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Structured Abstract

Purpose

This study theoretically articulates and empirically validates a model of relationships between market complexity (competition intensity, heterogeneity and technological change), strategic focus on product and service differentiation, ADS offerings and differentiation advantage.

Methodology

We develop and test hypotheses through structural equation modelling based on data from the Sixth International Manufacturing Strategy Survey (IMSS-VI), involving 931 manufacturers from 22 countries.

Findings

The results indicate that: (i) market complexity has a positive impact on strategic focus on product and service differentiation; (ii) focus on product and service differentiation, but not market complexity, has a positive impact on the extent to which business units offer ADS to their customers; (iii) ADS have a positive impact on service differentiation advantage, but no influence on product differentiation advantage.

Practical implications

Managers should incorporate decisions related to ADS provision as part of their manufacturing strategy formulation processes to align markets, strategic focus on product and service differentiation, and ADS provision. ADS seem an appropriate lever for market differentiation, since they appear not only to support service differentiation advantage, but also to be consistent with strategic focus on product differentiation.

Originality

The study provides novel insights and large-scale empirical evidence on the influence of the market environment on the offering of ADS, as well as on how relationships between the product and service activity in the manufacturing organization may affect differentiation advantage.

Keywords: servitization, advanced services, competitive advantage, manufacturing strategy.

Paper type: Research paper

1. Introduction

Over the last decades, manufacturing companies have faced complex markets characterized by intense competition, heterogeneous customers and technological change (Neu and Brown, 2005; Eloranta and Turunen, 2015). This has incentivized the development of manufacturing strategies based on differentiation and non-price-based value offerings as opposed to cost-based competition. Initially, these strategies involved mainly the offering of differentiated products. Implementing product differentiation strategies required manufacturers to focus on strategic priorities such as product customization, variety and innovation (Gerwin, 1993) and to obtain superior market performance on these dimensions (product differentiation advantage). More recently, manufacturers have also resorted to servitization by offering services that support products or their usage in a superior way (Gebauer, 2008). This approach has augmented their potential for differentiation, which can be useful especially when differentiating through products alone becomes difficult (Matthyssens and Vandenbempt, 2008; Oliva and Kallenberg, 2003). Implementing service differentiation strategies (i.e. achieving market differentiation through the offering of services) requires focusing on strategic priorities related to the provision of services, and obtaining superior market performance in service dimensions (service differentiation advantage).

Advanced Services (ADS) may have the greatest potential for market differentiation (Eggert et al., 2014; Sousa and da Silveira, 2017). ADS such as user training and consulting support customers in extracting additional value from the use of the product in their specific context (Smith et al., 2014). For example, truck manufacturer MAN offers a range of services focused on driver behavior and fuel consumption, assisting logistics firms to optimize their transport operations. Thus, ADS require intimate knowledge of customer core activities (Story et al., 2017). They often follow significant changes in a manufacturer's strategic

priorities and are a major distinction between servitized and non-servitized manufacturers (Baines et al., 2019; Lütjen et al., 2017).

Although achieving market differentiation is an often-cited goal of ADS, our understanding of relationships between manufacturing strategies based on differentiation and ADS provision remains incomplete (Bustinza et al., 2015). Despite the adoption of contingency views in recent servitization studies (Benedettini et al., 2017; Bohm et al., 2017; Josephson et al., 2016; Kohtamäki and Partanen, 2016; Turunen and Finne, 2014; Valtakoski and Wittel, 2018; Visnjic et al., 2019), there is still limited understanding of how market environment and manufacturing strategic priorities may shape the extent to which firms offer ADS to their customers (Fliess and Lexutt, 2019). Likewise, there is also to date limited large-scale empirical evidence to support these relationships (Baines et al., 2017).

Thus, a first goal of our study is to address the joint influence of market complexity (competition intensity, heterogeneity and technological change), strategic focus on product differentiation and strategic focus on service differentiation on the offering of ADS by manufacturing business units. Specifically, we wish to establish the extent to which ADS portfolios may be a reaction to market environments, a deliberate move aligned with strategic priorities, or both (Barnes, 2002; Miller, 1988). These findings should inform to what extent business units may develop ADS independently of the markets they are in and to what extent this decision may need to be integrated in their manufacturing strategy formulation processes (or alternatively, to what extent market environment and strategic priorities might support or hinder decisions to offer ADS). We deliberately incorporate market complexity in our model because the servitization literature suggests this is a major influence on servitization decisions (Neu and Brown, 2005; Eloranta and Turunen, 2015; Fliess and Lexutt, 2019).

There is also surprisingly limited large-scale evidence of the impact of ADS on operations-based differentiation advantage. This is in part due to extant research emphasizing the financial performance outcomes of servitization (e.g. Fang et al., 2008; Kastalli and van Looy, 2013; Eggert et al., 2014; Sousa and da Silveira, 2017). Thus, our second goal is to examine the impact of ADS provision by manufacturing units on their product and service differentiation advantage. Ascertaining whether ADS supports product differentiation advantage, service differentiation advantage or both is essential to evaluate the effectiveness of these strategies (Kowalkowski et al., 2017).

Although the relationship between ADS and service differentiation advantage is quite straightforward (Szász and Seer, 2018), its relationship with product differentiation advantage can be more complex. While some suggest synergies between ADS and product differentiation advantage (for example, because customer knowledge accrued via ADS might result in differentiated product designs; Baines and Lightfoot, 2014; Visnjic et al., 2017), others point to tensions between the product and service functions within the organization, which might hurt product-based advantage (for example, because pursuing both product and service differentiation might lead to conflicting goals and competition for resources; Josephson et al., 2016; Neu and Brown, 2005). Thus, our final goal is to examine the relationship between ADS and manufacturing strategies based on product differentiation. This has important implications because the product business often accounts for most of a manufacturer's revenue and resources and, as a consequence, managers need to assess the potential threat of ADS provision to their core product business (Benedettini et al., 2015; Reim et al., 2016).

To address these goals, we develop a theoretical model of the antecedents and outcomes of ADS in manufacturing business units. In what regards antecedents, the model examines

the joint impact of market complexity, and product differentiation and service differentiation priorities on ADS offerings. The antecedents section of our model draws on contingency theory (Donaldson, 2001) and its associated literature in servitization, which indicates that service offerings should fit with the external environment and business strategy of the firm (Vandermerwe and Rada, 1988; Neely, 2008; Eloranta and Turunen, 2015; Fliess and Lexutt, 2019).

On the outcomes section, we examine the impact of ADS on product and service differentiation advantage. This section draws on the Resource Based View (RBV) of the firm (Barney 1991; Peteraf 1993) and its associated literature in servitization, which suggests that service offerings relate to the development of valuable capabilities for competitive advantage (Ulaga and Reinartz, 2011; Eloranta and Turunen, 2015). In particular, knowledge acquired about customer value-creating processes is considered a fundamental source of advantage due to service provision (Gronroos, 2011; Payne et al., 2008; Schaarschmidt et al., 2018). We test the model using data from a large international sample of 931 business units from 22 countries in America, Europe and Asia.

The study makes several contributions to the servitization literature. First, we improve understanding of what contextual factors may influence ADS offering by manufacturing units (Baines et al., 2017; Forkmann et al., 2017; Kowalkowski et al., 2017), by examining the joint influence of market complexity and strategic focus on product and on service differentiation. Second, we provide new insights and evidence on relationships between product and service activities in manufacturing units (Fang et al., 2008; Visnjic et al., 2016; Josephson et al., 2016). This is an advance over prior large-scale empirical research, which has typically addressed either product or service related aspects of servitization, but rarely both simultaneously (Schaarschmidt et al., 2018). Third, by addressing the impact of ADS

on product and service differentiation advantage, we answer calls to explore different types of servitization outcomes, beyond commonly used financial indicators such as profit, revenue and market value (Benedettini et al., 2017). Finally, we respond to appeals for servitization theory validation using large-scale data (Bustinza al., 2015; Fliess and Lexutt, 2019; Kowalkowski et al., 2017; Gebauer et al., 2012).

2. Theoretical background and hypotheses

2.1 Theoretical model

ADS are services that support product utilization and its adaptation to a customer's unique needs, usage situations and behaviors (Smith et al., 2014; Sousa and da Silveira, 2017). They broadly correspond to what the service logic view of servitization calls customer support services (Eggert et al., 2014; Gebauer et al., 2005). Examples include user training, product upgrades (fitting the product to customer needs), consulting and product rental. ADS involve intense interaction and significant value co-creation with customers. Thus, they are mostly relational-oriented, complex and personalized to individual customers (Sousa and da Silveira, 2017; Story et al., 2017), and may be an integral part of differentiation strategies (Eggert at al., 2014).

The provision of ADS requires a *service function* within the organization to develop, sell and deliver the services. This function comprises sales and customer liaison staff, field service staff (e.g. maintenance and repair technicians), customer support systems and processes for service design and delivery (Ulaga and Reinartz, 2011). The provision of services also requires inputs from *product-related functions*, such as expertise on product and production process technology (Raja et al., 2013; Sousa and da Silveira, 2017). Key product-

related functions are the manufacturing function – responsible for the manufacturing of the product, involving production-related workers, equipment and systems – and the design/engineering function – responsible for the design of the products and associated production processes.

To understand the relationship between ADS and market differentiation, we develop a theoretical model of its antecedents and outcomes in manufacturing units. For antecedents, we draw on contingency theory (Lawrence and Lorsch, 1967; Donaldson, 2001). This theory maintains that organizations adapt (respond) to changing contextual (environmental) factors, in order to maintain fit and achieve high performance. Contextual variables are exogenous, difficult to influence and with high inertia; response variables are the organizational or managerial actions taken in response to contextual factors (Sousa and Voss, 2008). Specifically, we employ the *selection* form of fit, according to which fit results from a process of adaptation between context and organization over time (Drazin and van de Ven, 1985). This approach has been used in contingency theory to examine the congruence between organizations tasks environments (e.g. uncertainty and complexity) and response variables (e.g. organizational structure and processes) (Dess and Beard, 1984; Drazin and van de Ven, 1985). Therefore, the selection form of fit is especially appropriate to examine the complexity of a business unit's markets (as part of its external environment) as a contingency variable. We focus on market complexity because it emerges from the servitization literature as a major contingency for decisions to servitize (Neu and Brown, 2005; Eloranta and Turunen, 2015; Fliess and Lexutt, 2019). We expand on market complexity in the next section.

The influence of markets on organizations has been a central object of study in the strategic management field (Porter, 1980; Miller, 1988), having close relationships with contingency theory (Venkataraman, 1989). A central theoretical position is that a firm's

conduct can be a function of both market-structure factors (as "deterministic" forces to which firms respond) and strategic choice (management as a proactive agent with some latitude to select firm conduct) (e.g., Bourgeois, 1980; Miller, 1988). This position has strongly informed the manufacturing strategy's notion of alignment between markets, strategic priorities and decision areas. Achieving alignment requires appropriate processes of manufacturing strategy formulation (Barnes, 2002), including (i) gathering and processing information about the market environment, (ii) setting strategic priorities for the manufacturing function, and (iii) making internally consistent manufacturing strategy decisions (Hayes and Wheelwright, 1984; Hill, 1985).

In the manufacturing strategy literature, markets are posited to have both a direct and indirect effect on decision areas, via influencing strategic priorities (Barnes, 2002; Hill, 1985; Ward and Duray, 2000). Ascertaining the relative importance of direct and indirect (via strategic choice) effects of markets is important, since they have different implications for strategy (Miller, 1988; Venkataraman, 1989). However, there is limited large-scale empirical evidence on the importance of these two effects in decisions to offer ADS at the manufacturing strategic level. This is so even though the research stream on servitization contingencies suggests that service offerings need to fit with the external environment and strategy (Barquet et al., 2013; Gebauer, 2008; Vandermerwe and Rada, 1988; Neely, 2008; Eloranta and Turunen, 2015). Given our study goals, we decompose the influence of market complexity on ADS into a direct effect and an indirect effect through manufacturing strategy differentiation priorities. As discussed earlier, we consider two types of priorities, namely product and service differentiation as key sources of market differentiation (Porter, 1980) for manufacturing business units.

We draw on the Resource Based View (RBV) of the firm (Barney 1991; Peteraf 1993) to understand the differentiation advantage outcomes of ADS. The RBV considers firms as portfolios of resources and capabilities that provide competitive advantages when combined in a conscious and systematic way (Barney, 1991; Wernerfelt, 1984). Capabilities are routines or bundles of routines to perform specific tasks, corresponding to behaviours that are learned and supported by tacit knowledge (Peng et al., 2008; Winter, 2003). The servitization literature stresses that service offerings relate to the development of valuable capabilities (Ulaga and Reinartz, 2011; Eloranta and Turunen, 2015; Kamp and Perry, 2017). As will be discussed later, ADS can lead to the development of tacit knowledge about customers' value-creating processes that is idiosyncratic and difficult to imitate (Gronroos, 2011; Payne et al., 2008). Thus, it can provide sustainable operations-based competitiveness (Schroeder et al., 2002) in the form of product and service differentiation advantages.

In Figure 1 we show our theoretical model, which is rooted in contingency theory and the RBV. In the next sections, we articulate hypotheses associated with the model. The hypotheses include two relationships (H3b, H4b) that were validated in a study by Szász and Seer (2018) using the same constructs and data as in our study. However, Szász and Seer (2018) examined these relationships in a model looking at the service activity of manufacturing organizations in the absence of other relevant factors. Specifically, in examining H3b, they did not account for the influence of the market environment (H1) and the core product activity (H2a, H3a) on ADS. In examining H4b, they did not account for service differentiation focus (H5b) as determinant of service differentiation advantage. Our study re-examines these relationships in a broader, more comprehensive model that includes the role of the market environment and the core product activity (i.e. product differentiation focus and product differentiation advantage).

--- Figure 1 about here ---

2.2 Market complexity and advanced services

In our study, we focus on markets as a key aspect of the external environment. We define market environment based on Neu and Brown's (2005) concept of "market complexity", which is relevant to assess the impact of markets on servitization. This concept draws on Dess and Beard's (1984) three seminal environmental dimensions: *munificence* (from tame to hostile), *complexity* (from homogeneous to heterogeneous) and *dynamism* (from stable to dynamic). These have been considered the most critical dimensions of environment with respect to strategy (Keats and Hitt, 1988; Lawless and Finch, 1989) and have been employed in contingency research in manufacturing strategy (Ward et al., 1996). *Munificence* refers to the availability of resources that allow an organization to survive and grow. *Complexity* pertains to the heterogeneity of the factors that drive an organization's activities. To avoid confusion with the market complexity construct label in our study, we use the term *heterogeneity* for this dimension. *Dynamism* refers to the degree and nature of change in factors of the external environment.

Neu and Brown's (2005) concept of "market complexity" reflects the extent to which market environments are hostile, heterogeneous and dynamic. In the servitization literature, munificence is typically associated with competition intensity, which results in reduced product margins and sales growth (Neu and Brown, 2005; Gebauer, 2008). Heterogeneity is related to multiple customer segments with different needs and various product use scenarios (Neu and Brown, 2005; Green et al., 2017). Dynamism is most often associated with technological change (Neu and Brown, 2005).

We discuss the relationship between market complexity (competition intensity, heterogeneity and technological change) and ADS drawing on the servitization contingency literature. Mirroring the manufacturing strategy contingency literature, the servitization literature considers a two-pronged effect of market characteristics on manufacturing servitization (Fliess and Lexutt, 2019). There is a direct effect with service offerings being a response to, or aligned with complex markets (Vandermerwe and Rada, 1988; Neu and Brown, 2005; Gebauer, 2008; Neely, 2008; Ceci and Masini, 2011; Visnjic et al., 2019). There is an indirect effect through strategic priorities as complex markets incentivize strategic focus on differentiation, which is supported by servitization (Wise and Baumgartner, 1999; Oliva and Kallenberg, 2003; Matthyssens and Vandenbempt, 2008). We discuss how these two effects may apply with ADS.

With the direct effect, highly competitive or hostile environments may favor the provision of services to create new revenue streams along the product lifecycle, and improve profit margins (Baines et al., 2017). Specifically, ADS have been shown to increase revenue and profitability due to their high-value and differentiated nature (Eggert et al., 2014; Sousa and da Silveira, 2017). Intense competition is also associated with more demanding and sophisticated customers who may prefer to outsource non-core activities (Baines and Shi, 2015). Since ADS involve the management of customer processes, they may be especially adequate to fulfill these needs.

Highly heterogeneous markets may also favor the provision of customized services targeting needs which are not met by existing offers (Neu and Brown, 2005; Gebauer et al., 2011). Customers in these markets may also be more open to engage in long-term relational exchanges with the manufacturer because (i) there may be fewer alternative suppliers and (ii) switching costs may be high because of co-specialization of resources and capabilities

(Sjodin et al., 2019). These requirements have a good fit with the customized and relational nature of ADS.

Highly dynamic markets may lend themselves to value-added services that help customers exploit the full potential of product technological innovations (Visnjic et al., 2016; Baines et al., 2019). In these markets, customers adopt new technologies differently and their needs evolve rapidly (Neu and Brown, 2005; Gebauer et al., 2011). Consequently, manufacturers may benefit from providing customized and adaptable services, and introducing new services more frequently (Morgan et al., 2019). These services are more appropriately provided in a relational mode with high customer involvement than through transactional, rigid arrangements (Sjodin et al., 2016). Again, all these requirements have a good fit with ADS.

These arguments lead to our first hypothesis:

H1. Market complexity is positively associated with the offering of ADS by manufacturing business units.

We now discuss the indirect effects of market complexity on ADS, starting with the effect of market complexity on strategic focus on product and on service differentiation. Manufacturers operating in highly competitive markets may focus on product and on service differentiation to build barriers to entry and create customer lock-in (Miller, 1988; Wise and Baumgartner, 1999). Both differentiated products (e.g. via customization) and services (e.g. via customer interactions) may lead to stronger relationships with customers (Sousa and da Silveira, 2019; Vandermerwe and Rada, 1988) which are more difficult to disrupt by competitors (Kohli and Jaworski, 1990). Services may be even more difficult to imitate than products, for example due to their labor-intensity and intangible nature (Oliva and

Kallenberg, 2003). Heterogeneous markets may provide more opportunities to compete based on differentiated products and services due to more unsatisfied needs and more niche segments where manufacturers can build advantages over competitors (Miller, 1988; Gebauer, 2008). Markets with high levels of technological change may also provide opportunities for innovating and customizing (differentiating) products through technology because of uncertainty in designs and how customers may use new product technologies (Anderson and Tushman, 1990; Ward and Duray, 2000). There may be also more opportunities for manufacturers to differentiate through services. In the context of a servitized manufacturer, services relate to the product. In dynamic environments, product technology is often uncertain and specific to the manufacturer (rather than being an industry standard). Hence, the manufacturer that sells the product is in a privileged position relative to other manufacturers or independent service providers to offer services that help customers to deal with the technological uncertainty of products (Sjodin et al., 2019; Visnjic et al., 2019). Thus:

H2a/H2b. Market complexity is positively associated strategic focus on product differentiation/service differentiation in manufacturing business units.

The second indirect effect of market complexity concerns the relationship between strategic focus on product and on service differentiation and ADS. Service differentiation requires the provision of services which are hard to imitate by competitors and independent providers (Matthyssens and Vandenbempt, 2008; Kastalli and van Looy, 2013). Because of their customized and complex nature, ADS are especially appropriate for this purpose (Sousa and da Silveira, 2017; Eggert et al., 2014; Green et al., 2017). Strategic focus on product differentiation also aims to provide solutions to specific needs (Hill, 1985). A challenge in competing with highly differentiated products is that customers may have difficulties

exploring product benefits because they may lack a frame of reference to understand the products and their use (McNally et al., 2010). In this context, ADS may be important mechanisms to align products to a customer's unique needs (e.g. through context-based user training), not only at commissioning but also over the product lifecycle (Davies, 2004; Sousa and da Silveira, 2019). Thus:

H3a/H3b. Strategic focus on product differentiation/service differentiation is positively associated with the offering of ADS in manufacturing business units.

2.3 Advanced services and differentiation advantage

To discuss the differentiation advantage outcomes of ADS, we draw on the literature on servitization associated with the RBV. According to this literature, service offerings relate to the development of valuable capabilities that provide competitive advantage (Ulaga and Reinartz, 2011; Eloranta and Turunen, 2015). Specifically, learning about customers and their value-creating processes is considered a fundamental source of advantage associated with service provision (Bustinza al., 2015; Gronroos, 2011; Payne et al., 2008; Schaarschmidt et al., 2018). Customer knowledge has been addressed in the literature through several concepts including customer centricity (Antioco et al., 2008; Gebauer et al., 2011), customer proximity (Kastalli and van Looy, 2013) and relational capital (Kohtamäki and Partanen, 2016; Spring and Araujo, 2013). To become a valuable and difficult to imitate capability, this knowledge must be based not only on report data such as customer satisfaction, but also on deep understanding of customer experiences and processes (Payne et al., 2008). This includes information about user context, tacit elements and unconscious behaviors, all obtained via intense interactions which go beyond the traditional concept of customer orientation (Payne et al., 2008; Zhang and Chen, 2008; Raddats et al., 2017).

We argue that ADS can lead to product and service differentiation advantages through the development of customer knowledge as a capability. This can occur by several mechanisms. First, ADS involve understanding how customers use products in their context (Smith et al., 2014). This contextual knowledge can be valuable for designing new products or modifying/upgrading existing products towards unique customer needs (product differentiation advantage) (Baines and Lightfoot, 2014; Visnjic et al., 2017). It may also lead to higher quality service (e.g. customer support and training) grounded on the product usage context (service differentiation advantage). Second, the relational approach and intense customer interactions associated with ADS can help the manufacturer to observe customer behaviors and processes closely, tapping into tacit knowledge. This "relationship learning" (Kohtamäki and Partanen, 2016) may assist the manufacturer in anticipating future product and service needs and facilitate the co-development of new products and services with customers (Johansson et al., 2019; Yiu et al., 2019). Third, ADS relational approach can provide the manufacturer with the opportunity to influence customer processes (Payne et al., 2008) as if they were endogenous (Green et al., 2017). This ability fosters improved alignment between manufacturer and customer processes (Baines and Lightfoot, 2014; Rabetino et al., 2017), which may lead to reduced variability and improved service quality to the customer (Smith et al., 2014; Batista et al., 2017).

The strength of ADS benefits due to customer knowledge may depend on two factors. The first is how effectively the manufacturer can harness customer knowledge via ADS provision. This may depend on external capabilities (Paiola et al., 2013), particularly customer capabilities, i.e., capabilities inherent to the customer (Story et al., 2017). Acquiring deep customer knowledge may require customers to co-develop new capabilities with the manufacturer (Brax and Jonnson, 2009; Paiola et al., 2013; Raddats et al., 2017). It may also

require customer willingness to share information about their operations (Selviaridis et al., 2013), which involves issues of risk and data privacy. Similarly, the extent to which the manufacturer can influence customer processes depends of the latter's willingness and ability to adapt to the former's service processes (Matthyssens and Vendenbempt, 2010; Tuli et al., 2007).

The second factor is how effectively the manufacturer can turn customer knowledge accrued via ADS into differentiated products and services. Of importance is the development of knowledge integration mechanisms in the organization (Antioco et al., 2008; Foss et al., 2011; Schaarschmidt et al., 2018). These include processes and structures to capture, analyze, interpret, and integrate customer knowledge within and among different functional areas in the organization. Examples include information-sharing meetings, cross-functional teams, intensive vertical and lateral communication, and incentives for employees to share knowledge (Fliess and Lexutt, 2019; Foss et al., 2011). These mechanisms correspond to "inward-looking" absorptive capacity (Foss et al., 2011), enabling the organization to identify and exploit useful customer knowledge. Critically for product and service differentiation advantage is the integration of customer knowledge into and among the product-related and the service functions (Schaarschmidt et al., 2018).

Despite these challenges, the above discussion implies that ADS can not only support service differentiation, but also create synergies with the core product activity leading to further product differentiation. An alternative perspective is that tensions between the service function and the core manufacturing function might hurt product-based advantage (Josephson et al., 2016). There are two main sources of tensions. The first is the coherence between the two functions (Fang et al., 2008; Josephson et al., 2016). Incompatible goals, capabilities or even cultural values between the two functions may lead to internal conflicts

and disrupt the core manufacturing function (Gebauer et al., 2005; Martinez et al., 2010; Neu and Brown, 2005). A typical incompatibility is between the manufacturing function's classic goal of isolating the "technical core" from customers (Chase and Tansik, 1983) and service's goal of catering to heterogeneous needs through collaboration with customers. However, ADS might still fit with a manufacturing function that was focused on product differentiation because, contrary to that classic goal, providing differentiated products also relies on significant interactions with customers and flexibility orientation (Salvador et al., 2007; Sousa and da Silveira, 2019).

The second source of tension is competition for resources. Building capabilities for servitization may divert resources from the manufacturing function (Fang et al., 2008; Josephson et al., 2016). However, this risk might be mitigated with ADS because they have been shown to lead to higher sales and profitability, resulting from their high-value nature and, consequently, the ability to drive customer loyalty and command premium prices (Eggert et al., 2014; Sousa and da Silveira, 2017; Visnjic et al., 2017). In fact, ADS are often provided by service functions that operate as profit centers (Oliva et al., 2012; Fliess and Lexutt, 2019). Thus, ADS may not necessarily be a drain on manufacturing resources. From these arguments, we do not expect ADS to harm product differentiation advantage.

Based on the discussion, we put forward the following hypotheses:

H4a/H4b. The offering of ADS is positively associated with product differentiation advantage/service differentiation advantage in manufacturing business units.

Following strategic management theories, strategic focus on differentiation leads to suitable resource allocation and configuration policies that promote differentiation advantage (Porter, 1980). Such focus provides clear organizational priorities, directs scarce resources

to specific ends (e.g. appropriate equipment and skills), and fosters consistent image and reputation, leading to competitive advantage (Porter, 1980). This logic applies to service offers (e.g. Neu and Brown, 2005; Roth and Menor, 2003), as well as to product offers (e.g. Hill, 1985; Skinner, 1974). We submit the following hypotheses:

H5a/H5b Strategic focus on product differentiation/service differentiation is positively associated with product differentiation advantage/service differentiation advantage in manufacturing business units.

3. Methods

3.1 Research data

We tested our model with data from the 2013/2014 International Manufacturing Strategy Survey (IMSS-VI). The dataset included measures operationalized at our target level of analysis (business unit) and with excellent match to our theoretical constructs.

IMSS includes a large, representative sample of manufacturers worldwide. The survey is designed and carried out by an international network of scholars, and data is collected prior to, and independently from any specific study. Thus, the potential for researcher biases such as in sample selection, fieldwork and measurement is greatly reduced (Calantone and Vickery, 2010; Rabinovich and Cheon, 2011). Moreover, the use of a large instrument with hundreds of items may greatly reduce some causes of common method bias such as *consistent motif* and *implicit theories* (Podsakoff et al., 2003), as respondents have limited indication of what models of exogenous and endogenous variables may be explored by researchers. Finally, the data are commonly available to a large network of researchers, which facilitates

replication (Calantone and Vickery, 2010; Rabinovich and Cheon, 2011) and increases trust in results.

The following information about the survey was available from the network (IMSS, 2015) and appeared in previous studies, e.g. Sousa and da Silveira (2017) and Demeter et al. (2017). The survey was carried out in 22 countries by local researchers. It assessed the strategies, practices, and performances of manufacturing business units from ISIC sectors 25-30, which includes manufacturers of fabricated metal products, instruments, equipment, and machinery. Survey administration in 11 countries used the original questionnaire in English. In the remaining 11 countries, versions mainly given by double parallel translations were used.

The researchers initially contacted 7167 units; 2586 agreed to participate and received questionnaires; 1003 returned answers, of which 931 were considered complete for the purposes of the survey (response rate = 13%). Responses were given by directors of manufacturing/operations, or related functions. Valid responses were obtained from Belgium (29), Brazil (31), Canada (30), China (128), Denmark (39), Finland (34), Germany (15), Hungary (57), India (91), Italy (48), Japan (82), Malaysia (14), The Netherlands (49), Norway (26), Portugal (34), Romania (40), Slovenia (17), Spain (29), Sweden (32), Switzerland (30), Taiwan (28) and USA (48). Measured by the number of employees, responses included a diverse range of small, medium, and large sized units with quantiles 155 (25%), 300 (50%) and 1000 (75%). On average, 9.8% of the business unit turnover of the 931 companies was based on sales of services, while the remaining 90.2% was due to sales of parts/components or assembled products. This is consistent with our focus on manufacturing business units for whom product sales are the core of the business.

Researchers from all except two countries carried out non-response bias tests based on publicly available market performance indicators between respondents and non-respondents; no significant differences were reported.

3.2 Measures development

The model included four sets of variables, namely market complexity, product and service differentiation focus, ADS, and product and service differentiation advantage (see Appendix). We developed market complexity as formative as in our view it was caused by indicators representing independent aspects of the external environment (munificence, heterogeneity, and dynamism), which were not necessarily correlated. The remaining variables were developed as reflective as in our view they were the causes of their multiple indicators that according to theory should be correlated in the real world. These choices and guidelines followed the rationale in Diamantopoulos and Siguaw (2006).

Market complexity was given by three formative indicators measuring the munificence, heterogeneity and dynamism faced by business units (Dess and Beard, 1984; Neu and Brown, 2005). Technological change (by Chaudhuri and Boer, 2016) and competitive rivalry (by Sreedevi and Saranga, 2017) had been used previously as control variables in IMSS-VI studies.

Following Diamantopoulos and Winklhofer (2001) and Diamantopoulos and Siguaw (2006), we validated the formative scale through a Multiple Indicators, Multiple Causes (MIMIC) model. The model included the three formative indicators, the latent variable, and two reflective indicators to identify the latent variable. The reflective indicators measured the perceived threats (i) that new players could enter the market ("market entry") and (ii) that products made by the business unit were replaceable ("products will become substituted").

The MIMIC model had good fit (χ^2/df = 5.580, CFI = 0.947, NFI = 0.939, TLI = 0.737, RMSEA = 0.071 [0.035; 0.114]) except for the χ^2/df and TLI (Tucker Lewis Index) indicators. This was expected, as one assumption in formative scales is that formative indicators are not expected to be correlated (Diamantopoulos and Siguaw, 2006) and according to Kenny (2015) such low correlations lead to low TLI estimates. Bivariate correlations between formative indicators were indeed low (0.245, 0.124, 0.173) and the maximum variance inflation factor among them was 1.09 so multicollinearity was not problematic (Diamantopoulos and Winklhofer, 2001). The formative indicators had significant ($p < 0.01$) path loadings to the latent variable, which indicates convergent validity. Reflective indicators loadings were low (0.326, 0.464) but significant ($p < .001$) suggesting the latent scale could be identified. Following these results, we estimated market complexity by the average of the three formative indicators.

Focus on product and service differentiation were operationalized by "order-winner" (Hill, 1985) indicators at the business unit level. The product differentiation scale included four indicators with close match to three of Gerwin's (1993) dimensions of "required manufacturing flexibility" at the product level (i.e. mix, changeover and modification flexibility). Some of these indicators were previously used in IMSS-VI studies as part of "innovation order winners" (Chaudhuri and Boer, 2016) and "product variety" (Shou et al., 2017) scales. Focus on service differentiation indicators matched closely the two most commonly found strategic types ("after-sales service provider" and "customer support service provider") in Gebauer's (2008) services configurations framework (thus, the scale did not include content relating to Gebauer's two least common configurations, namely "outsourcing partner" and "development partner").

ADS was operationalized as in Sousa and da Silveira (2017), who also used indicators from IMSS-VI. Szász et al. (2017) used three of those five indicators to build a "service provision" scale. However, their scale included also services such as maintenance and installation, which Sousa and da Silveira (2017) classified as "basic", and Gebauer et al. (2005) called "product-related" due to their association orientation to product functionality.

Product and service differentiation advantage were measured by performance relative to main competitors. Both scales were symmetric in content with the product and service differentiation "focus" scales. The same indicators from the dataset were used in three previous studies. Wiengarten and Longoni (2015) and Cheng et al. (2016) used flexibility advantage scales containing volume and mix flexibility only. Chaudhuri and Boer (2016) used a scale including customization ability and new product introduction.

Consistent with previous studies, e.g. Chaudhuri and Boer (2016) and Sreedevi and Saranga (2017), all models controlled for business unit size. This was measured by the ln-transformed number of employees in the unit. Organization size is a well-known predictor of practices adoption and performance in manufacturing (Chaudhuri and Boer, 2016).

3.3 Measures validation

Table 1 presents the means, standard deviations, and case numbers of all observed indicators. We built market complexity as formative as we considered that its three components could vary independently from each other (Diamantopoulos and Siguaw, 2006). All other indicators were used as exogenous factors of reflective latent variables. The maximum variance inflation factor across all 18 observed indicators was 2.22, indicating that multicollinearity was not problematic in the sample. Cronbach's alphas of all reflective

variables were near to, or greater than 0.70, indicating they were reliable (Nunnally and Bernstein, 1994).

--- Table 1 about here ---

We carried out analyses in R version 3.4.3 (R Core Team, 2017) using RStudio desktop version 1.1.419 (RStudio Team, 2015) in a GNU/Linux system. We tested measurement and structural equation models with the lavaan package (Rosseel, 2012) using maximum likelihood estimates, which is the recommended approach for cases with missing data (Peters and Enders, 2002). All latent variables, except market complexity, were built as reflective.

We tested the unidimensionality, validity, and reliability of scales with confirmatory factor analysis (CFA) of the complete measurement model. Initial fit statistics were satisfactory (χ^2/df = 3.587, CFI = 0.929, NFI = 0.905, TLI = 0.906, RMSEA = 0.058 [0.052; 0.065]) (Bagozzi and Yi, 1988; Hair et al., 2010) but some standardized loadings λ were low. We refined the model by dropping three indicators including product customization (product differentiation focus), rental/lease of products (ADS) and mix flexibility (product differentiation advantage).

The refined model had satisfactory fit (χ^2/df = 2.412, CFI = 0.971, NFI = 0.953, TLI = 0.958, RMSEA = 0.043 [0.035; 0.051]) and all exogenous indicators R^2 were greater than 0.30, which is evidence of unidimensionality (Kumar and Dillon, 1987; Carr and Pearson, 1999; Liu et al., 2016). As shown in Table 2, convergent validity was supported as λ values were significant ($p < 0.001$) and average variance extracted (AVE) values were near to or greater than 0.50 (Fornell and Larcker, 1981; Bagozzi and Yi, 1988). The product differentiation advantage scale was marginally below the convergence threshold (AVE = 0.49). However, we maintained that scale because overall model fit was satisfactory, and it

had good conceptual symmetry with the product differentiation focus scale. Scales reliability was supported as all composite reliability (CR) values were greater than 0.60 (Bagozzi and Yi, 1988).

--- Table 2 about here ---

Discriminant validity is supported when pairwise correlations between latent variables are lower than the squared root of their respective AVEs (Fornell and Larcker, 1981). This was observed in all cases except in the correlation between service differentiation advantage and product differentiation advantage (Table 3). This could be explained by the slightly low convergence in the product differentiation advantage discussed earlier. So, we carried a nested models comparison test (Anderson and Gerbing, 1988) with unconstrained and constrained models of the two scales. In the constrained model the covariance between the two variables, and their own variances were fixed to one, and all indicator loadings were set free. The constrained model had significantly worse fit than the unconstrained model (χ^2 difference = 47.06, df = 1, $p < 0.001$), which is evidence to discriminant validity (Anderson and Gerbing, 1988).

--- Table 3 about here ---

3.4 Common method bias

The data were potentially subject to common method bias (CMB) as all variables were obtained with single respondents and (except business unit size) based on perceptual scales. However, and as indicated in studies such as Sousa and da Silveira (2017) and Longoni and Cagliano (2015), IMSS surveys incorporate well-known design strategies to minimize that threat. As recommended by Podsakoff et al. (2003), questions and scales were presented

using clear language, with careful translation when the questionnaire was not applied in English. There was explicit indication that responses would be treated anonymously, with neither individuals nor business units being identified in the consolidated dataset. Finally, the questionnaire included nine pages and almost three hundred items, which minimized the chance of "common rater effects" (Podsakoff et al., 2003: 882) across responses.

We implemented two methods in Podsakoff et al. (2003) to estimate the likelihood of CMB in our study data. First, we used principal component analysis to carry Harman's test of a single factor explaining most of the variance across measures. This was not supported as the scree plot indicated that four components described best the data structure, and the minimum mean square error of prediction (MSEP) (Josse and Husson, 2012) was given by two components. Second, and following recommendations in Podsakoff et al. (2003) and Brown (2006), we specified a correlated uniqueness measurement model. In the lavaan package (Rosseel, 2012), that specification consisted in allowing covariances among residuals of all first factors of latent variables, then among residuals of all second factors of latent variables, and so on. While trait loadings remained high ($\lambda \geq 0.505$), standardized residual covariances were relatively low (between -0.193 and 0.069), indicating low method effects in the model.

4. Results

We developed a structural model to test hypotheses H1 to H5. The measurement section was specified as indicated in Table 2 (refined measurement model). The structural section included five equations predicting service differentiation focus, product differentiation focus, ADS, service differentiation advantage, and product differentiation advantage. The model allowed direct correlations between service differentiation focus and product differentiation

focus, and between service differentiation advantage and product differentiation advantage. As indicated earlier, the model used maximum likelihood estimates due to missing values in the dataset.

Table 4 presents the path estimates and overall model fit. Fit statistics were all satisfactory (Bagozzi and Yi, 1988). Market complexity was not significantly related with ADS (p = 0.056), failing to provide support to H1. However, it was positively associated with product differentiation and service differentiation focus, supporting H2a and H2b. Thus, business units operating in markets of greater complexity (i.e. greater competitive rivalry, broader market span, and frequent technology change) provided more emphases on both product (product range, innovation, and new product introduction) and service differentiation (product assistance and support, customer services).

Both product differentiation and service differentiation focus were positively associated with ADS, supporting H3a and H3b. Thus, product and service differentiation were not only impacted by market complexity, but also appeared to incentivize the offering of advanced services such as consultancy, training, help desk, and product upgrades. Differentiation focus variables also related positively with their advantage correspondents, supporting H5a and H5b. Thus, there was a direct link between the "importance" given to product and service differentiation, and their advantage correspondents in service (product assistance, customer service) and product differentiation advantage (product customization and new product introduction). Finally, ADS was positively associated with service differentiation advantage but not with product differentiation advantage (p = 0.076), supporting H4b but not H4a. Thus, service differentiation advantage was higher in units with greater offering of advanced services.

--- Table 4 about here ---

5. Discussion and implications

5.1 Implications for theory

We examined antecedents (market complexity and strategic focus on product and service differentiation) and outcomes (product and service differentiation advantage) of ADS offerings by manufacturing business units. Regarding antecedents, the findings contribute to the manufacturing strategy literature by suggesting the decision to offer ADS aligns with markets only indirectly via strategy formulation processes (H2a, H2b, H3a, H3b), rather than being a direct response to markets (H1). Thus, the strategy formulation processes must include (i) evaluating markets intensity of competition, heterogeneity and technological change, and setting strategic differentiation priorities accordingly; (ii) translating differentiation priorities into an adequate ADS porftolio. Accordingly, manufacturing strategy content and process frameworks (e.g. Hayes and Wheelwright, 1984; Hill, 1985) – which focus primarily on product-related decisions - would benefit from being extended and further developed to explicitly include the alignment between markets and ADS. The findings also contribute to the literature on servitization contingencies (Baines et al., 2017; Forkmann et al., 2017; Kowalkowski et al., 2017) by increasing knowledge about how market complexity and strategic focus on product and service differentiation shape ADS offerings. They provide large-scale empirical support for the notion that ADS provision may be part of a deliberate strategy to compete based on differentiation in complex markets (Eggert et al., 2014; Baines et al., 2019; Zeithaml et al., 2014).

Against the background of contingency theory, our findings provide support for strategic choice in ADS, in detriment of "deterministic" market-structure influences (Miller, 1988). Thus, a manufacturer's decision to offer ADS may give more weight to the strategy

formulation processes than (directly) to factors of market complexity. Deviations from market incentives might occur in market-strategy alignment (e.g. units operating in complex markets might not compete based on product and service differentiation) and/or strategy-ADS alignment (e.g. a manufacturer might focus on product and service differentiation, but not deploy ADS). Although our results do show strong evidence of market-strategy-ADS alignment, the absence of a direct effect market-ADS opens the possibility for the existence of equifinality in ADS decisions, that is, manufacturing units may compete in similar markets (e.g. complex markets) but still offer different levels of ADS (Miller, 1988).

Regarding outcomes, we posited that ADS would impact differentiation advantage via knowledge about customers' value-creating processes involving the product. We found that ADS had a positive impact on service differentiation advantage (H4b), even after controlling for strategic focus on service differentiation (H5a). We also found that ADS did not relate to product differentiation advantage (H4a), after controlling for the effects of strategic focus on product differentiation (H5b). This latter finding is consistent with the notion that ADS impact on product differentiation advantage may depend on additional capabilities beyond customer knowledge. Integration between service and product-related functions (Bustinza et al., 2015; Schaarschmidt et al., 2018) may be especially critical, because customer knowledge is generated primarily via customer interactions in the service function. For this knowledge to result in product differentiation advantage, it may need to be shared with product-related functions, namely, design/engineering and manufacturing (Thomé and Sousa, 2016). On the contrary, new service development in servitized units can be usually carried out within the service function (Eggert et al., 2014). Thus, customer knowledge accrued via customer interactions might be adequately absorbed by the service function and leveraged to obtain service differentiation advantage without the need for substantial knowledge integration

mechanisms. Another possibility is of a significant time lag between offering ADS and obtaining product differentiation advantage, which our cross-sectional study could not capture. Thus, the relationship between ADS and product differentiation appears to be more complex than in the case with service differentiation. Overall, the findings on ADS outcomes inform the literature on capabilities associated with ADS (Ulaga and Reinartz, 2011; Story et al., 2017).

The study's findings may also shed light on the debate on whether servitization can disrupt strategic focus in manufacturing (Neu and Brown, 2015; Josephson et al., 2016; Schaarschmidt et al., 2018) and contribute to the literature on servitization risks (Benedettini et al., 2015; Reim et al., 2016). Specifically, we found that ADS seemed coherent with strategic focus on product differentiation and no evidence of risks to product differentiation advantage. Overall, our study provides large-scale empirical support to the view that ADS is consistent with product differentiation (Eggert et al., 2015; Biemans and Griffin, 2018).

Finally, the study contributes to the servitization-performance literature, by showing that ADS have a positive impact on operations-based differentiation advantage. These findings complement prior research indicating that ADS lead to increased profitability (e.g. Eggert et al., 2014; Sousa and da Silveira, 2017). Altogether, they suggest that operations-based differentiation advantage may be an important mediator from ADS to financial performance.

5.2 Implications for practice

Our study has implications for manufacturers considering offering ADS as a lever for differentiation. It supports the integration of ADS with manufacturing strategy formulation, and alignment between market complexity, product and service differentiation focus, and ADS. Managers would be encouraged to assess the intensity of competition, heterogeneity

and degree of technological change in their markets. The more their markets cumulatively exhibit these characteristics, the more suitable they may be for manufacturing strategies focused on product and service differentiation and ADS offerings.

On manufacturing strategy content, our theorizing suggests that in highly competitive markets business units may emphasize product and service differentiation to build barriers to entry and develop stronger relationships with customers (e.g. long-term service contracts associated with the products). In heterogeneous markets, managers may channel differentiation efforts to meet unfulfilled niche demands. In technologically dynamic markets, units may benefit from differentiating products through technology and competing with services that help customers deal with technological uncertainty. In developing new ADS offerings, units would be encouraged to emphasize services drawing on deep customer knowledge, making them harder to imitate by competitors and independent service providers. For example, they may focus on services such as context-based user training that help customers adapt differentiated products to their unique needs.

The strategy formulation process may benefit from close integration between business unit strategy and the functional strategies of marketing, manufacturing and service functions. In addition, managers are encouraged to set clear product and service differentiation priorities for the manufacturing and service functions, to guarantee appropriate resource allocation within the organization.

Our findings also assist managers in assessing the benefits and risks of ADS. Managers may not need to be discouraged by the view that ADS provision might be detrimental to product differentiation advantage – a significant concern given that product sales usually account for a major share of a manufacturer's business. However, our results do not directly

support expectations that ADS may contribute to product differentiation advantage either. Overall, managers may consider ADS as an appropriate lever for market differentiation.

We identified the development of customer knowledge as a key source of differentiation advantage accruing from ADS provision. Based on our theorizing, two areas would require management attention to enhance the differentiation advantage benefits of ADS. The first is to promote the development of customer capabilities in order to effectively tap onto customer knowledge. This might naturally occur as part of providing ADS to their customers. Manufacturers can work with customers to develop their ability to share information and adapt their processes to the manufacturer, for example via shared strategy discussions, process development meetings and relationship steering meetings (Kohtamaki et al., 2013). Alternatively, manufacturers could offer ADS primarily to customers already having appropriate capabilities (Story et al., 2017). The second area is to promote knowledge integration inside the organization between the service function - as the major customer-facing functional area - and product-related functions. Examples include cross-functional teams for new product and service design, with the inclusion of front-line employees; ICT-based information sharing processes between customers, the service and product-related functions; intensive vertical and lateral communication; and rewarding employees for sharing knowledge (Fliess and Lexutt, 2019; Foss et al., 2011).

5.3 Study limitations and future research

The study has limitations to be addressed in future research. Our construct of market complexity aggregated Dess and Beard's (1984) three dimensions of munificence, heterogeneity and dynamism. Future studies could examine the impact on ADS of other relevant environmental contingencies such as uncertainty (Kreye et al., 2019) and legal

factors (Franco et al., 2017). We were not able to measure the degree of customer knowledge capability in the business units. This was because of the complex and tacit nature of this construct, as well as data limitations. Future studies should develop scales to assess this construct at the business unit level. Finally, our manufacturing dataset included units with a relatively low share (9.8%) of service business. Future research should investigate industries with higher levels of servitization intensity (Franco et al., 2017).

Our findings also point to promising research avenues. Although we found that focus on both product and service differentiation might lead to ADS, ADS had different effects on product and service differentiation advantage. This gives further incentive to address relationships between servitization and both the product and service activity in tandem, as we did and was suggested in previous studies (Fang et al., 2008; Visnjic et al., 2016; Josephson et al., 2016). Moreover, this indicates that the relationship between ADS and product differentiation may depend on knowledge integration mechanisms between service and product related functions. Thus, future research could examine the role of these mechanisms in moderating relationships between servitization and differentiation advantage (Schaarschmidt et al., 2018; Johansson et al., 2019).

Future studies should also empirically examine how and why ADS might affect product and service differentiation advantage. In-depth or longitudinal case studies could explore different types of relationships between customers and servitized manufacturers, and how customer knowledge accrued by servitization is co-created, absorbed and leveraged by the manufacturer to sustain differentiation advantage.

5.4 Data limitations

IMSS is a global study of manufacturing strategies, practices and performance that includes multiple variables and single respondents. Its use in our study involves significant benefits but also limitations, which must be addressed carefully (Caniato et al., 2018).

Limitations are mainly due to the multi-national nature of the survey and use of single respondents. Data was collected in 2013/2014, so estimates particularly regarding the provision of advanced services might be below current (i.e. 2020) levels. Data were collected in multiple countries, which might lead to variance in construct measurement due to interpretation differences (Behr et al., 2014). This threat exists even though the measurement model fit estimates indicated good convergence validity, discriminant validity, and reliability of responses across the survey. Also, and even though country offices followed centrally-developed procedures for testing of non-response and late response biases, and the use of national industry databases for recruiting, convenience sampling have also occurred in a few countries to maximize longitudinality, i.e. obtain repeated responses from previous survey participants.

Since data were collected for general purposes, they qualify as "secondary" as opposed to primary. That involves a threat to construct validity, i.e. correspondence between variables and constructs of interest (Houston, 2004). This threat must be addressed by a three-pronged approach, as was done in our study, including (i) asserting the theoretical relationship between constructs and variables, (ii) assessing the validity and reliability of scales, and (iii) estimating the nomological fit of data to a structural model (O'Leary-Kelly and Vokurka, 1998; Houston, 2004).

As indicated by Flynn et al. (2018), the threat of respondent bias increases particularly when the unit of analysis includes multiple organizations, as a single respondent may be unable to assess them all precisely, or when constructs are of polyadic nature (i.e. may be viewed differently by different respondents). However, and following their guidelines, such risks could be minimized (and the use of single respondents justified) in our case due to factors including (a) the use of well-specified constructs that in theory should be perceived similarly by different individuals, (b) the focus on the operations function of a single business unit and (c) the large share of small and medium-sized enterprises in the sample (47% of business units had 250 or fewer employees), where single respondents can be the only reliable option (Kull et al., 2018). Finally, the IMSS clearly indicated that questionnaires must be answered by knowledgeable individuals, mainly "the Director of Operations/Manufacturing (or equivalent)" (IMSS, 2015), which might go a long way to reduce the threat of unreliable responses (Krause et al., 2018).

6. Conclusion

This study theoretically articulates and empirically validates a model of relationships between market complexity, strategic focus on product and service differentiation, ADS offerings and differentiation advantage. The model considers both the product and service activity of manufacturing units, and integrates contingency theory and the RBV. In doing so, it answers calls for a more holistic, theory-based understanding of servitization (Baines et al., 2017: Rabetino et al., 2017). By providing large-scale empirical evidence on these relationships, the study addresses calls for better validation of servitization theory (Kowalkowski et al., 2017; Gebauer et al., 2012).

The findings suggest that ADS provision in manufacturing units may be positively influenced by market complexity. However, this effect appears to be indirect, via strategic focus on product and service differentiation. This supports the notion that the provision of ADS may follow a deliberate strategic move, rather than a mere reaction to the market environment. ADS seem to contribute to service differentiation advantage without damaging product differentiation advantage. Thus, they appear to be an effective means to achieve differentiation advantage in complex markets.

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Appendix. Measurement Items (IMSS, 2015)

Market complexity. *How do you perceive the following characteristics of the environment in which your business unit operates?*

Competitive rivalry within industry *(1 = Very low; 5 = Very high)*
Market span *(1 = Few segments; 5 = Many segments)*
Rate of technological change *(1 = Very low; 5 = Very high)*

Product differentiation focus. *Consider the importance [in the last three years] of the following attributes to win orders from your major customers. (1 = Not Important; 5 = Very Important)*

Offer more product customization*
Wider product range
Offer new products more frequently
Offer products that are more innovative

Service differentiation focus *Consider the importance [in the last three years] of the following attributes to win orders from your major customers. (1 = Not Important; 5 = Very Important)*

Superior product assistance/support (after sales and/or technical support
Superior customer service (training, information, help-desk)

Advanced services. *To what extent the following services are offered alongside with the products by the business unit? (1 = None; 5 = High)*

Consultancy services
Training in using the products
Help desk/customer support centre
Product upgrades (software, product modifications)
Rental/lease of products (with responsibility for maintenance, repair and operation)*

Service differentiation advantage. *How does your current performance compare with that of your main competitor(s)? (1 = Much lower; 5 = Much higher)*

Product assistance/support
Customer service quality (e.g. training, information, help-desk)

Product differentiation advantage. *How does your current performance compare with that of your main competitor(s)? (1 = Much lower; 5 = Much higher)*

Mix flexibility*
Product customization ability
New product introduction ability

Firm size. *Size of the business unit. (# of employees)*

* Dropped after confirmatory factor analysis.

Figures

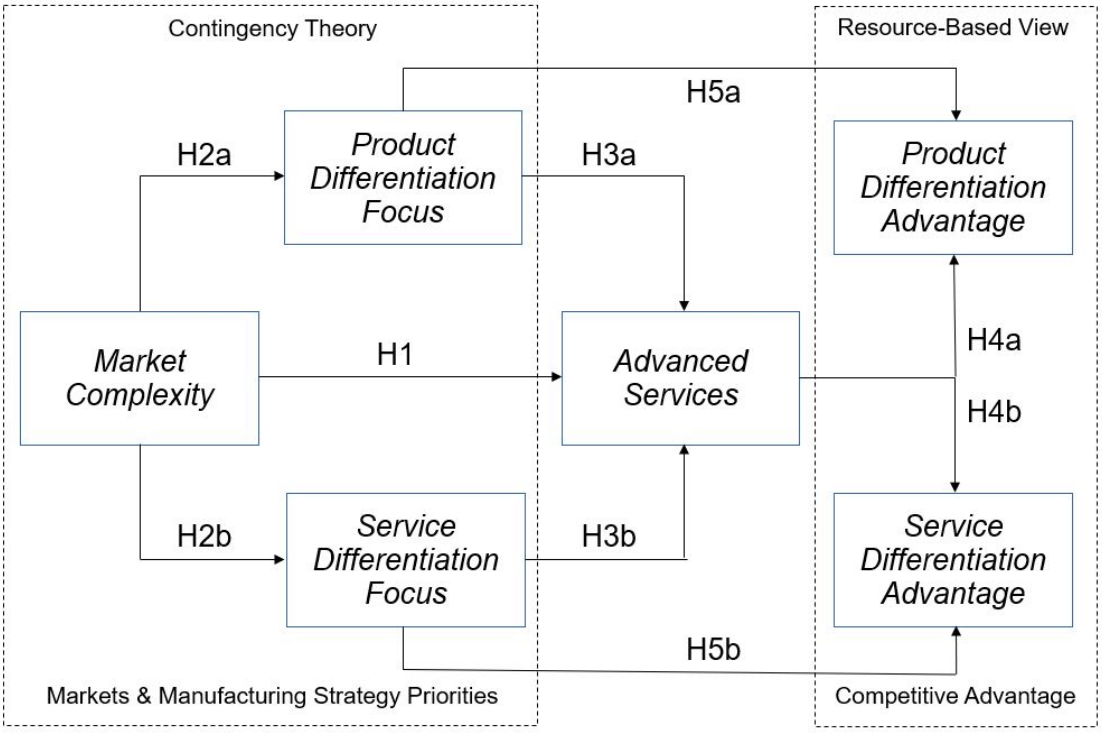

Figure 1. Theoretical model

Tables

Table 1. Descriptive statistics

Indicators/Variables	*N*	Mean	S.D.	Min	Max
Service differentiation focus ($N = 908$; $\alpha = 0.82$)					
Superior product assistance/support (after sales and/or technical support	913	3.88	0.95	1	5
Superior customer service (training, information, help-desk)	922	3.63	1.07	1	5
Product differentiation focus ($N = 905$; $\alpha = 0.76$)					
Offer more product customization*	922	3.68	1.04	1	5
Wider product range	924	3.51	0.99	1	5
Offer new products more frequently	918	3.25	1.09	1	5
Offer products that are more innovative	921	3.61	1.05	1	5
Advanced services ($N = 892$; $\alpha = 0.81$)					
Consultancy services	908	2.73	1.29	1	5
Training in using the products	920	2.87	1.35	1	5
Help desk/customer support centre	914	3.00	1.35	1	5
Product upgrades (software, product modifications)	914	2.59	1.36	1	5
Rental/lease of products (with responsibility for maintenance, repair and operation)*	903	1.87	1.17	1	5
Service differentiation advantage ($N = 842$; $\alpha = 0.73$)					
Product assistance/support	852	3.36	0.78	1	5
Customer service quality (e.g. training, information, help-desk)	852	3.36	0.85	1	5
Product differentiation advantage ($N = 847$; $\alpha = 0.69$)					
Mix flexibility*	863	3.43	0.80	1	5
Product customization ability	862	3.52	0.85	1	5
New product introduction ability	869	3.45	0.93	1	5
Market complexity	917	3.51	0.66	1.67	5
Firm size (LN)	929	6.02	1.72	1.10	11.92

Valid sample size (*N*) and Cronbach's alpha (α) in parenthesis next to each variable.
* Dropped after confirmatory factor analysis.

Table 2. Measurement model estimates

Variable	Loading	S.E.	CR	AVE
Service differentiation focus			0.82	0.70
Product support	0.79	0.02		
Customer service	0.87	0.02		
Product differentiation focus			0.77	0.54
Product range	0.62	0.03		
Frequent new products	0.83	0.02		
Innovative products	0.74	0.02		
Advanced services			0.80	0.51
Consultancy	0.65	0.03		
User training	0.80	0.02		
Help desk	0.72	0.02		
Product upgrades	0.66	0.02		
Service differentiation advantage			0.73	0.58
Product assistance	0.79	0.03		
Customer service quality	0.73	0.03		
Product differentiation advantage			0.65	0.49
Product customization ability	0.59	0.03		
New product introduction ability	0.79	0.03		
Market complexity	1.00	0.00		
Firm size (LN)	1.00	0.00		

Table 3. Correlations between latent variables

	1	2	3	4	5	6
1. Service differentiation focus	**0.83**					
2. Product differentiation focus	0.53	**0.73**				
3. Advanced services	0.51	0.47	**0.71**			
4. Service differentiation advantage	0.31	0.27	0.29	**0.76**		
5. Product differentiation advantage	0.19	0.36	0.23	0.74	**0.70**	
6. Market complexity	0.25	0.43	0.28	0.16	0.27	
7. Firm size (LN)	0.09	0.08	0.10	0.04	0.04	0.17

Square root of AVE is in bold across the main diagonal.

Table 4. Direct path estimates

(Hypothesis) Path	Std. Est.	SE	*p*-value
(H1) Market complexity → ADS	0.078	0.041	0.056
(H2a) Market complexity → Product diff. focus	0.442	0.034	< 0.001***
(H2b) Market complexity → Service diff. focus	0.239	0.038	< 0.001***
(H3a) Product differentiation focus → ADS	0.247	0.054	< 0.001***
(H3b) Service differentiation focus → ADS	0.354	0.047	< 0.001***
(H4a) ADS → Product diff. advantage	0.096	0.054	0.076
(H4b) ADS → Service diff. advantage	0.173	0.052	0.001**
(H5a) Product diff. focus → Product diff. advantage	0.297	0.049	< 0.001***
(H5b) Service diff. focus→ Service diff. advantage	0.238	0.048	< 0.001***
Firm size → Product differentiation focus	0.001	0.038	0.985
Firm size → Service differentiation focus	0.054	0.039	0.167
Firm size → ADS	0.037	0.036	0.294
Firm size → Product differentiation advantage	0.004	0.042	0.932
Firm size → Service differentiation advantage	0.003	0.040	0.947
χ^2 /df	2.446		
CFI	0.969	RMSEA	0.043
NFI	0.949	CI upper	0.035
TLI	0.957	CI lower	0.051

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

1

Revision Report
IJOPM-11-2019-0728
"Advanced services and differentiation advantage: An empirical investigation"

Summary: We are glad to submit a much-improved version of our paper to the IJOPM SI. We thank the Editorial Team and the two reviewers for their comments on our original paper. As shown below, we addressed the issues raised by the reviewers in a broad revision that included the study theoretical background, hypothesis development, methods, discussion and conclusions.

Please note that we have changed the title of the manuscript from "Servitization and differentiation advantage: An empirical investigation" to "Advanced services and differentiation advantage: An empirical investigation"

A. Answers to the Editorial Team:

1. The article has received quite some criticism from reviewers. Some of this stems from the use of IMSS data, which we had already identified as a potential issue when inviting it to the special issue. We had asked you to spell out the limitations of the data, and reiterate that request. Your current limitations section (as also problematized by reviewer 2) does not do that justice. There is obviously nothing you can do about the data itself, but in order to understand and judge your conclusions, it is vital that any reader would know about their applicability. This will require quite some work in the methods section still. Apart from the age of the data set, it is also a question of what data is collected vs. the theoretical and concept validity of what you intend to study. Plus there are results that would need to be discussed more thoroughly, esp. where they deviate from acceptable ranges.

Thank you and the reviewers for the great work on our previous submission. All these concerns are addressed as indicated below. First, we created a new section 5.4 at the end of the manuscript to focus on several data limitations including with data age. Second, as indicated below the development of the measurement model followed rather than preceded the theoretical constructs, even because our scales matched variables from previous empirical studies. Third, we reiterate below our view, which is supported by the mainstream literature, that no values deviated from acceptable ranges. R1 referred to values AVE = 0.49 and alpha = 0.69. However, both estimates (with marginal gaps at 0.01 below the most commonly accepted thresholds) are acceptable when measurement and structural models have overall good fit estimates, as indicated by the technical literature.

2. A second important issue that both reviewers have raised is that of anchoring in relevant literature. You will find very good suggestions from both reviewers in this regard.

We have significantly revised the theoretical background of the study by i) strengthening the grounding of the study on contingency theory and RBV; ii) enriching the coverage of the servitization literature, including that appearing in Operations Management journals, namely IJOPM. In doing so, we have incorporated in the manuscript all but one of the references that were suggested by the reviewers.

B. Answers to Reviewer 1:

1. This paper is characterised by little conceptual and theoretical maturity. The authors cover a lot of conceptual and theoretical ground without going into any descriptive or explanatory depth.

2

Thank you for the constructive and helpful feedback on our paper. Below, we outline how we have addressed your comments related to the theoretical background.

1.1 The authors lack definitions for many of their core concepts. Examples here are product differentiation, service differentiation, product-service differentiation, service business, product business, and capabilities. The authors also fail to describe the nuances of their assumptions behind these concepts and their linkages.

Thank you for the comment. We now define the core concepts of the study, as follows:

- product differentiation, service differentiation: first paragraph of Introduction section
- advanced services and capabilities: section 2.1

To avoid confusion, we removed the term “product-service differentiation”. We also removed the terms “product business” and “service business”; instead, we use the terms “manufacturing function”/ “service function” and “product activity”/”service activity”. In section 2.1, we define the terms “manufacturing function” and “service function” and how the service function relates to the manufacturing function.

1.2 The descriptions in the text often lack clarity. Examples could help a lot with clarifying the meaning of the concepts the authors are investigating and differentiating specific concepts from one another.

We believe that by addressing your comments 1.1, 1.4 and 1.5 we have improved the clarity and precision of the concepts. When appropriate, we also describe concepts in more detail, providing examples.

1.3 The authors fail to justify their research focus. While the paper lacks an explicit research question or aim, the authors are also inconsistent in the positioning of their argumentation. They start with identifying gaps in the literature that their study fills. Later in the introduction, they state that they integrate separate research streams. These are two fundamentally different lines of argumentation. In the current form, neither of these two lines of argumentation is justified. Why is it important to fill the identified gaps OR why is it important to integrate two research streams?

We have revised the Introduction section, which now explicitly formulates three goals for the study. We also explain why each of these goals is important. We have dropped the “integration of separate research streams” as a goal/contribution. Finally, we changed the title of the paper from "Servitization and differentiation advantage: An empirical investigation” to "Advanced services and differentiation advantage: An empirical investigation”.

1.4 There are further conceptual inconsistencies in the text which further add to the confusion and lack of clarity. For example, the authors refer to “product and service differentiation” (abstract), product-service differentiation (introduction), and product/service differentiation (Theoretical background). These suggest different concepts but seem to be intrinsically treated the same. Similarly, the authors differentiate environmental complexity into munificence, environmental complexity and dynamism. How can a concept be subdivided into itself? They also do not pick up these concepts in their conceptual framework.

Thank you for pointing this out. We have changed the manuscript as follows:

- We now consistently use the terms “product differentiation” and “service differentiation” as separate concepts. We avoid the use of the terms “product-service differentiation” and “product/service differentiation”.
- We now introduce the concept of market complexity in section 2.1 (research model) and expand on this concept in section 2.2 (discussing the three associated dimensions).

3

- In section 2.2, we clarify that we use the term "market complexity" to reflect the extent to which market environments are hostile, heterogeneous and dynamic, following Neu and Brown's (2005) study. Thus, the term "market complexity" does not correspond to Dess and Beard's (1984) dimension of complexity of external environments; instead, following Neu and Brown (2005), it aggregates Dess and Beard's dimensions of munificence, complexity and dynamism. We explain this in section 2.2 and, to avoid confusion, indicate that we will refer to Dess and Beard's complexity dimension by the term "heterogeneity".

1.5 The authors describe "market forces" and "capabilities" as theoretical perspectives. Instead, these are concepts which are based on theoretical perspectives. The authors fail to acknowledge the differences in theoretical underpinnings of their concepts. They state briefly that some of their concepts are based on the contingency perspective while others are based on the resource-based view or the market forces view. Neither of these theoretical lenses is described in more detail, including their assumptions, potential conflicts of definitions and conceptualisation, linkages amongst their descriptions etc. In my view, a paper publishable in IJOPM should show more theoretical rigour and underpinning that is currently the case in this paper.

Thank you for the suggestion. We have dropped the terms "market forces" and "capabilities". We now explain that the study is anchored on contingency theory and RBV. In section 2.1, we discuss contingency theory and the RBV in detail.

1.6 The authors argue that frameworks that integrate external and internal factors of servitization are missing. I refer them to the following exemplary papers that focus specifically on this integration: (Benedettini, Neely & Swink, 2015; Kreye, 2019; Reim, Parida & Sjödin, 2016). More care is needed in understanding the existing literature in the field.

We agree with your point. In the original manuscript we meant to say that there are still few large-scale empirical studies integrating external and internal factors, but this position was not clear. This position is subsumed under the following statement in the Introduction section: "Finally, we respond to appeals for servitization theory validation using large-scale data (Bustinza al., 2015; Kowalkowski et al., 2017; Gebauer et al., 2012)." Accordingly, we removed the mention to internal and external factors in the paper.

Thank you for the suggestion of references. They were all included in the manuscript.

2. I see a strong mismatch between the research framing and contextualisation in servitization on the one hand and the research design and data set on the other hand. The presented data set included only 9.8% of manufacturing companies with a service business. This seems a very biased sample to present meaningful insights on servitization.

It is not that 9.8% "of the companies" had a service business, but rather that "9.8% of the sales" of survey business units were due to sales of services. The reviewer's misunderstanding was likely due to our poorly constructed sentence. We rewrote the sentence on section 3.1 to clarify this aspect of our sample: "On average, 9.8% of the business unit turnover of the 931 companies was based on sales of services, while the remaining 90.2% was due to sales of parts/components or assembled products."

3. A crucial criticism point is the methodological rigour. While I appreciate the in-depth description of the research design and limitations of the survey, the presented study design does not seem to fit the purpose of investigation.

4

The analysis is based on structural equation modeling, which is considered one of the best methods for "the quantification and testing of substantive theories" by models that "explicitly take into account measurement error […] and latent variables" (Raykov and Marcoulides, 2006: 1). Besides, we used widely prescribed procedures for data validation and assessment of model fit (according to Diamantopoulous and Siguaw, 2006; Fornell and Larcker, 1981; Bagozzi and Yi, 1988; Anderson and Gerbing, 1988; and Peters and Enders, 2002, among others). However, we do acknowledge limitations regarding the study data, which were raised by two reviewers. In the new version we present a more clear and critical discussion of these limitations in section 5.4.

3.1 The response rate and absolute responses per country seem very low. This is particularly problematic given one of the focus areas of this research is the business environment where national differences may form a strong impact.

The response rate was similar or higher than other recent operations management studies (e.g. Yu and Ramanathan, 2015; Moshtari, 2016). As indicated on p.20, the research teams carried out tests for non-response bias and reported non-significant differences between respondents and non-respondents. Moreover, in our study as in others, e.g. Visnjic et al. (2019) exogenous country variables are controlled by contextual variables such as market complexity.

3.2 The authors seem to apply a back-tracking logic to the measures they have collected in their survey. I appreciate that this may be a practical way of suing existing large data sets such as the presented one; however, in this case it results in a lack of theoretical validity of the presented data. The attempted link between theoretical concepts and empirical measures does often not align. For example, the connection between product and service differentiation and “order winner” and manufacturing flexibility seems ill connected to me. Similarly the “differentiation advantage” was measured in terms of performance instead of capabilities. This disconnect between theoretical construct and empirical measure is very critical and undermines the validity of this research.

We respectfully disagree with the reviewer. The measures were developed after the theoretical model and were close matches to previous operationalizations available from the literature, which includes but is not limited to empirical studies based on IMSS data. The revised section 3.2 includes clear documentation of relationships between measures and the previous literature.

Specifically, please note that: (i) the flexibility item refers to “mix flexibility”; thus, this item does relate to product differentiation; (ii) differentiation advantage was measured as performance relative to the competition. To make this clear, we created an Appendix listing all the questionnaire items.

3.3 The authors present reliability tests for their measures. Some of the measures fail these reliability tests. This concerns particularly product differentiation and service differentiation measures, where low values of Cronbach Alpha and average variance extracted. Given that these theoretical invalid measures were the only measures that
significant links were found for, this makes the presented insights somewhat meaningless.

As indicated by Vaske et al. (2017: 165), and following extensive literature, "By convention, an alpha of .65–.80 is often considered `adequate' for a scale used in human dimensions research (Green et al., 1977; Spector, 1992; Vaske, 2008)". Hair et al. (2011) suggested 0.7 as lower threshold. Only one of the five latent scales had Cronbach alpha marginally lower than 0.7 (product differentiation advantage = 0.69), but still within generally acceptable limits. Besides, relatively lower alphas should be expected in scales with few (i.e. three or less) items. This outcome is natural, expected and has been extensively discussed by Vaske et al. (2017), among others.

5

The accepted threshold for AVE is 0.5 (Fornell and Larcker, 1981; Hair et al., 2011). Only one of the five latent variables had a marginally lower AVE (product differentiation advantage = 0.49); the other values were 0.70, 0.54, 0.51, and 0.58. As discussed in multiple empirical studies (e.g. Mueller et al., 2016; Amoroson and Cheney, 1991; etc.) an AVE value of 0.49 is acceptable for being so close to the lower threshold (and when the overall measurement model fit statistics are sound, as in our case).

4. The description of findings and discussion lack in depth and meaningfulness. I think the authors should outline first what hypotheses were supported through their data (findings) and then explain why these observations were made (i.e. explain theoretically what we can take from them in the discussion). The discussion should provide more theoretical development based on the empirical insights provided. This is currently still underdeveloped.

We rewrote the results section (section 4) to clarify more substantially what hypotheses (relationships between constructs) were supported by the data (relationships between operational variables).

More importantly, we revised and expanded the discussion section (section 5) to provide more theoretical advancements following the empirical results, against the background of the revised (and more solid) theoretical background for the study.

5. Similarly, the conclusions lack focus (because they do not present any meaningful answer to a research question). Basically, the study seems to confirm existing knowledge rather than provide novel or unexpected insights. At the moment, I do not see sufficient theoretical contribution in this paper. Similarly, the practical implications are relatively broad brushed with little insights that emerge logically from the empirical or theoretical
work.

We have clarified the goals and contributions of the study in the Introduction section. We have significantly expanded the discussion of the findings both for theory and practice (please refer to the revised section 5). In doing so, we have highlighted both novel insights and the contribution that our study makes for theory validation (acknowledging the scarcity of large-scale empirical studies in extant literature), namely, by validating a comprehensive theoretical model with large-scale empirical evidence. We made the implications for practice more specific and actionable by managers.

6. Limitations should go in the discussion or as currently Conclusions section. At the moment, research limitations appear in two parts of the paper.

We agree with the reviewer. We created a new section 5.4 focused on all data limitations. The section is available near the end.

7. The references seem to be skewed towards (industrial) marketing management instead of operations management. While (industrial) marketing management journals receive 20 references, IJOPM receives only 11. In addition, the IJOPM references are skewed towards papers by authors around Tim Baines and Rui Sousa only. IJOPM has published a much broader and more varied body of literature on servitization and service operations which should be acknowledged and embodied into the conceptual and theoretical developments.

Thank you for the suggestion. We have expanded the coverage of the servitization literature, including that appearing in Operations Management journals, namely, IJOPM (17 references).

6

8. The argumentation needs more rigorous referencing. For example, the authors state "…theoretical perspectives most commonly used…" (p.6) but provide only one reference.

In the example that you mention, the single reference that was provided (Eloranta and Turunen, 2015) was a literature review paper that concluded that *Market forces* and *Capabilities* were the two theoretical perspectives most commonly used to explain the competitive role of servitization. As a response to your comment 1.5, we have replaced market forces and capabilities by contingency theory and RBV and, as result, have removed this sentence from the paper.

Overall, we sought to be rigorous in the referencing.

9. The articulation of the hypotheses seems very simplistic and broad brushed. This connects, in my view, to the insufficient definition and clarity of the theoretical concepts. The phrasing and logic of the hypotheses needs more careful attention to specificity.

As a response to your previous comments (1.1, 1.2, 1.4, 1.5), we have clarified the definitions of the key concepts in our study. We have also strengthened the theoretical grounding of the hypotheses on contingency theory and the RBV. This provides more solid support and clarity to the logic of the hypotheses. In addition, we improved the logic of all hypotheses, except H5a/H5b, which were straightforward. Following a recommendation of Reviewer 2 we have significantly enriched the development of hypotheses H4a/H4b, namely by recognizing additional complexities surrounding the hypothesized relationships. Finally, we have improved the wording of the hypotheses' formulation.

10. Much of the descriptions in Section 3 can be presented in Tables. For example, the measures and their underpinnings in the literature can be summarised in a table. Also, the survey questionnaire should be included in an Appendix. The descriptions in the text can then focus more on the how principles of validity and rigour were followed throughout the methodological design.

Thank you for the helpful suggestions. Following these comments, we (i) included an Appendix with all measurement items, their respective survey questions and response scales; (ii) revised section 3.3 to focus on issues of validity and relationships between measures and the previous literature.

11. I appreciate the authors' detailed description of the data limitations. While these should come later in the paper, I also see that one key limitation was overlooked in the descriptions. In my view, some of the main limitations are practical as (a) the survey data was collected by different researchers across different countries who presumable contacted relevant companies in a different way and with different levels of care (represented in the low response rate) and (b) the interpretation of the questions and scale can vary greatly. These practical limitations are worth reflecting on.

Limitation (a) can be only partially the case, as all national survey teams followed procedures that were developed centrally and communicated clearly (in writing and in person) to the network. Thus, there were very few if any exceptions to instructions as follows: quality of responses were checked in 22/22 countries; responses were limited to ISIC 25-30 in 22/22 countries; non-response bias was tested in 20/22 countries; late response bias was tested in 21/22 countries. On the other hand, there was indeed a mix of invites based on convenience and random sampling across the network. This issue is now indicated in the limitations section 5.4.

7

Issue (b) is a well-known threat with international surveys, although the sound fit estimates of the measurement model indicate good convergence validity, discriminant validity, and reliability of responses across the survey. We add this issue and caveat to the limitations section 5.4.

12. I presume that the starting point of your evaluation are the current data set you have. In this instance, you will have to back track from the available data to infer the type of research you can investigate. In other words, the starting point is the data you have and you need to match the theory to that. This limits the methodological rigour and theoretical value your paper can have because you are unable to take the starting point in the need for theoretical development but rather in the availability of data. I suggest that you re-evaluate the measures you have from your data set and try develop an inductive set of variables you can include in your investigation. An example here is (confirmatory and/or exploratory) factor analysis to see how the measures cluster. From this you can derive a set of variables to include in your conceptual model of hypotheses.

The starting point was not the data, but (a) our theoretical model and (b) a review of previous empirical studies such as Sousa and da Silveira (2017), Szász and Seer (2018) and Visjnic et al. (2014). The revised section 3.2 includes clear discussions about relationships between measures and the literature.

13. The second step could be to explore the literature around the variables you receive from such factor analysis and develop a theoretical framing from there. Above, I suggest a few relevant papers in the servitization literature. Maybe an initially more meaningful approach here could be to take the initial framing within manufacturing rather than servitization specifically. As indicated above, the specific framing of servitization does not seem well suited to the data set you have available. If you choose to focus on services within manufacturing, one particular concern is the clarity in research. For me the value of ABS lies in the integration between product and service business streams. Separating these in the research investigations seems to limit the advancement of the field. If you choose to include the service operations aspect in your analysis, I suggest you explore the combined nature of product and services in more detail. You already have some initial starting points in your paper which you can conceptually develop further. As indicated, this back-tracking approach from a quantitative data set to the potential concepts and theory it enables you to investigate is very problematic and bears a huge risk of undermining your own research value. Depending on the data you have (and only you can evaluate this as very little of the original data set is currently included in the paper), you may find it worth going down this route.

We respectfully disagree with the reviewer. We did not adopt a back-tracking approach in this study, even because this study follows on other empirical studies that used both IMSS (e.g. Sousa and da Silveira, 2017; Szász and Seer, 2018) and other datasets (e.g. Visjnic et al., 2014). Developing a factor analysis at this point would in our view represent a move backwards, as those studies had developed and validated measures such as used in our study. Developing new measures based on induction at this point would in our view create confusion (discontinuity in research) and be unfaithful to the work in those previous studies.

We do agree that it is useful to strengthen the links between ADS and manufacturing strategy theory. We have done that in the revised manuscript.

14. Originality: In its current form, the paper seems to largely confirm existing research in the field. I see potential for further theoretical and conceptual development as the authors indicate a lot of different potentially interesting angles on their research. I detail this aspect further in the enclosed comments to the authors.

8

We have clarified the gaps, goals and expected contributions in the Introduction section. We have also significantly enhanced the Discussion section, including the implications for theory and for practice. In doing so, we have highlighted both novel insights and the contribution that our study makes for theory validation (acknowledging the scarcity of large-scale empirical studies in extant literature), namely, by validating a comprehensive theoretical model with large-scale empirical evidence.

15. Relationship to Literature: The literature seems largely positioned within the field of (industrial) marketing management with only selected references to the field of servitization in operations management (circling around a small set of authors). Concepts are presented only superficially. Much more depth is needed to improve the relationship to the literature (see enclosed comments to the authors).

In the Introduction and Theoretical background sections, we have clarified and made more precise the core concepts of the study. We have expanded the coverage of Operations-based literature, including that appearing in IJOPM.

16. Methodology: This is in my view the most critical shortcoming of the paper in its current form. Applied measures seem ill fitted and ill connected to the theoretical constructs they aim to investigate. At the same time, it seems impossible to collect further data to complement the current data set in a more methodological rigorous way. As a result, there is a big risk that the authors do simply not have the right data available to merit any theoretically meaningful study. I offer some more detailed and constructive thoughts on this in the enclosed comments to the authors.

We followed up on the reviewer's thoughts regarding this issue. Please refer to our manuscript revisions and comments as indicated elsewhere in this report. Furthermore, and again as suggested by the reviewer we developed a stronger limitations section outlining limitations with the study data.

17. Results: The results are currently presented very broadly without sufficient in-depth description. Furthermore, the key (i.e. only statistically significant) results appear to be based on data variables that were not excluded despite the fact that they did not comply with basic concerns of validity. This raises the concern of meaningfulness of the presented findings.

As indicated above, "we rewrote section 4 (results) extensively to clarify more substantially what hypotheses (relationships between constructs) were supported by the data (relationships between operational variables)."

Results were based on the refined measurement model, which excluded indicators with low validity. This issue is clarified on section 3.3, par. 3., and in the revised results section.

18. Implications for research, practice and/or society: This part is very under-developed and requires more meaningful and specific development based on the empirical work and conceptualisations. The managerial implications are currently largely prescriptive despite the lack of research pointing in this direction.

Regarding implications for research, please refer to our response to your comment #4. Regarding implications for practice, these were significantly enriched and expanded; they were also made more specific and actionable by managers. Finally, we avoided the use of prescriptive terms in the text.

19. Quality of Communication: The paper is overall well written and communicated. Some minor issues with English grammar remain in parts but would be corrected through thorough proof reading.

9

We sought to improve the quality of communication, and carried further rounds of proof reading in this new version.

10

C. Answers to Reviewer 2:

1. This paper starts promisingly with the intent of analyzing the relationship between advanced services and business strategies based on product and service differentiation, but falls short at multiple instances with missing information, failing to justify the full worth of this study. Please refer to attached comments, as this manuscript needs revision, both theoretically and empirically to reach its full potential.

Thank you for the constructive and helpful feedback on our paper. Below, we outline how we have addressed your comments.

2. Originality: The paper makes a good initial impression by presenting the intent to account for the external environment variable in analyzing the relationship between advanced services and business strategies in achieving market differentiation by employing large-scale data. However, the introduction can benefit more from elaborating on the significance of market differentiation for a manufacturing firm transitioning towards services. In addition, a clear statement of the aim of the paper is missing, and the three gaps identified in the introduction are based on three associated assumptions. A brief explanation on the importance/relevance of those assumptions is required to strengthen the motivation of the paper. The authors make claims about their research being advanced over existing research as they consider both product and service businesses in a manufacturing unit - this needs to be precisely articulated to convey the intended message, because there are several publications focused on product service systems and related outcomes, which weakens the authors' claims in this regard.

Thank you for the suggestions. We have significantly revised the Introduction section. Specifically:

- In the first paragraph, we better contextualize market differentiation for manufacturing firms, and clarify that such differentiation may be achieved via differentiated products and/or by offering services to customers.
- We explicitly indicate that the paper has 3 goals:
  - i) address the joint influence of market complexity (competition intensity, heterogeneity and technological change) and the manufacturers' strategic focus on differentiation (product and service) on the extent to which they offer ADS to customers;
  - ii) examine the impact of the offering of ADS on product differentiation and on service differentiation advantage;
  - iii) examine the relationship between the offering of ADS and manufacturing strategies focusing on product differentiation;
- We provide a brief explanation of why each goal is important.
- Following from the 3 goals, we state that "To address these goals, we develop a theoretical model of antecedents and outcomes of the offering of ADS by manufacturing business units."
- Finally, we clarify that our contributions in considering both the product and service businesses in a manufacturing unit relate to providing large-scale empirical evidence on: i) the impact of ADS on product- and service-differentiation advantage; ii) the relationship between the offering of ADS and manufacturing strategies based on product differentiation, given conflicting arguments in the literature about synergies vs conflicts between servitization and the performance of the product business.

3. Relationship to Literature: The paper demonstrates satisfactory assimilation of literature from relevant sources, yet the recommended reading attached here should help improve the arguments supporting the proposed hypotheses. Some of the ideas behind hypothesis generation conveniently avoid obvious concerns. For instance, hypotheses H4a/b fully rely on complete customer involvement and its ever so positive influence on product and service differentiation advantage without accounting for the complexities involved with access to

customers, customer behavior etc. Manufacturers cater to varied customer segments, and willingness of customers to participate in such co-development process is not always straightforward, including issues of data privacy, security, and so on. There also appears to be a general assumption that a manufacturer has all capabilities to drive their servitization goals, while the reality is quite the opposite. Not all the required resources and capabilities are available internally and sourcing these is yet another hurdle that such organizations have to deal with. The authors need to account for insights from the following studies to complement justifications for their proposed hypotheses, as currently they appear to be based more on ideal scenarios.

Recommended reading:
PAIOLA, M., SACCANI, N., PERONA, M. & GEBAUER, H. 2013. Moving from products to solutions: Strategic approaches for developing capabilities. European Management Journal, 31, 390-409.
STORY, V. M., RADDATS, C., BURTON, J., ZOLKIEWSKI, J. & BAINES, T. 2017. Capabilities for advanced services: A multi-actor perspective. Industrial Marketing Management, 60, 54-68.
CENNAMO, C. & SANTALO, J. 2013. Platform competition: Strategic trade-offs in platform markets. Strategic Management Journal, 34, 1331-1350.
BUSTINZA, O. F., BIGDELI, A. Z., BAINES, T. & ELLIOT, C. 2015. Servitization and competitive advantage: the importance of organizational structure and value chain position. Research-Technology Management, 58, 53-60
Baines, T., Bigdeli, A.Z., Sousa, R. and Schroeder, A., 2019. Framing the servitization transformation process: A model to understand and facilitate the servitization journey. International Journal of Production Economics.

Thank you for the helpful suggestions. We now acknowledge that manufacturers may require both internal and external capabilities to derive benefits from ADS provision. Specifically, given the focus of our study, we now discuss, as part for the development of H4a/b, the following two types of capabilities: i) customer capabilities (external); and ii) knowledge integration (internal). In addition, we improved the logic of all hypotheses, except H5a/H5b, which were straightforward.

Except for the Cennamo & Santalo (2013) paper (which we did not find to be directly related to our study), we now cite all the articles that you suggested in the hypothesis development section.

4. Methodology: The authors identify benefits of data from IMSS under section 3.2 titled data limitations, which is quite the contrary. The section should be adequately renamed, or the benefits need to be discussed elsewhere. It cannot be ignored that the data used is quite old - 2013/14 and while there is nothing the authors can do about such data, there is no satisfactory justification on the current validity and applicability of nearly 6 years old data in the methodology section either. This should be rectified. There are several limitations identified for using pre-gathered survey data, but it seems unnecessary to dedicate 10 pages of text to methodology in a journal paper, and some of the tests are more fitting for and should be moved to the findings section. Text on limitations and associated tests must be appropriately positioned together and be to the point; presently the section appears convoluted with too much information spread across multiple subsections. In addition, in the measures development there's an instance of $\chi 2/df = 5.580$ which is quite high. Many academics propose between 2 and 3 to be good and acceptable. There are instances of higher values being accepted, but the authors in this case must provide suitable supporting references to justify the acceptability of such high values. It is recommended that authors doubly verify the acceptable values for all other indices and suitably reference them.

We developed a new section 5.4 focused only on data limitations, including the fieldwork period.

Please note that the $\chi 2/df = 5.580$ refers to the MIMIC model, not to the measurement or structural models (for which the recommended limits are quite satisfactory at $\chi 2/df = 2.412$ and 2.446 respectively). The reason for the MIMIC/formative model "high" $\chi 2/df$ is the same for its "low" TLI, which was explained in the manuscript. As Kenny (2015) indicates, the $\chi 2/df$ is "an old measure of fit" for which "there is no universally agreed upon

standard as to what is a good and a bad fitting model". More importantly, he indicates the measure is directly "affected by the size of correlations in the model". As we had indicated in the manuscript, "formative indicators are not expected to be correlated". Since a successful (or good) MIMIC model includes indicators that (as opposed to ordinary measurement and structural models) must NOT be correlated, such (otherwise) "poor" χ2/df and TLI estimates are expected. We made this point clearer in the manuscript, section 3.2, par. 3.

In section 3.3 we provide multiple references to acceptable values of fit estimates (Bagozzi and Yi, 1988; Hair et al., 2010), unidimensionality (Kumar and Dillon, 1987; Carr and Pearson, 1999; Liu et al., 2016), AVE and CR (Fornell and Larcker, 1981; Bagozzi and Yi, 1988).

5. Results:

5.1 As mentioned in the previous comment, some of the results are mixed up in the methodology section, and should be re positioned in the findings section.

All findings regarding the theory and hypotheses (structural model) are presented in section 4 (Results). Quantitative analyses presented in the measurement section concern exclusively measurement scales and the measurement model. It is fundamental to keep analyses of the two empirical models (measurement/outer and structural/inner model) separate because the latter is testable only after the former has been validated.

5.2 The discussions in section 5 are not particularly satisfactory. It more so has the feel of a results section, focused more on stating the obvious with hypotheses outcomes, rather than arguing the relevance of such outcomes in a servitization-based setting. The product and servitization strategies are mentioned in several instances, without discussing how these strategies change the operational dynamics for a manufacturer focused on the delivery of advanced services. There are errors in referring to hypotheses as well – H2 & H3 are introduced in the discussions, without being proposed in the first instance in hypotheses development or the theoretical model (fig 1). The use of clear terminology is strongly recommended – here authors refer to business strategy as a single construct, assumingly representative of product & service differentiation focus without clearly mentioning this – clarity in writing is paramount here. Also, discussions are very restrictive – in one instance, for example, the authors mention – "This result encourages a more widespread usage of contingency approaches in the study of servitization Baines et al., 2017; Forkmann et al., 2017; Kowalkowski et al., 2017)" but they fail to mention what these contingency approaches could look like and what effect can these have on the service offerings. Overall, the discussions appear superficial without exciting insights of value to what we already know from existing research. The authors use statements like – "This reinforces the need for the product and service functions in the manufacturing firm to have a clear strategic orientation towards differentiation" but this is already asserted by earlier studies. What would be interesting is to know what such organizations can do to establish a clear differentiation based strategic orientation. Information or knowledge acquisition from customers was built upon heavily earlier on in the paper, but the findings provide no further information on how to acquire such information, or explain the tangible benefits of such customer information which limits the paper's contributions.

Thank you for the comments. We changed the manuscript as follows:
- In the original manuscript, we sometimes used the terms H2 and H3 to refer to the associated set of hypotheses (H2a, H2b, H3a, H3b). As per your comment, we now refrain from using the terms H2 and H3.
- We refrained from using the term "business strategy" as pertaining to our findings, and now use the terms "product differentiation" and "service differentiation".
- We revised and expanded the discussion section to provide more theoretical advancements following the empirical results, against the background of the revised (and more solid) theoretical background for the study.

13

In doing so, we have a more elaborate discussion of the implications of the findings associated with servitization contingencies. In addition, we draw on the concepts of "customer" and "knowledge integration" capabilities introduced in the hypotheses development sections to elaborate on what organizations can do to achieve product- and service-differentiation advantage through ADS provision. In doing so, we have highlighted both novel insights and the contribution that our study makes for theory validation (acknowledging the scarcity of large-scale empirical studies in extant literature), namely, by validating a comprehensive theoretical model with large-scale empirical evidence.
- We significantly enriched and expanded the implications for practice, making them more specific and actionable by managers.
- We clarified the goals and contributions of the study in the Introduction section.

6. Implications for research, practice and/or society: The implications seem farfetched and there is some inconsistency in the findings and the implications of this study. In terms of farfetchedness, as there is insufficient discussion on how market forces and internal capabilities explain the adoption of advanced services. Again, use of such language raises questions on the adoption of such services by whom? The manufacturing organization, or its customers? The impression until this point is the investigation being focused on impact of internal/external factors on the delivery of advanced service, and now the language changes to adoption, making the reading convoluted again. This needs to be clarified in the introduction, and followed through in the rest of the paper. In addition, relationship between operational performance and advanced services is described as a contribution of the study, with no prior reference to operational performance in the findings or the discussions of the paper. Again, issues in clarity arise – the authors need to clarify/define the measures/indicators against which they measured operational performance of the companies in their data set for this to accounted as a contribution of this study. The practical implications are very brief and some like - "Our findings suggest that firms operating in complex environments are especially well suited to adopt these strategies" need to be discussed on the basis of the indicators used to measure complexity, i.e., munificence, market complexity and dynamism and how these play out for a manufacturer.

Thank you for the comments. We changed the manuscript as follows:
- We made the implications less prescriptive and were careful to make them consistent with our findings.
- In the original manuscript, the term "adoption" meant the extent to which manufacturing firms offered advanced services to their customers. In the revised manuscript we refrained from the use of this term as it might cause confusion.
- In the Introduction section, we have clarified the terms "product differentiation advantage" and "service differentiation advantage" and how they relate to "performance". We have improved the description of the measurement of "product differentiation advantage" and "service differentiation advantage" (section 3.2), including the addition of an Appendix listing all the measurement items. The discussion of the findings (section 5) is now consistent with the revised terms.
- We significantly enriched and expanded the implications for practice, making them more specific and actionable by managers. In doing so, we discuss implications specific to intensity of competition, heterogeneity and degree of technological change.

7. Quality of Communication: Overall, there are issues with the language used which hinders the clarity of expression making the readability complex. Please refer to the earlier comments to make required changes in this regard.

Please refer to our responses to your earlier comments. We also carried out further proof-reading rounds in the new version.

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