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Diversification of Manufacturing Firms into Services: Analysis of Antecedents

ABSTRACT

This paper empirically investigates the drivers of servitization by manufacturing firms. By analyzing a sample of 2450 public manufacturing firms for the period of 1976 to 2000 we demonstrate that younger age, technology intensity, higher market share and stock of proprietary knowledge encourage manufacturers to introduce more services.

KEYWORDS: Servitization, Antecedents

INTRODUCTION

Manufacturers have increasingly introduced services to accompany their existing products in order to satisfy a broader array of customer needs and differentiate themselves from the competition (M. Sawhney, Balasubramanian, & Krishnan, 2003; Lusch, Vargo, & O'Brien, 2007). These services include repair and maintenance, warranties, installation, financial services, consulting, training, product analytics, performance monitoring, etc. This phenomenon is frequently referred to as “*servitization*” (Vandermerwe & Rada, 1988). In this study, we define servitization as the provision of services by an organization whose primary business activity is manufacturing products. A manufacturing firm (or unit) that has added services to its existing offerings is referred to as a *servitized* firm (or unit).

Servitization can be a means to achieve sustainable competitive advantage and counteract commoditization. Value-added services transform commodities to differentiated goods (D. E. Bowen, Siehl, & Schneider, 1989); they create synergies with the existing products which cannot be achieved by pure service or pure product firms. Portfolios of products and services are harder to imitate (Baines, Lightfoot, Benedettini, & Kay, 2009; Kastalli & Van Looy, 2013). Porter (1980) views service as an important element of product strategy. He argues that superior customer service, financing facilities, and logistics services can enhance value offering and increase the cost of switching for customers. Therefore services can also be used to lock-in customers and lock-out competitors (Vandermerwe & Rada, 1988).

Servitization has been a popular strategy in the manufacturing sector. In almost every manufacturing industry a growing portion of firms are complementing their products with value-added services (Vandermerwe & Rada, 1988; Wise & Baumgartner, 1999; Fang, Palmatier, & Steenkamp, 2008; Baines, Lightfoot, Benedettini, et al., 2009). Yet, despite wide industry adoption and the claimed benefits, many manufacturers have refrained from stepping into the uncharted territory of services (Cohen et al., 2006; Oliva and Kallenberg, 2003). In order to successfully develop and deliver services, a manufacturer must go through an organizational transformation, develop a service-centric culture, acquire new resources, and train employees. Such a bold transition has often proved to be a tough challenge and would requires strong motivation (Oliva and Kallenberg, 2003). It is not clearly understood why some manufacturers choose to, or are able to, make the transition from products to services while others do not. The main goal of this study is to investigate the drivers of servitization. This study is concerned with the following research question: *What factors motivate a manufacturing firm to develop and offer services?* In order to address this question, we use S&P Capital IQ's Compustat North America database as well as patent data construct a panel of 2450 publicly held manufacturers for the time period of 1976 to 2006. We analyze this data using multi-level regression analysis.

LITERATURE REVIEW

There exists limited empirical evidence in servitization literature with regards to the drivers of the phenomenon. Diversification literature also seems to ignore important aspects of servitization. Below we will discuss the insights that could be gained from each stream of literature.

Servitization

Since the introduction of servitization to the literature (Vandermerwe & Rada, 1988) research has been steadily growing in this area (Baines, Lightfoot, Benedettini, et al., 2009). Academic research emphasized servitization's marketing-related benefits (Lele & Karmarkar, 1983; DeBruicker & Summe, 1985; Hull & Cox, 1994) as well as operations issues (Armistead & Clark,

1991; Loomba, 1996; Goffin & New, 2001). Scholars have suggested that there is great potential for manufacturers in integrating services into their core products (Wise & Baumgartner, 1999; Oliva & Kallenberg, 2003; Baines, Lightfoot, Benedettini, et al., 2009; Baines, Lightfoot, Peppard, Johnson, Tiwari, Shehab, & Swink, 2009). Following prior empirical work (Fang et al., 2008; Kastalli & Van Looy, 2013; Suarez, Cusumano, & Kahl, 2013) we study servitization at the organization level and focus on all services sold by manufacturers.

Drivers of Servitization. Examination of previous research reveals a number of factors that potentially motivate manufacturers to adopt service strategies. Suarez et al. (2013) argue that decline of product revenues encourages manufacturers to diversify into services. The desire for differentiation is another factor that is emphasized as a reason for servitization (Wise & Baumgartner, 1999; A. Sawhney, 2004; Lusch et al., 2007). Kastalli and Van Looy (2013) state that manufacturers develop services in order to escape the commoditization trap. The competition in the manufacturing sector has led to commoditization of many product categories. Consequently, some manufacturers have shifted focus to services as a new basis for differentiation. Servitization may also be explained by complementarity between manufacturing and service activities. The availability of excess capacity in immobile production resources, such as knowledge and facilities, can motivate development of new services that can leverage the unused capacity and create synergies with manufacturing activities (Fang et al., 2008). Scholars have noted that services and products can play a complementary role and influence each other. Fang et al. (2008) state that the main benefit of servitization is due to the synergy realized between products and services. In many cases, firms offer services, such as repair and maintenance, to support their product business. Kastalli & Van Looy (2013) show that offering services increases the demand for products. The role of industry-level factors have also been examined by scholars. Cusumano et al. (2015) offer a conceptual framework that links different life cycle stages of a manufacturing industry to the different levels and types of services offered by the firms.

Given the significant attention to servitization in industry and academia, it is surprising how sparse our knowledge is regarding the circumstances that favor or discourage servitization. To the best of our knowledge, Cusumano et al. (2015) is the only study directed at explaining the factors that influence manufacturers' decision to offer services (industry lifecycle stage in this case) and we are not aware of any empirical evidence regarding their propositions or other possible drivers. Furthermore, there exist theoretical tensions that demand an empirical resolution. For instance, as we discussed earlier it has been argued that manufacturing firms resort to services when product revenues are declining. However servitization is a challenging strategic move (Brax, 2005; Baines, Lightfoot, Benedettini, et al., 2009; Baines, Lightfoot, Peppard, et al., 2009) and requires a significant upfront investment, which is less likely of a firm with declining revenues. A successful manufacturer with profitable business may have the necessary resources for developing new services. On the other hand, path-dependence due to the current success (Sydow, Schreyögg, & Koch, 2009) may limit the motivation for entering services as a radically new line of activity. It is not clear then whether servitization is motivated by financial success or loss. These effect may also realize at different levels of analysis.

Diversification

Diversification is one of the most investigated topics in strategic management. For the purpose of this study we define diversification as the degree to which a firm classified in one industry produces goods from other industries (Berry, 2015). The drivers of diversification have been extensively studied. As broad as it is, the literature on diversification also seems to lack sufficient attention to servitization.

Drivers of diversification. Various proactive and defensive reasons have been suggested for diversification (Reed & Luffman, 1986). Chatterjee and Wernerfelt (1988) notes that if transaction costs are higher in the market than in the organization diversification becomes an attractive strategy. Economies of scope and utilizing the unused capacity in immobile resources is one of the major rationales put forth by scholars to explain firms' move towards diversification. Excess capacity in physical assets (e.g. plant, equipment) is usually non-tradable in the market and is therefore a basis for diversification (Porter, 1985). Additionally, knowledge assets and production know-how can also be bases for diversification due to their minimal cost of transfer to other activities and difficulty to trade in the market (Porter, 1985, 1987).

Public policy has also been a major factor in firm's decision to diversify. Scholars have documented the role of anti-trust policies in incentivizing diversification (Auerbach & Reishus, 1988). Tax consideration have also been major factors in diversification decisions. If the taxation on dividends are high such that the shareholders prefer that their income be reinvested, company will be motivated to buy or develop other businesses in order to profitably use the free cash flow (Turk & Baysinger, 1989; Hoskisson & Hitt, 1990). Acquisitions typically lead to lowering of taxable income for corporations through increasing depreciable asset allowances (Auerbach & Reishus, 1988; Kaplan, 1989).

Low performance, uncertainty of future cash flow, and desire for risk reduction have also discussed as motives for diversification internal to the firm. Rumelt (1974) argues that high performance erodes the motivation for diversification. Research suggests that low performance motivate firms to diversify, however, continued low performance post-diversification leads to divestiture (Baysinger & Hoskisson, 1990; Hoskisson & Turk, 1990).

Firms may also diversify in order to hedge against uncertainties in the market and the business environment (Rumelt, 1974). Uncertainty in expected future performance, or maturity of an industry motivate diversification as a defensive strategy (Leontiades, 1982). Portfolio theory suggests that having multiple businesses reduces the risk as long the cash flows from those businesses are not perfectly correlated (Markham, 1973).

Diversification has also been suggested to help firm through decreasing the cost of capital since businesses can borrow from each other and decrease the threat of bankruptcy (Lewellen, 1971). This perspective assumes imperfect capital markets and information asymmetry between managers and investors, which means that internal funding will be more efficient than market funding (Chatterjee & Wernerfelt, 1988).

Furthermore, research has suggested managerial motives for diversification. Taking the perspective of agency theory (Jensen & Meckling, 1976) scholars have argued that managers' may pursue diversification for their own benefit. For example Amihud and Lev (1981) suggest that diversification may reduce the risk of job loss or income reduction for top management. Additionally, diversification increases firm size and consequently management compensation (Dyl, 1988). If managerial motives are involved, the threat, of course, is that diversification may be pursued even if it is detrimental to the firm.

However, there does not exist a specific theory to explain why a firm would diversify into services not in other products. We argue that this gap is due to lack of attention to customer-side complementarity, as explained below. This paper aims to extend the diversification literature and provide a theory of the drivers of servitization. By introducing the concept of customer-side complementarity we will attempt to broaden the applicability of diversification theories to the servitization phenomenon.

Customer-side Complementarity. The current theory of diversification does not completely address the interaction between the products and services in a servitized organization. What makes servitization different from the previously studied types of diversification is not only the fundamental differences in managing a service organization and a product organization (J. Bowen & Ford, 2002), but also, that products and services have interrelationship and will end up with the same customer. In most cases, there is complementarity between the two, i.e. customer-side complementarity. Two goods, as we define, have customer-side complementarity when the value of one increases for the customer once they also obtain the other one. For example, an engine and a maintenance package have customer side-complementarity because it is more beneficial for the customer to have both goods rather than either one. Ceteris paribus, buying the maintenance package from the same company saves time and search costs for the customer and ensures a better service due to higher compatibility with the product (compared to purchasing from a third-party).

Customer Value Chain. There is typically a process that a customer has to go through for buying an item, of which the purchase transaction is only one activity (Figure 1). We refer to this process as customer value chain. The customer first needs to identify the item and supplier that meet his needs best. Once the product is selected and the suitable supplier is identified, the customer needs to secure funds for making the purchase. The actual transaction then takes place which involves the costs of visiting the supplier, negotiation, contracting, transfer of funds, and receiving the purchased item. The next phases are transportation of the items to the customer's site (e.g. plant, office, home), installation, putting the product in use and maintaining it. Once the usage life of the product come to the end (i.e. when customer no longer needs the product), end-of-use activities, such as disposal or reselling, are carried out.

Each of these steps may involve costs and risks for the customer, and correspondingly, opportunities for the supplier to create additional value. The selection step may involve considerable costs (money, time, etc.) of search and information acquisition. As a result, customers may prefer long term relationships with fewer suppliers in order to economize on these costs (D. E. Bowen & Jones, 1986). There is a large risk element in this step due to the possibility of selecting the wrong item. Suppliers can offer consultation services in order to help customers select among a number of alternatives. Financing costs can also be a barrier for customers. It is fairly common for suppliers of expensive items to offer financing services, e.g. loan, to smooth the purchase process. The actual purchase transaction can also be made easier through the use of information technology, e.g. online ordering.

There is also a sunk cost of initiating the connection with the supplier which can be a basis for servitization. That is when a customer has already invested in information acquisition, visiting the supplier, or deciding on purchase of a product (sunk costs), they can economize on these costs if they make other purchases (e.g. accompanying services) from the same supplier rather than other suppliers. Such customer-side complementarities can be bases for the supplier to develop more and more services around the core product. This is especially true for the cases where purchase of product automatically creates the need for purchasing a service. For example, the buyer of an automobile will typically need maintenance service, which will be less costly to buy from the same seller. There are also risks for customers due to supplier's failure of fulfilling the promise. For example, the product may be defective or may not be delivered according to the agreements. These risks, then, creates the opportunity for sellers to offer return and warranty services.

For some products, e.g. production machinery, proper installation and use of the product needs extensive knowledge and training, and may not be hassle-free for the customer. As a result,

some manufactures provide installation and training services to help customers gain the most value from their purchased product. Finally, the customers may face risks and costs due to not being able to resell or dispose of the product at the end of its useful life. As a result, manufacturers may offer buyback, disposal, or swapping services. Leasing services are also aimed at decreasing not only the initial investment but also the hassle (i.e. costs and risks) of reselling or disposing of the products that are not needed anymore.

Based on the above framework, we will offer hypotheses in the next section to shed light on the drivers of servitization. In our theory development we will place a stronger emphasis on the effects that are specific to the relationship between products and services.

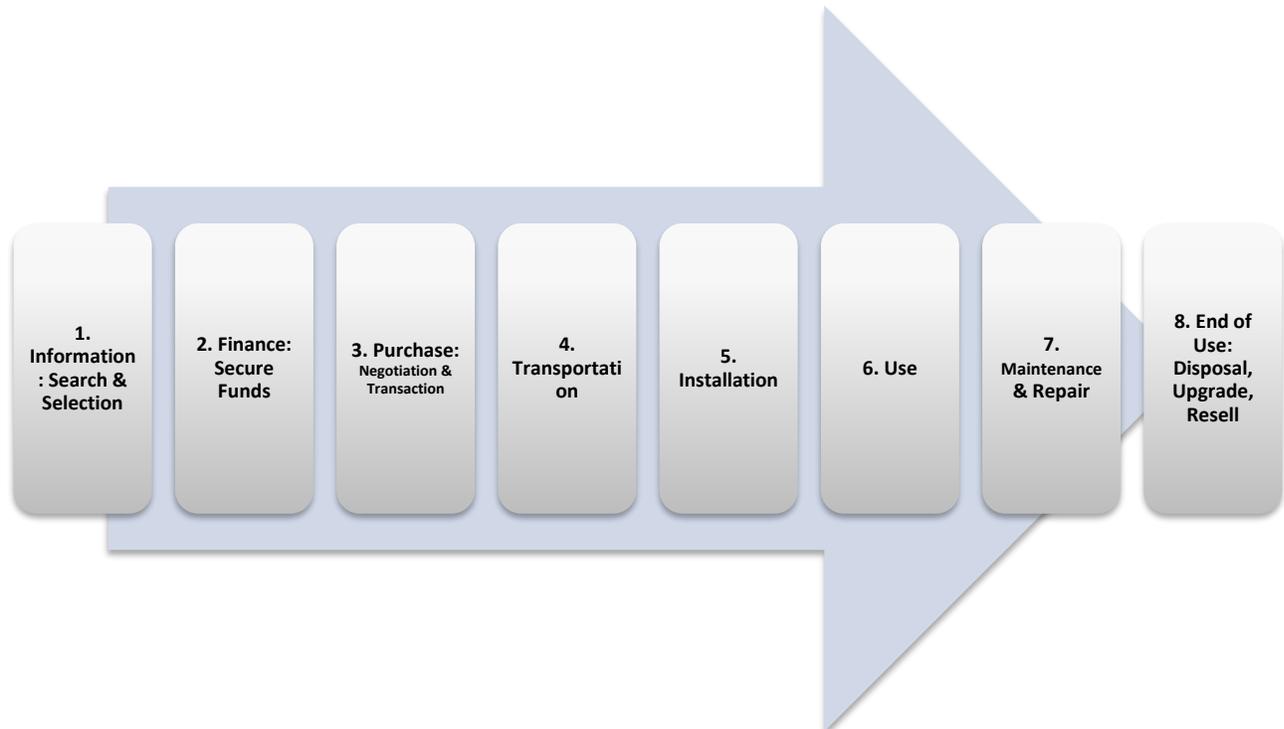


Figure 1. The Customer Value Chain

HYPOTHESES

High Technology Industries

In this section, we examine the effect of hi-tech industries. Companies in hi-tech industry produce more complex products and need a higher level of service to support customers. As we discussed earlier, one of the reasons a customer may need services along with the product is to reduce the risks and uncertainties associated with the purchase process and post-purchase experience. Examples of the risks involved in the customer value chain in Figure 1 include buying the wrong product type – one that does not meet customer needs well, buying a defective product, product failure under use, not being able to find suitable parts or a repair service provider, system downtime and lost business during the repair time.

These risks emanate from customers' lack of expertise and knowledge about the product. If a customer is sufficiently knowledgeable about a product they can better assess the suitability and quality of the product before purchase and use the product post-purchase. For instance, often times finding the right maintenance and repair service (M&R) provider is easier when the customer knows the product better. Knowing the technical characteristics of the product helps the owner to find a supplier with matching technical capabilities. Additionally, the relationship between M&R provider and the firm involves agency and knowledge asymmetry since the owner hires the M&R provider to perform a service on the product on his behalf (D. E. Bowen & Jones, 1986). Assessing the quality and performance of products is more difficult in hi-tech markets both pre- and post-purchase. Higher decision making difficulty, consequently, increases customer's need for services, e.g. recommendation service (Swaminathan 2003).

Hi-tech sectors use the most advanced technology available and continuously create new knowledge through heavy investment in research and development (Chandler and Hikino 1990). Continuous creation and accumulation of product-related knowledge gives manufacturers an edge over external service providers. We conclude that in industries characterized by higher technology both customer's need for receiving services and manufacturer's advantage for offering them increase; therefore, we should observe a higher level of servitization in these industries.

To the extent that product owner is knowledgeable about product, they can better observe the quality of the service delivered by the provider. In essence higher knowledge about the product decreases the knowledge asymmetry between the owner and service provider. As firms continue to operate in the market, their customers become more and more familiar with their products and the knowledge asymmetry between firms and customers shrinks. External service providers also become more mature and offer better service at lower cost. As a result, we expect servitization level to decrease with company's age.

Earlier in a firm's life cycle, there are at least two sources of ambiguity for the customer. First, the reliability and quality of the product may be uncertain due to supply chain and operations uncertainty. The production and distribution processes are not optimized and as a result many defects and incompatibilities may exist. Additionally, the design of the product itself is not optimized and may undergo multiple changes before a robust model is introduced. Second, customers may not be familiar with the product. There may be ambiguity in whether the new product actually matches their needs, how to install and use it. Simply put, the pros and cons of the product and its value relative to competitor products are not fully understood (Utterback & Abernathy, 1975; Cusumano et al., 2015). The mainframe computers introduced by IBM during the 1950s and 1960s were expensive machines based on a new and largely unknown technology. Customers perceived a high level of risk and were reluctant to purchase the products. However, IBM developed various services such as maintenance or leasing packages to attract buyers to the new product. Xerox had to offer similar services at the time of introducing the plain-paper copier in the 1960s since the market was not familiar to the new technology and was reluctant to adopt it (Cusumano et al., 2015). Due to these ambiguities, purchase risk is significantly higher earlier in the products' life cycle. Therefore, we expect manufacturing firms to offer a higher level of services in their earlier life cycle stages.

Hypothesis 1. Manufacturers in hi-tech industries have a higher level of servitization.

Hypothesis 2. Manufacturers with higher age have a lower level of servitization.

Industry Competitiveness and Market Share

Competitive dynamics also have important implications for servitization. Scholars have emphasized that servitization can be a means to differentiate a firm's offering from those of the competitors (Wise & Baumgartner, 1999; M. Sawhney et al., 2003; Vargo & Lusch, 2004). When competition increases in an industry due to entry of lower-cost competitors, margins shrink and differences among products fade due to imitation. The incumbents, in turn, attempt to diversifying into services which have higher margins. The motive and capabilities for such a maneuver is stronger for industry leaders and firms with higher market share. Suarez et al. (2013) argue that decline of product margins encourages manufacturers to diversify into services. Kastalli and Van Looy (2013) also state that manufacturers develop services in order to escape the commoditization trap. The competitive pressures from low-cost competitors in the manufacturing sector has led to commoditization of many product categories. Consequently, some manufacturers, especially the ones with stronger technology and knowledge base, will shift focus to services as a new basis for differentiation. Value-added services transform commodities to differentiated goods (D. E. Bowen et al., 1989). Therefore, beyond the traditional product diversification attempts to grow their business, manufacturers also have incentive to develop services around their products to increase the margin that they receive from the current product classes. Portfolios of products and services are distinctive, complex, and harder to imitate (Baines & Lightfoot, 2013; Kastalli & Van Looy, 2013); therefore, they provide strong bases for competition against low cost competitors.

This phenomenon is observed, for instance, when products from low-cost countries find their way to the market of a country with higher technology and product quality. The incumbents will not be able to lower their cost, especially since they have exploited cost reduction opportunities in response to existing competition among themselves. However, they have a technology advantage over the new entrants and the more promising route to competition is through differentiation. As we discussed, servitization is a means to differentiation specially to save product margins. One of the factors that helped Caterpillar keep its competitive advantage over Komatsu was its strong global service network, something that Komatsu lacked. IBM's redesigning of its strategy in 1990s also aligns with our argument. In the early 1990s IBM faced strong competition from Dell and Gateway who sold lower-priced computers directly to consumers. The consequence was a record loss of \$5 billion. However, IBM started to rethink its business. By acquisition of Lotus the company began selling solutions instead of products. These solutions were combinations of products and services, designed to meet a broad array of customer needs. These examples, portray firms with stronger foothold in the market that were challenged by smaller entrants and ventured into services. The above arguments lead us to expect a higher level of servitization for firms that are in more competitive industries and firms that already possess a higher market share.

Hypothesis 3. Level of servitization is positively associated with industry competitiveness.

Hypothesis 4. Manufacturers with higher market share have a higher level of servitization.

Knowledge Stock

Knowledge is a special resource. It is path-dependent and accumulates over time. It is also indivisible but can be applied to new activities with minimal cost. As a result, accumulated knowledge should provide strong motivation for diversification. Especially, successful development of services such as maintenance or product analytics requires leveraging proprietary knowledge about the products and generating economies of scope.

Teece (1980) points out that a key factor in analyzing diversification based on economies of scope is the transaction cost. He argues that only the shared resources that are difficult to trade through market mechanisms provide the conditions for diversification. According to Teece (1980) transfer of proprietary knowledge through the market mechanism entails three difficulties: 1- recognition of trading partners: it is not readily clear who would be willing to purchase or buy firm's knowledge, 2- disclosure: firms are not willing to share proprietary knowledge due to risks of opportunism by the trading party, and 3- even if the first two issues are solved, the buyer of proprietary knowledge faces challenges in forming the teams or sub-organizations that are capable of utilizing the acquired knowledge. Due to these features Teece argues that existence of proprietary knowledge provides sufficient condition for diversification. We expect that a manufacturer is more likely to develop services around its products if it possesses a large stock of proprietary knowledge.

Hypothesis 5. A manufacturer's stock of proprietary knowledge is positively associated with its level of servitization.

METHODS AND ANALYSIS

Data

To test our hypotheses, we use financial data and patent for US publicly-traded manufacturers. We will use the North America Annual Fundamentals database as well as the Business Segments database from Standard & Poor's (2015) Compustat. The former contains fundamental data for U.S. and Canadian public firms, and, the latter provides historical data about business and geographic segments of over 24000 North American companies since 1976. Our analysis is limited to the manufacturing firms, i.e. the firms with the one-digit NAICS code 3. We use NAICS industry classification system because it contains a greater level of detail than the SIC system, especially for services. We will combine the North America database with the Business Segments database by the GVKEY (Global Company Key) code, which is the unique company identifier in Compustat. Finally, we will capture each firms patent data from patent data provided by National Bureau of Economic Research (2015).

Following the literature, we will apply the following data filtering steps in order to construct the final sample. First, all of the observations with negative values on total revenues, assets, and R&D expenditure will be dropped. Second, firms with negative service revenues will be deleted. Third, observations with extreme values (i.e. the 1st and the 99th percentiles) on total revenues, assets, annual income, and research and development expenditure will be deleted in order to mitigate the effect of outliers or miss-recorded data. Finally, we will delete missing data list-wise. This leaves a sample of 2450 manufacturing firms and 16115 firm-year observations for the period of 1976 to 2015.

Dependent Variable - Servitization

Our approach for measuring service revenue (*Service*) is inspired by Fang et al. (2008). By examining the description and the SIC codes of the operating segments reported in the Compustat Business Segment database, the authors divide a firm's segments into service and non-service. By adding up the revenues coming from service segments, the authors compute the total service revenues manufacturers.

Independent Variables

We will determine hi-tech industries (*Hi-Tech*) based on the list provided by Hall and Vopel (1996). Firm age (*Age*) will be measured from the year of initial public offering to date. We measure *market share* by dividing firm sales by total sales of the industry in a specific year. Industry is defined as all firms with the same 4 digit NAICS codes. Industry competitiveness will be measured using *Herfindahl index* (Kwoka, 1985). Herfindahl index is the sum of squared market shares of all firms in an industry. Herfindahl index varies between zero and one, and a higher number indicates higher concentration of market share and lack of competition. In order to measure *knowledge stock*, we use patent information. We used the cumulative number of patents from 1976 to date as a measure of firm's accumulated knowledge. Following the literature (e.g. Liu and Wong, 2011) we assume an annual depreciation rate of 20 percent for the value of older patents.

Control Variables

R&D intensity captures firm-level differences in innovation effort and can be linked to the amount of new services developed by the firm. Therefore, we will control for it in the analysis. Firm size is another important factor to consider. Larger firms have more resources to develop new services. In order to control for firm size, we include total sales (*Sales*) in our analysis. We control for firm's *return on assets* and *net margin* as measures of profitability. More profitable firms may be more willing to develop new services. They may also be more successful in marketing new services. We also control for *slack* resources. Following Fang et al. (2008) and Lee and Grewal (2004), we operationalize slack as the common principal component between from two financial ratios (1) retained earnings to total assets and (2) working capital to total assets. Retained earnings is the portion of net earnings that a company chooses not to pay out as dividends, but to retain for unforeseen eventualities and implementation of corporate strategies (Bourgeois, 1981). Working capital is the difference between current assets and current liabilities. Current assets are the liquid assets (cash, inventories, receivables, etc.) and current liabilities are the payments due in one year. We also control for human resource productivity as an indicator of human resource qualifications. Firms with higher qualified workers are at an advantage for offering services. Consistent with prior research (Huselid, 1995; Koch & McGrath, 1996; Guthrie, 2001; Datta, Guthrie, & Wright, 2005) we operationalize human resource productivity with *sales per employee* – the ratio of firm sales to number of employees. Furthermore, we control for B2B vs B2C industries (*B2B*) as the need for service offering may be different in these two environments. We also control for industry growth (*Ind_Growth*) as firms in high-growth industry may have higher incentive to further focus on manufacturing compared to services. Finally, we account for competitive pressures and imitation effects by controlling for *service ratio of the leader* in the focal industry as well as total *service ratio of rivals* to a focal firm. In each case, the focal firm is excluded and the total services sales (of the firm with the largest market share or of all firms in the industry) is divided by the total sales. Additionally, we included year dummy variables to control for year to year variations in the industry.

Analysis Results

We analyze the data using multilevel regression model (Snijders & Bosker, 2011), particularly because our data has a multilevel structure. Firms will constitute the first level and industries the second level. Time, firm and industry were considered as levels of analysis. Since the distribution of sales and service sales are highly skewed we used their logged version in our analysis. Table 1 and 2 below, show the descriptive statistics and correlation among the variables, correspondingly. Results of the multi-level regression analysis are presented in Table 3.

Table 1- Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
ln(Service)	101137	1.037947	1.902397	0	8.500657
Hi-Tech	101137	0.34266	0.474602	0	1
Age	97805	9.057819	7.084913	1	31
Herfindahl Index	101137	0.279155	0.189678	0	1
Market Share	100596	0.071697	0.154368	0	1
Knowledge Stock	27703	205.2852	815.4223	1	28588
ln(Sale)	100597	4.309761	2.277387	0	10.46242
Return on Assets	100567	-0.09186	0.47607	-6.90541	0.332511
Net Margin	90429	-0.00781	0.168549	-1	0.371584
Service Ratio of Leader	100663	0.098001	0.176845	-0.01882	1.347144
Service Ratio of Rivals	97355	0.144471	0.098106	-6.7E-05	1.235383
Industry Growth	101136	1.007259	0.013153	0.921274	1.136685
B2B	84766	0.573602	0.494557	0	1
Sales Per Employee	93654	161.3299	557.4742	0	91135
Slack	96313	0.031353	0.014611	-1.07312	0.09537
R&D Intensity	67490	0.336332	1.58708	0	48.2029

Table 2- Correlation Table

	Ln (Service)	Hi-Tech	Age	Herfindahl Index	Market Share	Knowledge Stock	Ln (Sale)	Return on Assets	Net Margin	Service Ratio of Leader	Service Ratio of Rivals	Industry Growth	B2B	Sales Per Employee	Slack	R&D Intensity
ln(Service)	1.00															
Hi-Tech	0.01	1.00														
Age	0.10	-0.02	1.00													
Herfindahl Index	0.00	-0.09	0.07	1.00												
Market Share	0.17	-0.19	0.17	0.35	1.00											
Knowledge Stock	0.12	0.02	0.25	0.05	0.26	1.00										
ln(Sale)	0.33	-0.21	0.33	0.00	0.46	0.34	1.00									
Return on Assets	0.11	-0.12	0.09	0.04	0.13	0.06	0.41	1.00								
Net Margin	0.05	-0.10	0.07	0.02	0.13	0.07	0.34	0.79	1.00							
Service Ratio of Leader	0.07	0.09	0.00	0.04	-0.01	0.00	-0.03	-0.04	-0.03	1.00						
Service Ratio of Rivals	0.14	0.31	-0.07	-0.04	-0.11	0.00	-0.17	-0.12	-0.11	0.35	1.00					
Industry Growth	0.02	0.01	-0.04	-0.05	-0.08	0.00	0.04	-0.01	0.02	0.03	0.00	1.00				
B2B	-0.06	-0.22	0.05	-0.08	0.06	0.03	0.13	0.08	0.05	-0.13	-0.36	0.00	1.00			
Sales Per Employee	0.06	-0.01	0.09	-0.02	0.00	0.03	0.13	0.04	0.02	0.02	0.03	0.02	0.02	1.00		
Slack	0.04	-0.05	0.01	0.03	0.04	0.01	0.18	0.35	0.32	-0.02	-0.07	-0.01	0.04	0.02	1.00	
R&D Intensity	-0.06	0.13	-0.10	-0.06	-0.09	-0.05	-0.28	-0.31	-0.46	0.06	0.21	0.01	-0.13	-0.10	-0.35	1.00

Table 3. Multi-level Regression Results

	(1)	(2)	(3)
	ln(Service)_Lag1	ln(Service)_Lag2	ln(Service)_Lag3
Hi-Tech	0.565***	0.525***	0.510***
Age	-0.017***	-0.020***	-0.016**
Herfindahl Index	-0.111	-0.193	-0.232 ⁺
Market Share	0.542**	0.467**	0.433*
Knowledge Stock	0.001***	0.001***	0.001***
ln(Sale)	0.313***	0.294***	0.280***
Return on Assets	-0.038	0.181	0.193
Net Margin	-0.037	-0.124	-0.080
Service Ratio of Leader	0.200*	0.168 ⁺	0.227*
Service Ratio of Rivals	0.547*	0.458*	0.307
Industry Growth	-1.997 ⁺	-1.652	-0.818
B2B	-0.315**	-0.358**	-0.356**
Sales Per Employee	-0.001	-0.001	-0.001
Slack	-13.648	-7.126	-7.342
R&D Intensity	0.043	-0.010	0.132
Constant	1.821	1.598	0.874
Year Dummies	Y	Y	Y
ln(sd(Industry Effect))	-0.810***	-0.729***	-0.665***
ln(sd(Firm Effect))	0.446***	0.465***	0.484***
ln(sd(Residual))	0.248***	0.258***	0.269***
LL	-2.94e+04	-2.78e+04	-2.64e+04
AIC	58852.228	55693.940	52827.388
BIC	59228.915	56067.605	53198.118
N	16115	15151	14270

⁺ p<0.10

* p<0.05

** p<0.01

*** p<0.001

As a robustness check we use three lag values between dependent and independent variables. Models 1 to 3 use lag values of 1 to 3 years, correspondingly. The results indicate that firms in hi-tech industries have a higher level of servitization. Additionally, servitization is negatively associated with firm age. Therefore, we conclude that H1 and H2 are supported. Contrary to our expectation industry competition was not significantly related to servitization. However, market share had a significant and positive influence on servitization. Therefore, H3 is not supported, while, H4 is supported. Finally, the coefficient of knowledge stock is positive and significant in all three models indicating support for H5.

DISCUSSION AND CONCLUSION

Servitization is a major shift in the manufacturing sector. Many manufacturers have decided to add services to their offerings in an effort to differentiate themselves from the competition and secure higher margins. This work analyzes the factors that motivate manufacturers to offer services. We combined financial statement data and patent data in order to empirically analyze

these motivating factors. We obtained a sample of 2450 firms and 16115 firm-year observations and analyzed it using multi-level regression. The results indicate that firms in hi-tech sector have a higher degree of servitization. This is in line with our argument that because hi-tech products are more complex and technology intensive, customers' need a higher level of services from the firm. All aspects of the economic transaction from search, selection, purchase, installation, use and maintenance are more complex in the case of hi-tech products and therefore there is demand for manufacturers support of the product in the form of add-on services. We also find that manufacturing firm offer less and less service as they age. We argue that this is due to increased familiarity of customers with products, higher diffusion of product-related information, shift towards commoditization and maturity of service suppliers.

Surprisingly, we found that industry competitiveness was not significantly related to servitization. This result could be due to mixed indications of competitiveness for high and low ends of the market. Higher competition may drive high-end manufacturers to differentiate themselves through services, while, it may drive lower-end manufacturers to further focus on process improvement and cost reduction in their product business. This possibility is further strengthened by our finding that market share is positively associated with level of servitization. On average, firms with higher market share tend to offer a higher level of service due to their superior resources and technology. Manufacturers with larger market share also find a larger business opportunity for developing services, and therefore, they can better justify the costs of servitization. Finally, we show that firms with larger knowledge stock tend to offer more services. This is in line with our argument that diversifying into services requires a high level of knowledge and technology that can be widely different from knowledge required for manufacturing. Once a firm has invested in innovation and accumulated knowledge, its ability to venture into new areas of business increases and the marginal cost of applying knowledge is small. Therefore, a firm with a large stock of knowledge has higher ability and economic motive to diversify into services. Our findings are robust under different lag structures and shed light on the enabler and drivers of servitization across all manufacturing industries. Using the new framework of customer value chain, we were able to point to some aspects of servitization that are ignored in diversification theories. Some of the concepts proposed in this study such as knowledge asymmetry between firm and customer in hi-tech sector, firm age and maturity of service suppliers are particularly important in analysis of servitization and have not been explored sufficiently in the diversification literature. Our study advances this literature by showing that servitization has different characteristics compared to the traditional forms of diversification and offers new explanations as to why manufacturers become servitized.

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