interestingly, digital service innovation does not damage performance in these industries; it simply offers no contribution to achieve higher performance levels. On the other hand, in machinery and computer-based industries, the difference in mean ROS is consistently higher than 0.05, and statistically significant (P-value<0.05). This result confirms that adding digital service innovation to the other two technological innovations is a necessary key factor to enhance the performance of firms producing machines, vehicles, computers and electronic goods.

6. Discussion and conclusion

6.1. Theoretical implications

This study makes three important contributions to the literature on service management. First, it broadens the current, predominant OECD innovation frameworks (see Table 1) so as to include different forms of technological and non-technological service innovation. For example, it is argued that outcome-based contracts (e.g., Batista *et al*., 2017) should be conceptualized as organizational innovations. Product-service bundling (e.g., Aquilante and Vendrell-Herrero, 2021) should be conceptualized as marketing innovation, and digital service innovation (e.g., Setzke *et al*., 2021) as technological innovation. The objective of building this typology is to open up an academic debate on how current conceptualizations of service innovation in manufacturing can converge with the Oslo Manual (OECD, 2018). We consider that, as other academic communities have already done (e.g., Open Innovation and Global Value Chains) or are in the process of doing so (e.g., Public Innovation; e.g., Arundel *et al*., 2019), including current service innovation models in established innovation frameworks will allow an enhanced visualization of the community studying servitization in manufacturing. Featuring in the Oslo Manual automatically implies being included in surveys conducted by the majority of national statistical agencies, and greater visibility with regard to policy makers (Gault, 2018).

Second, whilst digital services are largely ignored in the mainstream literature on service innovation (e.g., see recent literature reviews – Gallouj and Savona, 2009; Carlborg et al., 2014; Snyder et al., 2016; Witell et al., 2016), this study reveals the actual importance of digital service innovation in the literature on service innovation. It is argued here that digital service innovation has important technological features that enable manufacturing firms to interact with their costumers and co-create a more integrative offer via streaming, secure data provision and/or remote monitoring, diagnosis and assistance (Vendrell-Herrero *et al*., 2021a). These capabilities are particularly important for firms operating in B2B-oriented industries with the need to establish link channels with consumers, and offer long life-span products (Bustinza *et al*., 2013; Kreye *et al*., 2021; Vendrell-Herrero, 2021b). Furthermore, this research theoretically conceptualizes that digital service innovation is indeed relevant as it intersects and connects technological innovation and digital servitization literature streams (see Fig. 1).

Third, this study shows that, under certain contextual conditions, manufacturing firms can gain additional benefits by deploying simultaneously-in-time product, process and digital service innovations. In particular, the results indicate that carrying out process and product innovation is a necessary condition for performance gains in firms in processing and science-based industrial manufacturing contexts. Yet, our findings present evidence that the deployment of product and process innovation is necessary for firms operating in machinery and computer-based industries, but insufficient in order to achieve the highest company performance levels. In these contexts, firms also need to undertake digital service innovation so as to fully benefit from technological innovation deployment. In other words, in the machinery and computer-based sectors, the optimal configuration for performance enhancement resides in the complementarity between product, process and digital service innovation. This is important because the literature on technological innovation has mainly focused on analyzing complementarity between process and product innovation (e.g., Hullova *et al*., 2019; Martinez-Ros, 2019; Prajogo, 2016), and has disregarded, to some degree, the role of service innovation in manufacturing contexts. This issue prompted a call for studies employing the integrative view to analyze the simultaneous deployment of different innovation types (Damanpour, 2014). This research therefore responds to this call and links technological innovation and service innovation by theorizing and empirically testing performance gains based on the complementarity between traditional technological innovations (process and product innovations) and digital service innovation in manufacturing.

The evidence presented in this study is of importance in order to understand innovation in present-day manufacturing. It reveals that the simultaneous-in-time deployment of technological innovations yields higher profits than single or non-innovation, which is consistent with the fact that simultaneous innovation is considered a widely prevalent strategy (Hullova *et al.*, 2019; Najafi-Tavani *et al.*, 2018).

6.2. Managerial and policy implications

This study presents at least three important implications regarding managerial practices. First, the proposed innovation model suggests that manufacturing companies should embrace digital technologies that allow better interaction with customers and facilitate capturing data systematically when offering services. In this manner, companies can sustain a cooperative and co-creative innovation process within the business ecosystem (Story *et al*., 2017), and enhanced capability to service scalability (Westerlund, 2020).

Second, the results suggest that digital service innovation in isolation is not conducive to improved financial performance. Therefore, companies pursuing such gains must consider digital service innovation a complement to their existing innovations in product or process so to benefiting from the inclusion of services—a leadership in product or process innovation is thus essential before embarking on digital service innovation. Furthermore, our results indicate that in order to unleash the full potential of digital service innovation, managers must deploy it simultaneously (in real time) with product and process innovation. An integrative view of innovation must therefore be applied (Dammanpour, 2010).

Third, there are contextual conditions that need to be taken into account when assessing the potential of the digital services for a particular company. The results suggest that the combined deployment of product, process and digital service innovation is most fruitful in machinery and computer-based industries. It is argued that offerings in these industries have certain commonalities that make digital service innovation specifically valuable. Their products have a long life span, and their offer is more oriented towards B2B markets, making link channels and co-creation more appealing. Within these industries is therefore important to adopt technologies that facilitate the capture of customer information (e.g. sensors) and allow information to be kept securely but accessible worldwide (e.g. cloud storage). Nonetheless, these results sustain that digital service innovation can also add significant value to firms in manufacturing industries apart from machinery and computer-based industries, but with similar patterns regarding product life span and B2B orientation.

This study also presents two important policy implications. First, it is well known that servitization is a mechanism used in developed countries to protect the manufacturing sector against increasing competition from emerging economies (Buckley et al., 2020), which ultimately creates employment (e.g., Lafuente et al., 2017). In this respect, innovation development programs (e.g. industrial policies) should consider digital service innovation as a fundamental aspect of technological innovation systems in territorial policy development (Bailey et al., 2020). This, in turn, will enable national and/or regional governments to implement specific policies to encourage service implementation in manufacturing, which will ultimately benefit business ecosystems and territorial competitiveness.

Second, forthcoming editions of the Oslo manual should include new realities regarding service innovation in manufacturing. A new categorization is put forward here to better monitor service innovation in manufacturing (see final row in Table 1). Considering the framework proposed here, or similar, will allow statistical agencies to monitor the degree of development and evolution of technological and non-technological service innovation in manufacturing. An interesting implication of the proposed framework is that it considers that industrial hybridization is different depending on the primary industry, which means that the type of service innovations in manufacturing are specific. Hence, service innovation questions on the CIS should be differentiated between manufacturing and service firms.

6.3. Limitations and directions for further research

As with other research, there are some methodological limitations to this study, which should be pointed out in order to give directions for future research. First, this study only investigated the complementarity effect of digital service innovation on technological innovation (process and product innovations), without, however, setting a successional pathway of implementation priorities. Hence, future longitudinal studies should attempt to determine the pathway required in order to adopt all three technological innovations. Second, the article follows a non-parametric method (fsQCA) to study the optimal outcome of innovation deployment. Future research should conduct a parametric analysis in order to quantify the economic benefits included in each configuration. Future studies could also test our propositions by exploring different innovation measurements, for example, patent-based indicators or constructs-based measurement models of innovations.

The possible existence of confounding variables is also acknowledged, which are not observed in our analysis, such as product portfolio disparities or exports and/or other sources of benefits that may influence a firm's return on sales (ROS). Furthermore, we exclusively focus our analysis on financial performance, disregarding somewhat wellbeing and social performance outcomes. Future studies should extend this study by integrating such concepts in order to provide a holistic perspective of digital service innovation (Gustafsson *et al*., 2020). Finally, the conclusions emerging from this study are based on the analysis of medium-sized Spanish manufacturers. Although this setting is considered relevant for the purposes of this study, it needs to be replicated in other settings in order to confirm the results.

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TABLES

Table 1: Innovation types in current manufacturing industries[a]

Technological innovation	**Non-technological innovation**	
	Organizational innovation	***Marketing innovation***
Product innovation	**Business Practice innovation**	**Packaging innovation**
"The introduction of a good that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics. Product innovations can utilize new knowledge or technologies, or can be based on new uses or combinations of existing knowledge or technologies." (Oslo Manual, 2005).	*"Involve the implementation of new methods for organizing routines and procedures for the conduct of work. These include, for example, the implementation of new practices to improve learning and knowledge sharing within the firm" (Oslo Manual, 2005).*	*"Part of a new marketing concept. Product design changes refer to changes in product form and appearance that do not alter the product's functional, technological or user characteristics. Examples are changes in the packaging of products such as foods, beverages and detergents, where packaging is the main determinant of the product's appearance." (Oslo Manual, 2005).*
Process innovation	**Workplace innovation**	**Placement innovation**
"*The implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software. It can be intended to decrease unit costs of production or delivery, to increase quality, or to produce or deliver new or significantly improved products." (Oslo Manual, 2005)*	*"The implementation of new methods for distributing responsibilities and decision making among employees for the division of work within and between firm activities, as well as new concepts for the structuring of activities. An example is the first Implementation of an organizational model that gives the firm's employees greater autonomy in decision making and encourages them to contribute their ideas." (Oslo Manual, 2005)*	*"Involve the introduction of new sales channels. Sales channels refer to the methods used to sell goods and services to customers. Examples are the introduction for the first time of a franchising system, of direct selling or exclusive retailing, and of product licensing." (Oslo Manual, 2005).*
Digital service innovation[b,c]	**External relations innovation**[b]	**Promotion/pricing innovation**[b]
"The introduction of a new service associated with existing products or new products of a company through the use of digital technologies. The service is built on digital elements that improve the operation of the product, or facilitate access to data in real time that allow improving the use of the product. Examples of these services include real time tracking, machine health monitoring, consultancy-based data analytics."	*"The implementation of new ways of organizing relations with other economic agents, such as the establishment of new types of collaborations with research organizations or customers, new methods of integration with suppliers, and the outsourcing or subcontracting for the first time of business activities in production". (Oslo Manual, 2005). New contractual arrangements with clients would be included in this category.*	*"New concepts for promoting or pricing a firm's goods and services. Examples are the use of celebrity endorsements."(Oslo Manual, 2005). Another example would be to bundle products and services in the same offer without a technological/digital element being embedded.*

a. Adapted by the authors based on the Oslo manual (2018)
b. Innovation forming part of service innovation in manufacturing
c. Category added by the authors

Table 2: Technological Innovation Configurations, number of firms.

Firm's Innovation configuration	***Full sample***	**NAICS 31**	**NAICS 32**	**NAICS 333/336**	**NAICS 334/335**
	All industries	Processing-based	Science-based	Machinery-based	Computer-based
# ***NO***	**6**	**2**	**2**	**1**	**1**
(%)	*1.42%*	*1.63%*	*1.65%*	*0.93%*	*1.39%*
# ***PRODUCT***	**4**	**3**	**1**	**0**	**0**
(%)	*0.95%*	*2.44%*	*0.83%*	*0.00%*	*0.00%*
# ***PROCESS***	**22**	**8**	**6**	**4**	**4**
(%)	*5.20%*	*6.50%*	*4.96%*	*3.74%*	*5.55%*
# ***SERVICE***	**3**	**1**	**0**	**1**	**1**
(%)	*0.71%*	*0.81%*	*0.00%*	*0.93%*	*1.39%*
# ***PROD+PROC***	**264**	**76**	**79**	**68**	**41**
(%)	*62.41%*	*61.79%*	*65.29%*	*63.55%*	*56.94%*
# ***PROD+SERV***	**15**	**3**	**7**	**3**	**2**
(%)	*3.55%*	*2.44%*	*5.79%*	*2.80%*	*2.78%*
# ***PROC+SERV***	**17**	**6**	**1**	**6**	**4**
(%)	*4.02%*	*4.88%*	*0.83%*	*5.60%*	*5.55%*
# ***ALL***	**92**	**24**	**25**	**24**	**19**
(%)	*21.75%*	*19.51%*	*20.66%*	*22.43%*	*26.38%*
TOTAL	**423**	**123**	**121**	**107**	**72**

Note: The configurations are as follows: NO (No Innovation), PRODUCT (Product Innovation Only), PROCESS (Process Innovation Only), SERVICE (Digital Service Innovation Only), PROD+PROC (Product and Process Innovation, PROD+SERV (Product and Digital Service innovation), PROC+SERV (Process and Digital Service Innovation), ALL (All three Technological Innovations).

Table 3. Analysis of necessary conditions

	Profit margin	
Condition	***Consistency***	***Coverage***
Full sample		
Product innovation	0.932	0.707
Process innovation	0.916	0.632
Service innovation	0.774	0.641
Processing-based industries (NAICS-31)		
Product innovation	0.944	0.719
Process innovation	0.906	0.642
Digital Service innovation	0.606	0.638
Science-based industries (NAICS-32)		
Product innovation	0.936	0.693
Process innovation	0.920	0.633
Digital Service innovation	0.784	0.602
Machinery-based industries (NAICS-333/336)		
Product innovation	0.929	0.734
Process innovation	0.924	0.686
Digital Service innovation	0.905	0.716
Computer-based industries (NAICS-334/335)		
Product innovation	0.922	0.726
Process innovation	0.918	0.666
Digital Service innovation	0.902	0.709

Table 4. Technological innovation configuration and performance

	Outcome variable		
	Performance (profit margin)		
	Product Innovation	Process Innovation	Digital Service Innovation
Full sample	●	●	—
	R = 0.725 / UC = 0.338 / C = 0.705 OSCe = 0.826 / OSCs = 0.733		
Processing-based industries (NAICS-31)	●	●	—
	R = 0.731 / UC = 0.345 / C = 0.713 OSCe = 0.833 / OSCs = 0.741		
Science-based industries (NAICS-32)	●	●	—
	R = 0.728 / UC = 0.349 / C = 0.706 OSCe = 0.831 / OSCs = 0.739		
Machinery-based industries (NAICS-333/336)	●	●	●
	R = 0.705 / UC = 0.289 / C = 0.701 OSCe = 0.806 / OSCs = 0.710		
Computer-based industries (NAICS-334/335)	●	●	●
	R = 0.702 / UC = 0.284 / C = 0.689 OSCe = 0.804 / OSCs = 0.706		

Black dots “●” indicate that companies implement the innovations; white dots “○” indicate that they do not implement the innovations, and a hyphen “–” indicates indifference. “C” stands for Consistency; “R” Raw coverage; “UC” Unique Coverage; “OSCy”: Overall Solution Consistency; “OSCe”: Overall Solution Coverage

Table5: T-test

	PROD+PROC		ALL		SIG
	# Firms	Profit margin Mean	# Firms	Profit margin Mean	p-value
Full sample	264	0.081	92	0.104	0.06
Processing-based industries (NAICS-31)	76	0.091	24	0.103	0.12
Science-based industries (NAICS-32)	79	0.093	25	0.086	0.38
Machinery-based industries (NAICS-333/336)	68	0.068	24	0.122	0.01
Computer-based industries (NAICS-334/335)	41	0.063	19	0.108	0.02

Note: PROD+PROC (Product and Process Innovation), ALL (All three Technological Innovations), SIG (Statistical significance). P-value is computed using One-tale two-sample t-tests.

FIGURES

Figure 1: Conceptual intersection between Technological Innovation and Digital Servitization

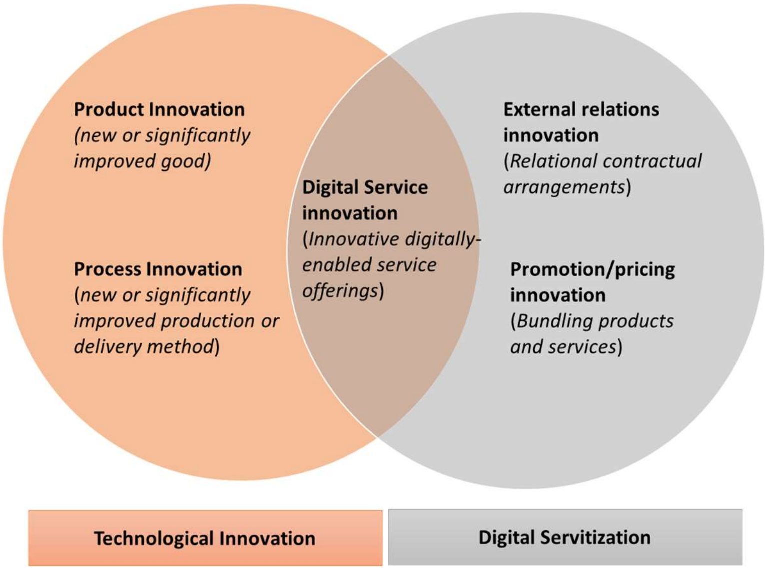
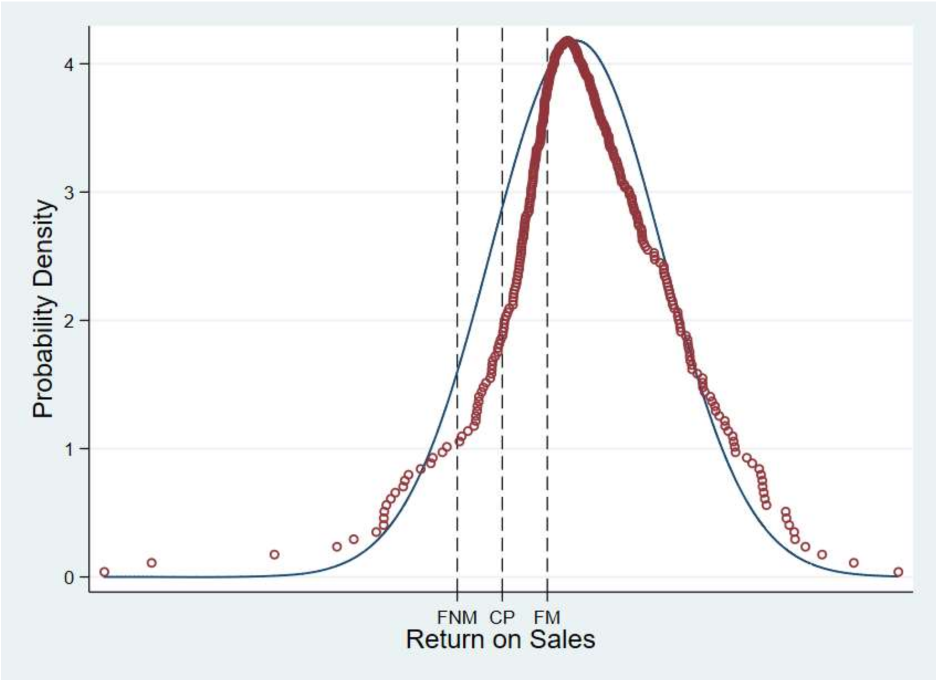


Figure 2: Distribution and calibration of Return on Sales



Note: FNM refers to full non-membership, and equals -0.05. CP refers to crossover point, and equals 0. FM refers to full membership, and equals 0.05.