Which Service? How Industry Conditions Shape Firms' Service Type Choices

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ABSTRACT

This article studies the role of industry conditions as determinants of manufacturing and software firms' decisions to offer services. It draws on the competence perspective on industry evolution and servitization to theorize and provide empirical evidence on how industry conditions affect firms' choice to offer two distinct types of services – product-oriented services and customer-oriented services. It is argued that firms are likely to offer product-oriented services in Schumpeterian industry environments to address high technological uncertainty by leveraging and reinforcing capabilities in the existing technology. In contrast, firms are likely to offer customer-oriented services in non-Schumpeterian industry environments to address value generation uncertainty by building competences in new technological or market areas. Based on longitudinal data on 410 public firms from manufacturing industries and the software industry, empirical evidence suggests that firms are indeed more likely to offer product-oriented services in Schumpeterian industry environments, such as in the early stage of the industry life cycle and under conditions of high R&D intensity and competition, whereas they are more likely to offer customer-oriented services in non-Schumpeterian environments, such as in the later stages of the industry life cycle and in highly cyclical industries.

KEYWORDS: servitization; service business model; manufacturing; product-oriented services; customer-oriented services; industry antecedents; industry evolution; industry life cycle

INTRODUCTION

Manufacturing and software firms are increasingly including services in their market offerings alongside products (Eggert, Hogreve, Ulaga, and Muenkhoff, 2014; Suarez, Cusumano, and Kahl, 2013; Valtakoski and Witell, 2018). Evidence from a number of manufacturing industries suggests that this strategy – often referred to as servitization – has the potential to generate higher performance, yet at times can also produce decreases in performance (Eggert et al., 2014; Fang, Palmatier, and Steenkamp, 2008; Suarez et al., 2013; Visnjic, Wiengarten, and Neely, 2016).

Motivated by the desire to unpack the complex relationship between servitization and performance, scholars have sought to develop a better understanding of the variety of antecedents that lead up to servitization (Baines, Lightfoot, Peppard, Johnson, Tiwari, Shehab, and Swink, 2009; Kowalkowski, Gebauer, and Oliva, 2017). Firm-specific antecedents, such as resource and capability endowment (Kindstrom, Kowalkowski, and Sandberg, 2013; Raddats, Burton, and Ashman, 2015; Ronnberg, Parida, and Kohtamaki, 2016; Sousa and da Silveira, 2017) or organizational characteristics (Antioco, Moenaert, Lindgreen, and Wetzels, 2008) and customer demand (Ostrom, Bitner, Brown, Burkhard, Goul, Smith-Daniels, Demirkan, and Rabinovich, 2010; Raja, Bourne, Goffin, Cakkol, and Martinez, 2013) have already been studied extensively. In contrast, the industry-level antecedents of servitization are only beginning to be understood (Ceci and Masini, 2011; Cusumano, Kahl, and Suarez, 2015; Fang et al., 2008; Raddats et al., 2015). While extant research has identified some industry characteristics that are associated with servitization (i.e. competition, R&D intensity, cyclical product sales, and the industry life cycle), there is a lack of in-depth understanding of the specific types of services that firms choose in any of these industry conditions (Cusumano et al., 2015; Kowalkowski et al., 2017). There is also a lack of theoretical arguments that shed light on the mechanisms underpinning the choice to provide a particular service under a particular industry condition.

There is no clear guidance as to which types of services appear at the later stage of the industry life cycle (Cusumano et al., 2015). Furthermore, the impact of other industry conditions that affect

firms' choice to offer specific services is poorly understood. For example, there is very limited theoretical guidance and only scant evidence regarding how firms' choice to offer services is affected by the early stages of the life cycle (Chesbrough, 2011) or by the R&D intensity of industries (Teece, 1986). To sum up, there is a lack of theory that stipulates the mechanisms connecting *specific* industry conditions to *specific* types of services as well as corresponding empirical evidence (Antioco et al., 2008; Cusumano et al., 2015; Eggert et al., 2014; Fang et al., 2008).

Drawing on the competence-based view of industry evolution (Uzunca, 2017), this article theorizes and provides evidence that servitization represents a competence-exploiting and a competence-building response to counter the uncertainty posed by different industry conditions. This is done in several steps. First, drawing on the competence-based view of industry evolution (Uzunca, 2017), specific types of uncertainty that firms face under each of the industry conditions that influence servitization are identified, as well as the competences that help face this uncertainty. Second, drawing on the servitization literature, this article distinguishes between two types of services that are based on different competences: product-oriented (PO) services that are performed on the product and therefore share technological competences with the products (e.g. installation, monitoring and maintenance, product customization), and customer-oriented (CO) services that build on the existing marketing/customer competences but are based on entirely new technological competences – for example, management consulting, financing, logistics (Baines et al., 2009; Fang et al., 2008; Mathieu, 2001). Third, this article juxtapose the type of uncertainty in each industry condition with the types of competences that PO and CO services build or exploit, and develops hypotheses on how industry conditions affect firms' decisions to offer PO and CO services. Finally, hypotheses are subjected to an empirical examination using a longitudinal panel of 410 public firms from manufacturing and software industries tracked over a period of twenty-one years from 1990 to 2011.

Our findings suggest that there are two distinct types of uncertainty and industry environments which are associated with distinct service responses: in Schumpeterian environments characterized by

high *technological uncertainty* (i.e. early stages of the product life cycle, high competition, and/or R&D intensity) firms use PO services to leverage and reinforce capabilities in the existing technology, whereas in non-Schumpeterian environments characterized by *value generation uncertainty* due to the declining potential of existing technologies (i.e. late stage of the product industry life cycle or high cyclicity) firms use CO services to build competences in new technological or market areas.

This study contributes to the growing literature on servitization by drawing on the competence-based view of industry evolution to answer one of the field's main questions: what type of services manufacturers and software firms offer under which industry conditions (e.g. Cusumano et al., 2015; Eggert et al., 2014; Kowalkowski et al., 2017). By developing new theory and testable hypotheses as well as providing large-scale empirical evidence across different manufacturing and software industries, our article provides an *industry-level* complement to prior research on the *firm-level* determinants of servitization (Kowalkowski et al., 2017; Valtakoski, 2017). Furthermore, this article contributes to research on servitization by further clarifying the role of services in firm strategy and improving understanding of the mechanisms that govern the complex relationship between products and services (Baines et al., 2009; Benedettini, Neely, and Swink, 2015; Eggert, Thiesbrummel, and Deutscher, 2015; Fang et al., 2008). This article also contribute to the literature on industry and organizational evolution more broadly by shedding new light on the strategic role services play and by proposing technological uncertainty and value generation uncertainty as environmental mechanisms that drive distinct competence strategy choices (Adner and Kapoor, 2010; Cusumano et al., 2015; Suarez et al., 2013; Uzunca, 2017).

THEORY AND HYPOTHESES

Industry Antecedents of Servitization: A Competence-based View

The conditions that prompt firms to offer services have been the focus of the servitization literature since its very beginning (Gebauer, Ren, Valtakoski, and Reynoso, 2012). The servitization literature has used a variety of theoretical lenses to explore firm-level antecedents of servitization (Eloranta and Turunen, 2015). In this process of unpacking the conditions in which servitization occurs, far less attention has been given to the industry conditions as opposed to the firm conditions. Extant literature provides some evidence for industry conditions as possible antecedents of servitization (i.e., the product industry life cycle, industry R&D intensity, level of competition and cyclicalities) but with limited theoretical explanation and empirical evidence. “The motivations for servitization are often discussed in the extant literature but are rarely defined and analyzed, and almost exclusively *assumed to be homogeneous across all sectors*” (Raddats et al., 2015, italics added). Table 1 provides an overview of the studies mentioning one or more industry conditions as determinants of servitization.

Insert Table 1 here

Industry evolution theory may be helpful in examining the mechanisms by which industry conditions induce firms to offer services. For instance, Cusumano et al. (2015) contrast the challenges that firms face in the early stages of the industry life cycle with the challenges that they face in the late stages of the industry life cycle and posit how this impacts the choice of services. They recognize the technological uncertainty that the customer faces in the early stages of the industry life cycle and suggest that services such as product customization may be helpful in reducing technological uncertainty.

Furthermore, the competence lens on industry evolution offers additional insights that help understand the mechanisms connecting industry conditions to firms’ service type choices. The competence-based view of industry evolution suggests that addressing the challenges, such as the uncertainty that different industry conditions bring to the fore, will require different competence

strategies (Bauer, Dao, Matzler, and Tarba 2017; Uzunca, 2017). For example, the challenges emerging in the early stages of the industry life cycle are very different from those that appear in the later stages and different competence strategy may be required to address them. At the same time, services differ with respect to the competences that they are exploiting or building (Fang et al., 2008). Thus, different industry conditions may prompt firms to prioritize different services that exploit different competences (Bauer et al., 2017).

The following section examines (product-oriented and customer-oriented) services according to the competences they exploit or build, and then the subsequent section develops theory and hypotheses concerning the impact of industry conditions on service type choices by juxtaposing a competence perspective on industry evolution with a competence perspective on service types.

Product-oriented and Customer-oriented Services: A Competence-based View

What differentiates servitization from other related phenomena is the complex relationship between products and services, since most types of services offered by firms primarily selling products could not exist without the underlying products (Cusumano et al., 2015; Visnjic Kastalli, Van Looy, and Neely, 2013). Thus, to understand how industry conditions shape firms' services type choices, one needs to determine the types of services offered by firms from the perspective of the interdependencies that exist between products and services (Visnjic et al., 2016).

While notable service classifications have appeared over the years (Cusumano et al., 2015; Gebauer, 2008; Goffin, 1999; Goffin and New, 2001), the most relevant classification in this respect distinguishes between product-oriented services that are performed on the product itself and customer-oriented services that go beyond products to serve customers' needs more broadly (Eggert et al., 2014; Fang et al., 2008; Mathieu, 2001; Raddats and Kowalkowski, 2014; Ulaga and Reinartz, 2011). Several labels have been used for this classification scheme, such as services supporting products versus

services supporting customers (Eggert et al., 2011; Eggert et al., 2014; Mathieu, 2001), product-oriented services versus customer-oriented services (Paiola, Saccani, Perona, and Gebauer, 2013; Tukker, 2004; Visnjic et al., 2016), and product-support services versus demand-chain services (Benedettini et al., 2015).

More specifically, product-oriented services – for instance, installation, maintenance, repair, or product optimization and monitoring – require technological knowledge of the underlying product, such as engineering skills as well as knowledge of product architecture and functioning (Baines and Lightfoot, 2013; Yamauchi, 2015). Firms already possess such competences, which could potentially give them a competitive advantage in the provision of this type of services (Ceci and Masini, 2011). Also, product-oriented services help firms to reinforce these technological product competences (Visnjic et al., 2016). For instance, technicians and purchasing managers involved in the purchase of products are also involved in the purchase of product-oriented services and can be used as a source of insight on the technological requirements of the customer (Visnjic Kastalli et al., 2013). Consequently, product-oriented services can be highly effective within the industry conditions characterized by high technological uncertainty.

By contrast, customer-oriented services that go beyond product functioning and operation (e.g., management consulting, logistics or financial services) draw on a different set of competences. Firms may target the same customer base and, therefore, may potentially exploit and reinforce existing customer-oriented competencies, such as maintaining customer relationships. Yet, because customer-oriented services are more diverse and go beyond the functioning of the product, product manufacturers generally need to explore new technological competences, including acquisition of specific service-process capabilities (Baveja et al., 2002; Kowalkowski, Brehmer, and Kindstrom, 2009) and investments in significant organizational change (Eggert et al., 2014; Kowalkowski et al., 2009). For instance, they need to acquire process and project capabilities (Ceci and Prencipe, 2008), deep knowledge of customer needs that go beyond the core product (Fjeldstad and Sasson, 2010), and the

capability to collaborate and co-produce with customers as well as other product and service providers (Davies, Brady, and Hobday, 2006; Paiola et al., 2013; Windahl, Andersson, Berggren, and Nehler, 2004). Thus, customer-oriented services can be highly effective in industry conditions characterized by high uncertainty regarding the value that can be generated from the existing technology – or, labeled as value generation uncertainty.

Matching Services to Industry Conditions: The Choice of Product-oriented versus Customer-oriented Services

Industry life cycle.

The life cycle stage of a firm's core product industry has a non-obvious impact on its likelihood to provide product-oriented services (Massa and Tucci, 2014). On the one hand, offering product-oriented services can help a firm reduce its and its customers' technological uncertainty, which is higher in the early stage of the product industry life cycle than in the late stage. On the other hand, the provision of product-oriented services can also help reduce a firm's value generation uncertainty, which is higher in the late stage of the product industry life cycle than in the early stage. We develop theory on the role of these two competing mechanisms and, correspondingly, formulate competing hypotheses (H1a and H1b) about the impact of the industry life cycle on a firm's likelihood to offer product-oriented services below.

The early stage of the industry life cycle is characterized by high technological uncertainty (Anderson and Tushman, 1990; Klepper, 1996; Utterback and Abernathy, 1975). At this early stage of industry evolution, there are multiple product variants, the production process is flexible and inefficient, and entry barriers are relatively low (Peltoniemi, 2011). Different competitors offer different product designs in the market place, aiming for their product design to be chosen as the dominant design adopted

by the majority of users (Utterback and Suarez, 1993). Success in this early stage of the industry life cycle stems from the ability to attract lead users and early adopters and, with their help, achieve a good product-market fit, ensuring that the chosen technology (including product design and focal features) satisfies market needs beyond what competing technologies can offer (Cusumano et al., 2015).

As both technology development and customer needs are in flux, technological uncertainty related to the choice of the technology trajectory, designs, and production techniques is high (Clark, 1985; Dosi, 1982; Utterback, 1994). At these early stages of the product development, customers are also unsure how to use the product or what functionality to use (Cusumano et al., 2015). Thus, in the early stages of the industry life cycle, one of the core foci of the firm is to reduce this technological uncertainty by building competences on the functioning of the product in the customer's environment, and on customer's needs as well as the implications they have for product design.

Product-oriented services can help this strategy of competence building and leveraging in several ways. Firstly, product-oriented services can help diminish technological uncertainty, improve product-market fit, and strengthen a firm's ability to establish a dominant design by bolstering its knowledge and competences on how the technology interacts with and addresses customer needs (Hienert and Lettl, 2017; von Hippel, 1986). For instance, the provision of product-oriented services can help create stronger ties and facilitate more frequent interaction with technical users of the product such as facility managers and technicians, facilitating the accumulation of experience on customer needs as well as on product functioning and use (Baden-Fuller and Haefliger, 2013; Yamauchi, 2015). The manufacturer can also collect data on the product's operations by offering monitoring services (Opresnik and Taisch, 2015). For example, high-tech and automation multinational, ABB, uses a system for service monitoring that collects critical information on the actual functioning of a whole suite of mining equipment to improve product design (ABB, 2015).

Furthermore, the provision of product-oriented services can help reduce technological uncertainty on the customer side. For instance, a firm may offer custom product designs supported by product-oriented services in the early stages of the industry life cycle to help customers assess the benefits of the product, entice potential customers to buy the product, and make it easier for the firm to learn about and improve product performance. For example, during the mid-1990s, Enterprise Resource Planning (ERP) software producers, Oracle and SAP, developed service departments to adapt their standardized products to the customized needs of clients in different industries and integrate them into industry-specific software modules offered by specialized vendors (Cusumano et al., 2015).

Offering monitoring and maintenance services can help reduce customer uncertainty regarding product quality and reliability, and it can also lead to quicker recovery when the product fails. It can help firms establish greater customer loyalty, which helps to survive the shakeout that ensues once a dominant design emerges in the industry (Suarez et al., 2013; Vandenbosch and Dawar, 2002). For example, in the early days, mainframe manufacturers opened large service units to help users install and maintain computers. At that time, customers were not skilled in using sophisticated equipment, and they faced higher risk in using it. So, providing product-oriented services helped mainframe manufacturers create and grow the market (Fisher, McKie, and Mancke, 1983). Considering that the provision of product-oriented services helps reduce the firm's and customers' technological uncertainty, which is higher in the early stage of the product industry life cycle than in the late stage, the following hypothesis is posited:

Hypothesis 1a: A firm is more likely to offer product-oriented services in the early rather than in the late stage of the life cycle of its core product industry.

As a product industry matures, it is increasingly characterized by a lower level of technological change and uncertainty and a higher level of product standardization (Utterback and Abernathy, 1975)¹. A dominant design is likely to have been established at this stage and the underlying technology stabilized and matured (Teece, 1986). Furthermore, from a customer perspective, a ‘dominant use’ has emerged, and the customers now use products for standardized functions (Kahl, 2007). New customers tend to be followers and conform to existing practices, thereby adopting the same standardized functions (Rogers, 2003). Because of the standardization in product technology and its use, customers begin to value product differentiation less and value price more. As products become increasingly commoditized, competition drives down prices and often leads to industry consolidation (Klepper, 1997; Peltoniemi, 2011).

At this stage, technological uncertainty is reduced, yet uncertainty concerning how the company can generate and capture sufficient value from the existing, maturing technology, i.e., value generation uncertainty, grows. First, there is growing concern regarding market potential due to increased price competition and, thus, firms need to leverage their technological and market competences to the fullest in order to sustain their market performance (Suarez, 2004). Furthermore, given that the innovation level related to the existing product technology goes down once a dominant design emerges, the threat of technological discontinuity coming from other technological fields increases (Adner and Kapoor, 2010). Thus, besides leveraging existing technological competences, discovering new tech competences that can eventually lead to more abundant sources of revenue and profit starts to represent an important part of the competence-building strategy pursued by firms (Burton, Story, Raddats, and Zolkiewski, 2017; Raja, Frandsen, and Mouritsen, 2017).

Product-oriented services may still help with the first part of the strategy – the exploiting/leveraging of existing technological competences in order to sustain their market performance. Many manufactured products such as cars and computers continue to require product-

oriented services throughout the industry life cycle to ensure their functioning: these include repair and maintenance, online support, warranty, and upgrades (Goffin, 1999; Goffin and New, 2001). Customers who are buying products in the mature phase are likely to be less technology savvy and in need of product-oriented services (Rogers, 2003). In many manufacturing industries, regulations require that some form of product support is offered for as long as the product is on the market. In the lift and escalator sector, for example, Otis and Kone, ThyssenKrupp, Schindler and their peers derive more than half their profits from services (EBIKON, 2013). Thus, product-oriented services continue to help firms leverage their existing technological and marketing competences to generate revenue and profit margins that help compensate for declining market potential in the core product business (Reinartz and Ulaga, 2008). Considering that the provision of product-oriented services also helps reduce a firm's value generation uncertainty, which is higher in the late stage of the product industry life cycle than in the early stage, the following competing hypothesis is posited to Hypothesis 1a:

Hypothesis 1b: A firm is more likely to offer product-oriented services in the late rather than in the early stage of the life cycle of its core product industry.

Compared to customer-oriented services, however, product-oriented services tend to be less firm specific, less knowledge intensive, and less customized (Antioco et al., 2008). Consequently, when the complexity and specificity of the resources and capabilities involved in the provision of product-oriented services tend to be relatively low and specialized, cost-effective service providers are likely to emerge and stimulate fierce competition in the market for product-oriented services (Eggert et al., 2014; Reed and DeFillippi, 1990). Therefore, firms may find it difficult to compete and differentiate based on product-oriented services alone once the industry matures (Antioco et al., 2008). Furthermore, as product-oriented services are closely tied to the core product business, the growth and margins of

product-oriented services may also stagnate and decline if the core product business stalls (Gadiesh and Gilbert, 1998).

Customer-oriented services, on the other hand, may help product manufacturers to build new technology competences where the opportunity for value generation is higher (Agarwal and Helfat, 2009; Sawhney et al., 2004). This can be achieved by leveraging existing customer relationships and other market competences that the firm has developed in the core product industry (Ceci and Masini, 2011). IBM's entry into business consulting services following the decline of their core IT product business represents a case in point (Gerstner, 2009). IBM had an extensive customer network that they could use as a resource to offer any service that would be useful to customers. They attained the direct resources and capabilities necessary to offer a business-consulting service through the acquisition of PWC Consulting in 2002 (IBM, 2002; Spohrer, 2017). Furthermore, IBM's entry into business consulting also extended IBM's competences in the new service technologies (e.g. cloud computing) and enabled them to transcend the technology decline and discontinuity in their existing business (Spohrer, 2017).

In addition, customer-oriented services can help stimulate growth in a saturated market by extending the market and technological capabilities of potential new customers that lack purchasing power. For instance, Hilti, the power tools producer, had produced professional-grade tools to sell to the most sophisticated customers. In order to enter the home user and small contractor niche, they started to offer tool rental services to those who could not afford to own these tools (Cusumano et al., 2015).

Finally, in mature, commoditized industries, customer-oriented services can help firms learn more about the customer business and therefore discover what 'justifiers' the customer's purchasing managers use to decide which supplier to choose among the many potential product providers that meet product quality and price requirements (Anderson, Narus, and Wouters, 2014). These justifiers represent 'extra perks' that a firm can give to delight a customer (e.g. a cancelation option, a trusted technician), reduce uncertainty about the value of its offering and, thus, win in a tiebreak with

competitors. Considering that the provision of customer-oriented services helps - through customer knowledge and loyalty building - reduce a product firm's value generation uncertainty, which is higher in the late stage of the product industry life cycle, the following hypothesis is posited:

Hypothesis 1c: A firm is more likely to offer customer-oriented services in the late rather than in the early stage of the life cycle of its core product industry.

Industry competition

Whether it is the early or mature stage of the industry life cycle, changes in the regulatory conditions or geographical boundaries of an industry may lead to an increase in the number of competitors and, thus, greater competition intensity. For example, as a result of globalization, it was estimated that US manufacturers had to cut the costs of their products by 30% to compete with Chinese producers (Neely, 2008; Wu, Yue, and Sim, 2006). Firms in highly competitive industries exhibit lower returns and decreased chances of survival (Barnett, 1997; Basu, Phelps, and Kotha, 2011). Hence, low returns put pressure on firms to reduce costs, improve differentiation, and/or increase customer loyalty (Chen, Katila, McDonald, and Eisenhardt, 2010; Fang et al., 2008; Porter, 1996) to strengthen their competitive advantage (Chen, 1996; Chen et al., 2010). This, in turn, alters a firm's competence strategy. Incumbents in industries characterized by high competition often seek to reduce the prospect of renewed technological uncertainty created by the entry of new rivals by improving or renewing technologies, by differentiating their core product offering in various ways, or through actions that increase customer 'lock-in' and loyalty to the products and technology on offer (Basu et al., 2011; Geroski, 1990).

Offering product-oriented services may provide a way to differentiate a firm from its competitors. First, product-oriented services allow firms to leverage existing technological competences to address a broader set of customer needs and, thereby, strengthen and extend customer

relationships (Gebauer et al., 2012). For instance, through servicing, manufacturers have a reason to visit customers on a regular basis and thus develop close customer relationships with the decision makers in the process of product purchase (e.g. technicians, facility managers and purchasing managers). Through these trusted relationships and close customer proximity, firms can be first to identify emerging customer needs and seize the opportunity to develop the next generation of technology and sell replacement products (Garbarino and Johnson, 1999; Heim and Field, 2007).

Furthermore, this leverage of existing technological competences through product-oriented services can create customer lock-in advantages enjoyed by firms that offer product-oriented services that may be sufficient to fend off competition from specialized third-party service providers. For instance, HP has a service where it delivers ink to its customers on a subscription basis. This is enabled by HP's cartridge technology where the corresponding HP dealer is informed automatically when the ink cartridge needs to be replaced (HP, 2017). This gives peace of mind to the customer and, for the firm, it means that customer lock-in is enhanced with the risk of losing a customer consequently lowered.

Moreover, product-oriented services can help to reinforce and renew existing technological competences by continuously learning about how technology interacts with customer needs throughout the product life cycle through frequent customer interaction (Hienerth and Lettl, 2017; von Hippel, 1986). In addition, if the firm accomplishes data-based technological integration with its customers, those customers increasingly cease to look at the relationship with the firm as a transaction that can be easily performed by a cheaper competitor and begin to look at the relationship as one of co-creation fed by trust and loyalty (Chick, Huchzermeier, and Netessine, 2014). Furthermore, customers are more likely to trust the technological capabilities of firms with a reputation for quality product-oriented services. For instance, the German truck body and trailer manufacturer, Schmitz Cargobull, has used IT monitoring technology to reduce the time needed to respond to the needs of their customers – the truck operators – to one 10th of what it was in little over a decade ago (Chick et al., 2014). Thus, product-

oriented services can be a vehicle for further innovation and technological renewal in the core product line as well as for the development of complementary products.

Intense competition in the core product industry could also motivate firms to seek additional sources of revenues and profits outside their core product business. Firms can respond to greater competition in their core product industry – and thus greater uncertainty about their ability to continue to generate value – not only through supplying product-oriented services but also by offering customer-oriented services. Customer-oriented services require significant investment in resources and capabilities that are highly service specific, have a strong tacit dimension, and are often socially complex (Kowalkowski et al., 2009). As a result, the resources and capabilities supporting customer-oriented services have the potential to generate greater value and to provide a competitive advantage even in highly competitive industries (Peteraf, 1993). As the provision of product-oriented services helps reduce a firm's technological uncertainty (which tends to be higher in more competitive environments) by enabling technological renewal, trust and loyalty building with customer's technical staff, a higher likelihood of offering product-oriented services is expected in more competitive environments. Yet, at the same time, the provision of customer-oriented services can also help firms improve their competitive position in the presence of higher competition by helping them differentiate. Thus, the following hypotheses are poised:

Hypothesis 2a: A firm is more likely to offer product-oriented services if the level of competition in its core product industry increases.

Hypothesis 2b: A firm is more likely to offer customer-oriented services if the level of competition in its core product industry increases.

Industry R&D intensity

Even if they are at the same stage of maturity, industries can differ in their level of R&D intensity and innovativeness due to differences in scientific advance, spillover from other industries, or feedback from their own technological advances (Klevorick, Levin, Nelson, and Winter, 1995). For instance, both the hospitality and pharmaceutical industry are mature, yet the pharmaceutical industry is significantly more R&D intensive. Moreover, R&D intensive industries often change rapidly and in unpredictable ways (Dess and Beard, 1984; Eisenhardt, 1989). Because of the rapid and uncertain nature of change, firms need to be prepared to quickly explore and develop new technological competences (Eisenhardt and Martin, 2000). For instance, R&D intensive industries periodically experience so-called ‘battles for dominance’ between generations of rival technologies that increase technological uncertainty (Suarez, 2004).

Product-oriented services can help address the above challenges. First, the role of product-oriented services in protecting and profiting from an innovation has been well-known since Teece’s (1986) seminal work. When the appropriability regime is weak and IP rights cannot assure that the innovator profits from innovation, complementary assets – such as capabilities for product-oriented servicing – determine who benefits from innovation. For instance, the first entrant in the market for hospital scanners was EMI. However, as EMI did not have a sales and service structure, GE and Technicare, who had sales and service capabilities in the relevant customer sector, were the companies that more successfully reduced customer uncertainty about which technology to adopt; in consequence, they were able to seize this market (Teece, 1986).

Second, firms in highly R&D-intensive industries are often able to reduce customer uncertainty over the value of a new generation of technology by owning complementary resources and capabilities, such as those that allow them to offer customers key complementary product-oriented services (Visnjic Kastalli and Van Looy, 2013). For instance, Tesla has developed an infrastructure of 1,191 Supercharger Stations with 9,184 Superchargers so that their customers can charge their Tesla electric vehicles wherever they go (Tesla, 2018). By creating this service for their customers, Tesla reduces

customer uncertainty about the value of their electric cars and, at the same time, protects their own innovation from competition that does not have a comparable service station infrastructure.

Thus, product-oriented services can help alleviate technological uncertainty with respect to each new generation of technology since they can be used to support customers who do not yet have the confidence or expertise to buy or to use the latest generation of the product (Cusumano et al., 2015; Schmenner, 2009). In this case, product-oriented services can represent a necessary requirement, an essential capability that allows firms to successfully compete in R&D intensive industries. Finally, as in the early life cycle stages, by offering product-oriented services such as maintenance or customer support, product manufacturers obtain valuable feedback about product use and customer needs, which feeds into their new technology and product development (Baldwin and von Hippel, 2011; von Hippel, 1998). Thus, as the provision of product-oriented services helps reduce firms' and customers' technological uncertainty, which increases with industry R&D intensity, the following hypothesis is proposed:

Hypothesis 3: A firm is more likely to offer product-oriented services if the R&D intensity of its product industry increases.

Industry cyclicalities

Finally, industry cyclicalities represents the extent to which a firm faces a market that is changing and uncertain as opposed to stable and predictable. While R&D intensity contributes to the technological uncertainty, industry cyclicalities is defined as the rate of change in the composition of customers and their needs and contributes to value generation uncertainty (Hanvanich, Sivakumar, and Hult, 2006; Rijdsdijk, Langerak, and Hultink, 2008). Concentration on the customer side in certain industries ties the demand for firms' products to the preferences and economic or environmental conditions that the customer is facing. For instance, the defense industry is highly dependent on the change in the political environment that their customer, the Department of Defense, faces (Kapletia and

Probert, 2010). Cyclicalities can appear because of the nature of the product and the purchasing process. Capital goods, in general, are subject to the ups and downs of the business cycle as customers usually postpone their purchases in the downturn. In sum, cyclicalities come from uncertainty stemming from the demand side, and cyclical industries are characterized by rapid and steep changes in the demand for products and, correspondingly, in fluctuating sales (Cohen et al., 2006; Fang et al., 2008).

This uncertainty about the market potential creates changes in the competence profiles that firms need. Firms must leverage their existing market and technology competences to cope with cyclicalities in the nature of the offering. Agility is a necessity in cyclical industry conditions (Dess and Beard, 1984), as it is about being able to redeploy and repurpose competences. Moreover, as frequent strategic adaptations are needed in times of pronounced value generation uncertainty, there is also a higher need for information-processing needs and complexity management on the client side as well as internally (Guthrie and Datta, 2008).

Service offerings in general tend to be less exposed to fluctuation than products, such as capital investments and durable goods (Gebauer and Fleisch, 2007). The reason is that most services are purchased continuously in small increments rather than solely as occasional one-off investments (Wise and Baumgartner, 1999). Services, therefore, stabilize cash flows and provide a reliable revenue stream, which represents a key benefit in economic downturns (Fang et al., 2008; Oliva and Kallenberg, 2003). Within services, product-oriented services can provide this benefit by leveraging technological and market competences that, for the most part, largely exist, rather than necessitating a significant investment in new ones (Wuyts, Rindfleisch, and Citrin, 2015). Thus, considering that the provision of customer-oriented services helps product firms make better use of their accumulated technological competences, the following hypothesis is poised:

H4a. A firm is more likely to offer product-oriented services if the cyclicalities of its product industry increases.

On the other hand, customer-oriented services are more helpful in anticipating and assessing changes in customer preferences related to value generation uncertainty. Customer-oriented services require resources and capabilities that have a strong tacit dimension, and are often socially complex (Kowalkowski et al., 2009). Strong, trusted relationships with loyal customers provide an important resource as they can help firms anticipate change before it is officially announced (Matthyssens and Vandenbempt, 1998; Raddats and Easingwood, 2010).

Through customer-oriented services, firms can develop new marketing and technological competences that help them leap out of the problematic product category or industry and find other value generation sources. In the aforementioned example, IBM's entry into business consulting was not only serving to leverage their marketing competences in the interests of generating additional returns, but it also extended IBM's competences in the new service technologies (e.g. cloud computing) and enabled them to transcend the technology decline and discontinuity in their existing business (Spohrer, 2017).

Furthermore, the development of customer-oriented services may also help build internal-firm capabilities that are needed to address customers' value generation uncertainty. Thus, for example, in 1987, Caterpillar created a unit called Caterpillar Logistics Services that was supporting Caterpillar and its customers as a provider of logistical services. Throughout the 1987-2012 period², having this separate logistics company not only led to more stable service revenues but also created better logistic competences for Caterpillar, thus creating new value for their customers. Developing logistics from a support function into a client-facing service organization led to the professionalization and digitalization of logistics (Visnjic, Jovanovic, Neely, and Engwall, 2017).

Finally, by providing customer-oriented services in cyclical industries, firms can improve customer capabilities, reducing value generation uncertainty, and improving the performance of customers. For example, joint projects to help customers innovate can help both customers and the focal

firm thrive in the long run. For instance, a manufacturer of subsea flexible pipes, Technip Flex, has helped their customer, oil field service giant, Schlumberger, by co-creating intelligent pipes that reduce the complexity of subsea drilling for Schlumberger, the oil field services giant, by monitoring and regulating temperature throughout an oil pipeline (Chick et al., 2014). Considering that the provision of customer-oriented services, through customer knowledge and exploration of new innovation opportunities with the customer, helps reduce a firm's value generation uncertainty which increases with the cyclicity of its product industry, the following hypothesis is poised:

H4b. A firm is more likely to offer customer-oriented services if the cyclicity of its product industry increases.

METHODS

Sample and Data Collection

To test the effect of different industry conditions on firms' choices to offer product-oriented or customer-oriented services, the Compustat Global and North America databases is used to retrieve data on publicly listed firms from a range of manufacturing industries over a period of twenty-one years, from 1990 to 2011 (Fang et al., 2008; Neely, 2008). These manufacturing industries range from chemical products to heavy machinery, transportation equipment, and computer hardware, and are identified under the primary Standard Industry Classification (SIC) codes of 10-39. In line with prior research (Suarez et al., 2013), firms with primary SIC code 7372, i.e. pre-packaged software products are also included.

To identify the service offerings of these product manufacturers, prior research using the Compustat Business Segment database (e.g. Fang et al., 2008; Suarez et al., 2013) is followed. Firms generally separate out product revenues from service revenues in their annual reports, which is then

captured and coded by Compustat. For firms with a public listing in the US, the database provides information on firm sales for different business segments as reported by the firm's management. Compustat then interprets these business segment descriptions and allocates corresponding SIC codes.

In line with prior research (Fang et al., 2008), SIC codes and segment descriptions are used to classify each of the approximately 1,200 business segments in our sample as either products or services. Service segments are further classified as either product-oriented or customer-oriented services³. The criterion is whether the service is performed on the product such as repair, installation, optimization, or maintenance services, or whether the service is not performed on the product such as finance, management consulting, logistics, or public relations services (see Appendix 1 for further details). The classification was carried out independently by two expert judges, and a small number of differences were resolved through discussion (less than 5%). Information on service sales is voluntarily disclosed by companies, leading to the possibility of selection bias. To avoid such bias, prior research is followed and only companies that list service sales at least once are included (Fang et al., 2008). The final dataset consists of a panel of 410 firms that offer product-oriented and/or customer-oriented services at least once during the period observed, 1990-2011. Firms are, on average, observed over 13 years, resulting in 5,320 firm-year observations⁴.

Measures

Dependent variables. Because the interest of this article is what drives firms to offer product-oriented and customer-oriented services, three binary dependent variables that capturing a product firm's service offerings⁵ are calculated. *Service_{f,t}* equals one when firm f reports sales in at least one service segment in year t and equals zero otherwise. *Product – oriented service_{f,t}* equals one when firm f reports sales in at least one product-oriented service segment in year t and equals zero otherwise. *Customer – oriented service_{f,t}* equals one when firm f reports sales in at least one customer-oriented service segment in year t and equals zero otherwise.

Independent variables. To measure the characteristics of a firm's primary manufacturing industry in a particular year, Compustat is used to retrieve data on all firms with the same primary four-digit SIC code. For variables whose measurement is based on US dollars, nominal values are transformed into real 1990 values using US dollar GDP deflators. *Industry maturity*_{*i,t*} captures the maturity level of industry *i* in year *t* based on the number of remaining firms in the industry. The number of firms in an industry typically grows in the emerging stage of the industry life cycle until it reaches a peak, which is typically followed by a shakeout in the maturity and decline stage (Utterback and Suarez, 1993). In line with Suarez et al., (2013), industry maturity is calculated as $\left[\frac{-1}{\text{number of active firms in industry } i \text{ in year } t} \times 100 \right]$ for all the years before the peak in the number of active firms in the particular product industry as well as the year of the peak, and as $\left[\frac{1}{\text{number of active firms in industry } i \text{ in year } t} \times 100 \right]$ for all years after the peak. Industry maturity is negative and increasing before the peak in the number of active firms, and positive and increasing after the peak. Next, *Industry competition*_{*i,t*} is calculated as one minus a Herfindahl index of industry concentration based on the market shares of all firms *f* active in manufacturing industry *i* in year *t*, i.e. $\left[1 - \sum_f (\text{market share}_{f,i,t})^2 \right]$. *Industry turbulence*_{*i,t*} is calculated as the standard deviation in total sales of all firms in industry *i* over the previous four years divided by the mean of total sales over the past four years (Fang et al., 2008). Finally, *Industry R&D*_{*i,t*} is calculated as the median R&D expenditures of all firms active in industry *i* in year *t* expressed as a share of firm sales in year *t* multiplied by one hundred.

Controls. Number of firm-level time-varying control variables that may affect a firm's servitization strategy is included. Firms with larger market shares in the primary manufacturing industry, with higher profit margins, with higher R&D spending, larger in size, and/or who have slack resources may be more likely to provide product-oriented or customer-oriented services.

*Market share*_{*f,i,t-1*} is calculated as the sales of firm *f* in year *t-1* divided by the total sales of all firms active in industry *i* in year *t-1*. *Firm ebitda margin*_{*f,t-1*} is calculated as firm *f*'s earnings before interest, taxes, depreciation and amortization in year *t-1* as a fraction of firm sales. *Firm sales*_{*f,t-1*} is the log of firm sales in year *t-1*, which is included as a control for firm size. *Firm R&D*_{*f,t-1*} is calculated as firm *f*'s R&D expenditures in year *t-1* expressed as a share of firm sales multiplied by one hundred. Finally, *Firm slack*_{*f,t-1*} is calculated as the cash and short-term investments of firm *i* in year *t-1* as a percentage of total firm assets. All firm-level control variables are lagged one year because of endogeneity concerns. For example, firms may obtain a larger market share in the manufacturing industry when they offer services. It has also been found that profit margins and overall sales are affected by servitization (Fang et al., 2008; Visnjic Kastalli and Van Looy, 2013). Finally, by providing product-oriented services, firms can access valuable information on the customer and on the product's use, which may stimulate R&D investment by the firm seeking to exploit this knowledge for the development of better products. Estimating the regressions without these firm-level control variables renders very similar coefficients in terms of size and level of significance. Table 2 provides an overview of the descriptive statistics and Table 3 displays a correlation matrix.

Insert Tables 2 and 3 here

Methodology

To estimate the likelihood that a product firm offers product-oriented and customer-oriented services in any given year, conditional logit models with firm fixed effects are estimated (McFadden, 1973, 1980)⁶. Firm fixed effects control for unobserved time invariant firm characteristics affecting a firm's servitization strategy, such as the firm's core manufacturing industry and its main product offerings. In addition, annual indicators to control for the increasing tendency of firms to move towards offering services over time are included. In line with prior work (Fang et al., 2008), the analysis only

includes firms which have variation in offering product-oriented and/or customer-oriented services over time.

Hence, our sample only includes firms that start and/or stop offering one or both types of services during our period of observation (1990 to 2011). Temporal variation is used in the life cycle of the firm's manufacturing industry and in different industry conditions to predict the use of product-oriented and customer-oriented servitization strategies.

RESULTS

Table 4 reports the results of the conditional firm fixed effects logit models on the likelihood of offering product-oriented services (columns 1 to 6), customer-oriented services (columns 7 to 12), and services in general (column 13). Alternatively, a random effects logit model is estimated. Yet, the Hausman test rejects the null hypothesis that the unobserved firm-level effects are uncorrelated with the other covariates ($\chi^2(29)=1,460$; $p > \chi^2=0.0000$). This indicates that the fixed-effects estimator should be used instead of the random-effects estimator. Because logit models are used with firm fixed effects, the fixed effects are assumed to be zero when calculating marginal effects. Models presented in columns 6, 12, and 13 are going to be used to calculate the marginal effects on, respectively, the likelihood of offering product-oriented, customer-oriented, and services in general.

Insert Table 4 here

In line with hypothesis 1a and in contrast to hypothesis 1b, manufacturing firms are more likely to offer product-oriented services in the early stages of the industry life cycle, presumably to draw on existing product knowledge and resources, attract lead users, facilitate initial product sales, and learn more about the product's functioning and customer needs. A standard deviation increase in industry maturity decreases the likelihood of providing product-oriented services by 1%. In the emerging stage of the manufacturing industry, firms are 7% more likely to sell product-oriented services than in the

most mature stage of the industry. This finding does not imply that firms only offer product-oriented services in the early stage, rather that they are more likely to offer them in the early stage compared to later stages.

Besides the industry life cycle, results suggest that competition in the manufacturing industry prompts firms to provide product-oriented services, in line with hypothesis 2a. A standard deviation increase in competition improves the likelihood of providing product-oriented services by 2%. Firms in the most competitive manufacturing industries are 6% more likely to offer product-oriented services compared to firms in the least competitive industries, arguably because this type of service offers a means of securing differentiation from the competition and of attaining and exploiting cost advantages through economies of scope.

In addition, in line with hypothesis 3, results suggest that R&D intensity of the manufacturing industry positively affects the provision of product-oriented services. A standard deviation increase in industry R&D intensity boosts the likelihood by 5%. Firms in the least R&D intensive industries are 41% less likely to offer product-oriented services compared to firms in the most R&D intensive industries. It can be argued that product-related services such as customer support and maintenance enable a company to capture value from product-related innovation and resources (Teece, 1986), while also developing knowledge resources about the product's functioning and use, which provide a valuable input for R&D (Ettlie and Rosenthal, 2011).

Finally, no support for hypothesis 4a could be found. The likelihood that a product manufacturer offers product-oriented services is not significantly affected by the cyclicalities in sales in the manufacturing industry. This finding was surprising, given the conventional wisdom and empirical evidence of firms introducing product-oriented services in the face of cyclicalities. There can be several interpretations of this finding. First, product-oriented services that are mostly introduced at the early stages of the life cycle (see H1a) may act to prevent cyclicalities that are often more likely at later stages. Thus, the inverse may be true and product-oriented services may be there before the cyclicalities occur.

Second, we are relying on secondary data sources that may not capture all the product-oriented services, and the relationship may be stronger and more significant than what our predictions indicated. Finally, as customer-oriented services are more likely to strengthen customer relationships than product-oriented services, firms may prioritize investments in customer-oriented rather than product-oriented services.

With respect to customer-oriented services, the effect of the industry life cycle runs counter to product-oriented servitization. While firms are more likely to offer product-oriented services in the early stages of the manufacturing industry, firms are more likely to provide customer-oriented services in the later stages of the industry, presumably as part of the search for new sources of sales growth outside their main business by redeploying resources to customer-oriented services when the manufacturing industry is mature and declining. This supports hypothesis 1c. A standard deviation increase in industry maturity increases the likelihood of offering customer-oriented services by 2%, with a maximum increase of 10% between the emerging and the most mature stage of an industry.

We find no support for hypothesis 2b. Whereas the level of competition in the manufacturing industry motivates firms to offer product-oriented services, it has no significant effect on the provision of customer-oriented services. Finally, results suggest that firms are more likely to offer customer-oriented services in the case of a cyclical product industry, in line with hypothesis 4b. Fluctuating sales in manufacturing seem to stimulate firms to search for growth opportunities outside their core product business. A standard deviation increase in industry cyclicity increases the likelihood of customer-oriented servitization by 1%. Firms in most cyclical industries are 5% more likely to offer this type of service compared to firms in the least-cyclical industries.

In terms of firm-level control variables, results suggest that firm size positively affects the provision of both product-oriented and customer-oriented services, and that firm R&D intensity positively affects the provision of product-oriented services, in line with the R&D intensity of manufacturing industry in general.

In conclusion, findings suggest that firms tend to offer product-oriented and customer-oriented services under different industry conditions. Firms are more likely to offer product-oriented services in the early stage of the industry life cycle and under conditions of high R&D intensity and competition, whereas they are more likely to offer customer-oriented services in the later stages of the industry life cycle and in highly cyclical industries. These findings suggest that firms offer product-oriented services to strengthen their competitive position in the product industry, whereas they offer customer-oriented services when the industry matures or enters its decline phase or when industry sales are cyclical. The different and sometimes opposite findings for product-oriented and customer-oriented services illustrate the importance of distinguishing between different types of services in order to better understand servitization strategies. When a distinction between product-oriented and customer-oriented services is not made, no effect of the life cycle of the manufacturing industry (industry maturity) on a product firm's likelihood of providing services is found, as reported in column 13 of Table 4. With respect to other conditions in the industry, industry competition and R&D intensity have significant positive effects. A standard deviation increase in industry competition increases the likelihood of servitization by 0.3%. A standard deviation increase in R&D intensity of the industry boosts the likelihood of a move towards services by 1.2%.

DISCUSSION AND CONCLUSION

Drawing on the competence-based view of industry evolution and service types, we theorize that the competence needs emerging in a given industry condition drive firms' choice to provide services that leverage or help build the required competences. In particular, we theorize that firms are more likely to offer product-oriented services in industry conditions, such as in the early or late stages of the product industry life cycle, in more R&D intensive, more competitive, and more cyclical

industries. On the other hand, we hypothesize that firms choose to offer customer-oriented (CO) services in industry conditions such as the later stages of the product industry life cycle as well as in more competitive and more cyclical product industries.

The results of our statistical analysis of longitudinal data on 410 public firms from manufacturing industries and the software industry suggest that firms may make an either/or choice between providing product-oriented and customer-oriented services, depending on the industry conditions they find themselves in. More specifically, they are more likely to offer product-oriented services in the earlier stage of the industry life cycle, in more R&D intense, or more competitive industries, whereas they are more likely to offer customer-oriented services in the later stages of the industry life cycle and in highly cyclical industries.

Our findings suggest that there are two distinct types of industry environments associated with two distinct service responses. On one side, in Schumpeterian environments characterized by high *technological uncertainty* (i.e. early product life cycle, high competition, and R&D intensity) firms use PO services to leverage and reinforce capabilities in the existing technology. Indeed, industry conditions such as the early stage of the industry life cycle, high level of competition, and high R&D intensity can be related to and reflect uncertainty over existing technology, where the first priority of firms is to develop existing technology competences by understanding customer needs, key priorities, and the product use environment to achieve product-market fit, achieve dominance in design, secure differentiation from low-cost competition, or survive a technology race. Building and leveraging technological competences of core products is a priority and, therefore, investing in product-oriented services that further these competences is a superior choice to investing in customer-oriented services.

On the other hand, in non-Schumpeterian environments characterized by *value generation uncertainty* due to the declining potential of existing technologies (i.e. late product industry life cycle and high cyclicity) firms use CO services to build competences in new technological or market areas. Indeed, these industry conditions confront a firm with a set of value generation challenges that are not

resolvable by further investment in the competences of the existing technology either because the technological opportunity is declining (late life cycle stage) or because the locus of the challenge is on the customer side (cyclicality). Leveraging marketing competences of core products and building technological competences beyond core products is a priority, and customer-oriented services are better suited since they can help transcend reliance on the existing technology. Due to the different competences required for their provision, product-oriented and customer-oriented services require different types and levels of investment and are, therefore, in competition for resources (Eggert et al., 2014; Fang et al., 2008; Mathieu, 2001; Ulaga and Reinartz, 2011). Visual depiction of our results is provided in Figure 1 below.

Insert Figure 1 here

Theoretical implications

This study addresses recent calls for a better understanding of the industry-level determinants of servitization (Kowalkowski et al., 2017; Suarez et al., 2013) and of the different types of services offered by manufacturing and software firms (Cusumano et al., 2015; Eggert et al., 2014; Fang et al., 2008). It offers four important theoretical implications for and contributions to extant literature. First, in line with Cusumano's (2015) observation, findings suggest that services are not simply product additions that help firms offer commoditized products but are an integral part of the strategies employed to tackle the fundamental challenges of technological and value generation uncertainty in different industry conditions. Three industry conditions (competition, R&D intensity and cyclicality) are considered in addition to the industry life cycle condition studied by Cusumano et al. (2015) and offer novel mechanisms, theory and evidence on the choice to offer one or the other service type under

different industry conditions. Furthermore, this study builds on existing efforts to understand the conditions under which servitization occurs (Antioco et al., 2008; Cusumano et al., 2015; Eggert et al., 2014; Gebauer, 2007; Raddats, Baines, Burton, Story, and Zolkiewski, 2016; Turunen and Finne, 2014) by presenting the first study of all relevant industry conditions associated with servitization identified by prior research and providing novel empirical evidence on a sample of both manufacturing and software firms.

Second, this study contributes to research on the process of servitization and the service continuum (Kowalkowski, Gebauer, Kamp, and Parry, 2017). In this specific research stream, more recent studies have questioned the earlier assumption that servitization is a linear process in which the servitizing firm adds layer upon layer of services. By providing theory and evidence that servitization represents a reaction to changing environmental conditions as a part of a broader competence strategy, this study lends support to the proposition that the servitization process is not a continuum but more akin to a contingent strategy (Kowalkowski et al., 2017; Matthyssens and Vandenbempt, 2010). Thus, the competence-based perspective on servitization helps address broader questions of servitization: why do services appear and what is the relationship between services and competitive advantage (Eloranta and Turunen, 2015).

Third, this study adds to the research on service resources and capabilities and service classifications by highlighting the importance of a competence-based foundation to the distinction between product-oriented and customer-oriented services (Fang et al., 2008; Mathieu, 2001). This study contributes to the literature on service resources and capabilities by distinguishing between the services that share technological competences with the products and those that do not (Huikkola and Kohtamaki, 2017; Raddats et al., 2015; Ronnberg et al., 2016; Story, Raddats, Burton, Zolkiewski, and Baines, 2017); the distinction between technology and marketing/customer competences is important to clarify from a technology-strategy perspective (explained below). This also sheds new light on service innovation (the development of service offerings) and its relationship to product innovation by stressing

the relationship with underlying competences and by identifying the mechanisms via which this relationship occurs (Gianiodis, Ettlie, and Urbina, 2014; Kindstrom and Kowalkowski, 2009; Mina, Bascavusoglu-Moreau, and Hughes, 2014; Valtakoski, 2017; Visnjic et al., 2016).

Fourth, this study has implications for the industry evolution literature by providing evidence for the choice of services at different stages of industry evolution and theorizing how services shape the capability of firms to transcend the challenges associated with different industry conditions (Cusumano et al., 2015). We shed light on the way the provision of services helps firms better leverage existing competences and develop new competences that may help increase performance under different industry conditions (Visnjic et al., 2017). In doing so, this study also represents a contribution to the nascent literature on the competence-based view of industry evolution (Uzunca, 2017). Our theorizing implies that the competences developed from service provision may influence industry evolution (Klepper and Thompson, 2006; Uzunca, 2017). For instance, services can help firms create new market spaces in the early stages of the product life cycle, influence the shakeout phenomenon observed in many product industries (Suarez and Utterback, 1995; Utterback and Suarez, 1993), or extend the lifetime of the current technology, thus postponing technological discontinuities (Adner and Kapoor, 2010). Finally, value is added to the literature on industry evolution by considering other industry antecedents of servitization, besides the industry life cycle, and by providing mechanisms (technological and value generation uncertainty) linking industry conditions and, more broadly, Schumpeterian and non-Schumpeterian industry environments to service type choices.

Managerial implications

This research is relevant to managers in firms that have traditionally focused on product offerings.

1. It offers novel insights into how industry conditions shape the choice of which specific types of services to offer under which industry conditions.

2. Specifically, it presents new arguments and evidence suggesting that firms should consider offering product-oriented services, i.e., services performed on the product such as product customization, monitoring, maintenance, and repair, in Schumpeterian industry environments, i.e., early in the product industry life cycle as well as in highly competitive and/or R&D intensive product industries. This stems from the fact that, in such environments, the customers of their main product business experience high technological uncertainty – that is to say, they are uncertain which of the many emergent and competing technologies in the marketplace they should adopt. Managers can mitigate that uncertainty and, thus, influence customer decisions to adopt their firm's products by leveraging and reinforcing existing key product knowledge and technologies through the offer of product-oriented services. Offering product-oriented services also helps the firm gain better insights into both extant and emergent customer needs as well as product functioning and use, thereby helping the firm improve key technologies and product design in order to win out in emerging, highly competitive, and/or highly R&D intensive product industries.
3. On the other hand, firms should consider offering customer-oriented services, i.e., services that go beyond mere product functioning and operation such as management consulting, logistics and financial services in non-Schumpeterian industry environments, i.e., in the later stages of the product industry life cycle as well as in cyclical product industries. That is because, in such environments, the customers of their main product business experience heightened value generation uncertainty – that is to say, they are uncertain about the value of the firm's maturing products/technologies and how to maximize the value derived from these maturing and increasingly commoditized products and technologies. Managers can mitigate that uncertainty by building capabilities in new technology and market domains through the offer of services that go beyond the knowledge and technologies underpinning the focal product, yet help enhance its value.

4. These insights should encourage managers to objectively assess the industry conditions they are in, the key challenges (technological or value generation uncertainty) posed by prevailing industry conditions, and the service strategy – offering product-oriented vs. customer-oriented services – that will allow them to leverage and/or build the competences needed to address the challenges posed by their industry conditions and, hence, improve their strategic position.
5. The above insights can also improve managers' understanding of the competence advantages that different types of services provide in different industry settings and, thus, facilitate the assessment and comparison of these advantages with those provided by other approaches to competence development such as M&A, strategic alliances, external sourcing, and open or radical/disruptive innovation (Chesbrough, 2011).

Limitations and future research

Our research has limitations that should be taken into account when interpreting the results. Although Compustat provides detailed information on firm sales in different service segments for a large sample of public firms from a range of manufacturing industries, it has a number of limitations common to all prior studies relying on the Compustat business segments database (e.g. Fang et al., 2008; Suarez et al., 2013). Information on service sales is voluntarily disclosed by companies, and some product manufacturers may simply not disclose the information, which might lead to selection bias. To mitigate this problem, prior research has been followed and only manufacturing firms that report service sales at least once during the observed time window are included. In addition, the distinction between product-oriented and customer-oriented services may be a matter of degree rather than the strict categorical distinction that is used for the sake of parsimony in theory development and empirical analysis.

Furthermore, product-oriented and customer-oriented services each contain different types of services that may have different properties (Goffin and New, 2001). Indeed, within both PO and CO services there is a variety of different services. For instance, spare-parts provision is different from labor-intensive services, such as maintenance, and may offer different competence advantages (Benedettini et al., 2015; Gebauer, 2008). Future large-sample quantitative studies can provide a more detailed insight into this issue by leveraging more fine-grained data on, and classifications of, PO and CO services which could be obtained through close collaboration with large MNEs with wide service portfolios.

Finally, prior research is followed by using the number of firms in an industry to measure the evolution of the industry life cycle (Utterback and Suarez, 1993). Given that the number of firms in an industry grows initially and declines afterwards (Klepper, 1996, 1997), the measure allows us to distinguish between the early stages of the industry life cycle, i.e., the development and growth phase, and the later stages of the life cycle, i.e., maturity and decline. However, data limitations restrict us from leveraging more fine-grained distinctions of the different stages of the industry life cycle. Besides the limitations related to the use of Compustat data, another limitation is that we examine only those industry determinants discussed by prior research on the servitization of manufacturing companies (e.g. Cusumano et al., 2015; Fang et al., 2008).

Conceptually, investments in both product and service innovation should have an impact on the likelihood of offering services. However, publicly reported R&D spending mostly captures product innovation and not service innovation. The main reason is that service innovation tends to be decentralized rather than centralized in an R&D lab (Blindenbach-Driessen and van den Ende, 2014; Storey, Cankurtaran, Papastathopoulou, and Hultink, 2016). As publicly reported R&D spending is used, hypothesis on the effect of industry R&D intensity is based on the assumption that it captures product innovation. While the impact of service innovation on the decision to offer product-related and customer-related services is considered to be an important matter, we are not able to study it empirically.

This study opens multiple avenues for future research. Future work could examine the interplay between products, product-oriented services and customer-oriented services, and how their underlying resource and capability bases are co-developed and leveraged over time. In addition, a better understanding of the antecedents of more nuanced types of services such as maintenance, repair, or upgrade would be a promising avenue for future research (Goffin, 1999; Goffin and New, 2001) and a natural extension of this study.

Future work on the performance impact of servitization could examine the performance impact of product-oriented and customer-oriented services in different industry conditions. For example, future research could shed more light on how the type and timing of service offerings affect relevant firm outcomes such as firm revenue, growth, profitability, and survival. Recent research suggests that product manufacturers are more likely to file for bankruptcy after moving into services (Benedettini et al., 2015). Our study implies that the latter outcome may be the result of a mismatch between industry conditions and the type of services offered. Finally, future research could examine the complementarity and tradeoffs between product-oriented and customer-oriented servitization and product innovation, examining more thoroughly how servitization impacts financial performance indirectly as well as directly (Bustinza, Gomes, Vendrell-Herrero, and Baines, 2017; Suarez et al., 2013; Visnjic et al., 2017).

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¹ Occasionally, the industry life cycle can be disrupted in order to establish new cycles (Anderson and Tushman, 1990). Such disruptions can be considered as re-establishing a new ferment phase, in the sense that uncertainty, product variation, and investment in product innovation are increased (Cusumano et al., 2014).

² Caterpillar Logistic Services was spun off and renamed Neovia in 2012.

³ When we encountered a description of a business segment that did not match the SIC code, we used two independent judges to decide whether this was a product or a service, and a product-oriented or a customer-oriented service. Differences between judges were minor and were resolved through discussion.

⁴ Following Fang et al., (2008), we include in our dataset only firms that provide service sales at least once during the observation period. Reporting sales in separate business segments represents a voluntary managerial disclosure, and firms may be offering services even if they do not disclose them in separate business segments. Thus, we decided to restrict the sample to those firms that voluntarily report sales in a service segment.

⁵ It should be noted that some of the research on servitization has used the share of sales stemming from services as an outcome measure. Because we are interested in the likelihood that a firm offers different type of services, rather than whether service sales replace product sales, we opt for binary measures capturing the different type of services that a company offers in a certain year.

⁶ Our main findings are robust to using linear fixed effects models.

TABLE 1: Overview of the Research on Industry Antecedents of Servitization

Authors and the year of publishing	Method	Summary of publication	Industry lifecycle - early	Industry lifecycle - late	Industry competition	Industry R&D intensity	Industry cyclicity
Baines et al., (2009)	Literature review	Define servitization and concludes that servitization has potential to maintain revenue streams and improve profitability.		X	X		
Baines and Shi (2015)	Literature review	Define servitization and advanced services, identifies stimulus, drivers and organizational change factors, impact on the customer and manufacturer, enablers and inhibitors and potential for the economy.	X	X		X	X
Baveja, Gilbert, and Ledingham (2002)	Anecdotal evidence	Argue that the expansion of services may be among the most important trends but trying to grow new services can create a series of unexpected obstacles.					X
Bohm, Eggert, and Thiesbrummel (2017)	Qualitative comparative analysis	Examine whether a healthy financial situation is a necessary requirement for successful service transition; healthy companies should focus on customers as a knowledge source, companies in an inferior financial situation need strong links with suppliers.		X			
Cohen, Agrawal, and Agrawal (2006)	Anecdotal evidence	Argue that companies realize the importance of providing spare parts and after-sales services, but most could make far more money in the aftermarket.			X		
Cusumano et al., (2015)	Conceptual study	Identify three categories of product-related services and develop propositions about the relative level of these services over stages of industry evolution. Then suggest how these services affect industry structure.	X	X	X	X	X
Eggert, Hogreve, Ulaga, and Muenkhoff (2011)	Quantitative study	Show that when product innovation is high, services supporting the product (SSPs) directly increase firm				X	

		profitability. When product innovation activity is low, services supporting the clients' actions (SSCs) have a significant, positive effect on firm profitability.					
Eggert et al., (2014)	Quantitative study	Show that services increase both the level and the growth of manufacturing firms' revenue streams. In contrast, they reduce the level but improve the growth of manufacturers' profits.	X	X			X
Fang et al., (2008)	Quantitative study	Show that service transition strategies are more effective at enhancing value when the service offerings are related more to the firm's core business and when firms have more available resources (i.e., resource slack).	X	X	X		X
Gebauer (2007)	Quantitative study	Show positive associations of the external environment (competitive pressure and customer expectations) and organizational factors that support services (e.g. service culture) with customer supporting services strategy.			X		
Gebauer et al., (2012)	Literature review	Elaborate the concept of service-driven manufacturing focusing on the provision, evolution and impact of services in industrial settings.			X		
Gaiardelli, Songini, and Saccani (2014)		Customer loyalty					
Kindström and Kowalkowski (2014)	Qualitative study	Investigate the nature and characteristics of business model elements required for successful service innovation. Examines resources and capabilities product-centric firms should develop and deploy to pursue service innovation.		X			
Martinez, Bastl, Kingston, and Evans (2010)	Qualitative study	Present challenges experienced by UK manufacturing companies undergoing a servitization journey to becoming product-service providers.			X		

Neely (2008)	Quantitative study	Finds that the manufacturing firms that have servitized are larger than traditional manufacturing firms in terms of sales revenues, generate lower profit margins and face some hidden risks.			X		
Oliva and Kallenberg (2003)	Qualitative study	Identifies the organizational dimensions considered when creating a service organization in the context of a manufacturing firm.		X	X		X
Reinartz and Ulaga (2008)	Anecdotal evidence	Explains why many struggle to make money from services and offers suggestions on how to improve position.		X	X		
Saccani, Visintin, and Rapaccini (2014)	Conceptual study	Analyses the linkages between the types of services that servitized manufacturers outsource and the relationships they establish with suppliers.			X		
Salonen (2011)	Qualitative study	Find that manufacturers develop product-related services through a dedicated service division while simultaneously pursuing the integrated solutions strategy.					
Santamaria, Nieto, and Miles (2012)	Quantitative study	Find that important differences exist between service and product (goods) innovations: service innovations are related to human resource development and closely linked to customers.				X	
Sawhney, Balasubramanian, and Krishnan (2004)	Anecdotal evidence	The key to success involves redefining the markets in terms of customer activities and outcomes, not products and services.		X	X		X
Shankar, Berry, and Dotzel (2009)	Anecdotal evidence	In tough economic times, companies need new ways to innovate and drive revenues and profits by combining a product with a service.		X	X		
Spring and Araujo (2009)	Conceptual study	Proposes a business model approach to analyze the roles of products and services in delivering benefits to customers.		X			

Suarez et al., (2013)	Quantitative study	Find a convex, nonlinear relationship between a product firm's fraction of total sales coming from services and its overall operating margins.		X	X		X
Teece (1986)	Conceptual study	Demonstrates that when imitation is easy, markets do not work well, and innovating firms need complementary assets to profit from innovation.	X		X	X	
Vandermerwe and Rada (1988)	Conceptual study	Assess the main motives driving corporations to servitization, and point out the changing competitive dynamics that require top managers to focus on services.	X	X	X		
Visnjic Kastalli and Van Looy (2013)	Quantitative study	Show that the firm under study is able to successfully transcend the inherent substitution of products by services and enact complementary sales dynamics.	X	X	X		X
Visnjic et al., (2016)	Quantitative study	Indicate that the interplay between service business model innovation and product innovation results in long-term performance benefits coupled with a degree of short-term performance sacrifice.	X	X	X	X	X
Wise and Baumgartner (1999)	Anecdotal evidence	Weak product demand and growing installed base are pushing manufacturers to provide services.		X	X		X

TABLE 2: Descriptive Statistics (n=5,320 firm-year observations; 410 product firms)

	Description	Mean	Std dev
<i>Dependent variables</i>			
Service _{f,t}	Binary measure equals to one in case firm f reports sales in at least one service segment in year t.	0.42	0.49
Product – oriented service _{f,t} (PO)	Binary measure equals to one in case firm f reports sales in at least one product-oriented service segment in year t.	0.12	0.33
Customer – oriented service _{f,t} (CO)	Binary measure equals to one in case firm f reports sales in at least one customer-oriented service segment in year t.	0.32	0.47
<i>Independent variables</i>			
Industry maturity _{i,t}	In line with Suarez et al., (2013), industry maturity is calculated as $\left[\frac{-1}{\text{number of active firms in industry } i \text{ in year } t} \times 100 \right]$ for all the years before and in the year of the peak in the number of active firms in product industry i, and as $\left[\frac{1}{\text{number of active firms in industry } i \text{ in year } t} \times 100 \right]$ for all years after the peak. Industry maturity is negative and increasing before the peak, and positive and increasing after the peak.	-0.30	2.86
Industry competition _{i,t}	One minus Herfindahl index of industry concentration based on the market shares of all firms f active in manufacturing industry i in year t, i.e. $\left[1 - \sum_f (\text{market share}_{f,i,t})^2 \right]$	0.65	0.25
Industry cyclicity _{i,t}	Standard deviation in total sales of all firms in industry i over the previous four years divided by the mean of total sales over the past four years (Fang et al., 2008)	0.32	0.37
Industry R&D _{i,t}	Median of R&D expenditures divided by sales in year t for all firms active in industry i in year t multiplied by one hundred.	6.74	6.44
<i>Control variables</i>			
Market share _{f,i,t-1}	Sales of firm f in year t-1 divided by the total sales of all firms active in industry i in year t-1.	0.92	4.45
Firm ebitda margin _{f,t-1}	Firm f's earnings before interest, taxes, depreciation and amortization in year t-1 as a fraction of firm sales	0.03	0.41
Firm sales _{f,t-1}	Logarithmic transformation of firm sales in year t-1.	5.95	2.70
Firm R&D _{f,t-1}	Firm f's R&D expenditures divided by firm sales in year t-1 multiplied by one hundred.	7.73	11.39
Firm slack _{f,t-1}	Cash and short-term investments of firm i in year t-1 as a percentage of total firm assets.	0.17	0.18

TABLE 3: Correlation matrix (n=5,320 firm-year observations; 410 firms)

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	<i>Dependent variables</i>												
(1)	Service _{f,t}	1.00											
(2)	Product – oriented service _{f,t} (PO)	0.44	1.00										
(3)	Customer – oriented service _{f,t} (CO)	0.80	0.13	1.00									
	<i>Independent variables</i>												
(4)	Industry maturity _{i,t}	0.07	0.06	0.04	1.00								
(5)	Industry competition _{i,t}	0.00	0.00	0.00	0.01	1.00							
(6)	Industry cyclicity _{i,t}	-	-	-	-	-	1.00						
(7)	Industry R&D _{i,t}	0.03	0.01	0.04	0.03	0.22	0.04	1.00					
	<i>Control variables</i>												
(8)	Market share _{f,i,t-1}	0.04	0.08	0.01	0.08	0.01	0.04	0.09	1.00				
(9)	Firm ebitda margin _{f,t-1}	-	-	-	-	-	-	-	-	1.00			
(10)	Firm sales _{f,t-1}	0.01	0.01	0.02	0.02	0.02	0.01	0.10	0.05	0.43	1.00		
(11)	Firm R&D _{f,t-1}	0.11	0.05	0.11	0.02	0.10	0.11	0.29	0.23	0.45	0.32	1.00	
(12)	Firm slack _{f,t-1}	0.02	0.04	0.01	0.05	0.08	0.06	0.44	0.08	0.15	0.25	0.46	1.00

TABLE 4: Firm-Fixed Effects Logit (n=5,320 firm-year observations; 410 firms)

	(1) PO	(2) PO	(3) PO	(4) PO	(5) PO	(6) PO	(7) CO	(8) CO	(9) CO	(10) CO	(11) CO	(12) CO	(13) Service _{f,t}
Industry maturity _{i,t}		-0.06** (0.03)				-0.05* (0.03)		0.05** (0.02)				0.05** (0.02)	0.00 (0.02)
Industry competition _{i,t}			1.18*** (0.31)			1.18*** (0.32)			-0.00 (0.21)			0.04 (0.21)	0.35* (0.19)
Industry cyclical _{i,t}				-0.18 (0.18)		-0.08 (0.18)				0.20* (0.12)		0.21* (0.12)	0.18 (0.11)
Industry R&D _{i,t}					0.15*** (0.04)	0.15*** (0.04)					0.02 (0.02)	0.02 (0.02)	0.05** (0.02)
<i>Controls</i>													
Market share _{f,i,t-1}	-0.01 (0.03)	-0.01 (0.03)	-0.02 (0.03)	-0.01 (0.03)	-0.02 (0.03)	-0.04 (0.03)	0.03 (0.02)	0.03* (0.02)	0.03 (0.02)	0.03 (0.02)	0.03 (0.02)	0.03 (0.02)	0.02 (0.02)
Firm ebitda margin _{f,t-1}	-0.19 (0.21)	-0.20 (0.21)	-0.18 (0.21)	-0.18 (0.21)	-0.19 (0.21)	-0.20 (0.22)	-0.00 (0.13)	-0.01 (0.13)	-0.00 (0.13)	-0.00 (0.13)	0.00 (0.13)	-0.01 (0.13)	0.03 (0.14)
Firm sales _{f,t-1}	0.65*** (0.11)	0.65*** (0.11)	0.68*** (0.11)	0.65*** (0.11)	0.67*** (0.11)	0.70*** (0.11)	0.73*** (0.08)	0.73*** (0.08)	0.73*** (0.08)	0.73*** (0.08)	0.72*** (0.08)	0.72*** (0.08)	0.84*** (0.07)
Firm R&D _{f,t-1}	0.02** (0.01)	0.02** (0.01)	0.03*** (0.01)	0.02** (0.01)	0.02** (0.01)	0.02*** (0.01)	0.00 (0.01)	0.01 (0.01)	0.00 (0.01)	0.00 (0.01)	0.00 (0.01)	0.00 (0.01)	0.01** (0.01)
Firm slack _{f,t-1}	0.27 (0.46)	0.22 (0.47)	0.22 (0.47)	0.26 (0.46)	0.32 (0.47)	0.22 (0.47)	0.02 (0.34)	0.03 (0.34)	0.02 (0.34)	0.01 (0.34)	0.01 (0.34)	0.02 (0.35)	0.28 (0.32)
Year fixed effects	Incl.	Incl.	Incl.	Incl.	Incl.	Incl.	Incl.	Incl.	Incl.	Incl.	Incl.	Incl.	Incl.
Firm fixed effects	Incl.	Incl.	Incl.	Incl.	Incl.	Incl.	Incl.	Incl.	Incl.	Incl.	Incl.	Incl.	Incl.
Log likelihood	- 900.526	- 898.430	- 893.295	- 900.016	- 891.978	- 882.795	- 1807.867	- 1805.641	- 1807.867	- 1806.478	- 1807.393	- 1803.593	- 2109.926
Observations	2,316	2,316	2,316	2,316	2,316	2,316	4,480	4,480	4,480	4,480	4,480	4,480	5,320
Firms	174	174	174	174	174	174	343	343	343	343	343	343	410

Robust standard errors in parentheses,

* p<0.1

** p<0.05

*** p<0.01

FIGURE 1: Empirical Results of the Effect of the Industry Antecedents on the Service Type Choice

Appendix I - Categorization of products and services

Following Fang et al., (2008), we operationalize engagement in servitization in two steps. First, by distinguishing between products and services and, second, by splitting the services offered into product-oriented and customer-oriented. For this purpose, we developed a codebook identifying, in the universe of segmental SIC codes, the one that is reputed to be services.

Services vs. Products: In order to perform our categorization of the SIC codes, we obtained definitions and labels of the codes from the US Department of Labor, and we analyzed each code with respect to whether it represents a product or a service. We focused principally on co-production with the customer as a criterion to distinguish between products and services (Cusumano et al., 2014). After extensive consideration of the information gathered, we proceeded in three steps. First, the complete SIC code divisions Services (7000-8999), Transportation, Communications, Electric, Gas, and Sanitary Services (4000-4991) and Finance, Insurance and Real Estate excluding investment activities on own account and the real estate codes (6000-6411) were classified as services. Second, similar to Neely (2008), we identified all SIC code definitions containing strings such as ‘maintenance’, ‘consult’, ‘develop’. The search following the keywords led to the consideration of 37 additional codes. However, after a thorough analysis of the definition, 18 codes were deemed not to be service related. Third, we manually reviewed all SIC codes. This led to a reclassification as non-service or services for 28 SIC codes based on a more precise analysis of the full SIC code definitions. The approach adopted for coding was conservative. When in doubt, codes were classified as product. It should be noted that services in the context of this study are looked at from a manufacturing perspective. Strictly excluded from services are the sale/re-sale of (own) products

and the pure investing of own capital. In the end, 315 out of 1,164 SIC codes have been classified as services.

Product-oriented versus customer-oriented. We identify which SIC codes correspond with product-oriented and customer-oriented services, and use the Compustat business segment database to classify all manufacturers according to the nature of the services offered each year. Again, the approach followed for categorization is structured. SIC codes in the division Finance, Insurance and Real Estate (6000-6799) and the groups Mobility (4000-4173), Transportation / Logistics / Warehousing / Storage (4200-4785), Communications (4800- 4899) and Utilities (4900-4971) are classified as customer-oriented services since they are not performed on products. Indeed, services such as transportation are classified in this way, even though they involve products. However, such services do not support the functioning of the products themselves.

Thereafter, SIC codes within the division Services (7000-8999) are manually divided into product-oriented and customer-oriented services. Indicatively, customer-oriented services concern health, education, amusement and consulting sectors, while product-oriented services cover repairing and maintenance. All remaining SIC codes were classified as product-oriented services since all definitions contained explicit references to the enhancement of specific product categories. After applying the above methodology, the categorizations were reviewed manually and questioned one by one. This resulted in a reassessment in seven cases. A random sample test comparing classifications with information available on company websites resulted in satisfactory results. As a final step, all of our classifications have been reviewed by an independent judge familiar with servitization research. The review produced no significant disagreements.