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WHY DO SERVITIZED FIRMS FAIL? A RISK-BASED EXPLANATION

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ABSTRACT

Purpose

In an effort to further explain why manufacturing firms that move towards service provision often fail to achieve the financial benefits they would expect, the purpose of this paper is to examine empirically the impact of service provision on the bankruptcy risks facing manufacturing firms.

Methodology

Using data drawn from a sample 129 bankrupt manufacturers (75 servitized and 54 non-servitized) and a framework categorising bankruptcy risks, the study explores the relationship between service provision and the environmental (external) and internal bankruptcy risks that manufacturing firms face.

Findings

The study finds that the presence of a service business leads to a greater number of bankruptcy risks for the supplying firm. This is essentially because of greater internal risks. In addition, two types of service offerings are identified – demand chain and product support services. When firms offer demand chain services, they are also exposed to greater environmental (external) risks.

Research limitations/implications

The study provides empirical evidence about the relationship between servitization and bankruptcy risks, and on how this is influenced by the type of services offered. The research could be extended through a more comprehensive assessment of organisational risks in order to further validate and develop its conclusions.

Practical implications

The study suggests that, as adding services introduces new risks for firms, managers have to seek means of mitigating these risks to ensure successful introduction of services.

Originality/value

The paper addresses the gap in the literature for structured analyses of the risk consequences of service strategies.

Keywords: service strategies, manufacturing, business failure, risk

1. Introduction

In the manufacturing world, services are in vogue. As markets demand greater customisation and faster innovation, academic and management literatures alike suggest that supplementing products with value added services can be a profitable option (Neely, 2008; Spring and Araujo, 2013; Wise and Baumgartner, 1999). Especially in developed economies, integrating services into products is thought to provide product manufacturers with opportunities for competitive advantage, particularly when they offer otherwise undifferentiated products (Gebauer et al., 2011; Matthyssens and Vanenbempt, 2010; Mathieu, 2001a; Cusumano et al., 2014). Service dominant logic (SDL) suggests that additional services directly enhance the value of the physical product, which is itself viewed as a conduit for delivering service (Vargo and Lusch, 2004). By virtue of being co-produced with the customer, services involve customers as operant resources in the co-creation of value that is often unique and difficult-to-imitate (Oliva and Kallenberg, 2003; Vargo and Lusch, 2004; Fang et al., 2008; Gebauer et al., 2011). In addition, services are recognised as a steady source of revenues and profit margins that in some industries far exceed the returns of the market for physical goods (Wise and Baumgartner, 1999; Gebauer et al., 2005; Raddats and Easingwood, 2010). Finally, marketing researchers assert that augmenting products with service elements increases customer satisfaction and strengthens customer relationships, thereby enhancing customer loyalty and retention (Brax, 2005; Gebauer et al., 2006; Johnstone et al., 2009).

In this context, the term, *servitization*, has been introduced to describe a growing propensity for manufacturing firms to develop service offerings that extend beyond their traditional core product offerings. Manufacturers in a diverse range of industries are servitizing, seeking to increase their share of revenues from services. However, while some companies report that servitization has delivered ambitious growth objectives, others appear to struggle to turn a profit from their service businesses. A Bain & Co. study indicates that only 21% of companies succeeded with service strategies (Baveja et al., 2004). In another study, services are reported to account for only a limited percentage of total revenue for the majority of Swiss and German capital goods companies (less than 20% for 72% of companies and less 10% for around 39% of companies) (Fischer et al., 2010). Stories of failures include many noticeable examples: Siemen's service division (Siemens Business Services) was mostly unprofitable (Gebauer et al., 2009), Intel's $150 million web-based services unit was shut down after few years (Sawhney et al., 2004), and Dürr's outsourcing service unit reined in its efforts to take over its automotive customers' painting and assembly processes (Fischer et al., 2010). Such results suggest that, despite their promise, servitization efforts can fail to outperform purer product manufacturing strategies. Indeed, the academic literature has raised a 'servitization paradox' – the value creating opportunities of servitization seem clear, yet the

bundling of services with product offerings does not always produce the returns that companies expect (Gebauer et al., 2005; Mathyssens and Vanderbempt, 2010; Neely, 2008, Spring and Araujo, 2013; Ulaga and Loveland, 2014). Given the apparent failures of many servitization programs, research is needed that identifies and elucidates factors that relate a service infusion strategy to organisational performance. There is good reason to suspect that an important factor is *risk*. As a manufacturing firm enters new fields of services, it likely changes both the levels and types of risks to which it is exposed. While other aspects of service strategies have been intensively studied in the literature, concomitant risk consequences have received little empirical attention (Nordin et al, 2011; Sawhney et al., 2004).

Managerial literature provides highly valuable insights into the benefits and problems for manufacturers of moving towards services. Yet, most studies focus on individual opportunities or challenges of service strategies (Spring and Araujo, 2013), leading to a fragmented understanding of the attendant risk consequences. Empirical research that comprehensively explores the effects of the new market position of the firm on risks is necessary. Such research must address two parallel changes associated with servitization. First, manufacturing firms that extend their activities into services change their relationships with the external environment. Second, they must integrate service processes, values and competences into existing internal organisational arrangements. Accordingly, this study builds on the distinction between environmental and internal risks (e.g. Miller, 1992) to investigate how these categories affect the impact of service provision on companies' risk profiles.

Prior research has examined different types of services offered by manufacturing firms, and offered service typologies (e.g. Eggert et al., 2011; Eggert et al., 2014; Fang et al., 2008; Johnstone et al, 2009). However, the relationship of service types to types of risks has not been explored. In order to better design and manage their service offerings, managers need to know how certain services might incur greater or lesser risks.

The contributions of the present study to management research and practice are threefold. First, the study responds to calls for research on the relationship between servitization and organisational performance (e.g. Gebauer et al., 2012; Kohtamäki et al., 2013a; Ulaga and Reinartz, 2011). It proposes that extended service strategies create new risks for the firm. Such a view has yet to be empirically examined, and may further explain why many firms do not attain from services the growth and profit gains that they would expect. Second, by disentangling the impact of servitization on environmental and internal risks, this research sheds light on the issues that are particularly critical when firms move into services. Third, the study confirms the heterogeneity of services offered by manufacturers, and provides insights into how they can be classified from a risk

perspective. In doing so, this paper's findings help managers make more informed decisions regarding service strategies and the risks they will need to face according to the service offering they will focus on.

2. Theory and hypotheses

Given its underlying concern with advancing the understanding of why manufacturing firms that enter the service market often fail to achieve rewarding financial performance (i.e., the 'servitization paradox' problem), this study concentrates on servitized firms that have failed in the most extreme sense, those that have declared bankruptcy. Bankruptcy is a clear and objective measure of failure. Moreover, because bankruptcy invites analyses of a firm's weaknesses and risks, a wealth of rich, objective data are often available for bankrupted firms. Accordingly, the present investigation of the risks of service-oriented strategies examines particular risks attributed to servitized firms around the time of their bankruptcies, and contrasts these risks with risk profiles of other similar bankrupted firms that kept pure product-centric orientations.

The remainder of this section discusses the literature related to the main constructs that provide the background to the investigation. First, the service-risk relationship as delineated by servitization research is reviewed. Then the discussion turns to the distinctions between environmental and internal risks found in the bankruptcy literature. Subsequent sections develop the research hypotheses, proposing first that both environmental and internal bankruptcy risks are increased under servitization, and second, that risk increases are also influenced by the types of services offered.

2.1 Servitization: a risk-based perspective

The aspect of risk is rarely referenced directly in the servitization literature. Indeed much of the literature implicitly assumes that risks reduce as manufacturing firms provide services. Key arguments are that, through services, manufacturers enhance the quality of customer relationships (Oliva et al., 2012) and develop capability based competitive advantage (Wise and Baumgartner, 1999). Although extensive scholarly attention has been devoted to the challenges of servitization (Gebauer et al., 2012), prior literature has largely neglected the conceptualisation of risk. However, some recent studies have raised the possibility that pursuing service related opportunities introduces new risks to the service provider. Fang et al. (2008) touch upon the issue when they identify two negative mechanisms, organisational conflict and loss of strategic focus, which may affect firm value. Similarly, Brady et al. (2005) contend that firms wishing to succeed with services (solutions) need enhanced skills in identifying, evaluating and managing long-term risks in supply streams.

Various other papers have outlined a shift of risk from the customer to the supplier in the context of solution offerings (e.g. Brax and Jonsson, 2009; Davies, 2004; Nordin and Kowalkowski, 2010; Storbacka, 2011) or relational services like process outsourcing (e.g. Gebauer, 2008; Oliva and Kallenberg, 2003; Raddats and Easingwood, 2010), as these involve the responsibility for suppliers to provide specific performance on activities previously carried out in-house by customers. Despite an underlying concern with risk, none of these studies particularly emphasises or fully delineates the servitization-risk connection. The relevance of risk to the performance of servitization strategies is more explicitly addressed by Sawhney et al. (2004), who contend that, while they should be encouraged to intensively explore the opportunities for new services, managers should be equally advised to assess the pitfalls and risks that these opportunities represent. As for research that more thoroughly analyses the risks involved with the extension of a firm's offering into services, perhaps the only work is the study by Nordin et al. (2011). This study is limited by its narrow focus on the characteristics of customisation, bundling and range of solution offerings. Moreover, like the majority of the extant studies on servitization (Jacob and Ulaga, 2008; Kohtamäki et al., 2013b; Raddats and Kowalkowski, 2014), it is based on qualitative evidence from a small number of cases. Thus, while prior work has addressed risks in only limited ways, it does suggest that examining servitization from a risk perspective may be of value in explain the servitization paradox issue.

In sum, an integrated view of the effects of services on risks does not exist, though prior work at least hints that risk is an important factor in driving servitization failures. The scant existing research in this area is mostly qualitative or theoretical, providing fragmented and inconclusive evidence about whether services increase or decrease a firm's exposure to risks. However, considerable documentation can be found on many aspects of servitization, and this can usefully be drawn upon to formulate specific research hypotheses. In addition, other streams of literature offer various arguments that can be brought to bear in developing further contributions to theory. This material provides the foundation for the present investigation that, as previously outlined, is centred on an empirical analysis of the impact of servitization on the risks causing manufacturing firms to fail.

2.2 Environmental and internal failure risks

According to organisational theory, firms are exposed to two types of bankruptcy risks: environmental and internal (Miller, 1992). Although these two types of risk originally reflected two different schools of thought on corporate failure (Mellahi, K. and Wilkinson, 2004), scholars currently coalesce around the idea that both environmental and internal forces play a role in determining organisational outcomes, including bankruptcies.

The first type of bankruptcy failure risks, environmental risks, refers to changes affecting the business landscape of the firm (Sharma and Mahajan, 1980). Because they emanate from outside the firm, these risks are beyond the direct control of the firm's managers (Sheth and Sisodia, 2005). Change drivers can be of different natures, including technology, globalisation, regulation, capital markets, competition, and demand trends. In addition to such general level constraints, which affect all the companies that operate in the same marketplace or industry, environmental risks also include firm specific jolts like brand switching by core customers, changing attitudes of stakeholders, or unfortunate events.

The second type of failure risks, internal risks, refers to mistakes in formulating or executing a firm's strategic market plan as a consequence of decision-making characteristics of top managers (Sharma and Mahajan, 1980). Allowing the financial leverage to rise too high, falling behind competitors in production technologies, having poor or no inventory control, miscalculating cash flows, embarking on unfavourable contracts with customers or business partners might all be fatal mistakes. This category also includes internal constraints, like historical liabilities or a lack of resources, which do not allow managers to take adequate actions to deal with environmental threats. Thus, a firm will fail if its management does not have the ability to deploy an effective business strategy, no matter how viable the strategy might be.

2.3 Research hypotheses

Research on service strategies suggests that services create a counter-cyclical, recession-resistant, high-margin revenue stream that reduces cash flow volatility and improves performance (Oliva and Kallenberg, 2003; Gebauer et al., 2005). Particularly in economic downturns, servicing an installed product base over the lifecycle may compensate for declining product sales, thereby stabilizing cash flows. Moreover, existing studies suggest that services are not as susceptible to commoditisation and pricing pressures as tangible products; instead, services enable firms to maintain barriers to imitation in mature or maturing industries (Gebauer and Friedli, 2005; Mathieu, 2001a). In addition, researchers argue that the criticality of service components for the use of some tangible goods, the frequently customised nature of service activities, and their influences on switching costs create customer loyalty which, in turn, also increases customer cooperation and knowledge sharing (Fang et al., 2008; Gebauer et al., 2011). Finally, the positive value experience that services can create via customisation, bundling, and better fit of customer needs improves customer satisfaction and relationship. These value creating opportunities are central to the Service Dominant Logic (SDL), which forcefully argues that service is the fundamental basis for exchange, goods are merely distribution mechanism for service, operant resources are fundamental sources of competitive

advantage, and customers are always co-creators of value (Vargo and Lusch, 2004). As such, SDL places a high priority on understanding the customer experience over time in order to focus on benefits created for customers and the value that is exchanged with customers. Accordingly, SDL suggests that servitization provides greater intimacy and value co-creation with customers, thereby reducing a firm's exposure to environmental bankruptcy risks, such as those that may be related to economic slumps, competition, or customer behaviour.

The foregoing arguments have played a key role in persuading scholars that manufacturers should seek service-led growth. However, it can be argued that they neglect other relationships between services and environmental failure risks. First, servitization is a form of business diversification; it can thus be examined from the perspective of portfolio theory (PT). On one hand, PT argues that diversification is beneficial because, through demand pooling, it buffers the firm from market volatility (Markowitz, 1952; Cardozo et al., 1983). Yet, PT also indicates that pooling effects occur only when a new business activity (service, product or market) represents a significant diversification from existing activities. If there is significant correlation between the demands for the various firm activities, and/or if such activities do not share the same productive assets, the benefits of pooling are not realised. This is indeed the case of several at-sale services commonly offered by manufacturing firms (e.g. product financing, distribution, delivery, retailing). When firms offer such services, the portfolio perspective suggests that demand volatility can actually be amplified, causing greater uncertainty, asset underutilisation, and exposure to environmental risks.

Second, researchers emphasise the customer centricity of service markets (e.g. Kindström et al., 2013). Because they need to satisfy the unique needs, goals and practices of individual customers, services require a market-oriented service development process, which starts with a desired outcome for the customer and evolves this outcome into a corresponding service concept (Kindström et al., 2013). However, manufacturers often lack formal service development processes (Gebauer et al., 2005; Lightfoot and Gebauer, 2011; Martin and Horne, 1992). Services tend to be developed according to product-based thinking that prioritizes efficiency, scale economies and standardisation, rather than flexibility, variety and customisation (Gebauer et al., 2006; Fang et al., 2008; Kindström et al., 2013). Service innovation in manufacturing is often driven by technology push, while customer preferences are only reflected as perceptions and ideas of front-line personnel interacting in the marketplace (Martin and Horne, 1992). Consequently, the available services might not appeal to the needs or tastes of the customers, increasing the possibility that a company fails because of environmental (market) risks.

Third, implementing a service strategy leads a manufacturing firm to engage in more numerous and more varied operating theatres. This exposes the firm to a wider array of regulatory,

legal, economic, and technological issues and associated environmental failure risks. Further, providing services entails differences in competition and operations strategy. For example, it reveals the presence of unusual competitors, entails significant input from customers (Mathieu, 2001a; Fang et al., 2008; Sampson and Froehle, 2006), and often relies on business partners to provide assets, skills, market knowledge, and access to customers (Windahl and Lakemond, 2006). Such differences introduce additional environmental uncertainties that may compromise performance and drive the firm out of business.

In accordance with the background above (and in contrast with the mainstream literature), it is postulated that the negative effects of services on environmental bankruptcy risks are greater than the positive ones.

H1: *Servitized manufacturing firms (SMFs) are exposed to more environmental failure risks than non-servitized manufacturing firms (non-SMFs).*

Some scholars have proposed that the Resource-Based View (RBV) provides a useful theoretical lens for the study of operations management in the in the context of servitization (e.g. Eggert et al., 2011; Fang et al., 2008). The RBV looks inside the firm in order to identify the 'VRIN[1]' resources on which basis corporate level strategy should be formed and directed (Barney, 1991). A resource-based perspective emphasises the possibility for a firm to leverage the tangible resources (e.g. sales network, call centres, some fixed factors of operations) and intangible resources (e.g. technological knowledge, customer relationship, brand reputation) that it accrues in the product domain to develop service extensions. At a more strategic level, the RBV claims that servitizing involves exploiting connections between products and services to generate new and synergistic resource combinations. Doing so should reduce internal inefficiencies, along with associated internal bankruptcy risks.

However, several arguments cast doubt on the prospect of reduced internal risks from service infusion. The diversification literature suggests that the benefits from economies of scope in a diversified firm are only realised if the costs of internal organisation (i.e. knowhow transfer to the new applications, congestions associated with sharing common inputs) are lower than the transaction costs of using factor markets (e.g. outside service providers) (Teece, 1980; Williamson, 1975). Thus, the servitized firm needs to find organisational modes to minimize control loss problems that arise from increased sharing of common inputs. Moreover, Fang et al. (2008) introduce the concept of service relatedness to indicate the extent to which the service business

[1] Valuable, rare, inimitable, and non-substitutable

shares common knowledge and resources with the core product business. While certain service extensions (e.g. maintenance, product modification and upgrade, integrated solutions) are closely related to product knowledge and resources, others (e.g. financial, logistic services) are not. Clearly, when firms offer such unrelated services, the benefits from economies of scope will be minimal. Further, service activities, especially when unrelated, require the expansion of the firm's resource base, including, in the parlance of SDL, the acquisition or development of operant resources that are new to the firm (Kowalkowski, 2010). Therefore, adopting a service transition strategy typically entails substantial investments (Eggert et al., 2014), which, if not shared with business partners, may increase financial risks (Nordin et al., 2011) and divert resource inputs from the core product business (Eggert et al., 2014; Fang et al., 2008; Oliva et al., 2012). Additionally, Transaction Cost (TC) theory suggests that increasing levels of diversification also increase the cost of controlling the firm's broader resource base (Conner, 1991).

Firms therefore need coordination capabilities in order to manage governance and information processing needs of greater complexity. Other needs that underpin the transition to services concern the adaptation of the relevant organisational elements (e.g. corporate structure, culture, human resources, measurement systems) to the presence of the service dimension (Gebauer et al., 2010). For example, companies can deliver services through a separate business unit, or they can integrate service activities into the corresponding product unit. Existing research seems to acknowledge that there is not a generally applicable organisational structure. Rather, research suggests that each firm needs to make the appropriate choice according to the specific service strategy that it intends to pursue (Gebauer et al, 2012; Oliva et al., 2012). Similarly, at the cultural level, firms must expand their traditional product culture to include a service-related climate and culture (Gebauer and Fleisch, 2007). In particular, corporate goals, norms and beliefs need to be updated to closely embrace customer-centricity (Mathieu, 2001a; Wise and Baumgartner, 1999).

All of these increased demands are likely to increase the possibility of managerial mistakes in strategy design and implementation of new services, a risk that is compounded by the fact that manufacturing managers often lack the background and skills necessary to deal with the increased demands that they must face. For example, manufacturing managers may simply be unaware of the limitations of their existing competences, organisational structures, and processes in supporting a service-based market approach (Eggert et al., 2014). Similarly, managers are confronted with the fact that achieving initial results from service initiatives takes longer than with products, so they may underestimate the probability that implementing the necessary organisational structure and change processes will lead to the expected results (Gebauer and Fleisch, 2007). Moreover, while managerial commitment is essential to successful organisational change (Kotter, 1995),

manufacturing managers may have difficulty in committing to service initiatives, because they divert financial and managerial resources from traditional sources of competitive advantage (Gebauer et al., 2005; Gebauer and Fleisch, 2007; Oliva et al., 2012).

Based on the above arguments, it can be posited that the presence of additional internal risks for manufacturing firms that pursue service opportunities. Accordingly:

H2: *Servitized manufacturing firms (SMFs) are exposed to more internal failure risks than non-servitized manufacturing firms (non-SMFs).*

Prior research acknowledges that the services offered by manufacturing companies are far from homogeneous, indicating that service types may differ substantially in their impacts on firm performance (e.g. Eggert et al., 2011; Eggert et al., 2014; Fang et al., 2008; Johnstone et al., 2009). The previous discussion suggests that this may be relevant also to risk related performance. A review of the servitization and broader service literatures identifies a number of service classification schemes. Some of these classifications include all forms of services (e.g. Lovelock, 1983; Schmenner, 1986), while others are particular to industrial (e.g. Boyt and Harvey, 1997), product (e.g. Samli et al., 1992; Frambach et al., 1997) or consumer (Shafti et al., 2007) services, or they focus specifically on manufacturers' offerings (e.g. Mathieu, 2001b; Sawhney et al., 2004), or even on specific forms (e.g. industrial services, solutions) of such offerings (Raddats and Easingwood, 2010; Windahl and Lakemond, 2010). Although they offer a vast variety of dimensions and concepts to characterise emerging service patterns, existing service typologies provide very little theoretical guidance regarding the risk implications of different service types. The typology proposed by Boyt and Harvey (1997) is one of the rare service classification schemes that explicitly incorporate a risk dimension. However, its focus is on the risk associated with industrial service failure and its resulting impact on customer operations. In contrast, the current study is concerned with risks for the service provider.

The issue of risk is also indirectly addressed in the distinction between services supporting the product (SSP) and services supporting the customer (SSC) proposed by Mathieu (2001b). Whereby SSP tend to ensure proper product access or functioning (e.g. after-sale services), SSC help optimise customer processes, actions and strategies associated with the supplied product (e.g. financing, training, spare parts management). Compared to SSP, SSC have been associated with greater differentiating power (Eggert et al., 2011; Eggert et al., 2014; Mathieu, 2001b), customer intimacy, and level of customisation (Raddats and Kowalkowski, 2014), all of which may reduce (environmental) bankruptcy risks. Nevertheless, SSC may be more risky, as they are purported to

entail greater competition from professional service organisations (Raddats and Easingwood, 2010; Salonen, 2011), the need to acquire more service specific capabilities (Kowalkowski et al., 2009; Gremyr et al., 2010; Eggert et al., 2014), a more intense organisational change (Kowalkowski et al., 2009; Gremyr et al., 2010; Eggert et al., 2014), and a shift of responsibility to the supplier for the customer processes (Oliva and Kallenberg, 2003; Eggert et al., 2011). However, it must be noted that such properties do not apply consistently at the level of individual SSP and SSC. For example, becoming responsible for customer processes applies to SSC that entail specific forms of outsourcing (e.g. maintenance management), but it does not apply to other SSC services (e.g. financing, training, consultancy). Further, Mathieu (2001b)'s distinction is specific to product services. In contrast, manufacturers increasingly offer also stand-alone services that are completely independent from the product business (Mathieu, 2001a; Raddats and Kowalkowski, 2014).

Shafti et al. (2007) argue that the extent to which a service classification can be applied depends on the purpose to which it was initially developed. And, as discussed above, the academic research does not seem to have produced a service typology that appears relevant in a risk perspective. Thus, an exploratory approach is taken in offering the following hypothesis:

H3: *Servitized manufacturing firms (SMFs) offering different types of services are exposed to different bankruptcy risks.*

3. Methodology

3.1 Sample and data collection

The empirical data for this study came from the 212 bankrupted firms included in the overall sample described by Neely (2008). To identify this sample, Neely (2008) analysed a global sample of 10846 manufacturing firms listed in the OSIRIS database. These were all the firms in the OSIRIS database with: (i) primary or secondary US SIC codes relating to manufacturing (range 10-39 inclusive); and (ii) more than 100 employees. Using the business descriptions included in the OSIRIS database to classify firms as either "servitized" or "pure manufacturers", Neely observed that, while only 30.51% (3309) of the firms in the entire sample were servitized, 53.30% of the firms that declared bankruptcy were servitized (113 of 212 firms). He concluded that servitized firms appear more likely to declare bankruptcy than pure manufacturing firms.[2]

Evidence related to the hypotheses was evaluated by means of collecting data about the cause(s) for each of the bankruptcies. The data collection took six months to complete (from

[2] Focusing on bankruptcy likelihood as firm performance, this result can be interpreted as evidence of the servitization paradox.

October 2009 to March 2010) and relied exclusively on secondary sources, thus avoiding potential coverage errors (King and He, 2005) and biases associated with self-reported primary data. Secondary data are less likely to be influenced by self-report biases, particularly those that inquire about past events (Harris, 2001) or about attitudes that may be reconstructed to reflect positively on the respondent (Huston, 2004). In addition, because they are usually publicly available, secondary data allow for replication and validation studies (Cantalone and Vickery, 2010).

Most of the data describing the bankruptcies were collected from the Factiva database (Bureau van Dijk Electronic Publishing), which covers a wide range of business news, including newspapers, investment analysis reports and stock quotes. The use of press as source of data is liable to the criticism that news can be biased by editorial policies and journalist judgement. However, newspapers have been heavily relied upon as source of data in recent social science research. As observed by Franzosi (1987), no data source is exempt from error and "in the absence of systematic and comparative validation, there is no a priori reason to believe that data collected from newspapers would be less valid than other commonly used sources." At the same time, no alternative source of information appeared available for the information sought.

The data gathering protocol involved first a search of the Factiva database for all documents mentioning the company during a time frame of five days before and one calendar month after the date of the bankruptcy filing. Documents were reviewed in order from the oldest to the most recent publication date until data saturation occurred (Bowen, 2008), i.e. additional documents added no new information about the bankruptcies. This quite often involved progressively expanding the time frame and repeating the search, sometimes up to several months after the filing.

In order to increase the validity of the data used for the study (Lake et al., 2010), various financial news archives, answers databases and company databases were also accessed. Searches were run using each firm's name, combined with the keyword "bankrupt". The companies' websites were also checked at this stage. Although the websites usually omitted reporting the bankruptcy, they nevertheless provided useful information about the histories of the firms. Further information was extracted from narratives in annual reports in and around the year when the bankruptcy occurred.

As the data were collected, a detailed case study was written to summarize the relevant information regarding each firm and the causes of the bankruptcy.

3.2 Data cleaning and validation

The original sample consisted of 113 servitized manufacturing firms (SMFs) and 99 non-servitized manufacturing firms (non-SMFs). In order to enable comparisons between manufacturing

segments, the firms were classified according to their two-digit primary US SIC codes in the OSIRIS database. 24 SMFs and 11 non-SMFs, whose primary SIC code did not fall in the 10-39 (manufacturing) range, were eliminated from the sample. Also excluded was a pure service firm that had been mistakenly allocated a manufacturing SIC code. Information regarding bankruptcy causes was not gathered for these firms and the corresponding case studies were left uncompleted. As bankruptcy related information was sought for the other firms, 4 SMFs and 14 non-SMFs were further excluded due to a lack of information describing their bankruptcies. Additionally, the data collection effort uncovered errors in the automated process used by Neely (2008) to classify firms (i.e. search for specific keywords in the "description and history" field of the OSIRIS company record). It was determined that 17 SMFs and 12 non-SMFs had not declared bankruptcy. These firms were therefore excluded from the sample. Finally, it was found that 12 firms that the automated coding in Neely (2008) had classified as SMFs were actually non-SMFs, while 20 firms supposed to be non-SMFs were reclassified as SMFs.

In particular, the original classification of the firms as either SMFs or non-SMFs was reviewed by manually examining the 'description of the business' section of the annual report for the year when the bankruptcy occurred. If the report was not available, the 'description and history field' of the OSIRIS database was used, as this is often extracted from the annual report. The 12 core types of manufacturers' services identified by Neely (2008) (listed in Table 4) were used to determine servitization status for each firm. Firms were coded as servitized if their business descriptions provided clear evidence that they offered one or more of these service types. Such an approach was grounded on the principle that, though virtually all manufacturers offer at least some types of services (see Schmenner (2009) for a historical review), what distinguishes a servitized firm from other manufacturing firms is the relevance and strategic use of the services (Oliva and Kallenberg, 2003; Gebauer and Friedli, 2005; Gebauer, 2009). The fact that SMFs called explicit reference to service aspects in their business descriptions strongly suggests that the services were core to their businesses. In contrast, while non-SMFs might have offered some levels of service, such services were not likely to be strategically important, on the grounds that they were not mentioned in annual reports. Appendix A provides illustrative examples of firms classified as SMFs and non-SMFs.

Given the corrections and exclusions noted above, the final sample for the study consisted of 75 SMFs and 54 non-SMFs. Table 1 provides descriptive statistics for the sample, demonstrating a variety of firm sizes and industries for both SMFs and non-SMFs. Clearly, the sample was broad and diverse enough to enable identification of servitization as a major difference between firms, whereas such a distinction might not have been as easily made using other research designs.

< Insert table 1 here>

One important question about the sample is whether firms chose to servitize because of prior financial problems. Some firms could, for example, have seen servitization as a potential solution to financial distress, but this would mean that firms choosing to servitize were already prone to bankruptcy and hence the servitization would not be an important factor in differentiating between the two sets of firms. To explore this potential source of bias, the financial performance of the SMFs prior to servitization was compared to their industry averages. The year of initial servitization was determined for each SMF by examining the annual reports in the Capital IQ database. For 34 firms, the Capital IQ database did not provide annual reports old enough to allow establishing the initial year of servitization. However, it could be established that 18 of these firms were servitized for at least five years before their bankruptcies and that 14 of the remaining 41 firms were servitized at their foundation, suggesting they decided to servitize well before threats of bankruptcy emerged. The initial year of servitization could be determined for the last 27 firms. The ROA and ROE of these firms in the year immediately prior to their servitization were compared with the average ROA and ROE for all firms in the same three-digit SIC industry classification, using data from the Compustat database. Data were not available for three of these firms in Compustat. For the remaining 24 firms, 13 firms had nominally better pre-servitization ROE than their industry peers, and 11 firms had nominally better ROA. Statistical tests comparing these 24 SMFs with their industry averages showed no significant differences for either mean or median values of ROA or ROE in the year prior to servitization. Collectively, these results suggest that poor prior performance was not a consistent reason why SMFs initially servitized.

3.3 Research instrument development

A framework of the causes of bankruptcy proposed by Ooghe and Waeyaert (2004) was used to develop a coding instrument (codebook) for examining the risks that led each of the sample firms to fail. The Ooghe and Waeyaert (2004) framework was particularly useful, for several reasons. First, the framework has been previously applied in empirical studies (Novak and Sajter, 2007; Ooghe and De Prijcker, 2008). Second, unlike other models for analysing failure, the Ooghe and Waeyaert (2004) framework specifically regards the causes of bankruptcy. Third, it proposes a wider range of potential failure causes than other frameworks. Finally, it allows investigation of bankruptcy at a level of analysis consistent with the data collected in this study, specifically, qualitative data regarding the firms and their bankruptcies.

In line with other studies of corporate collapse (e.g. Sharma and Mahajan, 1980; Mellahi and Wilkinson, 2004; Sheth and Sisodia, 2005), the Ooghe and Waeyaert (2004) framework structures

the potential causes of business failure under the headings of environmental and internal risks. Specifically, the framework identifies two categories of environmental risks: (i) general environment and (ii) immediate environment (see Table 2). The general environment category includes factors that are common to all the firms in a given industry: economics, technology, foreign countries, politics and social factors. In contrast, the immediate environment comprises factors that are specific to the business context of the individual firm: customers, suppliers, competitors, banks and credit institutions, stockholders and misadventure.

Internal failure risks are outlined in the Ooghe and Waeyaert (2004) framework as belonging to three categories: (i) management abilities, (ii) corporate policy, and (iii) company characteristics. Management abilities include: motivations, qualities, skills and personal characteristics. The corporate policy category refers to strategy and investments, commercial, operational, finance and administration, and corporate governance. Finally, the company characteristics category includes the company's maturity, size, industry and flexibility.

In order to assign risk types to each of the company bankruptcies, the case studies prepared for the first 50 SMFs in the list identified by Neely (2008) were initially examined. Typically the case studies identified a combination of factors underlying each firm's bankruptcy. In the first round of analysis, the specific factors were identified and then these were grouped into generic factors describing the causes of bankruptcy. Formal definitions for each of these generic factors were produced and combined to create a codebook used for subsequent coding. A shortcoming of the original Ooghe and Waeyaert (2004) framework is that it does not provide an explicit list of the factors within each of the main categories it discusses. Hence the empirical data were used to enrich the original Ooghe and Waeyaert (2004) framework. During this process, the definitions of the individual factors causing bankruptcy were repeatedly revised to avoid ambiguity and overlap.

Not all of the risk factors included in the original Ooghe and Waeyaert framework were present in the company case histories. However, each and every one of the risk factors identified in the case histories did correspond to one of the factors identified in the framework; i.e., no new risk factors were uncovered. Both these results suggest that the original framework was sufficiently comprehensive.

Notably, the data sources did not provide information regarding "management abilities" category in the original framework. While this is a limitation of the study, the coding method does at least assess management abilities indirectly, through their impacts on mistakes in corporate policy (Ooghe and De Prijcker, 2008). Management abilities are the main antecedents of decisions regarding corporate policy, and the actual causes of bankruptcy are these decisions. Therefore,

though the codebook neglects management abilities, it captures corporate policy risk factors, consistent with a focus on the immediate causes of bankruptcy.

Once the codebook had been developed, the remaining case studies in the sample were examined. This second phase resulted in slight refinements to the codebook, as a few new factors emerged and a few discrepancies with previously identified factors originated. However, no significant modifications to the codebook were introduced after the first 80 firms in the sample were analyzed; this suggests that theoretical saturation had been reached, i.e. analyzing additional firms would not have led to further changes to the codebook (Miles and Huberman, 1994). Appendix B provides a copy of the final codebook used; it defines 35 factors that can result in bankruptcy.

3.4 Data analysis

The data analysis procedure followed the content analysis technique formulated by Berelson (1952). This technique uses pre-established procedures and rules of coding to systematically classify textual/qualitative material according to purposively selected content categories. The content analytic approach is argued as a scientific approach for extracting both manifest and latent communication contents, describing specific phenomena and making inferences about constructs of interest (Weber, 1990). It also allows qualitative data to be converted into a quantitative form, so that appropriate statistical analyses can be performed to enhance the validity of findings. Content analysis is a well regarded methodology in social science research and its use in this study is supported by recent operations and supply chain management literature - see, for example, Montabon et al. (2007); Tate et al. (2010); Tangpong (2011); Hofer et al. (2012).

The approach used was modelled on Montabon et al. (2007) and closely followed guidelines in Tangpong (2011). The 35 factors in the contained in the codebook served as content categories to frame the coding of data. The recoding unit was identified as the "idea(s)" (Tangpong, 2011) regarding the causes of bankruptcy found in the case study documents developed for the firms. The use of a large recording unit was based on ensuring semantic validity of the coding (Tangpong, 2011), given that the same factor could have been worded in many different ways in the documents. Extended descriptions of the framework factors were developed in order to provide the coders with specific instructions for recognising these factors in the text (Appendix B).

The content analysis was performed by two independent coders and was executed over a period of three weeks. A member of the research team served as the first coder, thus assuring that the coder was familiar with the coding process (Milner and Adler, 1999). In order to validate coding reliability, an independent experienced researcher was recruited as the second coder. Following the example of Hofer et al. (2012), to minimize bias, the research objectives were not discussed in the

training session given to the second coder. Both coders examined all the firms in the sample and completed a coding sheet for each firm according to the definitions provided for the coding factors (Appendix B). The second coder was asked to re-examine the first few firms a second time, after he analysed all the 129 sample firms.

The coding results showed a percentage of agreement of 96.21% between the two coders. Importantly, reliabilities for the two coders exceeded recommended minimums. Overall reliability across the two initial sets of codes was 0.775, as measured by Krippendorff's alpha (Krippendorff, 2004a). Calculated separately for the data sets of SMFs and non-SMFs (Krippendorff, 2004b), reliability was 0.774 and 0.777, respectively. Among categories of risks, the lowest reliability was obtained for the corporate policy category (0.734), still well within the levels typically considered appropriate (Krippendorff, 2004b). In addition, the second coder reported no substantive problems in capturing the reported causes of failure through the framework. Based on these results, the information provided by the content analysis was deemed to be a valid measure of the constructs of interest (Tangpong, 2011).

After the coding was completed, the few discrepancies that remained were discussed until the two coders reached agreement. Appendix C shows how the framework factors were applied to the coding of the example firms in Appendix A.

Group and paired *t*-tests were used to analyse the research hypotheses. Sample matching and ANCOVA were also performed to ensure that the results were not due to differences between SMFs and non-SMFs other than their differences in servitization. Finally, cluster analysis was employed to classify SMFs' service offerings for the exploration of H3.

4. Results

Table 2 illustrates the impacts of the risk factors in the coding framework, showing the frequency of each factor's occurrence in contributing to bankruptcies of the SMFs and non-SMFs in the study sample. For both SMFs and non-SMFs, the most common environmental causes of failure were economic downturn and industry recession - followed by competition from foreign countries, increased price of raw materials and energy, failure of core customers (especially for SMFs). Environmental risks were concentrated on these five factors. Internal operating risks were more widely spread. Except for cost of expansion through acquisitions for SMFs, none of the risk factors significantly outweighed others. SMFs were affected on average by 3.65 risk factors, while non-SMFs were affected on average by 2.87 risk factors. A group *t*-test indicated that this difference in mean numbers of risks is statistically significant at p=0.001.

< Insert tables 2 and 3 here>

For conceptual clarity, it is should be stressed that this result does not demonstrate that servitization (or lack thereof) caused bankruptcy. Instead, it shows that bankrupted firms who had servitized were exposed to more risks than bankrupted firms who had not servitized. It is worth re-iterating that this study does not compare bankrupted firms against non-bankrupted firms. Instead, it makes use of risk profiles available in data generated for bankrupt firms.

Hypotheses H1 and H2 posit that SMFs are more exposed to environmental and internal bankruptcy risk factors, respectively. The results of group *t*-tests presented in Table 3 provides no support for H1. However, the results provide strong support for H2; SMFs appear to be more exposed to internal risks than non-SMFs are ($p<0.0005$). In order to explore these effects further, similar *t*-test comparisons were conducted for the four risk sub-categories identified in the proposed risk categorization framework. The results in Panel B of Table 3 confirm that risk counts in the general and immediate environmental risks sub-categories do not differ across SMFs and non-SMFs. The results further indicate that both sub-categories of internal risks differ significantly across the two types of firms; the statistical significance of these differences are $p=0.03$ and $p<0.0005$, respectively.

There were no indications of differences in industry membership or firm size across the sub-samples of SMFs and non-SMFs. However, to control for the possibility that differences in risk factors between SMFs and non-SMFs are artefacts of other factors such as the nature of the products offered, size of the firm, and timeframe of the bankruptcy, risk differences were evaluated among matched pairs of SMFs and non-SMFs. Firms were paired on the following criteria: they were within a ratio of +/- 20 in number of employees, they had gone bankrupt within the same two-year period, they were headquartered in the same country, and they were members of the same two-digit SIC industry classification. Using these criteria, 27 matched pairs were constructed. Tightening the criteria further produced a substantial reduction in sample size.

Panel C of Table 3 repeats the analyses using the 27 industry-size-year matched pair firms identified above. The results confirm support for H2 and lack of support for H1.

Finally, the possibility was considered that firm age might also confound the results, as SMFs were on average significantly younger (33.4 years old) at the time of bankruptcy than non-SMFs (51.9 years old). To control for this possibility, an ANCOVA was executed with the total number of risks as dependent variable, and including both firm size (employees) and age at bankruptcy as covariates. The ANCOVA results confirmed that SMFs had significantly more internal risk factors than non-SMFs, with no significant differences in external risk factors, while controlling for age and size factors.

Hypothesis H3 posits that different service types are associated with different risks leading to bankruptcy. As previously contended, the literature does not provide a categorisation of service offerings (and ultimately services) that appears appropriate to this study. Consequently, cluster analysis was used to establish servitization types. Cluster analysis is an inductive method of classification, centred on grouping items (here firms) based on some measurement of proximity among such items (Saunders, 1994). The cluster analysis was performed using the two-stage procedure in SPSSV.18, with service type codings as criteria. The procedure with default settings automatically selects the optimum number of clusters according to the specified distance measure (log-likelihood) and assigns observations to clusters using a clustering criterion (Schwarz's Bayesian Criterion). The analysis yielded two servitization groups; one group containing 38 firms, the other containing 37 firms. Repeated analyses using different distance and clustering criteria yielded identical results. In addition, the analyses were repeated five times with random hold-out samples of 10%. The results from all five runs were nearly identical. In only one run, two observations were assigned to a different cluster. These results indicate that the cluster solution is robust to both clustering method and sampling issues. Appendix D shows examples of firms in each of the two servitization groups.

Table 4 shows the number of firms in each group that offers each service type. Chi-square tests indicate that firms in group one, which were named "Demand Chain Services" were significantly more likely to offer both retail and distribution services, as well as financial services. Firms in group 2, which were named "Product Support Services" were significantly more likely to offer more product-centric services including systems and solutions, installation and implementation, and maintenance and support services.

< Insert table 4 here>

In order to investigate evidence in support of H3, ANOVA was conducted for numbers of risk types, with post hoc comparisons across three groups: demand chain SMFs, product support SMFs and non-SMFs. Table 5 provides the results of comparisons for total bankruptcy risks, and for the risk sub-classes identified earlier. The results again indicate that firms in both of the SMFs groups incur more total risks than firms in the non-SMFs group do. However, the total number of risks does not differ significantly across the two servitization strategy groups.

< Insert table 5 here>

As Table 5 shows, a significant difference between numbers of environmental bankruptcy risks for demand chain and product support SMFs provides support for H3 ($p<0.05$). Further, the results indicate that the demand chain SMFs encountered more general environment bankruptcy risks than product support SMFs did, though this difference is only marginally significant ($p=0.07$).

Interestingly, the results also indicate that demand chain SMFs encountered more total environmental bankruptcy risks than non-SMFs did, thus amending the findings pertaining to H1. Again, this difference is marginally significant (p=0.06); thus, conclusions associated with these findings must be regarded as tentative.

Results in the lower half of Table 5 confirm that firms in both servitization strategy groups encounter more internal bankruptcy risks than non-SMFs firms do. Significant differences exist for both corporate policy risks and for corporate characteristics risks. However, the number of internal risks does not differ across the two servitization strategy groups; thus H3 is not supported at this level of analysis.

In summary, the results indicate that SMFs do incur significantly more bankruptcy risk types than non-SMFs; the key difference is in numbers of internal risks. However, demand chain SMFs also have more total environmental risks than non-SMFs do. And they appear to encounter more general environmental risks than product support SMFs do.

5. Discussion

5.1 Theoretical contribution

This study sought to assess the relationship between a manufacturing firm's servitization and its exposure to bankruptcy risks, and in particular the influence on this relationship of the type of services offered by the firm. The findings show that the presence of a service business increases bankruptcy risks for the supplying firm. The overall findings evidence no significant impact on environmental bankruptcy risks, but significantly higher internal bankruptcy risks. However, when differentiating firms according to the types of services they offer, the findings highlight that servitized manufacturing firms (SMFs) offering demand chain services (i.e. retail and distribution, financial services) are also exposed to greater environmental risks. In contrast, the findings identify that SMFs offering product support services (i.e. systems and solutions, installation and implementation, maintenance and support) encounter significantly less general environmental risks than demand chain SMFs, although still not less environmental risks than non-SMFs.

These results make several contributions to servitization research, general management and bankruptcy literatures. They provide empirical evidence of the impact of servitization on organisational (bankruptcy) risk. Prior studies have contended that the introduction of services may modify the risks faced by a manufacturing firm, but have not provided detailed insight into the servitization-risk relationship. This study responds to calls for more detailed insights (Fang et al., 2008; Nordin et al., 2011) and for empirical evidence from quantitative studies on services (Jacob and Ulaga, 2008; Gebauer et al., 2012). In addition, the study extends the conversation on the

servitization paradox, as increased risks may partially explain why manufacturing firms can fail to achieve the performance they expect through service provision.

This study distinguishes between environmental and internal bankruptcy risks. By suggesting that services enable manufacturing firms to secure their market position and achieve customer-centric value, the mainstream servitization literature and SDL generate the expectation of lower environmental risks under servitization. The findings of this research challenge such an expectation, indicating that service offerings do not reduce environmental bankruptcy risks. As noted, this may result from a more complex interaction between the firm and the business environment. The offering of services may expose the firm to greater demand volatility, to different customer needs, to the uncertainties of a wider range of operating theatres and, thus, also to greater environmental bankruptcy risks. The data examined in this study do not show that environmental bankruptcy risks increase or decrease, the findings instead suggest that the positive and negative effects of services on these risks may cancel each other out.

This study does find that the presence of a service business increases a firm's internal bankruptcy risks. This is consistent with transaction cost theory, as service diversification is likely to increase the cost of internal organisation and control, with economies of scope arguments underscoring that some service extensions involve operant resources that are new to the firm, and with the notion that successful service deployment requires structural changes in the arrangement of organisational design factors. Most importantly, dealing with these internal challenges requires managerial attitudes and approaches that may not be straightforward for a company with an historical focus on goods. The findings of the present research complement the existing servitization literature by suggesting that few firms are able to easily and quickly cope with the internal challenges of deploying a service strategy, and few managers are competent in controlling the attendant risk consequences.

This study responds to calls from scholars for studies that adopt a more fine-grained view of services when researching their impact on manufacturing firms' performance (Eggert et al., 2011; Eggert et al., 2014; Fang et al., 2008). The study finds that demand chain services and product support services present significant differences with respect to the servitization-risks connection, thereby providing evidence on the heterogeneity of manufacturers' service offerings. The evidence of greater impact of environmental risks on demand chain SMFs provides empirical support for portfolio theory which, as noted in the formulation of H1, indicates that risk pooling effects are not realised if the various firm's activities exhibit highly correlated demands and do not share the same productive assets. Indeed, because demand chain services are only sold with new product units, their demand is highly correlated with volatility in the product market. By contrast, revenues from

product support services (and maintenance contracts in particular) are often counter-cyclical to product sales and therefore more resistant to economic cycles that drive capital investment (Neely, 2008; Eggert et al., 2014). Demand chain services tend also to be unrelated to the firm's existing resource base. Their resource requirements, essentially assets such as distribution facilities or stores, are highly service specific, while product support services have better chances to exploit manufacturing core resources. Therefore, the results suggest that pooling effects may be a key mechanism to contrast the increase of environmental failure risks for firms that diversify into services. This in turn indicates that the perspective of diversification research can be directly relevant to the examination of manufacturers' service strategies, supporting the call of Gebauer et al. (2012) for a greater use of general management theories in servitization research.

The results also prompt a more speculative comment regarding the use of the RBV perspective to study the practicalities of service transition. It was noted (H2) that the RBV perspective would suggest lower internal risks for product support services because of greater synergies with the product business (Fang et al., 2008), whereas no significant differences were found between types of service offerings at the level of internal bankruptcy risks. The RBV emphasis is on how firms can leverage existing resources and capabilities to provide services. Product support services enable greater spillovers. However, especially when they are aimed at supporting complex technical assets over the lifecycle, product support services also require the implementation and management of a broad set of service-related resources and capabilities. In contrast, demand chain services tend to be focused on few types of assets and competences. According to the findings of the present study, this characteristic of demand chain services may counterbalance the reduced opportunities of spillovers by downsizing the overall internal organisational challenge. Therefore, it can be contended that the RBV should not be applied in isolation to examining the risks of services; the amount of resources and capabilities that are involved with service provision is also a central issue to uncover the differential risk effects of service types.

Managerial contribution

To defend their market position and grow their profits, many manufacturing firms are upgrading their offerings with services. However, the results of this study suggest that service extensions lead to increased bankruptcy risks for the firm, highlighting the importance for managers to be aware that the risks of service strategies may outweigh the benefits. While they indicate that manufacturing managers cannot just adhere to calls to adopt SDL, these results should not be interpreted as a suggestion to avoid service strategies. According to such results, internal risks are

more salient. Hence, management abilities appear to have significant potential for controlling the risk consequences of service transitions.

This study highlights that the type of service offering has an influence on the relationship between services and bankruptcy risks. Because they require limited technical knowhow, demand chain services are attractive for manufacturing firms in search of new revenue opportunities. However, building on the results of this study, managers should consider that such services amplify uncertainties and risks associated with the product business.

Limitations and future research directions

The limitations of this study provide other opportunities for future research. First, the investigation focused on data associated with bankruptcy filings. Bankruptcy is the most extreme form of organizational failure; it therefore invites thorough analysis by business writers and analysts, thereby providing a source of rich secondary data. Future research would do well to study a much broader set of low performing SMFs, though obtaining data comparable to the data used in this study may prove to be quite difficult. Second, the bankruptcy risk factors examined in this study reflect variables identified in previous studies of corporate performance outcomes. However, studies of related factors, especially those relating to the strengths and weaknesses of internal managers, would be useful. Third, this study controlled for contextual factors including firm age, size, location, and industry. However, other factors such as product business diversification, market position, existing capabilities, and readiness to change of the firm might be important moderators of the servitization-risk relationship. Fourth, the data used in this study do not enable a thorough investigation of whether it is the transition process or the nature of the service offering that causes servitized firms to be exposed to more bankruptcy risks. Although it is likely that both aspects have a role and that their relative importance depends on the type of services, studies that explicitly and fully address such question would be valuable. Finally, although the conclusions of this study fall short of providing a complete resolution of the servitization paradox, they are suggestive of some of the particular challenges to servitization that tend to offset the strategy's purported benefits. Such conclusions are based on bankruptcy data and the analysis of a number of risk factors associated with bankruptcy exposure. In order to advance research further, there is real need of a more comprehensive definition, measurement and comparison of the risks that a manufacturer incurs when it chooses to move away from its traditional manufacturing focus.

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Appendix A – Examples of firms' classifications

Non-SMFs

Firm	Business description	Source
Delta Woodside Industries, Inc.	"The Company produces woven textile fabrics through its Delta Mills operation. Delta Mills is the only business segment of the Company. The Company currently manufactures woven textile fabrics from cotton yarn, wool, flax or synthetic fibers or from synthetic filament yarns... The Company believes that it is a leading producer of cotton pants- weight woven fabric used in the manufacture of casual slacks such as Levi Strauss' Dockers(R) and Haggar Corp.'s Wrinkle- free(R). Other apparel items manufactured with the Company's fabrics include women's chino pants, and career apparel (uniforms). The Company also sells camouflage fabric and other fabrics to apparel manufacturers for their use in manufacturing apparel for the United States Department of Defense."	2005 Annual Report

SMFs

Firm	Business description	Source	Services offered
Daw Technologies, Inc.	"Daw Technologies, Inc. is a global supplier of ultra- clean manufacturing environments, or cleanrooms, primarily to microelectronics manufacturers, but also to customers in the pharmaceutical, biotechnology and food processing industries... In addition to selling cleanroom design and installation services, and cleanroom component products, on a stand alone basis, the Company is one of only a handful of companies worldwide that offers a fully integrated, or turnkey, approach to cleanroom design and installation... In contrast to the traditional approach, the Company believes that its integrated cleanroom approach can provide customers with greater flexibility and project control by reducing the number of vendors, subcontractors and suppliers and simplifying coordination of the project... Specifically, the Company provides, either separately or as part of an integrated package, architectural engineering and design, manufacturing, installation, construction, project management, testing, certification, tool fit- up, and continuing on- site service and support for cleanrooms. The Company also designs, engineers, manufactures, and services certain principal component systems for advanced cleanrooms. The Company also designs, engineers and manufactures environmentally controlled mini- environments, primarily for use in the microelectronics, pharmaceutical and biotechnology industries..."	2002 Annual Report	Design and Development services Installation and Implementation services Maintenance and Support services

Appendix B. Definitions of the risk codebook factors

GENERAL ENVIRONMENT

Economics

1. *General economic downturn*: Extended decline in general economic activity affecting the regional, national or global economy.
2. *Recession in the industry*: Depressed market conditions in the firm's industry. Typically demand shortfall causing profit margins in the sector to be strongly reduced. Could also refer to negative cycles affecting the customers' industries.
3. *Industry overcapacity*: Excess production capacity in the firm's industry. Typically due to saturation of the market, increased capacity of the firms in the industry, or intense competition from new companies entering the market.
4. *Increased price of raw materials and energy*: escalation in material and/or energy costs.
5. *Changes in currency exchange rates*: currency depreciation or appreciation. These use to respectively inflate foreign debt and hit sales.

Technology

6. *Technological advance*: Introduction of new product or service technology. Transition of the industry sector to next-generation technologies.

Foreign countries

7. *Competition from foreign countries*: Entry onto the market of foreign producers. Increase in competition from foreign producers, typically price-based competition from cheap imports.

8. *Problems with projects abroad*: Increase in labour and other production costs in foreign countries. Political changes in foreign countries. Typically affecting production activities at foreign plants.

Politics

9. *Impact of regulations*: Regulatory obstacles. These might include, for example, labour agreements not allowing to shed employees, regulations affecting product or service markets, as well as limitations imposed to the use of products or services by customers.

Social factors

10. *Compensation payments following litigations*: Liabilities for damages to people. Environmental liabilities.

IMMEDIATE ENVIRONMENT

Customers

11. *Failure or decreased spending of key customers*: Bankruptcy of major customers causing these to shut down activities. Troubles facing major customers and weakening demand for the company's products or services. For companies having mainly governmental customers, this could also include cut of public spending.
12. *Switching of key customers to competitors*: Expiring of key contracts without chances of renewal. Loss of orders from key customers.
13. *Shift in customer taste*: Changes in customer demand patterns resulting in decreasing market for the company's products or services. Also failure to adapt products or services to shifts in market demand.
14. *Lack of customer interest for new products or services*: Inability to make new products/services pay because of less than expected customer interest.
15. *Loss of reputation*: Any cause of damage to the public image of the company. Emergence of issues like poor product quality, delivery inefficiencies, frauds, etc. Also lawsuits and allegations. Typically leading to sale losses.

Banks and credit institutions

16. *Tightening of lending conditions*: Company's lenders imposing harsher financial burdens and/or restrictions to additional borrowing.
17. *Exceptional and unforeseeable events*: Natural disasters (e.g. hurricanes, floods, fires) that hit company's facilities or its markets.

CORPORATE POLICY

Strategy and investment

18. *Inability to restructure*: Failure to restructure operations. Typically in conjunction with the need to upgrade equipment, modernise operations and/or move production abroad in order to reduce production costs. Could also be related to the need of downsizing operations. Inability includes inability to attract the necessary capital, managerial inertia to change, as well as problems in implementing the restructuring plan.
19. *Excessive time to market for new products or services*: New products or services not being available on the market when planned.
20. *High cost of introducing new products or services*: Investment of substantial resources in new products/services or in renewing existing ones. Especially R&D costs but also marketing, advertising and other expenses. This could also include the cost of developing/acquiring the technical capability to offer new services.
21. *Excessive restructuring charges*: Investments to improve the cost structure of the company (e.g. technology upgrades). Cost of resizing operations, to either expand or scale down production.
22. *Cost of expansion through acquisitions*: Investments in acquisitions, made to grow and/or diversify the company. This could include the expansion of manufacturing or service production capacity, the broadening of product or service lines, the extension of geographical reach.
23. *Changes of ownership*: Cost incurred when spinning off from other companies or going public. Also liabilities taken over when spinning off from or merging with other companies.

Commercial policy

24. *Lack of proper merchandising for products or services*: Marketing mistakes, like poor or expensive advertising strategy, ineffective communication with the customers, wrong channels to market.
25. *Unfavourable contracts with customers*: Contracts that accrued larger expenses than the company had planned. Penalties due to late completion of projects.

Operational policy

26. *Operational inefficiencies*: Inability to run operations in an efficient manner. High cost of operations compared to competitors.
27. *Excess inventory*: Poor inventory management practices resulting in the product being overstocked along the supply chain.
28. *Failure in integrating acquisitions*: Inefficiencies/costs resulting from the attempted integration of newly acquired facilities with existing ones.
29. *Problems with business partners*: Termination of agreements with business partners. Unprofitable agreements with business partners. Legal disputes with business partners.

Personnel

30. *Non competitive wage and benefit levels*: High salaries and bonuses paid to managers and workforce.

Finance and administration

31. *Accounting errors*: Improper recording of financial data, resulting in the revision of previously issued financial statements. Also possibly accompanied by shareholder lawsuits.
32. *Speculation and illegal actions by executives:* Malpractices and frauds committed by the company's executives. Also failure to recognise and avoid frauds.

COMPANY'S CHARACTERISTICS

Size
33. *Insufficient resources and reputation to keep up with competitors*: Inability to face the competition from larger rivals that might have operated longer, have better name recognition, more established business relationships, and greater financial, marketing, technical and other resources than the company.

Industry
34. *Labour legacy liabilities*: High personnel costs. Also cost of providing pensions, healthcare, and other benefits to retired workers.

Flexibility
35. *Inability to reduce costs when production decreases*: Operations becoming inefficient when the company scaled down production. Typically related to the inability to shut off overheads.

Appendix C. Examples of coding

Non-SMFs

Firm	Text in case study document	Relevant bankruptcy causes*
Delta Woodside Industries, Inc.	The company's financial troubles were primarily due to the unanticipated success of foreign imports, primarily from China, and the high level of overcapacity in the domestic textile industry. Like many US textile manufacturers, Delta was forced to make aggressive cost cuts and close down numerous textile plants. It had to engage into a comprehensive reorganization strategy that resulted in high restructuring expenditures. The company suffered its final blow when the US Defence Department reduced its orders from apparel manufacturers that used Delta's fabrics, since this segment was a primary source for the entire Delta's profit margin. Also contributing to the failure were continued high energy costs which increased production costs as well as increased costs of yarn and greige fabric.	3. Industry overcapacity 4. Increased price of raw materials and energy 7. Competition from foreign countries 11. Failure or decreasing spending of key customers 21. Excessive restructuring charges

* after agreement between coders

SMFs

Firm	Text in case study document	Relevant bankruptcy causes*
Daw Technologies, Inc.	Daw blamed its misfortune on the dramatic downturn that affected the semiconductor industry since 2000, as well as the general economic slowdown. The company had largely expanded during the '90s and built some of the biggest fabrication labs in the world. These huge manufacturing facilities became a liability when the semiconductor industry went into downturn. In fact, the company did not manage to shut overheads of its manufacturing operations off enough when demand decreased. Daw decided to change its business model and rely on other firms to handle its manufacturing. It also sold its mini-environments segments in order to concentrate on more profitable segments. This was not enough. In addition, a few contracts in Europe accrued larger expenses than the company initially targeted. The company also underwent financial woes because accounting errors with its European operations missed about $10 million in losses from these contracts – in April 2002 Daw was forced to make financial restatements. Finally, the company suffered from internal inefficiencies, primarily related to high salaries paid to middle managers.	1. General economic downturn 2. Recession in the industry 22. Cost of expansion through acquisitions 25. Unfavourable contracts with customers 30. Non competitive wage and benefit levels 31. Accounting errors 35. Inability to reduce costs when production decreases

* after agreement between coders

Appendix D – Examples of servitization groups

Demand chain SMFs

Firm	Business description	Source	Services offered
Oakwood Homes Corp.	"Oakwood Homes Corporation… designs, manufactures, markets and distributes manufactured and modular homes and finances the majority of its retail sales. Prior to November 1, 2002, the Company also provided a variety of insurance products to its customers and assumed a portion of the related underwriting risk through its captive reinsurance business... At September 30, 2002, the Company's manufactured homes were sold at retail through 224 Company owned and operated sales centers located primarily in the southeastern and southwestern United States and to approximately 600 independent retailers located throughout the United States."	2002 Annual Report	Retail and distribution services Financial services

Product support SMFs

Firm	Business description	Source	Services offered
Silicon Graphics	"SGI is a leading provider of products and services for use in high- performance computing and data management. We sell solutions based on a complete range of scalable servers and storage products… Our service portfolio offers system solution engineering services, professional and managed services, and traditional customer support and education. SGI Professional Services is a total solution provider…We design solutions to help our customers achieve their technology and business goals and overcome their greatest challenges…. SGI Managed Services include… hardware installation, system deployment, implementation, and on- site and remote system management. SGI Support Services… include hardware and software support...."	2006 Annual Report	Systems and solutions Installation and Implementation services Maintenance and Support services

Table 1 – Description of the sample

Industry sector (SIC code)	Description	# non-SMFs	%	# SMFs	%
10	Metal mining	1	2%	0	0%
13	Oil and gas extraction	0	0%	1	1%
14	Mining and quarrying of non-metallic minerals, except fuels	1	2%	1	1%
15	Building construction, general contractors and operative builders	2	4%	1	1%
16	Heavy construction, other than building construction contractors	0	0%	2	3%
17	Construction, special trade constructors	0	0%	2	3%
20	Food and kindred products	1	2%	2	3%
22	Textile mill products	6	11%	4	5%
23	Apparel and other finished products made from fabric and similar material	2	4%	3	4%
24	Lumber and wood products, except furniture	0	0%	3	4%
25	Furniture and fixtures	1	2%	0	0%
26	Paper and allied products	1	2%	1	1%
27	Printing, publishing and allied industries	2	4%	0	0%
28	Chemicals and allied products	4	7%	2	3%
29	Petroleum refining and related industries	2	4%	0	0%
30	Rubber and miscellaneous plastic products	5	9%	1	1%
31	Leather and leather products	0	0%	1	1%
32	Stone, clay, glass and concrete products	0	0%	2	3%
33	Primary metal industries	8	15%	6	8%
34	Fabricated metal products, except machinery and transportation equipment	2	4%	4	5%
35	Industrial and commercial machinery and computer equipment	3	6%	13	17%
36	Electronic and other electrical equipment and components, except computer equipment	5	9%	15	20%
37	Transportation equipment	6	11%	4	5%
38	Measuring, analysing and controlling instruments; photographic, medical and optical goods; watches and clocks	1	2%	4	5%
39	Miscellaneous manufacturing industries	1	2%	3	4%
	Total	54	100%	75	100%

		# firms	Mean	Std. Dev.
Firm size (#employees)	Non-SMFs	54	2329.67	4008.70
	SMFs	75	6544.97	22142.63
Profit margin* (%)	Non-SMFs	44	-23.27	98.39
	SMFs	66	-11.58	29.59
Stock turnover* (times/year)	Non-SMFs	44	8.62	6.73
	SMFs	64	13.21	23.84

* based on 1999 data

Table 2 – Impact of the framework factors by firm category

	Risk Factors	Entire Sample				Servitized Sample Only			
		# SMFs	%	# non-SMFs	%	# demand chain SMFs	%	# product support SMFs	%
ENVIRONMENTAL RISKS	**GENERAL ENVIRONMENT**								
	1. General economic downturn	22	29%	18	33%	10	26%	12	32%
	2. Recession in the industry	34	45%	16	30%	17	48%	17	46%
	3. Industry overcapacity	9	12%	2	4%	6	16%	3	8%
	4. Increased price of raw materials and energy	14	19%	8	15%	11	29%	3	8%
	5. Changes in currency exchange rates	0	0%	4	7%	0	0%	0	0%
	6. Technological advance	1	1%	4	7%	0	0%	1	3%
	7. Competition from foreign countries	12	16%	14	26%	11	29%	1	3%
	8. Problems with projects abroad	1	1%	1	2%	0	0%	1	3%
	9. Impact of regulations	2	3%	1	2%	1	3%	1	3%
	10. Compensation payments following litigations	1	1%	2	4%	1	3%	0	0%
	IMMEDIATE ENVIRONMENT								
	11. Failure or decreased spending of core customers	11	15%	6	11%	5	13%	6	16%
	12. Switching of key customers to competitors	6	8%	3	7%	2	5%	4	11%
	13. Shift in customer taste	8	11%	3	7%	6	16%	2	5%
	14. Lack of customer interest for new products or services	6	8%	4	7%	1	3%	5	13%
	15. Loss of reputation	6	8%	3	6%	5	13%	1	3%
	16. Tightening of lending conditions	3	4%	1	2%	3	8%	0	0%
	17. Exceptional and unforeseeable events	5	7%	2	4%	2	5%	3	8%
INTERNAL OPERATING RISKS	**CORPORATE POLICY**								
	18. Inability to restructure	11	15%	9	17%	8	21%	3	8%
	19. Excessive time to market for new products or services	8	11%	0	0%	3	8%	5	13%
	20. High cost of introducing new products or services	9	12%	5	9%	1	3%	8	21%
	21. Excessive restructuring charges	4	5%	4	7%	4	11%	0	0%
	22. Cost of expansion through acquisitions	28	37%	11	20%	10	26%	18	49%
	23. Changes of ownership	4	5%	0	0%	4	11%	0	0%
	24. Lack of proper merchandising for products or services	3	4%	3	6%	2	5%	1	3%
	25. Unfavourable contracts with customers	4	5%	2	4%	2	5%	2	5%
	26. Operational inefficiencies	11	15%	9	17%	7	18%	4	11%
	27. Excess inventory	3	4%	3	6%	1	3%	2	5%
	28. Failure in integrating acquisitions	5	7%	4	7%	1	3%	4	11%
	29. Problems with business partners	6	8%	2	4%	1	3%	5	13%
	30. Non-competitive wage and benefit levels	4	5%	0	0%	2	5%	2	5%
	31. Accounting errors	5	7%	4	7%	3	8%	2	5%
	32. Speculation and illegal actions by executives	4	5%	3	6%	2	5%	2	5%
	COMPANY'S CHARACTERISTICS								
	33. Insufficient resources and reputation to keep up with competitors	13	17%	0	0%	5	13%	8	21%
	34. Labour legacy liabilities	6	8%	3	6%	5	13%	1	3%
	35. Inability to reduce costs when production decreases	5	7%	1	2%	2	5%	3	8%
	Total	274		155		144		130	
	Average (per firm)	3.65		2.87		3.79		3.51	

Table 3 – Comparison of environmental and internal risks for non-SMFs and SMFs

Panel A		N	Mean	Std. Deviation	t	p
Environmental risks (H1)	non-SMFs	54	1.70	1.18	0.85	0.198
	SMFs	75	1.88	1.15		
Internal risks (H2)	non-SMFs	54	1.17	0.86	3.26	<0.0005
	SMFs	75	1.77	1.25		
Panel B		**N**	**Mean**	**Std. Deviation**	**t**	**p**
General environment risks	non-SMFs	54	1.30	1.04	0.09	0.932
	SMFs	75	1.28	1.09		
Immediate environment risks	non-SMFs	54	0.41	0.63	-1.58	0.116
	SMFs	75	0.60	0.72		
Corporate policy risks	non-SMFs	54	1.09	0.78		
	SMFs	75	1.45	1.08	-2.20	0.030
Corporate characteristics risks	non-SMFs	54	0.07	0.26		
	SMFs	75	0.32	0.50	-3.63	0.000
Panel C Sample pairs matched on size, time-frame, and industry						
		N	Mean	Std. Deviation	t	p
Environmental risks	non-SMFs	27	1.78	1.19	-1.46	0.156
	SMFs	27	2.19	1.04		
Internal risks	non-SMFs	27	1.15	0.91	-2.70	0.012
	SMFs	27	1.78	0.97		
		N	Mean	Std. Deviation	t	p
General environment risks	non-SMFs	27	1.33	1.07	-1.22	0.235
	SMFs	27	1.63	1.15		
Immediate environment risks	non-SMFs	27	0.44	0.64	-0.62	0.542
	SMFs	27	0.55	0.75		
Corporate policy risks	non-SMFs	27	1.04	0.85	-1.91	0.067
	SMFs	27	1.41	0.75		
Corporate characteristics risks	non-SMFs	27	0.11	0.32	-2.56	0.017
	SMFs	27	0.37	0.56		

Table 4. Servitization groups identified by cluster analysis

	Demand Chain Services (N=38)	Product Support Services (N=37)	p
Retail and distribution	34	11	<0.0005
Financial	6	0	0.014
Transportation and trucking	2	0	0.253
Property and real estate	2	1	0.510
Outsourcing and operating	3	2	0.513
Consulting	5	4	0.517
Procurement	2	3	0.487
Design and development	8	12	0.197
Leasing	0	3	0.115
Systems and solutions	5	21	<0.0005
Installation and implementation	2	15	<0.0005
Maintenance and support	1	34	<0.0005

Table 5. Multiple comparisons across non-SMFs, demand chain SMFs, and product support SMFs

Types of Risks	non-SMFs N=54 (1)	Demand Chain SMFs N=38 (2)	Product Support SMFs N=37 (3)	F	p
Total risks	2.87	3.79	3.51	4.69	0.011
Different groups (p<0.05)	2,3	1	1		
Environmental risks	1.70	2.13	1.62	2.22	0.113
Different groups (p<0.06)	2	1,3	2		
General environment risks	1.30	1.50	1.05	1.67	0.192
Different groups (p<0.07)		3	2		
Immediate environment risks	0.41	0.63	0.57	1.33	0.269
Different groups (p<0.05)					
Internal operating risks	1.17	1.66	1.89	5.16	0.007
Different groups (p<0.05)	2,3	1	1		
Corporate policy risks	1.09	1.34	1.57	2.69	0.072
Different groups (p<0.05)	2,3	1	1		
Corporate characteristics risks	0.07	0.32	0.32	5.44	0.005
Different groups (p<0.05)	2,3	1	1		