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**MANUFACTURING FIRMS DIVERSIFYING INTO SERVICES:
A CONCEPTUAL AND EMPIRICAL ASSESSMENT**

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ABSTRACT

Manufacturing firms often diversify into related service activities due to expected leverage effects of existing technological expertise, customer relationships and brand identity. Previous research has conceived this process as one-directional, whereby the installed product base in the end defines the boundaries of service diversification. Within this contribution, based on concepts forwarded by economical theories of multiproduct firms we argue that the presence of both product and service activities within one and the same firm can be conceived as bi-directional. When testing our propositions on product and service performance data of 48 national subsidiaries of a large international equipment manufacturing company by means of fixed effect panel data models, the presence of positive, strategic, complementarities becomes apparent. Moreover, adopting more sophisticated service models generates additional beneficial effects. Managerial implications on the level of business model choice and directions for further research will be discussed.

INTRODUCTION

Manufacturing firms diversifying their offerings to include services has been a raising phenomenon over the last decades. As competition in manufacturing industries intensified, creating pressures on product margins, manufacturing firms started to differentiate by complementing and enriching their initial product offerings with services (Porter, 1985; Oliva and Kallenberg, 2003). In addition, manufacturing firms diversifying into services might experience additional growth in terms of revenue and profit.

A number of authors have conceptualized this process of diversification into services, often referred to as ‘servitization’ (Bowen, Siehl, & Scheider, 1989; Canton, 1984; Martin & Horne, 1992; Mathe & Shapiro, 1993; Oliva & Kallenberg, 2003; Quin, Doorley, & Paquette, 1990; Vendermerwe & Rada, 1988). From this literature, it becomes apparent that diversification in services implies a shift towards a more customer-oriented and relationship-based strategy that enhances customer satisfaction thereby offering additional growth potential and improved profitability to the manufacturer.

It can be noticed that “servitization” is often seen as a one-way process from product-dominant to service dominant business models, where product offerings become gradually embedded in more sophisticated service packages (Chase, 1981; Gebrauer, Fleisch, & Friedli, 2005; Martin et al., 1992; Oliva et al., 2003). This conception of service diversification seems to introduce growth implications: the installed product base is eventually defining the market potential for services. Hence it is not surprising

to observe that firms even start to extend initial offerings towards services that become independent from the own installed product base (Desmet et al., 2003). While such an evolution from related towards more unrelated services, might offer more growth possibilities, it also raises issues on whether and to what extent economies of scope are present when adopting such a more independent service business model.

Moreover, recent research in this field, focusing on implied change and implementation processes, testifies of the hurdles that manufacturing companies have been facing in the implementation of servitization strategies (Oliva et al., 2003; Brax, 2005; Gebrauer et al., 2005; Laine, Paranko, & Suomala, 2007; Mills, Neaga, Parry, & Crute, 2008). As such the notion of ‘service paradox’ is being coined (Gebrauer et al. 2005), depicting an absence of expected benefits when diversifying into service activities. While several authors are suggesting a lack of managerial attention and skills to manage effectively service activities to explain this phenomenon, the nature of the underlying service business model might be playing a crucial part as well. To the extent that services become more independent, experiencing economies of scope might become more difficult.

But do firms really face the choice between staying close to the product base and accepting growth limitations on the one hand, and moving into more unrelated service activities implying increased risks to become confronted with the service paradox?

Building on arguments stemming from economical and strategic theories on multiproduct firms, we advance an alternative reading, arguing that the relationship

between product and services can be conceived as reciprocal, rather than unidirectional.

Introducing the notions of economies of scope and complementarities allows us to enrich our understanding of the value dynamics when engaging in integrated service diversification, i.e. providing services in line with the initial product offerings ((Milgrom & Roberts, 1995; Siggelkow, 2002; Tanriverdi & Venkatraman, 2005b; Cottrell & Nault, 2004a; Tanriverdi & Lee, 2008)). Indeed, building on the idea that both economies of scope (production side) and complementarities (consumer side) might arise, leads to the hypothesis that value dynamics between products and services can be reciprocal and hence that the implied growth potential might exceed the boundaries defined by the installed product base.

The purpose of this paper is to elaborate conceptually and assess empirically such a broader conception of service diversification and its implied value dynamics. Although efficiency-based theories and the notion of economies of scope have been used by researchers to explain diversification efforts of service firms (Nayyar, 1993; Hallowell, 1999; Kim, 1987; Fraquelli, Piacenza, & Vannoni, 2004), we are not aware of any study that advances and examines empirically this argument in the specific setting of manufacturing firms engaging in related service diversification.

After providing a framework for service diversification of manufacturing firms we develop hypotheses that allow us to test the existence of complementarities between product and service activities. We argue that manufacturing firms can achieve economies of scope when diversifying in product related services by enacting both

demand and supply side complementarities. Further, we will argue that not all services have the same value-enhancing impact on products; the more sophisticated service offerings become, the more product activities will benefit from service activities. We test the empirical relevance of these ideas on 44 subsidiaries of an industrial equipment manufacturer over the ‘2001-2007’ period.

The remainder of the paper is hence structured as follows. First we review the existing literature on service diversification by manufacturing firms. Next, drawing on the efficiency-based theory of diversification and multiproduct firm, we develop a more encompassing view on the value dynamics associated with the process of servitization, from which we derive our hypotheses. We subsequently describe the data and empirical models, after which we present the empirical results. We end with discussing managerial implications as well as directions for future research.

BACKGROUND AND HYPOTHESIS

The notion “servitization of business” has been first coined by (Vendermerwe et al., 1988) to delineate the tendency of manufacturing firms to “increasingly offer fuller market packages or ‘bundles’ of customer-focussed combinations of goods, services, support, self-service, and knowledge”, in order to gain competitive advantage and increase customer satisfaction¹. As such, this notion is inspired by the work of Levitt

¹ Though the definition of the phenomenon has been widely accepted, the name ‘servitization’ hasn’t been used that frequently and different labels which depict the phenomenon were used (Oliva et al., 2003; Ren & Gregory, 2007). One encounters terms such as “manufacturer attempting to extend into services”, “service orientation, service strategies or even service manoeuvres of manufacturers” (Mathieu, 2001; Oliva et al., 2003; Gebrauer et al., 2005).

who described services as an advanced layer of an augmented product offering (Levitt, 1980). Services are represented as an instance of product differentiation, instrumental to better satisfy customer needs. The relevance of the notion of augmented products and the value implications in terms of customer satisfaction and loyalty have been further corroborated by subsequent research (Gronroos, 2002; Kotler, 1994; Levitt, 1980).

From the definition formulated by Vandermerwe and Rada, it becomes apparent that one of the main reasons why manufacturing firms opt for services resides in the potential to meet underlying customer needs more effectively (Lele, 1986). As such services enrich initial product offerings and provide opportunities for manufacturing firms to distinguish themselves from the competition (Bowen et al., 1989; Robinson, Clark-Hill, & Clarkson, 2002; Vendermerwe et al., 1988); (Canton, 1984; Vendermerwe et al., 1988; Quin et al., 1990)

Servitisation also entails a promise to create additional revenue streams (Anderson & Narus, 1995; Quin & Gagnon, 1986; Quin et al., 1990) characterized by higher profit margins (Cohen, Agrawal, & Agrawal, 2006; Levitt, 1980; Ovans, 1997; Wise & Baumgartner, 1999) and allows to translate cyclical demand patterns and revenues into more stable ones (Cusumano, 2004; Mathe et al., 1993; Van Looy, Gemmel, & Van Dierdonck, 2003) This 'economical' imperative gains importance as products move across the lifecycle and become more standardized; introducing services can be seen as a way to transcend competitive dynamics based on price alone.

Apart from directing our attention to the market benefits of servitization earlier studies also point out the nature of the servitization process: companies start from a pure product base, and expand their offerings by adding layer over layer of services, resulting in more intensive customer relationship and a service portfolio covering an increasing portion of their installed base. This definition implies however a one-way conception consisting of a development from product-dominant to service-dominant business activities; while the portion of service offerings grows, products remain to represent the basis for the firm's service offerings. But is such a one-way conception of value dynamics accurate?

Insights from the resource-based view are illuminating in this respect. Initially, sources of economies of scope have been defined within manufacturing environments, strictly connected to production facilities (Panzar et al. 1977; 1981). Further research generalizes the construct of economies of scope bringing more on the level of the firm/business as a whole (Teece 1982). According to the resource-based view, firms enter multiple businesses or product lines to exploit excess capacity of their resources (Robins & Wiersema, 1995; Farjoun, 1994; Markides & Williamson, 1994). The use of common resources in multiple businesses or multiple product lines within a single business creates synergies in the form of economies of scope (Teece, 1982; Prahalad & Hamel, 1990; Barney, 1991; Davis & Thomas, 1993). Two units or businesses, a and b, enjoy sub-additive cost synergies when they share common resources (i.e., $\text{cost [a, b]} < \text{cost [a]} + \text{cost [b]}$) (Panzar & Willig, 1981; Teece, 1982). It is important to notice that this also mean that economies of scope are achievable and the diversification is justifiable, only if the firm can leverage existing knowhow or other proprietary knowhow in the new business (Ramanujam & Varadarajan, 1989; Teece,

1980; Teece, 1982). In light of these findings, it is conceivable that manufacturer can diversify in related services and achieve synergies in form of economies of scope, by leveraging at least part of the same set of resources from product to service business and vice versa.

More recently, the construct of economies of scope has been enriched with the notion of strategic complementarities, defined as super-additive value synergies (Milgrom et al., 1995; Siggelkow, 2002; Tanriverdi et al., 2005b) achieved on the customer side (Cottrell et al., 2004a; Tanriverdi et al., 2008).

We argue that manufacturing firms can achieve synergies by diversifying in product related services. Further, we argue that product and service businesses represent strategic complements that can realize a) super-additive sales synergies and b) sub-additive cost synergies of a reciprocal nature.

First, we elaborate that consumption synergies can be achieved. Further, we argue that not all services have the same value-enhancing impact on products; the more sophisticated service offerings become, the more product activities will benefit from service activities. Second, we argue that service diversification can contribute to overall performance, to the extent that more traditional economies of scope are being achieved.

Consumption complementarities

Complementary to economies of scope on the production side, more recent research outlines synergies between strategic complements on the consumption/demand side. Authors argue that synergies can be achieved on the customer side and subsequently appropriated by the firm (Cottrell & Nault, 2004b; Tanriverdi et al., 2008). Cottrell et al. (2004) illustrates the presence of demand side economies of scope with examples from the software industry, where customers might prefer purchasing applications from the same vendor as they spread costs of learning. In addition to arguments such as interoperability and easiness of use (Cottrell et al. 2004), customer prefer to form long term relationships with a smaller group of reliable suppliers in order to handle information asymmetries. Long term relationships with reliable and reputed suppliers ensure the overall reduction of risk, especially when buying intangible goods in markets characterized by information asymmetry (Nayyar & Kazanjian, 1993). Focusing on a limited number of supplier leads over time to more efficient transactions and lowers the overall transactional costs (Panzar et al., 1981). Stated otherwise, sub-additive cost synergies on the customer side translate to super-additive sales synergies on the supplier side. Manufacturers experience higher sales performance which can eventually lead to higher margins to the extent economies of scope on the production side will be achieved.

Given that customers prefer to purchase products and services from the same vendor and hence interrelate the purchase decision for products and services, the two businesses activities represent strategic complements (Milgrom et al., 1995). Complements, by definition, imply influences of a reciprocal nature, which ever of

the activities has been introduced first. In this respect, it is also important to notice that the activities that represent strategic complements can be subject to both upward and downward movements (Milgrom et al., 1995; Harrison, Hitt, Hoskisson, & Ireland, 2001). Failure to properly manage complementary activities can lead to loss in revenues and finally profits for the firm (Stieglitz & Heine, 2007; Siggelkow, 2002). Therefore, manufacturer diversifying in services should realize that if compromising on quality, image or reputation in any of the two business activities this might have a negative effect on the other one (Nayyar et al., 1993).

To summarize, on the customer side, buying complementary products/services increases value – stemming from interoperability and a decrease of coordination costs. These sub-additive economies of scope on the customer side translate into super-additive complementarities on the supplier (manufacturer) side resulting in a positive, reciprocal, relationship between the sales of both activities. This leads to the following, testable, hypotheses:

Hypothesis 1: Sales of service activities in a manufacturing firm are positively influenced by the sales of product activities

Hypothesis 2a: Sales of product activities in manufacturing firm are positively influenced by the sales of service activities

Apart from a positive impact of the overall scale of service activities on product sales, it can be noticed that enacting such leverage effects might vary depending on the intensity of the interaction with customers. Relationship-intensive services allow for a

more complete coverage of customer's product-related processes, thereby insuring higher cost-effectiveness and subsequently more interest for the overall manufacturer's offering. As such, the potential for the occurrence of demand oriented economies of scope seems much higher for more sophisticated services implying more frequent and intensive involvement in customer operations, leading to the following hypothesis:

Hypothesis 2b: *Performance of product activities in manufacturing firm is positively influenced by the level of sophistication/development of service activities*

Production complementarities

Traditional economies of scope or sub-additive cost synergies are achieved by leveraging knowledge and capabilities across different products or activities. We will further label these economies of scope as production complementarities to distinguish them from the consumption complementarities outlined in the previous paragraphs. Numerous studies have examined the existence of cross-business synergies stemming from different functional areas including manufacturing (Rumelt, 1974; Robins et al., 1995), R&D (Chatterjee & Wernerfelt, 1991), marketing and advertising (Capron & Hullan, 1999; Chatterjee et al., 1991), and managerial and human resource practices (Ilinitich & Zeithaml, 1995; Prahalad & Bettis, 1986). Following Tanriverdi et al. (2005), we define knowledge relatedness as 'the extent to which a multibusiness firm uses common knowledge resources across its business units.' Potential sources of resource relatedness to be considered in service diversification represent technological knowledge relatedness and customer knowledge relatedness. In the case of servicing

products, original manufacturers have an advantage due to the intimate knowledge of the product design, access to genuine spare parts, engineering capabilities and understanding of product functioning. Moreover, when offering services, firms also extend their access to customers. Once services are deployed, feedback from service activities might be instrumental for sales and marketing performance as well as product development activities. It is also important to note that due to large differences in the practice of managing manufacturing and service activities, managerial knowledge relatedness might be absent in the case of service diversification resulting in diseconomies of scope as well (Levitt, 1980).

Product knowledge relatedness

Synergies arising from product knowledge have been the traditional focus of diversification research and they refer to synergies on the level of R&D, product design and manufacturing processes. When a firm starts to provide services on its own products, there is a natural knowledge relatedness to be exploited on the level of technological capabilities and knowhow that can be transferred from product engineering departments to the service activities of the firm. Economies of scope from the technological knowledge resource relatedness are realized by spreading the investment in engineering capabilities and technological knowhow over products and services. Technological expertise represents assets that can be leveraged when engaging in related service activities to improve service quality and overall customer value compared with an independent service provider.

Apart from the product knowhow, manufacturers possess many of the specialized production technologies required to fabricate spare parts or to upgrade existing equipment (Oliva et al., 2003). This specialized production technologies and technological expertise can also be leveraged when engaging in related service activities to improve service quality and overall customer value, thereby adding to the demand-side economies of scope for the customer. Vice versa, information on performance of products, collected by the service technicians working at the customer site has its direct use in R&D, activities and might result in manufacturing process improvements (Oliva et al., 2003).

Customer knowledge relatedness

Customer knowledge refers to the needs, preferences, and buying behaviours of customers—why they purchase specific products and services, which product/service attributes they value, what value they hope to get by using them (Tanriverdi et al., 2005b). Customer knowledge develops over long periods of time and requires frequent interactions with customers (Woodruff, 1997). (Srivastava, Fahey, & Christensen, 2001)) develop a similar construct labelled “intellectual market based assets”. These assets involve identifying and selecting market segments, developing appropriate offerings and assembling the resources required to produce and deliver the offerings. Firms invest considerable resources in creating deep and insightful customer knowledge (Fahey, 1999; Glazer, 1991) and considerable synergies can be created by leveraging this knowledge across different businesses that aim at the same customer base.

In the case of service diversification, service business can readily benefit from the long-term relationships with the customer and incur lower customer acquisition costs; they have the timely and detailed information on the customer's requirements for services. Further to that, given that they have the proprietary knowledge on the product and the service needs, they are best placed to offer targeted services that fit the needs of the customer (Oliva et al., 2003).

From the opposite perspective, service encounters are an important source of information on customer needs and preferences. This is especially important for products with long lifecycle where the equipment is purchased perhaps only once in a decade, but serviced throughout its lifetime. As a firm provides more services information becomes available on the actual functioning of the product as well as the broader needs and concerns of the customers. This information can contribute considerably to the efficiency of the sales performance for product activities. In addition, both products and services might benefit from joint communication and advertising activities, can share distributional infrastructure, country-specific knowledge and even human resources, all resulting in economies of scope in the traditional sense.

(Lack of) Organizational knowledge relatedness

Finally, the concept of managerial knowledge relatedness suggests that economies of scope between two businesses activities can be exploited to the extent that businesses can rely on similar organizational and managerial insights, experiences and practices (Tanriverdi & Venkatraman, 2005a)..

In the case of service diversification, such managerial or organizational economies of scope might be absent. On the contrary, examples from practice warn us that services and products require different organizational and managerial practices (Levitt, 1980) and many authors and case studies show that organizational principles, structures and processes required for services are distinct and hence new to manufacturing companies (Oliva et al., 2003).

Recent research testifies of the hurdles that manufacturing companies have been facing in the implementation of servitization strategies (Oliva et al., 2003; Brax, 2005; Gebrauer et al., 2005; Laine et al., 2007; Mills et al., 2008). The notion of ‘service paradox’ is being coined (Gebrauer et al. 2005) to depict an absence of expected strategic and financial benefits when diversifying into services and due to lack of managerial attention and skills to manage effectively service activities within manufacturing firm (Reinartz & Ulaga, 2008).

This lack of managerial and organizational knowledge introduces diseconomies of scope when product manufacturers diversify into services.

These arguments lead to the following hypothesis:

Hypothesis 3a: Manufacturing firms diversifying into services benefit from production complementarities when economies of scope on the level of products and customer knowledge outweigh diseconomies of scope on the level of managerial and organizational practices.

EMPIRICAL ANALYSIS

The empirical research has been conducted in close collaboration with a large multinational industrial equipment manufacturer that has been developing its after-sales service portfolio over the last years and has gradually embraced more service intensive business models. Currently the firm is active in more than 100 countries and employs over 25.000 people worldwide. Consolidated annual revenues exceed 7 billion USD.

The firm under study provides machinery and solutions for industrial customers in a variety of industries. Product offerings include a variety of equipment types that complement each other to cover all potential industrial applications. For the majority of customers - mostly industrial manufacturers themselves, situated in a wide range of industries - products represent investment goods with a lifecycle of 10 years and more. The whole range of products offers substantial potential for services.

Over the last decade, the company has developed a range of services to support its products ranging from traditional after sales services (e.g. spare parts) to fully integrated service packages that include maintenance and monitoring services. Firm's strategy is governed by the idea that customers are best served by having their machines attended to, maintained and repaired by well-trained qualified staff, which guide customers in terms of improvements and reduced energy costs. In this respect customers are considered best served by using original parts and consumables for their machines.

Today, the company's global strategy is to offer these services to all of its customers with the aim of reaching a 1 to 1 ratio, i.e. services are provided for every machine sold. While standard service packages and spare part arrangements have been implemented worldwide, current developments imply extending and standardizing service offerings related to inspection, preventive maintenance and total maintenance plans, extending service business from their machine service to related workplace services including taking charge of the relevant part of energy optimization at client site.

Their approach towards servitization has been gradual. As a leader in its industry— with a competitive advantage based on top quality products— the development of complementary after sales service activities has been perceived as a natural diversification strategy. Apart from the expected market advantages - offered by delivering more complete solutions to its customers – services is also regarded as an important source of sustainable growth.

We have collected data for individual subsidiaries of a firm under study, relating to the 2001-2007 time period. These subsidiaries belong to the same company and sell the same range of products in different country markets resulting in a quasi-experimental design. The data have been obtained from internally available information sources collected at the level of the individual subsidiaries as well as at the level of headquarters.

To ensure comparability of the data, we have only chosen subsidiaries that act as the sales and service centers for a given country or a region, offering a comparable range

of product portfolio. Our analysis is based on the sales and service centers that have a tradition of servicing equipment for at least 7 years, equal to a minimum lifecycle of the equipment being sold; this excludes 15 newly bought or formed subsidiaries that are still in the process of integrating and becoming service providers. This criterion ensures that we have comparability of the subsidiaries with respect to the maturity of the service diversification process (Oliva et al., 2003). In total, our sample consists of 44 subsidiaries.

Despite their homogeneity with respect to products, brands and corporate governance, each subsidiary differs significantly in terms of organizational structure, local practices, management style, and approach to servitization. Between country differences become obvious when looking at the service share of total revenues: while the average share of services within total sales equals nearly 40% for the company as a whole, it varies between 11 % and 63% on the level of individual subsidiaries. Given that the industry, reputation and corporate strategy are shared among the country subsidiaries, it can be stated that this study design is based on the variability in the organizational practices and environmental factors. The collaboration with one single firm allows us to access data on performance which are not available from public sources.

Dependent variables

In hypotheses 1 and 2, given our focus on consumption complementarities, we use the products and service sales as dependent variables. For hypothesis 3 we use profit margin as a dependent variable to test the existence of production complementarities between products and services (Hoskisson, Hitt, Johnson, & Moesel, 1993;

Venkatraman & Ramanujam, 1986). In our research we use net profit margin, which represents the ratio between profits obtained after deducting all direct and indirect costs accrued by a subsidiary and before interest and taxes, and total sales. To sum up, three dependent variables are used for testing of the hypothesis. Let **product_sales_{*i,t*}** represents the sales of the products in a given subsidiary *i* for a given year *t*. Similarly, **service_sales_{*i,t*}** denotes the sales of the services in a given subsidiary *i* for a given year *t*. Finally, **net_profit_{*i,t*}** denotes the net profit margin.

In hypotheses 1 and 2, we introduce a one-year lag into our performance measures to form the instrumental variables of the regressors. The range of the time variable *t* is from 2001-2007; introducing a one year lag, implies 6 time periods in models with sales volume.

Independent variables

While sales of products represents dependent variables in testing hypotheses 2a and 2b, it represents the explanatory variables in testing hypothesis 1. Similarly, sales of services represents dependent variable in testing hypothesis 1, while it represent the explanatory variable in testing hypotheses 2a and 2b. Given considerable levels of correlation between services and products sales in the same subsidiary *i* and year *t*, as well as the expected mutual relationship between products and services, we anticipated that the right-hand side variables are endogenous. Therefore, we opted to introduce instruments for the right-hand side variables in the model. Details of the model will be discussed in the next section “Statistical methods and the analysis”.

Service sophistication index

A service sophistication index has been constructed by calculating the proportion of service packages (as opposed to sales from spare parts) in relation to the total service sales. Spare parts sales represent over-the-counter selling of spare parts, while service packages involve visits of the technicians who perform the service, thereby bundling parts and service. The service sophistication index therefore measures how much subsidiaries have succeeded in offering more complete service solutions to their customers and acts an independent variable when examining hypothesis 2b. Service sophistication is calculated as follows:

¶ *Service sophistication index* $_{i,t}$ = *service package sales* $_{i,t}$ / *service sales* $_{i,t}$, where

Service sales $_{i,t}$ = *spare parts sales* $_{i,t}$ + *service package sales* $_{i,t}$

Service coverage

In order to test the impact of service diversification on economic performance in hypotheses 3, we have designed a specific indicator of service diversification, labeled service coverage.

The specificity of the service diversification and the complex nature of the relatedness between products and services have motivated us to construct a specific diversification indicator. In the case of service, diversification traditional measures of diversification as Herfindahl index (Montgomery, 1982), the entropy index (Jacquemin & Berry, 1979; Palepu, 1985) and concentric index (Robins & Wiersema, 2003) are less efficient and can even lead to wrong conclusions, especially when compared over time. The underlying reason for this is that services are much less

prone to demand fluctuation of investment cycles than equipment. Though this is considered to be one of their major advantages (Quin et al., 1986; Anderson et al., 1995), it poses problems for measurement. In good economic years when the demand for equipment is high, demand for services will remain to respond moderately to the upward trend. In the years of economic downturns, when the equipment demand shrinks due to overall decreasing demand for new equipment, service demand will stay moderate and even benefit from ‘aging’ equipment population and lack of equipment renewal in the market. Stated differently, share of services in total sales, as well as entropy measures can fluctuate over time, solely due to the different sensitivity between products and services in relation to economical market conditions.

Service coverage avoids this bias by dividing service sales with equipment population sold over a period of years. Service coverage also represents more intuitive measure of extent of service diversification and depicts better the effect of multi-period returns of this type of diversification.

Service coverage is defined as sales of services divided by the volume of sold equipment sold over previous 4 years. Note that the 1-year gap between the service sales and sold volume of equipment is to account for the warranty period where services, even if effectuated within the first year, would be delivered to the customer free of charge.

$$\mathbb{I} \quad \textit{Service coverage}_t = \textit{service sales}_t / (\textit{equipment volume}_{(t-1) + (t-2) + (t-3) + (t-4)})$$

(Corrected) Gross Domestic Product

Finally, considering that each subsidiary represents one country, we include annual GDP data to control for within country fluctuations that might affect sales and margins of the subsidiaries under study. In order to better depict the economic climate in the country, we correct GDP by deducting exports and adding imports. Country data on GDP, as well as exports and import statistics, have been obtained from 2008 World Development Indicators Online of The World Bank. 2007, accessed through the World Resource Institute.

Number of employees

In testing the economies of scope in production we control for the number of employees, considering that employee fluctuations might affect the realized margins of a subsidiary. Controlling for the number of employees is especially important in case of service diversification, given relatively higher labor intensiveness of service activities compared to product activities.

Table 1 provides an overview of summary statistics of all variables used in the analysis.

Table 1:
Descriptive statistics for the Independent and Dependent Variables

Variable	Observations	Mean	Std. deviation	Min	Max
Equipment sales	308	18570	24151	559	146965
Service sales	308	10905	11237	223	78325
Profit margin	287	0.30	0.06	0.14	0.45
Service coverage	273	4.66	2.63	0.74	14.34
Servitization index	307	0.57	0.23	0.09	0.94
GNP	308	755	1702	11	11722
GNP/capita	287	15.1	12.9	0.4	49.8
Employees	287	121.2	113.2	7.0	725.0

STATISTICAL METHODS AND EMPIRICAL MODELS

We tested our hypotheses using a fixed-effects panel model with instrumental variables. We introduced fixed-effects to address issues in longitudinal panel analyses such as unobserved heterogeneity among cross sections and its association with model variables (Greene, 2003). The fixed-effects model includes dummy variables for each subsidiary, thereby “specifying an estimable conditional mean” and addressing biased and inconsistent parameter estimates (Greene, 2003: 285).

In testing hypotheses 1 and 2, we use instrumental variables to address issues of endogeneity that might arise due to the complementary nature of products and services sales (Wooldridge, 2002). In practice, we developed a system of equations which are estimated by using two-stage least square generalizations of simple panel-data estimators (Baltagi 2001, Anderson and Hsiao 1981).

$$\text{¶ } \textit{service_sales}_{i,t} = a1 + b1 \times \textit{product_sales}_{i,t-1} + c1 \times \textit{gdp}_{i,t} + v1_i + \varepsilon1_{i,t} \quad (1)$$

*where product_sales*_{i,t-1} = *f*(*product-volume*_{i,t-1})

$$\text{¶ } \textit{product_sales}_{i,t} = a2 + b2 \times \textit{service_sales}_{i,t} + c3 \times \textit{gdp}_{i,t} + v2_i + \varepsilon2_{i,t} \quad (2)$$

*where service_sales*_{i,t} = *f*(*product_sales*_{i,t-1}, *service_sales*_{i,t-1})

$$\text{¶ } \textit{product_sales}_{i,t} = a3 + b3 \times \textit{service_sales}_{i,t} + c3 \times \textit{service_sophistication}_{i,t} + c3 \times \textit{gdp}_{i,t} + v3_i + \varepsilon3_{i,t} \quad (3)$$

*where service_sales*_{i,t} = *f*(*product_sales*_{i,t-1}, *service_sales*_{i,t-1}),

and *service_sophistication_index*_{i,t} = *f*(*service_sophistication_index*_{i,t-1})

$$\mathbb{I} \quad total_sales_{i,t} = a1 + b1 \times service_share_{i,t-1} + c1 \times gdp_{i,t} + v1_i + c \quad (4)$$

$$\mathbb{I} \quad net_profit_{i,t} = a4 + b4 \times service_coverage_{i,t} + c4 \times service_sophistication_{i,t} \\ + d4 \times employees_{i,t} + e4 \times gnp_percapita_{i,t} + v4_i + \varepsilon_{i,t,t} \quad (5)$$

In all equations, v_i and $\varepsilon_{i,t}$ represent the country dummies and specific residuals, respectively. In equations (1), (2) and (3) all explanatory variables are regressed on their lagged values (Wooldridge, 2002), while service sales have been in addition regressed on the lagged equipment sales, in line with what is proposed in equation (1).

RESULTS

Table 2 and 3 summarizes the results obtained in relation to hypothesis 1 and hypothesis 2 respectively. Results indicate that products and services have mutual value-enhancing properties and that by diversifying in services product manufacturer can achieve complementary effects between both businesses activities. As shown in the table 1, higher levels of product activities in time t-1 are positively associated with higher levels of service activity within the next period (t).

Table 2
Results of the Fixed-Effects Regression Analysis
of Service Sales Performance

Variables	Coefficients	P> t
Equipment sales t-1 (a)	0,36	0.00
GDP	5,49	0.00
Constant	839	0.00
Wald statistics	5858	0.00
Within R-sq.	0,55	
F for firm fixed effects	28,30	0.00

(a) Equipment sales in t-1 has been instrumented on equipment volume sold in t-1.

In addition, Table 3 reveals that variations on the level of service activities are positively associated with product activities. Apart from the effect of the scale of service activities, model 2 also reveals positive effects the larger the share of sophisticated services, suggesting strongly that not all service activities seem to have the same value-enhancing properties. As such, this latter observation confirms hypothesis 2b.

Table 3
Results of the Fixed-Effects Regression Analysis
of Products Sales Performance

Variables	Coefficients	P
Service sales (a)	1,54	0,00
Service sophistication index (b)	12526	0,05
GDP	7,83	0,00
Constant	-11418	0,01
Wald statistics	9512	0,00
Within R-sq.	0,78	
F for firm fixed effects	104,62	0,00

(a) service sales are instrumented on services sales in t-1 and equipment sales in t-1

(b) service sophistication index is instrumented on service sophistication index in t-1

Table 4 shows the empirical results of production complementarities as advanced in hypothesis 3. Service coverage has a positive and highly significant impact on profit performance. Results presented in the Table 4 reinforce the idea that “multi product-service” firm is an effective way to organize product and service businesses and that manufacturers do achieve complementarities by diversifying in services. Stated otherwise, results presented below indicate that subsidiaries which achieve higher levels of service coverage obtain significantly higher profit margins.

Table 4 also signals that the impact of servitization index on profitability is positive, yet not significant. When discussing this observation with the company under study, it became apparent that there are two influences working simultaneously on profitability. One is the cost-efficiency of services provided and the other relates to the pricing tactics deployed, especially with respect to spare parts. The lack of significance for the servitization index can be attributed to the fact that prices of less sophisticated services (parts delivered) in a number of countries imply margins equal or even higher than more sophisticated service activities.

Table 4				
Results of the Fixed-Effects Regression				
Analysis				
of Net Profit Margin performance				
Variable	Coef.	Std.	t	P>t
Service coverage	0.0337	0.0109	3.09	0.00
Servitization index	0.0582	0.0405	1.44	0.15
Employees	-0.0002	0.0001	3.11	0.00
GNP/capita	4.0700	1.2200	3.33	0.00

Constant	0.1742	0.0290	6.01	0.00
F statistics	9.19			0.00
Within R-sq.	0.14			
F for firm fixed effects	12.14			0.00

CONCLUSION AND DISCUSSION

Servitization has traditionally been conceived as a one-way process from product-dominant to service dominant business models where product offerings become gradually embedded in more sophisticated service packages. This conception of service diversification seems to introduce growth implications: the installed product base is eventually defining the market potential for services. Within this contribution we questioned this conception. Building on arguments stemming from the resource based view on the firm and transaction cost economics, we hypothesized that consumption and production complementarities might result in positive relationships of a bi-directional nature. Testing these hypotheses on panel data from a manufacturing firm diversifying into related service diversification confirmed the relevance of such a broader conception. As such, these findings have several implications. First, our results shed a new perspective on the trade-off between staying close to the product base and accepting growth limitations on the one hand, and moving into more unrelated service activities implying increased risks to become confronted with the service paradox on the other hand. Our findings reveal that firms can opt for related service diversification and experience growth dynamics beyond the current installed product base. Secondly, the positive impact of service activities is reinforced, the more sophisticated service activities become; findings suggesting a concrete alternative for unrelated service diversification. Thirdly, these observations

might also contribute to a more effective approach to handle the aforementioned service paradox: the presence of mutual beneficial relationship might inspire companies to devote sufficient senior managerial attention towards defining and deploying service activities within manufacturing environments.

At the same time, our study has its limitations, leading to concrete suggestions for further research. Our empirical results have been obtained from collaborating intensively with one single company; this has proved to be highly valuable to obtain the required detailed information and to establish the relevance of enriching the servitisation concept by means of a quasi-experimental design. At the same time, future research might investigate the occurrence of such value dynamics on a larger scale, including contingencies that might affect the advanced complementarities. Such future efforts might devote specific attention to the organizational and managerial practices that affect the presence and magnitude of these complementarities. As mentioned, reaping the benefits of servitization implies transcending the complexities induced by hosting products and services under one and the same corporate roof. As pointed out, there are huge differences in managing product and service activities, and findings from previous case studies emphasize the need of organizing services separately from their product counterparts. While we fully agree with this viewpoint, our findings also suggest that organizational arrangements are needed that allow complementarities between products and services to arise. So besides differentiation, integration becomes a point of concern, at least if complementarities are to be realized. Not only the nature of such organizational arrangements presented itself as an important area for future research; introducing the presence and nature of economies of scale of services seems as relevant.

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