Manufacturers' Strategic Intensity on Servitization and its Impact on Firm Profitability: A Panel Analysis

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1. Introduction

This study explores the development of services in the manufacturing sector on two levels. First, it portrays how the landscape of services in the manufacturing industry evolves over the past 10 years. Second, it investigates how manufacturers' strategic focus on services impact its profitability. The first chapter introduces into the topic of services in a manufacturing context. Therein, chapter 1.1 points out the relevance of the topic from a marketing and a practitioner's perspective. The following chapter 1.2 states the research questions and the objectives of the study. Finally, chapter 1.3 concludes with an overview of the study's structure. The chapter's overall goal is to present extant research gaps and to show how the conducted research helps to close them.

1.1 Relevance for Marketing Research and Management

Manufacturers in developed countries such as Germany, United States, and Japan are increasingly under competitive pressure (Oliva and Kallenberg 2003; Wise and Baumgartner 1999). Modern advancements in telecommunication and logistics technology create ideal conditions for global competition from low-cost countries (Porter 1986; Raddats et al. 2016). Therefore, manufactured goods become increasingly commoditized (Rust and Miu 2006) and price-based competition decreases thin profit margins (Foote et al. 2001; Wise and Baumgartner 1999). Traditionally, manufacturers in developed countries have been able to establish a competitive edge through product and process innovations (Porter 1987). However, fast and widespread access to know-how in the era of information technology renders this advantage in most cases unsustainable (Baines et al. 2009; Gebauer and Fleisch 2007). Consequently, manufacturers have started to enhance their manufactured goods with more service offerings (Chase and Erikson 1989; Vandermerwe and Rada 1988). These services range from simple after-sales services such as maintenance and installation, to more advanced services such as advisory services (Mathieu 2001a; Zeithaml and Brown 2014). For instance, the German tool and machine manufacturer Trumpf GmbH offers a wide range of services next to their core physical products, like maintenance, software, trainings, and technical customer care (Trumpf 2020). Another example is the chemical company BASF which offers for instance painting products for the automotive industry (BASF 2016). The company has also a comprehensive painting service taking charge of the entire automotive painting process (BASF 2020). The shift to-

wards services is a worldwide trend among manufacturers. Services increasingly generate a major part of manufacturers' total revenues. In 1990, service revenues in U.S. manufacturing accounted on average for about 8.9% of total revenues (Fang, Palmatier, and Steenkamp 2008). That figure increased tremendously over the years to 42.2% in 2005 (Fang, Palmatier, and Steenkamp 2008). Crozet and Milet (2017) find out that French manufacturers also increased their service offerings from 1997 to 2007. These global developments underline how the importance of services in manufacturing has changed over the last decades.

However, service offerings in manufacturing are not a new phenomenon, but always coexisted next to manufactured products. Basic services such as installation and maintenance have been a part of manufacturers' portfolio from the very beginning (Vandermerwe and Rada 1988). The significant change is the extent and meaning of services within the manufacturing industry (Vandermerwe and Rada 1988). First, services were regarded just as a supplement to the core physical product without an important meaning in itself (Kyj 1987; Vandermerwe and Rada 1988). This was also driven by the fact that most goods-based companies had an established company culture focusing on physical goods (Vargo and Lusch 2004). The sales force for instance was incentivized to sell as many products as possible and services were often given for free in the process (Ulaga and Reinartz 2011). However, driven by competitive pressure the manufacturers' attitude towards services has changed significantly over time (Lusch, Vargo, and O'Brien 2007; Vandermerwe and Rada 1988). Especially, since the late 1980s manufacturers increasingly regard services not as a supplement but as an important source for a sustainable competitive advantage (Vandermerwe and Rada 1988). This is showcased by iconic examples such as IBM's strategic refocus on business consulting (Gerstner 2002), Rolls Royce's innovative service program "Power-by-the-Hour" (Smith 2014), or Michelin's fleet solution for commercial tires (Ulaga, Dalsace, and Renault 2006). Thus, services have evolved from an insignificant byproduct to a strategically critical part in the manufacturing business.

The real-world applications also stimulate the interest of marketing research into the topic. In the late 1980s, Vandermerwe and Rada (1988) analyze how manufacturers enhance their physical offerings with services. They coin the term "servitization" (Vandermerwe and Rada 1988, p. 315) which describes manufacturers shift from a goods-centered to a service-centered focus (Raddats et al. 2019). This sets essentially the foundation for the research field of servitization (Osterrieder 2021). Since then, researchers increasingly deal with questions con-

cerning services in goods-based firms. Themes of the research include for example the conceptual foundation of servitization (e.g., Vandermerwe and Rada 1988; Vargo and Lusch 2004), implementation of services (e.g., Rabetino, Kohtamäki, and Gebauer 2017; Ulaga and Reinartz 2011), and its implications (e.g., Eggert et al. 2014; Fang, Palmatier, and Steenkamp 2008; Nezami, Worm, and Palmatier 2018). There are still many open research questions within these servitization topics. The following paragraphs present the development of services in manufacturing (i.e., service landscape) and financial outcomes of services as two distinct research gaps.

There have been several research studies conducted to find out how industrial services can be classified into different types (Mathieu 2001a; Neely 2008; Ulaga and Reinartz 2011). However, there are three aspects which demand more research in this topic. First, there is no universally accepted classification within the literature. Some authors prefer a simple 2-type classification (Mathieu 2001a) while others place services along a continuum (Zeithaml and Brown 2014). The missing consistency makes a comparison and synthesis of research results much harder. In addition, it underlines that research into service classifications is a highly complex research field with apparently no one-size-fits-all solution. Second, the seminal research in this field is based primarily on qualitative data such as in-depth interviews (Mathieu 2001a) and case studies (Ulaga and Reinartz 2011). However, quantitative research is essential for verification and generalizability of research results (Park and Park 2016). Hence, there is a need for quantitative data to analyze different service types in manufacturing. This becomes also clear in the outlook statements of quantitative papers, which underline that their results need to be tested and backed up using quantitative data (Ulaga and Reinartz 2011). For instance, Ulaga and Reinartz (2011, p. 22) underline "A natural next step would be an empirical validation to quantify the proposed effects.". Third, there is no research looking at service types from a dynamic perspective. Studies in this domain are exclusively looking at manufacturers' services at a single point of time (e.g., Neely 2008), but not how services evolved over time. For instance, Lee and Hong (2016, p. 572) state: "Currently, our analysis is limited to a current snapshot of an industry.".

These three aspects constitute the first research gap to be addressed by this study. Specifically, this study aims to provide a comprehensive quantitative analysis on the manufacturers' servitization development. On the one hand, this provides empirical validity to existing research about service classifications. It offers a chance to consolidate existing knowledge to

create a consistent understanding of services in manufacturing. On the other hand, it contributes significantly to the better understanding of how services unfold in manufacturing over time. From a managerial perspective, this study gives a unique overview of service offerings among manufacturers. Managers can use this information to benchmark their own company's service offerings against their respective industry. This helps them to critically assess their current strategic position in services. In addition, the longitudinal view helps them to detect long term service trends and make strategic decision based on that information.

Another major research stream deals with the financial implications of manufacturers service offerings. The shift towards services is not a given success road for manufacturers (Gebauer, Fleisch, and Friedli 2005). This is shown on the one hand in real world cases and on the other hand in academic research. Highly cited examples of IBM's shift towards services (e.g., Allmendinger and Lombreglia 2005; Davies, Brady, and Hobday 2006) and Rolls Royce's Power-by-the-hour service program (e.g., Baines 2015; Smith 2014) depict services as a source for sustained competitive advantage. In contrast, there is also research showing that manufacturers struggle to turn their service initiatives into financial success (e.g., Benedettini, Neely, and Swink 2015; Gebauer, Fleisch, and Friedli 2005; Neely 2008). These mixed financial results of servitization indicate a complex relationship between services and financial outcomes. The initial tenor of research was that services help manufacturers to strengthen their market position (Vandermerwe, Matthews, and Rada 1989; Wise and Baumgartner 1999). However, research into financial outcomes reveals that achieving success through services depends on many contingency factors. For instance, seminal research indicate that financial success of service offering depends on the level of service revenues (Fang, Palmatier, and Steenkamp 2008), the specific service type (Eggert et al. 2014), and the service business model (Visnjic, Wiengarten, and Neely 2016). These findings are significant contributions to the better understanding of financial implications. However, there are two research gaps in this field to be addressed. First, the number of quantitative research in this domain is still low. Wang, Lai, Shou (2018) identify only 41 quantitative research studies from 2002 to 2017 in their meta-analysis about financial outcomes of servitization. Second, there is only a few research studies combining textual and numerical data on servitization (e.g., Neely 2008; Visnjic, Wiengarten, and Neely 2016). However, Lee and Hong (2016, p. 572) point out that an "annual report contains various types of numerical data such as security prices and financial statements. By combining them with textual data, more advanced business model anal-

yses […] might be possible". Hence, there is a great potential to gain new insights from combining textual and financial data from manufacturers' annual reports.

This study addresses both research gaps. First, it presents a new quantitative study of financial implications which can help to validate existing research findings and their generalizability. Second, this research uses a unique panel dataset of textual and financial data from manufacturers' annual reports. There has been no prior research that has employed the study's unique servitization measurement in this scale and context. Hence, this study contributes significantly to the literature with new insights on how servitization translates into financial success. Managers profit from this research as well. The study results help managers to identify critical success factors for servitization and derive valuable lines of action to turn their service business into profitable venture.

1.2 Research Questions and Objectives

Several review articles underline that servitization research experiences a surge in recent years (Lightfoot, Baines, and Smart 2013; Rabetino et al. 2018). However, there are still two methodological challenges in this research field. First, the research relies predominantly on qualitative data such as in-depth interviews, and case study analyses (Rabetino et al. 2018; Raddats et al. 2019). Second, a lot of relevant information for business research is in form of text (Berger et al. 2020). There are only a few servitization studies that take advantage of textual data (e.g., Benedettini, Swink, and Neely 2017; Visnjic, Wiengarten, and Neely 2016). This study addresses both methodological challenges with the help of two main parts.

The first part of this research focuses on the descriptive analysis of service classifications. To date there is no research using qualitative data to describe comprehensively how servitization in manufacturing has developed over time. This study closes this research gap by analyzing a comprehensive quantitative dataset about manufacturers service offerings. Using a broad- and fine-grained service classification (i.e., service types), the study portrays the servitization landscape in the U.S. manufacturing industry. In this context prior research shows also that servitization may develop differently depending on the manufacturing industry and firm size (Crozet and Milet 2017). Accordingly, the study states following three research questions:

(1.1) How do service types develop over time?

(1.2) How do service types develop in different manufacturing industries?

(1.3) How do service types develop depending on firm size?

The objective of the first part is to give a comprehensive overview of how servitization evolved to its current state in the different manufacturing industries. Moreover, it supposed to clarify the predominant service types offered in manufacturing. In order to do so, this first part focuses on a descriptive analyses of textual servitization data.

The second part focuses on financial implications of servitization. There is already quantitative research in this field (e.g., Eggert et al. 2014; Fang, Palmatier, and Steenkamp 2008). However, to date there are only a few publications that take advantage of textual data as an input (Visnjic, Wiengarten, and Neely 2016). This study combines financial and textual data to investigate the financial outcome of servitization. Specifically, the research study focuses on how servitization impacts firm profitability, which adds a new quantitative study to the extant literature. Prior research indicates that financial implications may differ depending on service types and contingency factors (Antioco et al. 2008; Eggert et al. 2014). Thus, the study states the second set of research questions as follows:

(2.1) How do different service types impact a firm's profitability?

(2.2) How do contingency factors influence the relationship between service types and profitability?

In order to provide a comprehensive analysis and answer the two research questions, this study proceeds as follows. First, it develops a theoretical foundation to establish a link between servitization and financial outcomes. Most servitization research does not specify an underlying theory (Wang, Lai, and Shou 2018), since they are exploratory in nature or they are based on conceptual thoughts. However, among the used theories in servitization, the Resource-based view (RBV) is the most popular one (Wang, Lai, and Shou 2018). In the context of this research, the Resource-based view presents a suitable theoretical foundation as well. The RBV theory can explain a potential direct relationship between servitization and financial performance (Eggert et al. 2014). In addition, it can justify how contingency factors influence the relationship of servitization and financial performance (Fang, Palmatier, and Steenkamp 2008). This theoretical analysis significantly contributes to a better conceptual understanding of causal relationships within servitization. A set of hypotheses and an according conceptual model is the result of this initial theoretical analysis. They are empirically tested using a unique panel data set.

The following figure 1.1 gives an overview of how the data and the two parts of this study are interconnected.

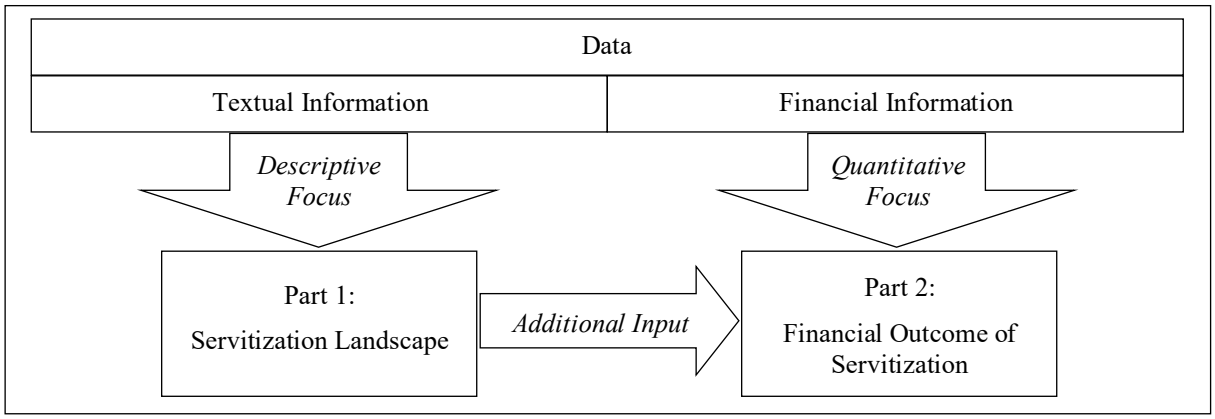

Figure 1.1: Two-Part Data Analysis

1.3 Research Design

This study is structured into six main chapters. Figure 1.2 gives an overview of the structure and how the individual chapters are interconnected.

Chapter 1 introduces into the overall topic of servitization in a manufacturing context. Subchapter 1.1 shows the relevance of the topic for marketing research and management. It also reveals existing research gaps. In the subchapter 1.2, the research questions and the objectives are stated. The current chapter 1.3 gives an overview of the study's research design.

Chapter 2 conducts a literature review of the relevant servitization research. First, the term servitization is characterized and defined in subchapter 2.1. This ensures a consistent terminology throughout the entire study. Subsequently, a literature overview is given for servitization research in subchapter 2.2.

Chapter 3 focuses on the first set of research questions dealing with the descriptive analysis of the servitization landscape. Therein, subchapter 3.1 presents the servitization data, subchapter 3.2 explains how variables are measured, and subchapter 3.3 describes the used analysis method. The results of the descriptive analysis are shown in subchapter 3.4 and subchapter 3.5 presents the conclusions of the analysis.

Chapter 4 presents the theoretical framework for the financial impact of servitization. In the subchapter 4.1 the Resource-based view theory is presented in general. Subchapter 4.2 puts the RBV theory into the context of servitization. Finally, subchapter 4.3 derives the hypothe-

ses based on the prior stated theoretical considerations and builds a conceptual model to be tested in the next chapter.

The fifth chapter starts with a description of the data used for the study's second part. Subchapter 5.2 operationalizes the variables of the conceptual model followed by subchapter 5.3 which presents the method of fixed effects panel regression to test the conceptual model. Subchapter 5.4 presents the results of the fixed-effects panel regression.

The study concludes with a discussion of the results in chapter 6. At the beginning, subchapter 6.1 discusses the study's key findings in its two main parts. Subsequently, the implications for marketing research and management are presented in subchapter 6.2. Finally, the research limitations as well as future research avenues are discussed (subchapter 6.3).

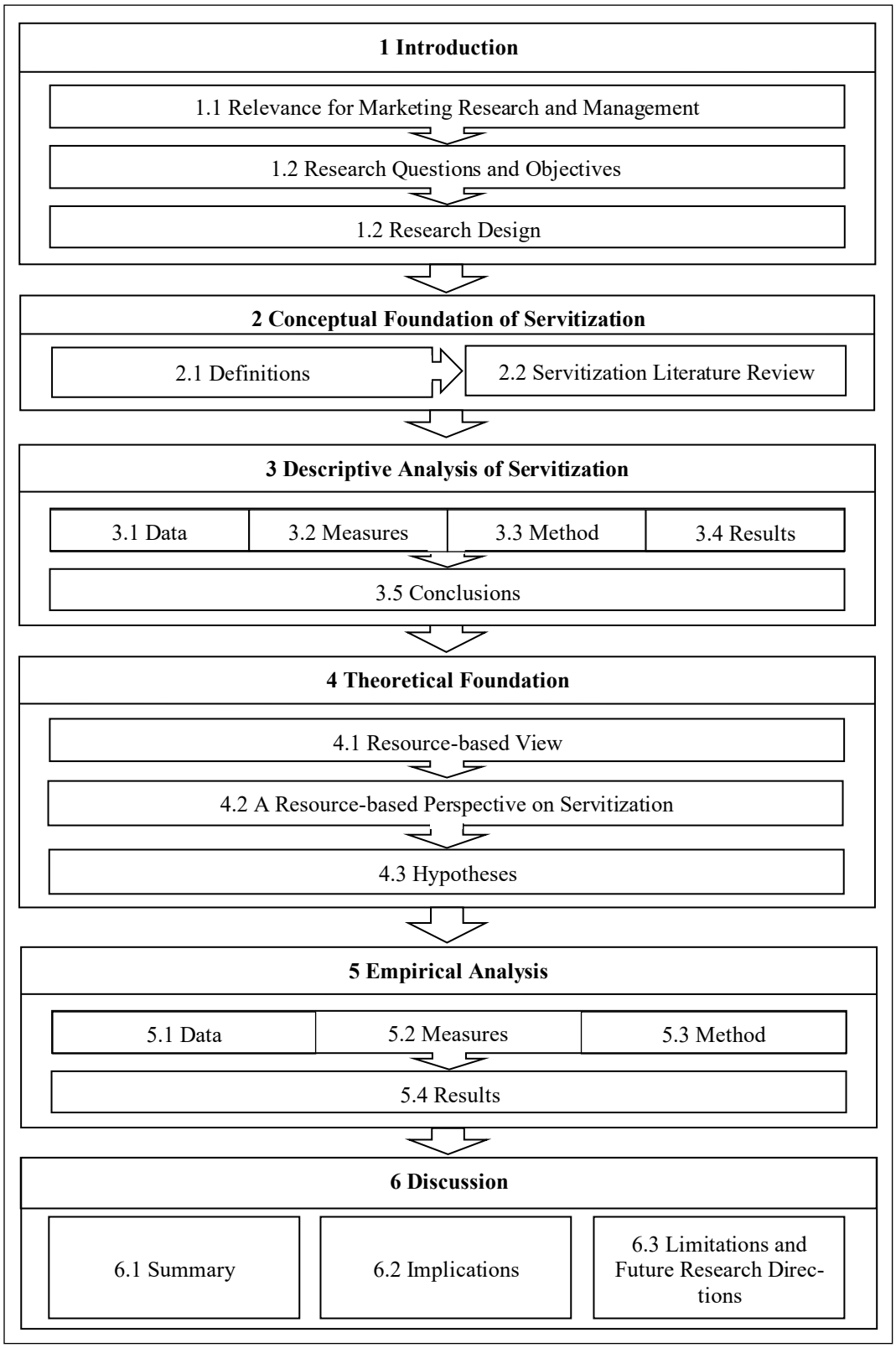

Figure 1.2: Overview of Research Design (Adapted from Eggert 1999)

2. Conceptual Foundation of Servitization

This chapter sets the conceptual foundation for the rest of this study. First, subchapter 2.1 discusses in detail services in a manufacturing context. It develops a working definition for servitization, which will be the underlying understanding of industrial services in this study. Subsequently, the chapter 2.2 conducts a literature review on servitization.

2.1 Definitions

In order to develop a concise idea about the meaning of servitization, this study utilizes a two-step procedure. The first step is to gather existing definitions of services in a manufacturing context (subchapter 2.1.1). In a second step, those definitions are structured and synthesized to detect fine nuances of servitization (subchapter 2.1.2). Based on the insights of both steps the study presents its working definition for servitization.

2.1.1 Existing Terminology and Characteristics

In extant literature there are several terms used to describe services in a manufacturing context. Exhibit 1 shows a chronological overview of used terms and their definitions in research. Following the chronological order, the following paragraphs discuss each of these definitions.

The phenomenon of manufacturers' adding services to their physical offerings is far from new and dates back to the early 20th century (Livesay and Porter 1969). For instance, from 1899 to 1948 U.S. manufacturers expanded their portfolios through the addition of services such as financing and maintenance (Livesay and Porter 1969). However, the systematic exploitation of services as a competitive advantage started with manufacturers' move into so called "systems selling" (Murray 1964). In the early 1960s, manufacturers started to bundle their manufactured goods and services into "systems" to create a competitive advantage through product differentiation (Mattsson 1973; Murray 1964). A system is defined as a set of products and services which together fulfill a customer need (Mattsson 1973). Mattsson (1973) defines system selling as the sale of a product, service, and know-how bundle to meet a customer's needs. In an industrial context, examples for such systems are inventory handling systems, air conditioning systems, and production control systems (Mattsson 1973). The manufacturer's tacit know-how about the system and customer processes plays a key role in systems selling (Mattsson 1973). That specific know-how about the systems' functionality in an individual

customer context creates the systems' overall value that goes beyond the sum of its individual parts (Mattsson 1973). Systems selling has several typical characteristics. First, manufacturers can sell systems on different levels. They can either sell the full system or only parts of it. Hence, system selling moves along a continuum with one extreme the manufacturer being the supplier of a single subsystem and the other extreme being the manufacturer providing the full system (Mattsson 1973). In line with this, the different subsystems (i.e., products and services) can be sold separately as well (Mattsson 1973). Another characteristic is that the sold systems and subsystems are to a certain degree standardized (Mattsson 1973). Limited customization happens depending on a customer individual needs (Mattsson 1973). However, the term systems selling did not establish itself as a key term to describe services in a manufacturing context. Despite this fact, it is important to know about it for two reasons. First, researchers occasionally use the term to describe manufacturers' combined product-service offerings (e.g., Davies, Brady, and Hobday 2007; Millman 1996). Second, it is the first systematic conceptualization of manufacturer's service offerings which builds the foundational reference for many following definitions (Cova and Salle 2008; Jacob and Ulaga 2008; Levihn and Levihn 2016).

In the late 1980s, the term "servitization" was coined by Vandermerwe and Rada (1988) in their seminal article "Servitization of Business: Adding Value by Adding Services". Driven by competition and changing environmental conditions (i.e., technological advances and globalization) firms increasingly offer services to stay competitive (Vandermerwe and Rada 1988). Service companies as well as manufacturers increase their portfolios by offering bundles consisting of products, services, and tacit know-how to fulfill individual customer needs (Vandermerwe and Rada 1988). It is important to notice, that the push towards services is on a strategic level which means that services take over an increasing or even dominant role in a manufacturer's business (Vandermerwe and Rada 1988). For instance, manufacturers do not only add some basic services such as maintenance, but offer an entire maintenance package that may even extend their traditional product line (Vandermerwe and Rada 1988). A key characteristics of servitization is that the bundles of products and services are highly flexible (Vandermerwe and Rada 1988). The individual parts, so called modules, of a bundle can be sold also separately giving the manufacturer the flexibility to adjust to customer needs. In line with this notion, is also the fact that modules in a bundle can be standardized or highly customized depending on customer needs (Vandermerwe and Rada 1988). A final key character-

istic of servitization is that its focus is on building close customer relationships (Vandermerwe and Rada 1988). The process of offering services next to products engages the manufacturer more with the customer (Vandermerwe and Rada 1988). That can create a more intimate relationship that go beyond the traditional transaction-based customer relationships in manufacturing. To sum up, servitization can be defined as a firm's strategic refocus on services by offering combined bundles of products, services, and know-how (Vandermerwe and Rada 1988). The idea of servitization is related to the previously stated systems selling definition (Mattsson 1973; Vandermerwe and Rada 1988). However, the key difference is that servitization puts a higher strategic focus on services (Vandermerwe and Rada 1988). The term servitization has established itself as one of the key terms to describe the provision of services in a manufacturing context. Different research communities engaged in the field of services in manufacturing such as operations management and service science also use the term servitization (Rabetino et al. 2018). Hence, it is a universally accepted terminology and will be used as a key term in this study as well.

Anderson and Narus (1995) take a different perspective when it comes to adding services in a manufacturing context. They observe manufacturers adding more and more services to their offerings without a value assessment (Anderson and Narus 1995). That means, the manufacturers are so focused on selling additional services that they do not reflect on how that service creates additional customer value[1] (Anderson and Narus 1995). This situation arises two problems. First, customers get services which they do not really need (Anderson and Narus 1995). Second, companies fight with high service management costs (Anderson and Narus 1995). As a solution for this problem, the authors describe the strategy of some manufacturers to create a bundle of products and essential services, which they call "naked solution" (Anderson and Narus 1995). Those naked solutions are then supplemented with optional existing or new services depending on the individual customers' needs (Anderson and Narus 1995). Even though the term naked solution describes a specific product-service constellation, it does not capture the full meaning of services in a manufacturing context. It rather focuses on the specific management of services in a manufacturing context. Moreover, research does rarely use the term

[1] Customer value is defined as a customer's preference for product attributes that contributes to the customer's end goal (Woodruff 1997).

naked solution. Therefore, naked solutions will not be used to define services in a manufacturing context.

In the late 1990s, the role of services in manufacturing also attracted the interest of governmental organizations. The Dutch ministries of economic affairs and environment were one of the first to fund a research project to explore the role of services in manufacturing (Goedkoop et al. 1999). The primary objective was to find out how services impact manufacturers' economic sustainability and the environment (Goedkoop et al. 1999). The research team of that project terms the combination of services and products into systems as "product service systems" (PSS) (Goedkoop et al. 1999). In particular, their definition of a PSS is that it is a set of products and services to fulfill a customer's needs while creating customer value and decreasing environmental impact (Goedkoop et al. 1999). The key difference to existing definitions is the ecological underpinning of product service systems. While economic benefits remain the focus of PSS, the environmental impact is assessed as well (Goedkoop et al. 1999). Another key characteristic is the sustainability claim of PSS (Goedkoop et al. 1999; Mont 2002). PSS aims to be ecological and profitable in the long run, and not only in the short run (Mont 2002). The PSS terminology established itself quickly among researchers (Annarelli, Battistella, and Nonino 2016; Mont 2000; Tukker and Tischner 2006). Specifically, a distinct PSS research community evolved in Scandinavia and contributed many insights in the context of services and products (Baines et al. 2007; Rabetino et al. 2018). Hence, it makes sense to take the definition of PSS into consideration when determining the meaning of services in a manufacturing context.

In the early 1990s large U.S. corporations such as IBM and General Electric initiated the concept of "solutions" by taking over entire customer processes (Gerstner 2002; Windahl et al. 2004). Since then there has been a plethora of research conducted in the field of solutions (Nordin and Kowalkowski 2010). Despite the large research output, there is neither a universally accepted term nor a widely used definition for solutions (Woisetschläger et al. 2010). There are different terms for solutions such as "customer solutions" (Tuli, Kohli, and Bharadwaj 2007), "business solutions" (Macdonald, Kleinaltenkamp, and Wilson 2016), or "integrated solutions" (Wise and Baumgartner 1999). However, despite the inconsistent terminology, the different definitions of solutions have all a similar understanding of the term. A solution is an integrated set of products and services, which fulfill customer needs through customer-supplier relational processes (Nordin and Kowalkowski 2010; Tuli, Kohli, and

Bharadwaj 2007). There are three frequently mentioned characteristics of solutions. First, they usually address a complex customer problem (Davies et al. 2001). Second, solutions are usually consist of highly integrated components which together create the value for the customer (Davies et al. 2001; Wise and Baumgartner 1999). That means the individual products and services are highly complementary and tuned to work best together. A third characteristic is the high level of customization that a solution entails (Wise and Baumgartner 1999). Solutions usually penetrate deeply into customer processes and therefore has often to be customized depending on individual customer circumstances (Davies et al. 2001). The solution concept is highly intervened with services in a manufacturing context (Rabetino et al. 2018). Compared to the other terms, the solution term takes a more customer-centric view and aims to fulfill a customer need comprehensively (Tuli, Kohli, and Bharadwaj 2007). All in all, solutions describe a specific case of services in a manufacturing context. Given the frequent use and the general research interest in solutions, its definition will be integrated into the context of this study as well.

Another term that is used to describe manufacturers' move into services is "service infusion" (Edvardsson et al. 2000; Zeithaml and Brown 2014). Service infusion is defined as the move of manufacturers to add increasingly complex services and solutions to their business model (Zeithaml and Brown 2014). Service infusion has two main characteristics. First, those services are an addition to the existing business model (Zeithaml and Brown 2014). Hence, service infusion takes place at a more tactical level of the firm. On the other hand, there are different types of service infusion. According to Zeithaml and Brown (2014) manufacturers infuse their business models with different service types along a service infusion continuum. The one end of the continuum are services in support of products (SSP) such as maintenance and installation (Mathieu 2001a; Zeithaml and Brown 2014). The other end are services in support of customers (SSC) such as advisory services and business process outsourcing (Mathieu 2001a; Zeithaml and Brown 2014). The service infusion concept established itself especially in the marketing literature (Ostrom et al. 2015). Researchers in marketing use frequently service infusion as their conceptual foundation (e.g., Eggert, Thiesbrummel, and Deutscher 2014; Forkmann, Henneberg, et al. 2017; Kowalkowski, Witell, and Gustafsson 2013). Therefore, the service infusion definition will be considered for the working definition of this study as well.

Stremersch, Wuyts, and Frambach (2001) use the term "full service" to describe a manufacturer's comprehensive offering of products and services. They underline that a full service's objective is to solve an entire customer problem (Stremersch, Wuyts, and Frambach 2001). There is no significant difference to the definition of solutions. Hence, the full service definition will be considered implicitly in the working definition of servitization.

Services in manufacturing span across a variety of disciplines such as marketing and operations management (Rabetino et al. 2018). A major research stream next to the marketing literature is the German production management literature (Meier and Uhlmann 2017; Meier, Uhlmann, and Kortmann 2005). In this research domain a key term to describe services in manufacturing context is "hybrid service bundles" (Meier and Uhlmann 2012). Hybrid service bundles are defined as the planning, development, implementation, delivery, and usage of integrated product-service combinations for industrial applications (Meier and Uhlmann 2012). The key characteristic is that it has a rather technical connotation since its origins is in the production management literature. The literature to hybrid service bundles is almost exclusively in German. Hence, there is no international research stream referring to this definition. Since it is closely related to the definition of solutions, it will not be incorporated separately into the final working definition.

A similar term is "hybrid offerings" which is also used in the context of manufacturing and services (Ulaga and Reinartz 2011). Shankar, Berry, and Dotzel (2009) define hybrid offerings as innovative product-service combinations which aim to create superior customer value. This definition entails a new characteristic which was not mentioned explicitly in prior definitions, namely innovation. Innovative in this context means that the bundle of product and service creates new benefits for the customer and that the combined parts create greater value than the sum of the individual parts (Davies et al. 2001). Another characteristics of hybrid offerings is that they can be categorized into one of four types (Ulaga and Reinartz 2011). Ulaga and Reinartz (2011) add a value proposition layer to the traditional SSP-SSC classification, which results in four hybrid offering types. The meaning of hybrid offerings will be incorporated into this study's final working definition as well.

Finally, another term to describe services in manufacturing is "service transition". Especially in the marketing literature this term is used to describe the shift of a manufacturer's strategic focus from products to services (Ostrom et al. 2015). Fang, Palmatier, and Steenkamp (2008)

define service transition as a manufacturers strategic refocus on solutions and services to gain a competitive edge in the market. It is a broader definition, that includes stand-alone services as well as combinations of product and services. Similar to other terms, a key characteristic of service transition is that it stresses the strategic level of the shift. Services become more and more the center of the manufacturer's business (Kowalkowski et al. 2015). Since service transition is especially relevant in the marketing literature, it will be considered in this study as well.

2.1.2 Consolidating of Definitions

The subchapter 2.1.2.1 first structures the different definitions of industrial services along two dimensions. Second, similarities and distinctions among four main definitions are elaborated. Based upon that, subchapter 2.1.2.2 synthesizes the definitions into the final working definition of this study.

2.1.2.1 Structuring of Definitions

The prior overview of the ten definitions indicate that the research uses a diverse terminology to describe services in a manufacturing context. While all definitions have some similarities and are partly based on each other, each individual one has its own distinctive nuance or unique focus. This study employs a 2-step procedure to derive the elements for a working definition that balances universal applicability and sufficient specificity. First, the definitions will be structured to detect how they are interconnected with each other. Second, the most relevant characteristics will be determined. In the next subchapter the insights from the two prior steps will be synthesized to develop the final working definition.

The review of definitions indicates that the ten terms can be structured along two dimensions. The first dimension is the role a manufacturer assigns to its service business. This can be either a tactical role or a strategic role. A tactical role of services means that the manufacturer keeps its focus on its physical products (Zeithaml and Brown 2014). Services are mainly seen as add-ons to the existing portfolio of manufactured goods. In contrast, a strategic role means that manufacturers see services as the new focus of the firm. That means manufacturers no longer see themselves as goods-based but as service-based companies. This is in line with the service-dominant logic developed by Vargo and Lusch (2004, 2008). According to service-dominant logic, traditional goods-based companies (i.e., manufacturers) shift their business

focus from products to services, and they become essentially service-based companies (Vargo and Lusch 2004; Wise and Baumgartner 1999). This often means that physical products just play a subordinate role compared to services (Vargo and Lusch 2004).

The second dimensions to structure the definitions is based on their broadness. Some definitions aim to be as general as possible (e.g., servitization), while others are more specific (e.g., hybrid service bundles). Figure 2.1 visualizes how the different definitions can be categorized along the two dimensions. The boundaries between the categories are not clear cut and can become blurred. Some definitions span across multiple categories since there might be alternative interpretations.

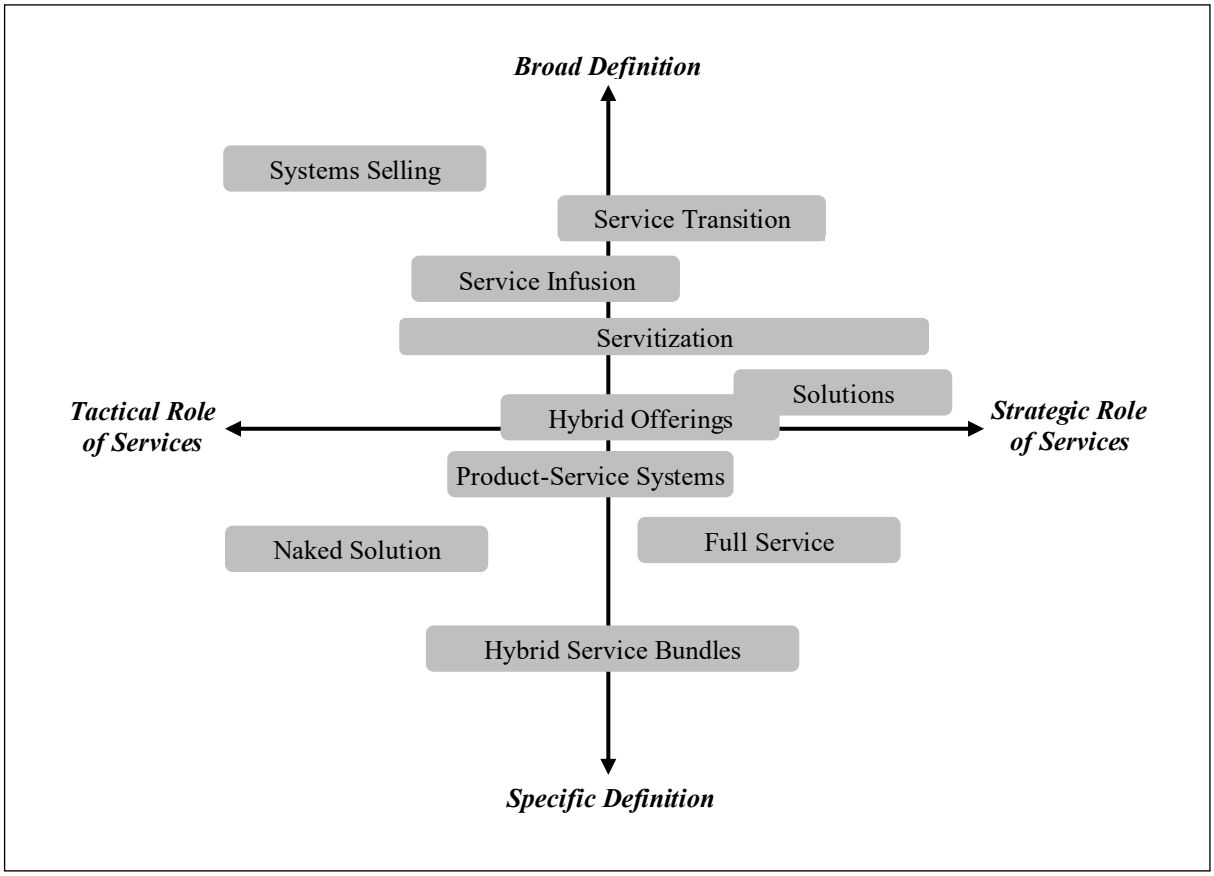

Figure 2.1: Structuring of Definitions

Most definitions look at services in manufacturing from a strategic perspective and provide a more general definition. This is also the objective of this study. In the context of this study services are seen as a strategic measure of manufacturers to improve their competitive position. Hence, the remainder of this study will consider only the terms in the strategic column to derive a working definition for this study. Full service, product service systems, and hybrid

service bundles take a more specific view on services. They are not discussed separately, but implicitly through the solutions definition.

The second step in the procedure is to determine relevant characteristics of services in a manufacturing context. The four more general terms (i.e., servitization, service infusion, service transition, hybrid offerings) are often used interchangeably in literature (Rabetino et al. 2018). However, they have slightly distinctive characteristics which gives them different meanings (Ostrom et al. 2015). The following paragraphs discuss first commonalities and then distinctions among the definitions.

As mentioned before one common characteristic of all four terms is that they all see services as a strategic measure for manufacturers to gain a competitive advantage. Another commonality exists between service infusion and hybrid offerings. Both categorize services in a manufacturing context (Mathieu 2001a; Ulaga and Reinartz 2011; Zeithaml and Brown 2014). First, Mathieu (2001a) introduces the distinction between services in support of products (SSP) and services in support of customers (SSC). Ulaga and Reinartz (2011) use that categorization as one dimension in their category matrix of hybrid offerings. Another common characteristic exists between servitization and service transition. Servitization as well as service transition underline the impact of services on customer relationships (Kowalkowski et al. 2015; Vandermerwe and Rada 1988). Both terms stress that a strategic refocus on services has the potential to create closer customer relationships (Kowalkowski et al. 2015; Vandermerwe and Rada 1988).

Differences in the terms can be found especially in the details. Servitization is defined with more specific elements than the other terms. Next to services and products, Vandermerwe and Rada (1988) also list support, self-service, and knowledge as distinctive parts in a servitization process. Service infusion underlines the complexity of service product bundles which is not explicitly done by the other terms (Zeithaml and Brown 2014). Another difference exists between hybrid offerings and the other terms. Hybrid offerings include a value dimension next to the SSC-SSP categorization (Ulaga and Reinartz 2011). That creates a matrix of four distinctive service categories (Ulaga and Reinartz 2011). Table 2.1 summarizes the discussed similarities and differences between the four definitions.

Key Similarities	Key Differences
▪ Strategic role of services	▪ Knowledge as additional element
▪ SSP-SSC classification	▪ Complexity as a characteristic
▪ Improving customer relationships	▪ Value dimension in hybrid offerings

Table 2.1: Similarities and Differences of Definitions

The term solution sets itself apart from the other definitions as it describes a special case of service product combinations in a manufacturing context. Although there is no universal definition of the term solution, it is commonly referred as a combination of integrated products and services which address a specific customer problem (Woisetschläger et al. 2010). It is important to notice that solutions go beyond mere service product bundles. The individual elements are highly integrated and can create the value only bundled together in the solution frame (Brady, Davies, and Gann 2005; Nordin and Kowalkowski 2010). Moreover, in solutions manufacturers may take full operational responsibility of a customer's process (Ulaga and Reinartz 2011). That means the manufacturer installs, operates, and maintains the solution over its entire lifecycle (Davies et al. 2001). The solution concept is highly intervened with the other terms describing services in a manufacturing context. For instance, Ulaga and Reinartz (Ulaga and Reinartz 2011) describe solutions in their typology as Process Delegation Services (PDS). This underlines that solutions are one specific type in a manufacturer's service portfolio.

2.1.2.2 Synthesizing of Definitions

This chapter synthesizes the different definitions into one working definition. The prior analysis reveals three key elements to be included into the final definition.

First, services in manufacturing can be seen from a tactical as well as strategic perspective. Most definitions see services as a strategic measure for manufacturers to gain a competitive advantage (Fang, Palmatier, and Steenkamp 2008; Vandermerwe and Rada 1988; Wise and Baumgartner 1999). This predominantly strategic perspective captures the essence of servitization which is "the transformation of a firm from taking a product- to taking a service-centric approach" (Raddats et al. 2019, p. 207). Hence, the first element of the final working definition is the strategic nature of manufacturers' service business.

The second key aspect to be considered is the broadness of the definition. The solutions definition for instance is very specific and does not apply to all services in a manufacturing con-

text. Zeithaml and Brown (2014) introduce a service infusion continuum that covers the entire range of manufacturers' services. On the one end, there are services in support of products (SSP) such as installation, and maintenance (Mathieu 2001a; Zeithaml and Brown 2014). On the other end, there are services in support of customers (SSC) such as consultation, and solutions (Mathieu 2001a; Zeithaml and Brown 2014). This classification into SSP and SSC is another element to be incorporated into the final working definition.

The third key element is that services in manufacturing can entail additional characteristics. Several definitions (such as servitization or hybrid offerings) mention knowledge as an important aspect (Ulaga and Reinartz 2011; Vandermerwe and Rada 1988). In line with service-dominant logic, the manufacturer's tacit know-how is an important factor for the success of service-based offerings (Vargo and Lusch 2004, 2008). Hence, knowledge may play an important role in service offerings and therefore will be considered in the final definition as well.

Servitization is one of the most used terms in literature and established itself as a key term to describe manufacturers' move into services (Rabetino et al. 2018). That is why this study also uses the term servitization as its foundation. However, there is no widely accepted definition of the term. Authors often use it as a general term to describe manufacturer's move into services without defining it in detail (Rabetino et al. 2018). Therefore, based on the prior analysis of existing definitions, this study develops a working definition of servitization which aims to capture the essence of services in manufacturing. The original definition of servitization by Vandermerwe and Rada (1988) is blended with three key elements derived from other definitions. The final working definition for this study is stated as follows:

Servitization is a strategic, transformational process in which a manufacturer shifts its focus towards the provision of services, products, and knowledge to gain a competitive advantage. Manufacturers' services range from services in support of products (SSP) to services in support of customers (SSC).

2.2 Servitization Literature Review

Since the seminal article of Vandermerwe and Rada (1988) and increasing real world applications (Gerstner 2002; Wise and Baumgartner 1999), the research interest in servitization has grown significantly (Rabetino et al. 2018). In the last ten years, there has been a plethora of studies conducted by different research streams such as marketing, operations, and service

management (Rabetino et al. 2018; Raddats et al. 2019). This immense interest in servitization from different disciplines creates a large and diverse research output covering topics from conceptualization to implementation of services (Raddats et al. 2019). The primary research methodology is qualitative, with interviews and case study analyses being the most-frequently used methods (Rabetino et al. 2018; Raddats et al. 2019). Major dissemination channels are a diverse set of academic journals such as Industrial Marketing Management, Harvard Business review, and International Journal of Operations & Production Management (Baines et al. 2017).

Several literature reviews on servitization reveal that there are multiple research communities involved into servitization research (Baines et al. 2017; Lightfoot, Baines, and Smart 2013; Rabetino et al. 2018). These cover multiple research topics such as drivers, organizational structure, classification, and strategies of servitization (Baines et al. 2009). The objective of this chapter is to give a comprehensive overview of existing servitization research independent from specific research communities. Literature is chosen based on its link to servitization regardless of the dissemination channel (e.g., marketing, operations, or production journals). Existing research is categorized into one of five groups based on its focus. Subchapter 2.2.1 looks at the first research focus, namely the general conceptualization of servitization. The next subchapter 2.2.2 deals with the second research focus, the drivers of servitization. The third research focus is about strategy in servitization context (subchapter 2.2.3). Subchapter 2.2.4 presents research about servitization implementation as the next research focus. Finally, subchapter 2.2.5 discusses the final research focus of servitization outcomes. The literature review concludes with a summary and evaluation of the current state of servitization research in subchapter 2.2.6. Figure 2.2 summarizes the structure of the literature review on servitization.

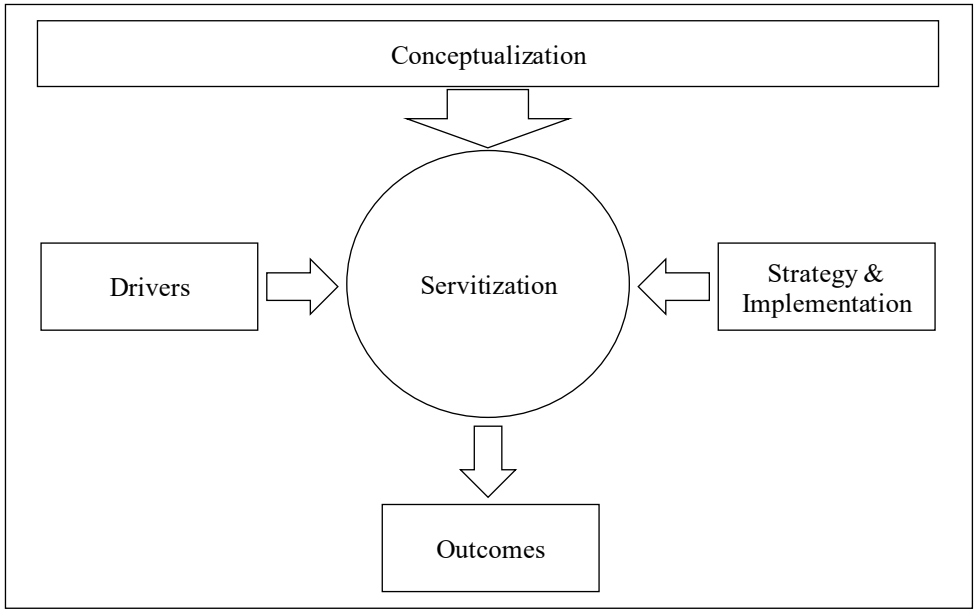

Figure 2.2: Structure of the Servitization Literature Review

2.2.1 Conceptualization

Subchapter 2.2.1.1 gives an overview of the early concepts pertaining servitization. The fundamental concept of service-dominant logic is the focus of subchapter 2.2.1.2. The final subchapter 2.2.1.3 discusses the concept of value creation as another conceptual cornerstone of servitization.

2.2.1.1 Early Concepts

One of the earliest conceptualization of servitization comes from Mattsson (1973) who presents the idea of "systems selling". According to that concept manufacturers move along two extremes when offering different products and services. On the one extreme, they can offer only the physical product, which is labeled as "product selling" (Mattsson 1973). On the other extreme, manufacturers can supply the physical product and all necessary services for its operation such as the software, which is labeled as "systems selling" (Mattsson 1973). In addition, Mattsson (1973) presents three characteristics which apply to systems selling. First, individual elements of the system (i.e., the individual products and services) can theoretically be sold separately as well (Mattsson 1973). So, there is no strict dependency of each element to be marketed together. Second, systems consist of standardized elements and some customization depending on customer needs (Mattsson 1973). Finally, the knowledge involved in systems selling goes beyond the manufacturer's product know-how (Mattsson 1973). The manu-

facturers needs a "more extended and deeper" (Mattsson 1973, p. 109) understanding of customer needs for the correct design of the system. Figure 2.3 summarizes the conceptualization of system selling according to Mattsson (Mattsson 1973).

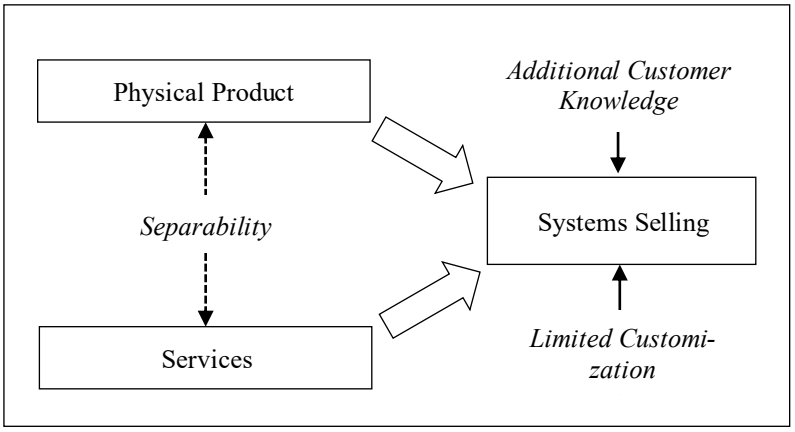

Figure 2.3: Concept of System Selling

Another conceptual reflection on servitization comes from Vandermerwe and Rada (1988). In their seminal article, they describe the evolutionary development of services role in manufacturing through three stages. The first stage is characterized by a clear division and distinction between manufacturers and service providers (Vandermerwe and Rada 1988). Companies were either engaged in producing physical goods or providing services (Vandermerwe and Rada 1988). The second stage is characterized by the blurring boundaries between services and products. Especially manufacturers realize that services and goods are often inseparable and hence start to offer them together (Vandermerwe and Rada 1988). In the third and last stage, services start to overcome their add-on character and take a dominating role in the manufacturer's business (Vandermerwe and Rada 1988). Companies offer bundles consisting of goods, services, support, self-service and knowledge (Vandermerwe and Rada 1988). Figure 2.4 visualizes the evolutionary path of servitization according to Vandermerwe and Rada (1988).

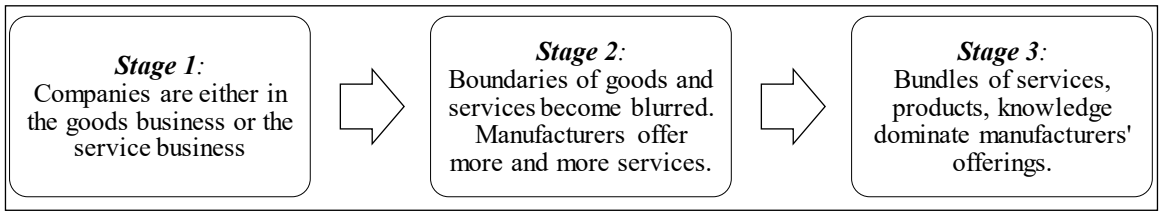

Figure 2.4: Three-stage Evolution to Servitization

The relationship between services and physical goods is often complementary since most physical products such as machines and equipment require a minimum level of services such

as installation and maintenance (Vandermerwe and Rada 1988). However, with technological advances products and services become more and more intervened with each other (Vandermerwe and Rada 1988). Services start to account for a significant part of the value created in manufacturing (Vandermerwe and Rada 1988). All in all, Vandermerwe and Rada's (1988) conceptualize servitization as a transformative process in which services play a key role in delivering value to the customer. This core idea is the underlying foundation for many following research studies into the topic (Baines et al. 2017; Rabetino et al. 2018).

A third major conceptualization is provided by the first research into product-service systems (PSS) in the late 1990s (Goedkoop et al. 1999). The original PSS concept expands the pure economic view on servitization by an ecological perspective (Goedkoop et al. 1999). That means the combination of products and services have the potential to decrease environmental impact (Mont 2004). For instance, in the consumer segment the introduction of carsharing services can decrease the individual car use while increasing the demand for public transportation (Meijkamp 1998). This is beneficial for the environment since less individual car rides reduce carbon emissions. That means the PSS concept has the potential to unlink "environmental pressure from economic growth" (Goedkoop et al. 1999, p. 21). This can mean a win-win situation for corporations and the environment. This idea is especially prevalent in the PSS community which often looks at service product bundles from an environmental and sustainability perspective (Mont 2002; Rabetino et al. 2018).

Another major conceptualization comes from Wise and Baumgartner (1999) who interpret servitization as a downstream move along the value chain[2]. The authors argue that manufacturers need to focus on services because of their high revenue and profit potential (Wise and Baumgartner 1999). In many industries services account for the majority of revenues over the lifetime of a physical good (Wise and Baumgartner 1999). For instance, in the railroad industry the initial sale of trains represents only a fraction of the lifetime revenue potential (Wise and Baumgartner 1999). The substantial part of revenues is generated through services of railroad operations such as training, and maintenance (Davies et al. 2001; Wise and Baumgartner 1999). In addition, manufacturers are often in the pole position to offer services because of their installed base, which is the number of physical goods in use (Wise and Baumgartner

[2] The value chain concept views a firm as a system of processes which transform inputs such as labor and equipment into outputs (Porter 1985).

1999). The installed base is a great opportunity for manufacturers to sell services because they have the know-how about their own products and already the relationship to the customer (Wise and Baumgartner 1999). On top of it manufacturers' can capitalize on the usage data of the installed base to offer new services (Ulaga and Reinartz 2011). Overall, Wise and Baumgartner (1999) see servitization as a logical move of manufacturers to remain profitable and exploit new revenue streams.

2.2.1.2 Service-Dominant Logic

Vargo and Lusch (2004) introduce in their seminal article "Evolving to a New Dominant Logic for Marketing" a fundamentally new conceptualization of goods and services in a marketing context. First, the authors outline the evolutionary path of the economic schools of thought and their influence on marketing theory and practice. That evolutionary path consists essentially of four main stages leading up to the service-dominant logic (Vargo and Lusch 2004).

First, during the 19th century the field of economics establishes itself as a new social science field (Vargo and Lusch 2004). At that time, the focus of the economy is the exchange of commodities, in which value is assumed to be embedded in the physical product itself (Vargo and Lusch 2004). Wealth in a society is determined by the amount of tangible goods a society possessed (Vargo and Lusch 2004).

In the second stage, beginning in the early 20th century, new conceptual ideas of marketing develop and create essentially three schools. The commodity school deals with characteristics of commodities, while the institutional school looks at marketing's role in the value creating process (Vargo and Lusch 2004). The functional school investigates the role of marketers in the process (Vargo and Lusch 2004). Commodities and a goods-centered view remain the focus of exchange during this stage (Vargo and Lusch 2004).

The third stage in the mid-20th century, focuses on marketing as a management function (Vargo and Lusch 2004). Customer-centricity and the meaning of value in use start to become important topics for research and management (Vargo and Lusch 2004).

The fourth stage, starting in the late 20th century, interprets marketing as a process in which skills and knowledge are the primary unit of exchange (Vargo and Lusch 2004). Physical goods are reinterpreted as "distribution mechanisms for service provisions" (Vargo and Lusch

2004, p. 3). The result of this evolutionary development is a new paradigm, which shifts the focus of marketing from a goods-dominant logic to a service-dominant logic. Figure 2.5 summarizes the evolutionary path of the economic schools of thought and their influence on marketing theory and practice.

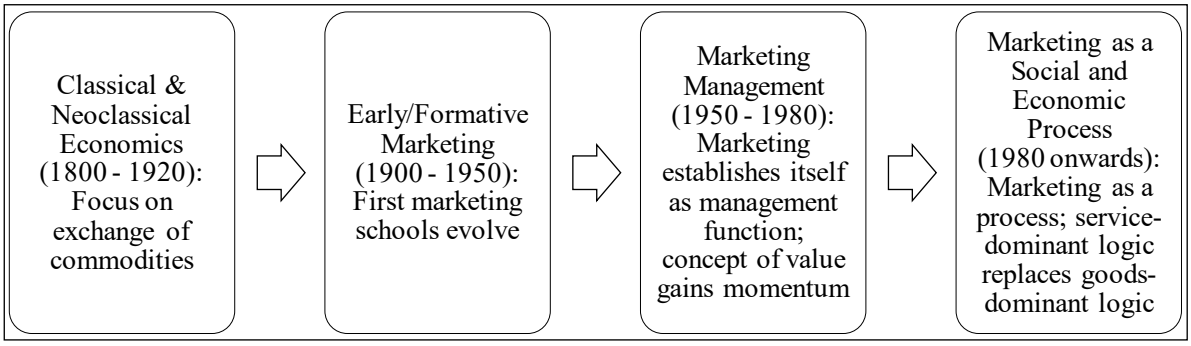

Figure 2.5: Evolution of Service-Dominant Logic (Adapted from Vargo and Lusch 2004).

The difference between operand and operant resources is the key distinguishing aspect between goods-dominant logic and service-dominant logic skills (Vargo and Lusch 2004). While operand resources center around physical goods, operant resources are defined as knowledge and skills (Vargo and Lusch 2004). Based on this two resource forms, Vargo and Lusch (2004) develop eight foundational premises to characterize the service-dominant logic. The first premise states that specialized skills and knowledge replace physical goods as the primary unit of exchange (Vargo and Lusch 2004). Consumers or customers are interested in the benefits that they can extract through the application of specific know-how, skill sets and services (Vargo and Lusch 2004). They are not interested in the physical product itself but the benefits its renders. The second premise is that indirect exchange often covers services as the fundamental unit of exchange (Vargo and Lusch 2004). Through specialization it becomes harder to see that people essentially exchange services for services (Vargo and Lusch 2004). Money, goods, organizations etc. represent mediums for that exchange (Vargo and Lusch 2004). The third premise clarifies the role of goods in the service-dominant logic. According to Vargo and Lusch (2004) physical goods are only vehicles to render the desired service in form of specialized knowledge and skills. People own goods not for the sake of the physical material, but for the purpose of the benefits (i.e., services in form of knowledge and skills) they provide (Gummesson 1995; Vargo and Lusch 2004). The fourth premise states that knowledge is the foundation to gain a competitive advantage (Vargo and Lusch 2004). A sustainable competitive edge requires more than superior product features (Barney 1991). It re-

quires hard to imitate service assets (i.e., knowledge and skills) which produce more value for the customer than competitor offerings (Barney 1991; Quinn, Doorley, and Paquette 1990; Vargo and Lusch 2004). The fifth premise defines services as embedded in all existing economies (Vargo and Lusch 2004). Through an increase in specialization of economies, the ever-existing role of services (in form of specialized knowledge and skills) becomes more evident (Vargo and Lusch 2004). The sixth premise by Vargo and Lusch (2004) states that customers are always co-creators of value. The value creation process does not end with the production process. The customer continues the value creation through the consumption process (Vargo and Lusch 2004). The seventh premise underlines that value is not embedded in products (Vargo and Lusch 2004). Hence, companies can only make value propositions (Vargo and Lusch 2004). That means goods have a potential to create value, but the actual realization of that value is done by the customer (Vargo and Lusch 2004). The final premise states that the service-dominant logic emphasizes customer orientation and customer relationships (Vargo and Lusch 2004). This represent the transition process of marketing overall from a "production focus to a consumer focus and […] from a transaction focus to a relationship focus" (Vargo and Lusch 2004, p. 12). Figure 2.6 summarizes the eight premises of the service-dominant logic.

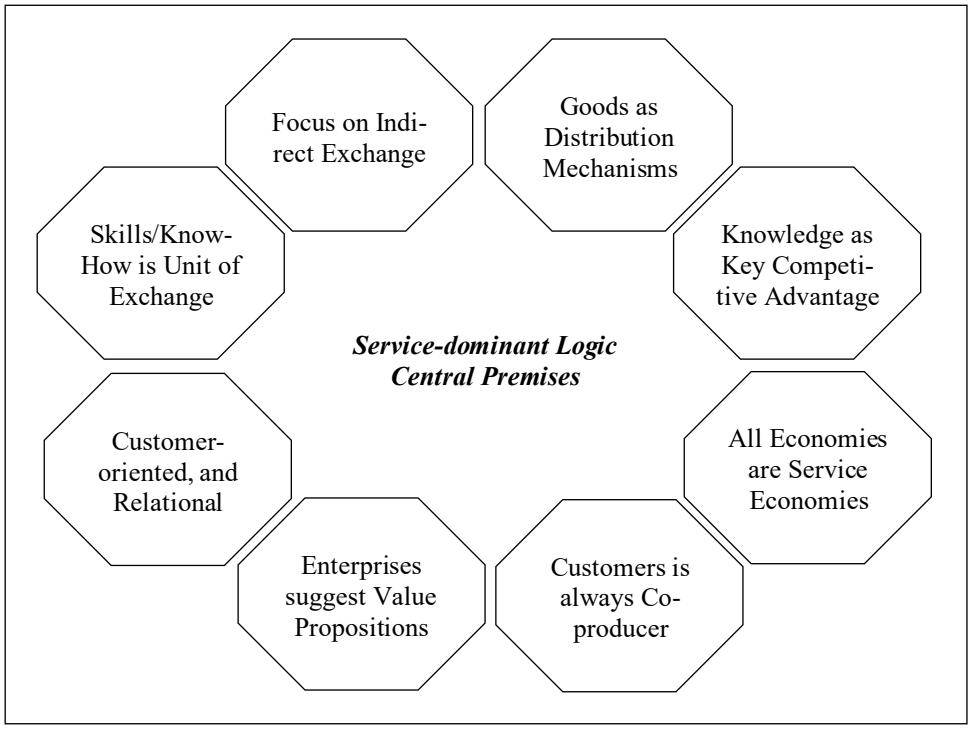

Figure 2.6: Central Premises of Service-Dominant Logic (Vargo and Lusch 2004)

This conceptualization of service-dominant logic has a fundamental impact on marketing research. The article of Vargo and Lusch (2004) about service-dominant logic has over 16,000 citations (Google Scholar 2020) and represents an important milestone in understanding the role of services and products in today's world. The service-dominant logic resonates well with the concept of servitization. Manufacturers' shift their strategic focus from physical products to the provision of services and know-how (Davies 2004; Vandermerwe and Rada 1988; Wise and Baumgartner 1999). They transform more and more from a goods-centered to a service-centered business (Raddats et al. 2019). This represents essentially the transition idea of service-dominant logic.

2.2.1.3 Customer Value Perspective

Customer value is defined as "a customer's perceived preference for and evaluation of those product attributes […] that facilitate […] the customer's goals and purposes in use situations" (Woodruff 1997, p. 142). Superior customer value represents a sustainable competitive advantage in business markets (Ulaga and Eggert 2006; Woodruff 1997). Hence, there is a large research interest into the topic of customer value (Eggert et al. 2018). Eggert et al. (2018) conceptualize customer value by decomposing its core elements and presenting two alternative marketing perspectives on customer value.

Customer value consists of two interconnected core elements, namely value-in-use and value-in-exchange (Eggert et al. 2018). The value-in-use concept takes a subjective view of value and focuses on the customer's utility of goods and services (Eggert et al. 2018). Specifically, the contribution to the customer's goals determines the value-in-use of a product or service (Eggert et al. 2018). Value-in-exchange takes an objective perspective on value and describes a good's purchasing power through market prices (Eggert et al. 2018). These two elements are highly interconnected. The marginal value-in-use (i.e., utility) of the last available unit determines the value-in-exchange of a good or service (Eggert et al. 2018).

There are two main alternative perspective on customer value in marketing, namely the traditional exchange view and the emerging resource integration view (Eggert et al. 2018). The underlying idea of the exchange view of marketing is that manufacturers embed value into their products and services through the creation process (Eggert et al. 2018; Kleinaltenkamp et al. 2015; Vargo, Maglio, and Akaka 2008). This value is then exchanged with the customer in a market transaction which represents the value-in-exchange (Eggert et al. 2018;

Kleinaltenkamp et al. 2015). After that transaction, the customer on its own realizes the value-in-use of the product or service (Eggert et al. 2018).

The second perspective recognizes that value in business markets is always jointly created with the manufacturer and customer (Eggert et al. 2018; Vargo and Lusch 2004). Fueled by the service-dominant logic and the trend towards servitization (Oliva and Kallenberg 2003; Vargo and Lusch 2004), the resource integration view of marketing emerged (Eggert et al. 2018). The key difference to the exchange view is that value-in-use is no longer realized by the customer alone (Eggert et al. 2018). Instead, the manufacturer (i.e., provider) and the customer jointly integrate their resources to realize the value-in-use of a product or service (Eggert et al. 2018; Grönroos and Voima 2013). Figure 2.7 visualizes the two alternative perspective of marketing.

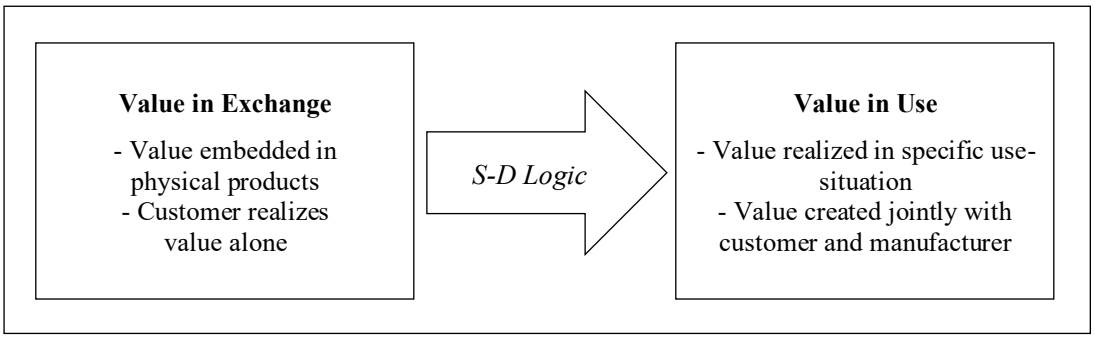

Figure 2.7: The Exchange View and the Resource Integration View of Marketing (Adapted from Eggert et al. 2018)

The resource integration view of marketing ties in well with servitization of manufacturing. In the process of servitization manufacturers penetrate more and more into the customer's value creation process (Davies et al. 2001; Payne, Storbacka, and Frow 2008; Ulaga and Reinartz 2011). The entire category of services supporting the customer (SSC) builds upon the idea that value is co-created with the customer in the specific use situation (Mathieu 2001a). Services such as consulting or taking over entire customer processes require a close collaboration between a manufacturer (i.e., provider) and the customer (Tuli, Kohli, and Bharadwaj 2007). Those services can only benefit the customer when there is a close collaboration and integration of resources. Tuli, Kohli, and Bharadwaj (2007) show specifically that successful solutions consists of multiple relational processes including resource integration. As an example, General Electric Healthcare division offers hospitals (i.e., its customer) an advisory service next to its capacity management solution (Zeithaml and Brown 2014). This way the St. Luke's Episcopal Hospital in Houston, Texas increased its yearly capacity by 750 patients

(Zeithaml and Brown 2014). This showcases how closely servitization and the concept of customer value are related.

2.2.2 Drivers

The servitization literature lists several driving forces for manufacturers' push into services. They can be categorized into strategic, financial, and marketing drivers (Baines et al. 2009). These three driving forces are discussed in the subsequent chapters. Subchapter 2.2.2.1 looks at the strategic motivation for services. The subchapter 2.2.2.2 focuses on marketing drivers. Financial drivers are discussed in subchapter 2.2.2.3. The final subchapter 2.2.2.4 concludes by summarizing the drivers and setting them in context to each other.

2.2.2.1 Strategic

A frequently mentioned driver for servitization is the intense competition in business markets (Gebauer, Gustafsson, and Witell 2011; Ulaga and Reinartz 2011; Vandermerwe and Rada 1988; Wise and Baumgartner 1999). This competition can be differentiated on two levels. First, the origin of the competitor is an important factor since there are significant differences in the economic settings of countries (Bernard and Koerte 2007; Kumar 2006). Second, the basis of competition may be different depending on the specific manufacturing sector. In manufacturing, firms compete mainly on price and product attributes such as quality and branding (Miles 2018). Naturally, companies can face competitive pressure from multiple areas, such as price-based and product-based competition.

In multiple areas the competitive pressure increased for manufacturers. First, technological advances in communication and logistics create ideal conditions for the globalization[3] of manufacturing (Kumar 2006). Hence, there has been a sharp increase of international competition putting pressure on local manufacturers (Kumar 2006; Raddats et al. 2016). Especially larger corporations outsource their manufacturing capacity into low-cost countries (Vestring et al. 2005). Second, a more international manufacturing industry often results in more price-based competition (Wise and Baumgartner 1999). Foreign manufacturers are able to produce the same goods at a fraction of the costs especially due to lower labor costs (Miles 2018). Fi-

[3] Globalization describes the process of international economic integration through liberalization of trade, investment, and finance (Van Der Bly 2005; Khor 2001).

nally, a traditional product differentiation strategy (Porter 1985) becomes less effective in the manufacturing industry. The widespread access to technologies makes the competitive advantage of product differentiation often not sustainable (Baines et al. 2009; Gebauer and Fleisch 2007). Against this backdrop, manufacturers are looking for new ways to solidify their competitive position in their markets. The trend towards servitization is a major strategy of manufacturers to stay competitive (Oliva and Kallenberg 2003; Wise and Baumgartner 1999).

Servitization research reveals a number of mechanism on how services help manufacturers sustain a competitive edge. One major reason for manufacturers to offer services is to build barriers of entry for competitors (Vandermerwe and Rada 1988; Wise and Baumgartner 1999). The labor intensity of services and its often high integration with products makes it hard for the competition to imitate the same value (Baines et al. 2009; Gebauer and Friedli 2005; Oliva and Kallenberg 2003). This is especially the case when the services and products address highly complex customer needs (Neu and Brown 2005, 2008).

A second strategic driver is the commoditization[4] of core products (Reimann, Schilke, and Thomas 2010; Rust and Miu 2006; Vandermerwe and Rada 1988). There are two main mechanism which facilitate the development of commodity markets. First, the widespread access to production technologies and know-how pave the way for more companies to produce advanced manufactured goods (Raddats et al. 2016; Rust and Miu 2006). Second, the low barriers for international trade attract low-cost countries to enter developed markets such as the Unite States, Japan, or Germany (Porter 1986; Raddats et al. 2016). In those markets, products from low cost countries have the competitive advantage of having significantly lower labor costs compared to domestic products (Miles 2018). Local manufacturers cannot effectively differentiate their products based on physical features or price anymore (Raddats et al. 2016). Therefore, manufacturers turn to services in an attempt to escape the commodity threat (Anderson and Narus 1995; Levitt 1980).

A third driver is the deregulation of certain markets such as public transportation or telecommunication markets (Davies et al. 2001; Vandermerwe and Rada 1988). Davies et al. (2001)

[4] Commoditization refers to a “marketing competition characterized by increasing homogeneity of products, higher price sensitivity among customers, lower switching costs, and greater industry stability” (Reimann, Schilke, and Thomas 2010, p. 188)

show in their case study analysis that the deregulation and privatization of the British railroad and telecommunication market created new opportunities for the provision of services. The new private owners and operators of the deregulated markets often lack the know-how and expertise for maintaining complex systems such as trains and telecommunication equipment (Davies et al. 2001). Manufacturers have the necessary knowledge for the proper operation of the equipment and hence are predestined to provide services under these new market conditions (Davies et al. 2001).

Three other strategic drivers include preventing customers from becoming competitors (Bitner et al. 1997; Vandermerwe and Rada 1988), smoothing out revenue fluctuations (Wise and Baumgartner 1999), and innovation management (Schaarschmidt, Walsh, and Evanschitzky 2018). First, customers may build service capabilities inhouse and become potentially a competitor to the manufacturer's service division (Bitner et al. 1997; Vandermerwe and Rada 1988). Hence, a manufacturers' proactive service offering can prevent such a move from customers keeping the market less competitive for the manufacturer (Vandermerwe and Rada 1988). Second, revenues in manufacturing are volatile (Wise and Baumgartner 1999). For instance, the U.S. manufacturing sector experienced a sharp decline in sector revenues from 2014 to 2016 (Miles 2018). In 2017, the revenues were growing again (Miles 2018). The provision of services can provide manufacturers with more steady revenue streams (Wise and Baumgartner 1999). Third, services help manufacturers to get closer to customer processes and learn from them (Kastalli and Van Looy 2013). This newly acquired knowledge presents an opportunity for proactively developing innovative products and services for customers (Schaarschmidt, Walsh, and Evanschitzky 2018).

2.2.2.2 Marketing

The second major driving force for servitization is marketing. Especially, customer demand pushes manufacturers towards services (Baines and Lightfoot 2014; Raddats et al. 2016; Vandermerwe and Rada 1988). In business markets as well as in consumer markets customers require companies to provide additional services next to their physical product (Woisetschläger et al. 2010). Those required services often go beyond simple installation and maintenance services (Gebauer et al. 2010). For instance, customers may outsource an entire non-strategic process to the manufacturer (Gebauer et al. 2010). Customers want to focus on their core business and capabilities, and therefore rely more on manufacturers to maintain

auxiliary processes (Baines and Lightfoot 2014). That means service provisions evolve to a necessary requirement for manufacturers to meet customer needs. Moreover, research indicates that services influence the purchase process in industrial settings (Gebauer and Fleisch 2007). This underlines service's significant role in marketing and sales.

The addition of services can build closer relationships and create a lock-in effect through two mechanisms. First, the provision of services leads to a higher involvement of manufacturers into customer processes (Oliva and Kallenberg 2003; Tuli, Kohli, and Bharadwaj 2007). In a service setting value is co-created with the customer together (Vargo and Lusch 2004). This creates a more intimate and closer customer relationships (Tuli, Kohli, and Bharadwaj 2007; Vargo and Lusch 2004). Second, highly integrated services can create customer dependency on the manufacturer's service (Reinartz and Ulaga 2008; Vandermerwe and Rada 1988). This increases the customer's switching costs and creates a lock-in effect (Blut et al. 2016; Reinartz and Ulaga 2008). Overall, these two mechanisms can increases customer loyalty, while at the same time making new market entries more costly and complex (Bustinza et al. 2015; Rabetino, Kohtamäki, and Gebauer 2017; Vandermerwe and Rada 1988).

A third marketing-based driver for servitization is closely related to the external commodity threat, namely product differentiation[5] (Levitt 1980; Mattsson 1973). Manufacturers add increasingly services to their products to make them unique in the marketplace (Vandermerwe and Rada 1988). Services support a manufacturers' product marketing by providing additional distinctive characteristics which are intangible and harder to imitate (Oliva and Kallenberg 2003; Raddats et al. 2016; Raddats, Burton, and Ashman 2015).

2.2.2.3 Financial

The third driving force of servitization is the financial attractiveness of services. Due to intense competition and commoditization, the profit margins of manufactured goods are increasingly under pressure (Miles 2018; Wise and Baumgartner 1999). Services offer three financial advantages for manufacturers. First, the sale of a physical product often represents a small fraction of the lifetime revenue potential of that product (Wise and Baumgartner 1999). For instance, the sale of computer hardware represents only 20% of the overall revenue poten-

[5] Product differentiation describes a strategy that focuses on establishing one or more unique product or service attributes which are valuable to the customer and set the firm's offering apart from competitors (Porter 1985).

tial (Wise and Baumgartner 1999). Most of the revenue potential lays in services such as training and technical support (Davies 2004; Wise and Baumgartner 1999).

The second advantage is the continuous and more frequent character of services. While some capital equipment may be sold once every 10 years , services such as maintenance needs to be performed continuously throughout the products entire lifetime (Wise and Baumgartner 1999). From a financial perspective this means services represent a more steady revenue stream, which is often countercyclical (Davies, Brady, and Hobday 2006; Wise and Baumgartner 1999). Less volatile revenue streams can help to reduce a company's overall business risk (Griffin and Dugan 2003). Hence, manufacturers prefer to have steady revenue flows.

Finally, services often have higher profit margins than physical goods (Wise and Baumgartner 1999). For instance, in the power equipment industry the margins for the physical equipment are two to five percent (Henkel et al. 2004). In contrast, the service business in the same industry has 15 to 20 percent profit margins (Henkel et al. 2004). This higher overall profitability is another financial driver towards servitization (Wise and Baumgartner 1999).

2.2.2.4 Summary

The driving forces of servitization are highly interconnected and together create the dynamic push towards services. Moreover, the list of driving forces shows that servitization is used by manufacturers as a proactive strategy (e.g., product differentiation), and as a defensive strategy (e.g., entry barriers). Figure 2.8 summarize the underlying mechanisms of strategic, marketing, and financial drivers of servitization.

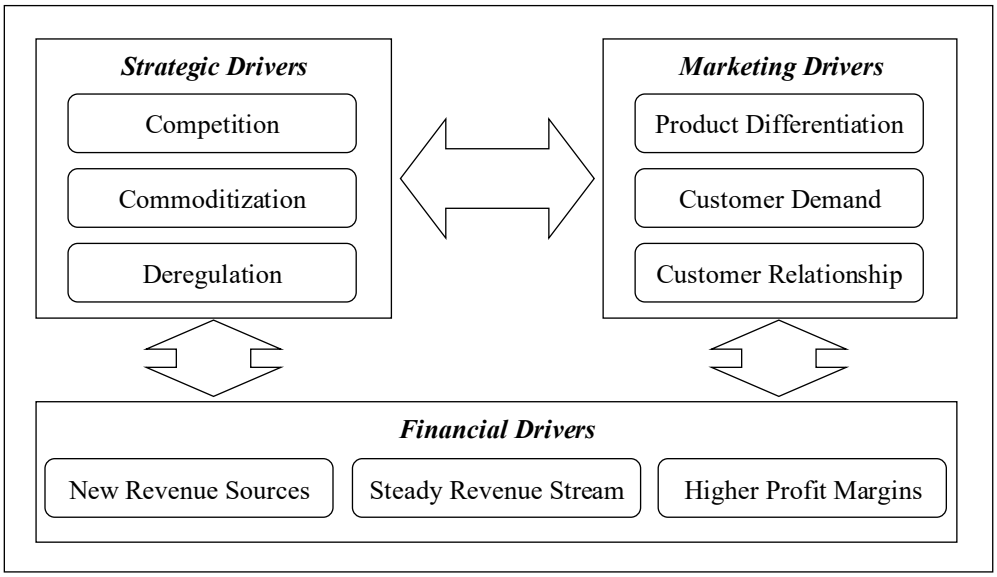

Figure 2.8: Drivers of Servitization

The core driving force for servitization is the intense competition in the business markets (Lilien 2016; Luoto, Brax, and Kohtamäki 2017; Oliva and Kallenberg 2003). It is essentially the core underlying trigger for almost all the other drivers. High competition leads to more product offerings which facilitate the degradation of products to commodities (Martinez et al. 2010; Rust and Miu 2006). Commodity markets are often characterized by price-based competition which in return leads to diminishing profit margins (Heil and Helsen 2001; Reimann, Schilke, and Thomas 2010). Facing decreasing overall profitability, manufacturers are looking for ways to regain their competitive edge through product differentiation (Wise and Baumgartner 1999). Therefore, they refocus on services in an attempt to gain a differentiation advantage, to build entry barriers, and to have healthy profit margins (Raddats et al. 2016; Vandermerwe and Rada 1988; Wise and Baumgartner 1999). The ultimate goal of servitization is to create a sustainable competitive advantage and escape the negative impact of fierce competition.

2.2.3 Strategy

Another research stream in servitization deals with its strategic implications. Review articles identify multiple research areas within servitization strategy (Rabetino et al. 2018; Raddats et al. 2019). This chapter employs a top-down method in which first broad, and then more specific strategy aspects are discussed. Subchapter 2.2.3.1 looks at servitization business model research. The following subchapter 2.2.3.2 analyzes organizational implications of servitization. The subchapter 2.2.3.3 presents research on service typologies.

2.2.3.1 Business Models

The servitization process in manufacturing comes with major strategic changes to a manufacturer's business model (Kindström 2010; Reim, Parida, and Örtqvist 2015; Storbacka et al. 2013). Traditional product-based business models do not reflect adequately the meaning of services for the manufacturers' business (Foote et al. 2001; Kindström 2010; Storbacka 2011). Hence, research investigates how the addition of services changes manufacturers' business models (Huikkola and Kohtamäki 2018; Kindström and Kowalkowski 2014). However, there is no one-size-fits-all approach since a successful business model depends on multiple contingency factors (Gebauer et al. 2010; Huikkola and Kohtamäki 2018). Research suggests a configurational approach when developing a servitization business model (Gebauer 2008; Kohtamäki, Henneberg, et al. 2019; Raja et al. 2018). This way individual firm and environmental factors can be considered. In the following paragraphs four servitization business models are presented.

The product-oriented business model keeps the physical product in the focus (Huikkola and Kohtamäki 2018; Tukker 2004; Visnjic, Wiengarten, and Neely 2016). Services are built around the core products of the manufacturer and support its sales, its operation, and the disposal at the end of its lifetime (Huikkola and Kohtamäki 2018; Ulaga and Reinartz 2011). Typical services in this business model include financing, maintenance, repairs, and documentation services (Huikkola and Kohtamäki 2018; Tukker 2004). A key characteristic of this business model is its transaction-based nature (Huikkola and Kohtamäki 2018). The goal of the firm is to sell as many products as possible in order to generate high profits (Huikkola and Kohtamäki 2018). Services are regarded as a support mechanism for this objective. This business model prevails among manufacturers (Huikkola and Kohtamäki 2018). A possible reason for the popularity of this business model is its simplicity. The straightforward role of the physical product and the services makes the business model easy to understand and implement (Huikkola and Kohtamäki 2018). However, the downside of this business model is that it builds mainly on product features as sources of competitive advantage. In a highly competitive market environment this may not be sufficient for a "true product differentiation" advantage (Huikkola and Kohtamäki 2018). Moreover, the transaction-based nature of the business does not foster close customer relationships and associated higher customer loyalty (Huikkola and Kohtamäki 2018). Hence, the manufacturer is exposed to various risks such as price erosion (Huikkola and Kohtamäki 2018).

Another servitization business model is the use-oriented business model (Reim, Parida, and Örtqvist 2015; Tukker 2004). This business model surrounds around the idea that the primary objective of the manufacturer is to ensure the availability of the product (Reim, Parida, and Örtqvist 2015; Ulaga and Reinartz 2011). Hence, services in this business model go beyond simple installation and maintenance. In order to ensure that the product is usable at all times, the manufacturer offers services such as remote service, preventative maintenance, and product upgrades (Reim, Parida, and Örtqvist 2015; Ulaga and Reinartz 2011). These services are often contractually agreed upon service-agreements between the manufacturer and the customer (Huikkola and Kohtamäki 2018). A key characteristic of this business model is that it can generate steady revenue streams for the manufacturer (Huikkola and Kohtamäki 2018; Tukker 2004). Services that ensure usability of the product are performed on a more regular basis than other services (Huikkola and Kohtamäki 2018). In addition, manufacturers often combine this services with fixed-price models or leasing agreements (Huikkola and Kohtamäki 2018; Tukker 2004). While the product remains a central element in this business model, services become more important as well (Tukker 2004). They are not simply an optional add-on anymore, but an important element for the overall proposed value of the physical product. A potential downside of this business model is that it does not prevent commoditization of products and that it can be undermined by new technologies (Huikkola and Kohtamäki 2018).

A third servitization business model is the process-oriented business model (Huikkola and Kohtamäki 2018; Ulaga and Reinartz 2011). In this business model, operational services such as project management, consulting, and operations management play a central role (Huikkola and Kohtamäki 2018; Ulaga and Reinartz 2011). The core idea is that the manufacturers uses its know-how to optimize the business processes of the customer (Huikkola and Kohtamäki 2018; Ulaga and Reinartz 2011). This can be achieved through a variety of measures such as consultation (Ulaga and Reinartz 2011) or outsourcing of some services (Huikkola and Kohtamäki 2018). This way the customer can improve its operational efficiency (Huikkola and Kohtamäki 2018). This strategy requires the manufacturer to have a very deep understanding of the customer's business processes (Ulaga and Reinartz 2011). A key characteristic of this business model is the required close customer relationship (Huikkola and Kohtamäki 2018). The advantage of this business model is that the manufacturer is very close to the customer. This way they can learn from the customer and come up with new innovations

(Huikkola and Kohtamäki 2018). A potential disadvantage is that the manufacturer can become a subcontractor instead of service partner for the customer (Huikkola and Kohtamäki 2018).

Finally, the fourth servitization business model is the result-oriented business model (Huikkola and Kohtamäki 2018; Reim, Parida, and Örtqvist 2015; Tukker 2004). This business model goes one step further than the process-oriented model and guarantees the customer a certain outcome (Huikkola and Kohtamäki 2018; Ulaga and Reinartz 2011). That means the manufacturers assumes full responsibility to achieve a certain goal for the customer (Huikkola and Kohtamäki 2018; Ulaga and Reinartz 2011). Services play the key role and the product becomes the vehicle to render the services and the desired outcome (Huikkola and Kohtamäki 2018; Tukker 2004; Vargo and Lusch 2004). This is often linked with outcome-based pricing models such as price per unit or performance based pricing (Huikkola and Kohtamäki 2018; Tukker 2004). An example for this business model is the Michelin fleet solution (Ulaga, Dalsace, and Renault 2006; Ulaga and Reinartz 2011). The French tire manufacturer Michelin takes over all products and services surrounding commercial tires and has a price per kilometer for its fleet solution (Ulaga, Dalsace, and Renault 2006). The key advantage of this business model is that it is hard to imitate by competitors (Huikkola and Kohtamäki 2018). A strong customer relationship and the manufacturers' deep understanding of the customer processes are tacit value elements which cannot be easily copied (Huikkola and Kohtamäki 2018; Tuli, Kohli, and Bharadwaj 2007; Ulaga and Reinartz 2011). However, a potential downside of this model is its higher complexity and that manufacturers assume partially the customers' operational risk (Ulaga and Reinartz 2011). To continue the Michelin example, if logistics companies have less order volumes, than the driven kilometers decrease. This results in less revenue for Michelin's kilometer-based fleet solution.

These four servitization business models are frequently mentioned in literature (Huikkola and Kohtamäki 2018; Tukker 2004; Ulaga and Reinartz 2011) and can be also seen in real world settings like Michelin's fleet solution (Ulaga, Dalsace, and Renault 2006). They are not mutually exclusive and may even build upon each other (Huikkola and Kohtamäki 2018). For instance, the result-oriented model will require all the elements of the process-oriented model as well (Huikkola and Kohtamäki 2018; Ulaga and Reinartz 2011). Moreover, firms may not rely on a single business model strategy, but employ different ones depending on their respective business environment (Huikkola and Kohtamäki 2018). The path from product-oriented

to result-oriented business models reflect manufacturers' move from transaction-based to relationship-based orientation (Oliva and Kallenberg 2003). In addition, the servitization business models can be categorized along two levels. First, the role and importance of services differ from business model to business model. Second, the penetration into customer processes varies depending on the business model. Figure 2.9 visualizes how the four servitization models can be categorized along these two characteristics.

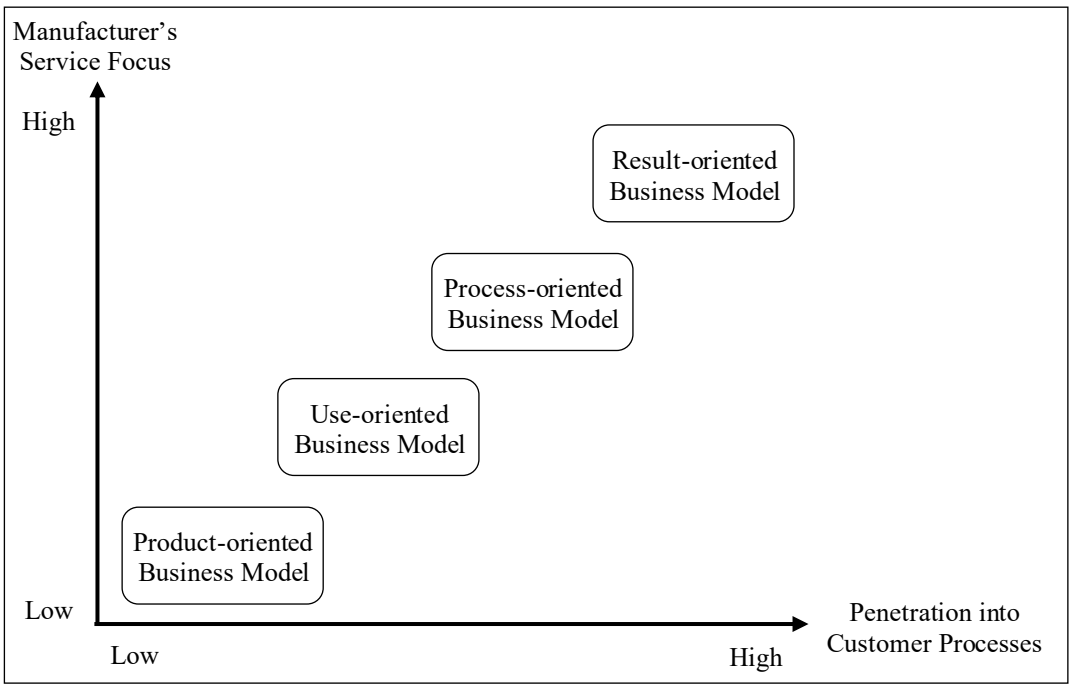

Figure 2.9: Characterization of Servitization Business Models (Adapted from Huikkola and Kohtamäki 2018)

2.2.3.2 Organizational Parameters

The servitization process in manufacturing creates major organizational changes in a company. The following paragraphs discuss servitization research about organizational aspects.

Research identified several organizational parameters which influence the servitization process in manufacturing (Antioco et al. 2008; Gebauer, Fischer, and Fleisch 2010; Ulaga and Kohli 2018). These parameters can be categorized into three main groups, namely corporate culture, human resource management, and organizational structure (Gebauer, Fischer, and Fleisch 2010).

One of the key antecedents for successful service provision is a manufacturers' corporate culture (Antioco et al. 2008; Gebauer, Fischer, and Fleisch 2010; Homburg, Fassnacht, and Guenther 2003). Traditional product-based companies are characterized by a culture sur-

rounding the physical product (Dubruc, Peillon, and Farah 2014; Homburg, Fassnacht, and Guenther 2003). Their mission and vision are based on the manufactured product itself (Homburg, Fassnacht, and Guenther 2003). However, the servitization process requires a change in the manufacturer's culture from product-oriented to service-oriented (Gebauer 2007; Homburg, Fassnacht, and Guenther 2003). This means the entire company must adopt the idea to be a service-provider (Gebauer 2007; Homburg, Fassnacht, and Guenther 2003; Mathe and Shapiro 1993). In this change process, the company's executive team plays a key role in fostering a service-oriented company culture (Antioco et al. 2008). Research shows that a "greater top management commitment to and visionary leadership of services leads to a greater emphasis on an SSP business orientation" (Antioco et al. 2008, p. 348). However, the culture change needs to take place down to the lowest hierarchical company level (Homburg, Fassnacht, and Guenther 2003; Mathe and Shapiro 1993). The employees are essentially delivering the service (Homburg, Fassnacht, and Guenther 2003; Mathe and Shapiro 1993). Hence, their behavior must be service-oriented. Along this line, Antioco et al. (2008) determine two elements which support the service orientation of employees. First, service rewards have a positive impact on service business orientation (Antioco et al. 2008). Second, service technology, such as IT-based service tools, also support the company's overall service orientation (Antioco et al. 2008). In return, Homburg, Fassnacht, and Guenther (2003) find a positive relationship between service-oriented corporate culture and service profitability and quality of customer relationships.

A second organizational parameter for servitization is human resource management (Gebauer, Fischer, and Fleisch 2010; Homburg, Fassnacht, and Guenther 2003). Employees in services need specific capabilities for the provision and sales of services (Antioco et al. 2008; Böhm et al. 2020; Ulaga and Kohli 2018; Ulaga and Reinartz 2011). The sales process of services is often longer and more complex due to "strong customer involvement, or even cocreation, to elaborate the offering" (Ulaga and Reinartz 2011, p. 13). Specifically in the context of solutions, sales personnel need strong communication skills (Ulaga and Kohli 2018; Ulaga and Reinartz 2011). On the one side, solution offerings often involve collaboration with customer contacts higher in the hierarchy (Ulaga and Reinartz 2011). Salespeople need to know how to interact with these new customer contacts when selling a solution (Ulaga and Reinartz 2011). A critical capability in this context is the salesperson's ability to communicate the value of the offering while reducing the customer's uncertainty (Ulaga and Kohli 2018; Ulaga and

Reinartz 2011). On the other side, solutions often involve multiple departments within the manufacturer (Ulaga and Reinartz 2011). Salespeople need to be able to effectively coordinate the internal communication to deliver the solution (Ulaga and Reinartz 2011). Service employees need formal training in order to gain the necessary capabilities to sell and deliver services (Antioco et al. 2008). The level of employees' service training is positively correlated with higher service volumes (Antioco et al. 2008). Against this backdrop, manufacturers need to adjust their recruitment, training, and assessment when hiring new service employees (Gebauer, Fischer, and Fleisch 2010). Such a service-oriented human resource management has a positive impact on service profitability and quality of customer relationships (Homburg, Fassnacht, and Guenther 2003).

A third parameter is the organizational structure of servitization and how it facilitates a manufacturer's service orientation. Essentially a company has different options to structure its products and services portfolio. Based on strategic business units (SBU)[6], Gebauer et al. (2009) investigate four different organizational structures and their impact on service orientation. These organizational structures include product SBU, product–service SBU, service–product SBU, service SBU and product SBU (Gebauer et al. 2009). Figure 2.10 summarizes the different SBUs and their main characteristics.

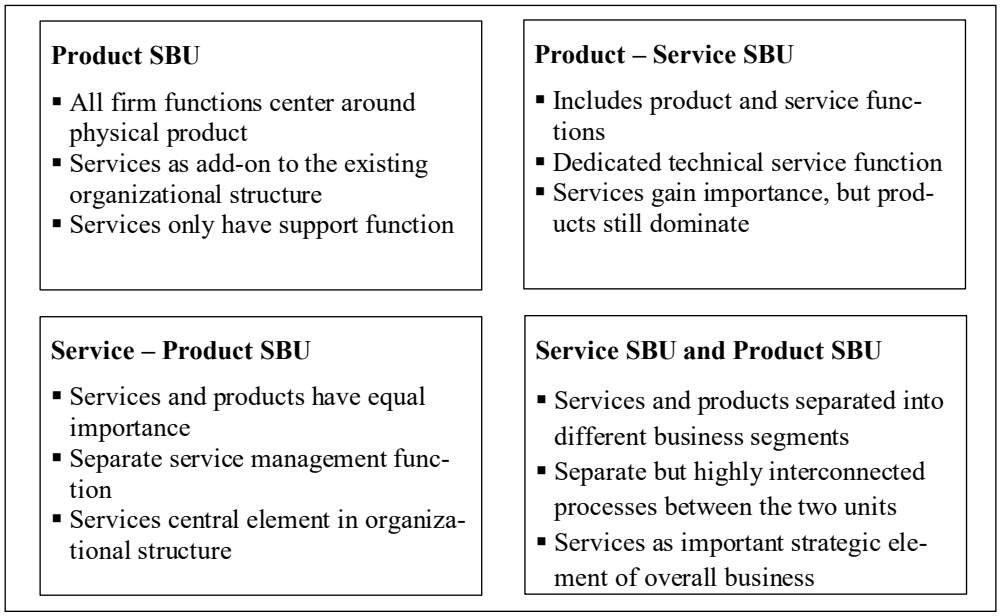

Figure 2.10: Types of Strategic Business Units (Gebauer et al. 2009)

[6] Strategic business units (SBUs) are organizational units with independent management of at least three important functions such as marketing, sales, manufacturing, research and development, accounting and finance, or human resources (Homburg, Workman, and Krohmer 1999).

The four SBU types put different emphasis on the importance of services. While the products SBU focuses on physical products, the separated service and product SBUs put equal focus on services and products (Gebauer et al. 2009). Hence, the organizational structure of a firm can aid or hinder its servitization process.

Next to this general classification of organizational structures, research investigates contingency factors for different structures such as organizational empowerment (He et al. 2015), value chain position (Bustinza et al. 2015), and type of service offered (Galbraith 2002). Organizational structures are configurational and can lead to financial success through multiple paths (Ambroise, Prim-Allaz, and Teyssier 2018; Bustinza, Vendrell-Herrero, and Baines 2017). There is no one-size-fits-all approach for the appropriate organizational structure in the servitization process.

2.2.3.3 Service Typology

Manufacturers can offer different types of services from basic maintenance services up to complex business solutions (Ulaga and Reinartz 2011). The choice which services to offer presents a strategic decision which influences other important factors such as the business model configuration (Huikkola and Kohtamäki 2018). Hence, it is important to understand the different categorization of services (i.e., service types). Servitization research identified several different service typologies (Kohtamäki et al. 2013; Raddats et al. 2019). Table 2.2 gives an overview of the major service typologies in literature.

Service Typology	Dimensions	Authors
SSP – SSC Classification	▪ Service in Support of Products (SSP) ▪ Service in Support of Customers (SSC)	Mathieu (2001a)
Installed Base Services (IB Services)	▪ Basic Installed Base Services ▪ Maintenance Services ▪ Professional Services ▪ Operational Services	Oliva and Kallenberg (2003)
Product-Service Systems (PSS) Categories	▪ Product-Oriented PSS ▪ User-Oriented PSS ▪ Result-Oriented PSS	Tukker (2004)
Service Classification	▪ Design & Development Services ▪ Systems & Solutions ▪ Retail & Distribution Services ▪ Maintenance & Support Services ▪ Installation & Implementation Services ▪ Financial Services ▪ Property & Real Estate Services ▪ Consulting Services ▪ Outsourcing & Operating Services ▪ Procurement Services ▪ Leasing Services ▪ Transportation & Trucking Services ▪ End-of-life Support Services	Neely (2008) Lee and Hong (2016)
Hybrid Offerings	▪ Product Life-Cycle Services (PLS) ▪ Asset Efficiency Services (AES) ▪ Process Support Services (PSS) ▪ Process Delegation Services (PDS)	Ulaga and Reinartz (2011)
Product-Service Offerings	▪ Base Services ▪ Intermediate Services ▪ Advanced Services	Baines and Lightfoot (2014)
Service Infusion Continuum	▪ Entitlement Services ▪ Value-added Services ▪ Asset Management ▪ Supplementary Services ▪ Business Process Outsourcing ▪ Smart Services ▪ Software as Service ▪ Managed Services ▪ Advisory Services ▪ Integrated Product–Service Solutions	Zeithaml and Brown (2014)

Table 2.2: Service Typologies (Adapted from Raddats and Kowalkowski 2014)

One of the frequently used typologies in literature is the SSP-SSC classification (e.g., Antioco et al. 2008; Eggert et al. 2014; Forkmann, Henneberg, et al. 2017). This typology divides manufacturers' services into two categories depending on their primary objective. Services in support of products (SSPs) focus on the smooth operation of the physical product (Mathieu 2001a). Typical SSPs include installation, maintenance, and repair services (Mathieu 2001a).

The second category are services in support of customers (SSCs) which go beyond simple product-focused services and focus on customer processes (Mathieu 2001a). Typical SSCs can include for example training, and advisory services (Mathieu 2001a). The distinction between SSP and SSC can be determined along three main dimensions. First, the direct recipient of the service differs between the two service types (Lovelock 1983; Mathieu 2001a). SSPs are primarily concerned with the physical product, while the SSCs puts customer's actual needs in the focus (Mathieu 2001a). The second dimension looks at the strength of customer relationship (Mathieu 2001a). SSPs are often transactional in nature and therefore have a low level of relationship building potential (Frambach, Wels-Lips, and Gündlach 1997; Mathieu 2001a). In contrast, SSCs require the manufacturer to have a deep understanding and high involvement into customer processes (Mathieu 2001a). Hence, SSCs can foster stronger customer relationships (Mathieu 2001a). A final dimension is the customization level of SSPs and SSCs. The SSPs surround the manufacturer's product and therefore can benefit from high standardization (Mathieu 2001a). In contrast, SSCs such as advisory services need to be highly customized to individual customer settings (Mathieu 2001a).

Oliva and Kallenberg (2003) focus their service typology on the idea of installed base (IB) services. The installed base of a manufacturer is "the total number of products currently under use" (Oliva and Kallenberg 2003, p. 163). IB services are provided to keep this installed base up and running throughout its entire lifecycle (Oliva and Kallenberg 2003). The four IB service categories can be characterized along two dimensions as seen in table 2.3.

Customer Interaction	**Value Proposition**	
	Product-oriented Services	**End-user's Process-oriented Services**
Transaction-based Services	Basic Installed Base Services (e.g., Installation and Repair services)	Professional Services (e.g., Process-oriented Consulting)
Relationship-based Services	Maintenance Services (e.g., Preventative Maintenance)	Operational Services (e.g., Managing Operations)

Table 2.3: Service Typology based on Customer Interaction and Value Proposition (Adapted from Oliva and Kallenberg 2003)

The value proposition dimension is similar to the SSP-SSC classification and distinguishes between product and process-oriented services (Oliva and Kallenberg 2003). However, Oliva and Kallenberg (2003) do not regard product-oriented services to be always transactional and process-oriented services to be always relational. Customer interaction is introduced as a new categorization criterion. For instance, maintenance services still have the potential to build

close customer relationships (Oliva and Kallenberg 2003). Preventative maintenance on a regular basis may build up a close relationship between the manufacturer and its customers (Oliva and Kallenberg 2003). On the other hand, customer training may be process-oriented but still transactional in nature (Oliva and Kallenberg 2003). If the customer training is for example a one-time event, it is rather unlikely to build a strong customer relationship (Oliva and Kallenberg 2003).

A third service typology is based on the Scandinavian concept of product-service systems (PSS) (Mont 2002; Tukker 2004). There are three main PSS service categories. First, the product-oriented services focus on the smooth operation and usability of the physical product (Tukker 2004). Next to installation and maintenance, this can also include process-related services such as education and trainings (Tukker 2004). The second category is the use-oriented service (Tukker 2004). The manufacturer maintains ownership of the physical product and sells the usage in form of renting or leasing the product to the customer (Tukker 2004). This means services are often included in the leasing or renting agreements (Tukker 2004). The final category is the result-oriented services (Tukker 2004). In this setting, the manufacturer promises a certain outcome (Tukker 2004). Possible services in this category include for example business process outsourcing (Tukker 2004).

Neely (2008) identifies a total of 12 service categories, which allows for a finer grained view on servitization. Most of the categories are self-explanatory such as maintenance, installation, and financial services. Lee and Hong (2016) expand Neely's classification by end-of-life support services such as refurbishing or recycling services.

Another service typology is developed by Ulaga and Reinartz (2011). They expand the SSP-SSC categorization by a value proposition dimension. This results in four distinctive service offerings as depicted in table 2.4 (Ulaga and Reinartz 2011).

Value Proposition	Service Recipient	
	Service Oriented Toward the Manufacturer's good	**Service Oriented Toward the Customer's Process**
Input-based (Perform a Deed)	Product Life-Cycle Services (PLS) (e.g., Maintenance Services)	Process Support Services (PSS) (e.g., Consulting Services)
Output-based (Achieve Performance)	Asset Efficiency Services (AES) (e.g., Remote Diagnostics)	Process Delegation Services (PDS) (e.g., Fleet Management Services)

Table 2.4: Service Typology based on Service Recipient and Value Proposition (Adapted from Ulaga and Reinartz 2011)

Product life-cycle services (PLS) ensure that the product is accessible and usable throughout its entire lifecycle (Ulaga and Reinartz 2011). They focus solely on the product and manufacturers perform an agreed upon deed (Ulaga and Reinartz 2011). Asset efficiency services (AES) go one step further and ensure the customer productivity gains from the use of the product (Ulaga and Reinartz 2011). The value proposition is to achieve a certain performance of the product. A typical AES is for example remote diagnostic services which detect potential product failures ahead of time and proactively react to it (Ulaga and Reinartz 2011). The third category are process support services (PSS) which shift the focus from the product to the customer's process (Ulaga and Reinartz 2011). The manufacturer performs a certain deed with PSS services such as advising the customer how to efficiently use the product in their individual process (Ulaga and Reinartz 2011). The final and most advanced category is process delegation services (PDS) (Ulaga and Reinartz 2011). The manufacturer takes full responsibility for a certain customer process (Ulaga and Reinartz 2011). Typical PDS are integrated business solutions such as fleet solutions. For instance, the tool manufacturer Hilti offers a fleet management solution which takes over a company's entire tool management process (Hilti 2020).

The fifth service typology takes a customer perspective on services (Baines and Lightfoot 2014). There are three types of customers in a manufacturing service setting. First, customer who perform services inhouse, second customers who engage in services themselves and include manufacturers, and finally customers who outsource their services (Baines and Lightfoot 2014). Based on these three customer types, manufacturers offer base, intermediate and advanced services (Baines and Lightfoot 2014). Base services are ensuring the functionality of the product at a minimum level (Baines and Lightfoot 2014). Typical services include

spare part delivery, warranty, and installation (Baines and Lightfoot 2014). Intermediate services focus on the continuous maintenance of the product throughout its lifecycle (Baines and Lightfoot 2014). Services in this category are for instance preventative maintenance, overhaul, and customer training services (Baines and Lightfoot 2014). The final category of advanced services goes beyond product and process services. The manufacturer and customer agree upon a certain performance outcome of the service (Baines and Lightfoot 2014). This can go as far as the manufacturer taking full responsibility of a customers' process (Baines and Lightfoot 2014)

The final classification defines manufacturers services along a continuum (Bustinza et al. 2015; Zeithaml and Brown 2014). Similar to the SSP-SSC classification, the one end of the continuum presents service categories in support of the product, while the other end has service categories in support of the customer (Zeithaml and Brown 2014). Figure 2.11 depicts how the different service categories can be positioned along the service infusion continuum (Zeithaml and Brown 2014).

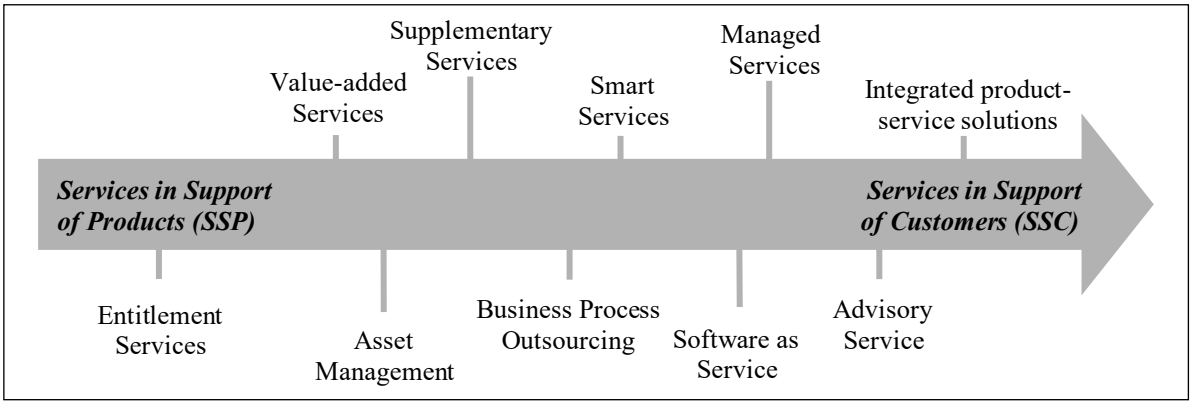

Figure 2.11: Service Infusion Continuum (Adapted from Zeithaml and Brown 2014)

There are a total of ten service infusion categories. The first category are entitlement services which are basic services such as warranty, installation, and repairs (Zeithaml and Brown 2014). They focus on the proper functioning of the product. Value-added services have a supplementary character and can enhance the "purchase, protection, or usage of the product" (Zeithaml and Brown 2014, p. 7). Examples for value-added services are financing, warranty extensions, and priority technical support (Zeithaml and Brown 2014). The next category is asset management services (Zeithaml and Brown 2014). Since manufacturers usually have a deep understanding of their product category, they are poised to take over the entire responsibility for the product category (Zeithaml and Brown 2014). For instance, a printing machine

manufacturer can take over all printing related processes of a company from providing the printer up to managing the supplies (Zeithaml and Brown 2014). The fourth category is supplementary services. These services are more detached from the physical product and are usually sold separately (Zeithaml and Brown 2014). Services in this category are based on the manufacturer's deep know-how of the industry (Zeithaml and Brown 2014). An example are software systems which improve the customer productivity (Zeithaml and Brown 2014). The next category is business process outsourcing. This means that the customer outsources an entire non-strategic process to the manufacturer (Zeithaml and Brown 2014). The manufacturer's specialization enables it to perform those processes at lower cost (Zeithaml and Brown 2014). For instance, the technology company Xerox runs back-office processes such as payroll, accounting, and finance for some of its customers (Zeithaml and Brown 2014). The sixth category is smart services. The characteristic feature of this category is that it relies on sensor technology and that is heavily automated (Zeithaml and Brown 2014). Manufacturers equip their products with sensors and sophisticated software systems and analyze the generated data to anticipate for example potential problems (Zeithaml and Brown 2014). In addition, the data can be used to develop new services such as optimized capacity management (Zeithaml and Brown 2014). Another service infusion category is software as a service (SaaS) (Zeithaml and Brown 2014). The key difference to other software products is that the manufacturer licenses its product via the internet (Zeithaml and Brown 2014). These are often cloud-based applications which improve the customer's operational productivity (Zeithaml and Brown 2014). The next category is managed services. This enables the manufacturer not only to take over customer processes but also implement changes to it (Zeithaml and Brown 2014). Hence, it is more strategic than traditional asset management or business process outsourcing services (Zeithaml and Brown 2014). An example is HP's managed printing services, which not only ensure printing capabilities but also implement changes for cost saving and efficiency improvements (Zeithaml and Brown 2014). The eight category is advisory services. These entail consulting services targeted towards the customer's top management (Zeithaml and Brown 2014). Manufacturers' experiences in an industry can help its customers to improve managerial and operational performance (Zeithaml and Brown 2014). IBM's consultancy business is a frequently mentioned example for advisory services (Zeithaml and Brown 2014). The final category is integrated product-service solutions. In a solution offering manufacturers draw on their extensive experience to meet customer needs (Zeithaml and Brown 2014). This means to

"customize, integrate, deploy, and support a package of goods and services" (Zeithaml and Brown 2014). For instance, IBM offers its customers a solution to migrate their systems to the cloud (Zeithaml and Brown 2014). This solution involves products such as servers as well as services such as consulting (Zeithaml and Brown 2014). The high integration of these elements provides the actual value to the customer (Davies 2005; Zeithaml and Brown 2014).

The overview of service typologies shows that there are a variety of classifications. The typologies are partially interrelated and build upon each other (Raddats et al. 2019). Differences arise based on for example the underlying definition of services and the level of granularity. While some divide services into only two categories (e.g., Mathieu 2001a), others employ a finer differentiation (e.g., Zeithaml and Brown 2014). However, all in all the distinction between services in support of the product (SSP) and services in support of the customer (SSC) prevails in research (Antioco et al. 2008; Eggert et al. 2014; Forkmann, Henneberg, et al. 2017).

2.2.4 Implementation

The implementation of a servitization strategy is linked to major changes for a manufacturer. Subchapter 2.2.4.1 gives an overview of major research topics about the change process in servitization. The subchapter 2.2.4.2 discusses resources and capabilities needed for successful service provision.

2.2.4.1 Change Process

The literature often describes servitization as a "transformational" process (Baines et al. 2020; Bustinza, Vendrell-Herrero, and Baines 2017; Storbacka et al. 2013). It comes with far-reaching changes for the manufacturer in multiple strategic areas (Kindström 2010; Reim, Parida, and Örtqvist 2015; Storbacka et al. 2013). In order to implement these complex changes manufacturers, need a change process (Rabetino, Kohtamäki, and Gebauer 2017).

Rabetino, Kohtamäki, and Gebauer (2017) identify three major processes that realign during a manufacturer's servitization efforts. First, operations management processes such as service operations, supply chain, and project and risk management change (Rabetino, Kohtamäki, and Gebauer 2017). On the one hand, the objective is to increase operational flexibility and adaptability (Rabetino, Kohtamäki, and Gebauer 2017). On the other hand, the changes aim to im-

plement effective service structures (Rabetino, Kohtamäki, and Gebauer 2017). The second area to be adjusted is the customer management processes. These include fundamental marketing elements such as segmenting, communication and pricing (Rabetino, Kohtamäki, and Gebauer 2017). The final process to change is the innovation process of the manufacturer. The closer relationship to the customer enables the manufacturer to co-develop new products and services with the customer (Baines et al. 2010; Rabetino, Kohtamäki, and Gebauer 2017). Table 2.5 present examples for these three process changes.

Process Change	**Objective**	**Example**
Operations Management	1) Increase Cost Efficiency 2) Increase Operational Flexibility 3) Lock-In Existing Customers	Modularity of Products and Services: The firm has a core offering and offers optional add-on services and products.
Customer Management	1) Identify Customer Segments and Needs 2) Manage Customer Relationships 3) Market Product-Service Offerings	Customer Segmentation: The firm segments its customers based on the required service level.
Innovation	1) Manage Service Portfolio 2) Benchmark best Service Development Practices 3) Co-develop Lifecycle Solutions	Product Design Process: The firm includes a service representative into the development and design of new products and services.

Table 2.5: Servitization Change Process (Adapted from Rabetino, Kohtamäki, and Gebauer 2017)

Another research stream investigates the transition towards services in stages (Lütjen, Tietze, and Schultz 2017; Oliva and Kallenberg 2003; Vandermerwe and Rada 1988). Services are added gradually to the existing product portfolio. Early servitization research identifies two main stages (Vandermerwe and Rada 1988). In the first stage, services are simply added next to the physical product (Vandermerwe and Rada 1988). Both co-exist next to each other. In the second stage the distinction between manufactured goods and services becomes more and more blurred (Crozet and Milet 2017; Vandermerwe and Rada 1988). Manufacturers start to offer a combination of goods, services and know-how (Vandermerwe and Rada 1988). Later servitization research develops a more differentiated view on the servitization stages (Brax 2005). Oliva and Kallenberg (2003) describe four stages, while Lütjen, Tietze, and Schultz (2017) come up with three stages. In addition, research finds out that the sequential order of the stages may be configurational depending on contingency factors (Gebauer 2008; Matthyssens and Vandenbempt 2010). Even though research comes to different granularity of

servitization stages, the underlying idea is that manufacturers gradually move from product-focused to more customer-focused services.

A third research stream deals with digitalization as an enabler for servitization (Coreynen, Matthyssens, and Van Bockhaven 2017). So called "platforms" present manufacturers with innovative technological possibilities to implement services (Cenamor, Rönnberg Sjödin, and Parida 2017; Kohtamäki, Parida, et al. 2019). For instance, the Internet of Things (IoT) technology[7] can scale up the manufacturers diagnostic capabilities and deliver higher value to the customer (Paiola and Gebauer 2020; Rymaszewska, Helo, and Gunasekaran 2017; Ulaga and Reinartz 2011). Technologies such as a customer self-service platforms present new opportunities to implement innovative services (Nie and Kosaka 2016). This digitalization process requires manufacturers to revamp their IT technology and have the capability to analyze the data (von Leipzig et al. 2017; Ulaga and Reinartz 2011).

Another change process is the requirement for new governance mechanism (Sjödin, Parida, and Kohtamäki 2019; Wathne and Fjeldstad 2019). The value creation process especially in services often goes beyond the mere transactional exchange between customer and seller (Vargo, Maglio, and Akaka 2008). This is especially true for services supporting the customer such as business solutions (Mathieu 2001a; Tuli, Kohli, and Bharadwaj 2007). Value in theses settings is co-created closely with all the involved actors (Payne, Storbacka, and Frow 2008; Vargo and Lusch 2016). This co-creation process creates potential tensions between suppliers and customers due to two main reasons (Colm, Ordanini, and Bornemann 2020). First, the co-creation process increases complexity of the service provision since they require an interplay between multiple parties (Colm, Ordanini, and Bornemann 2020). Second, established relationship roles and tasks of manufacturers (i.e., suppliers) and customers change dramatically with certain services, for instance when suppliers take over entire customer processes (Colm, Ordanini, and Bornemann 2020; Ulaga and Reinartz 2011). This can lead to opportunistic behavior from any of the involved parties (Colm, Ordanini, and Bornemann 2020). To mitigate these potential tensions, manufacturers develop different governance mechanisms, such as contracts and agreements (Colm, Ordanini, and Bornemann 2020; Sjödin, Parida, and

[7] Internet of Things (also referred to as Industry 4.0 or Industrial Internet) describes technologies which "facilitate the decoupling of machine software from hardware across the socio-technical industrial system and enable fuller utilization of product data in combination with other data." (Kowalkowski et al. 2017, p. 8).

Kohtamäki 2019). For instance, at the beginning of a business solution the involved parties may face the risk of opportunistic behavior from either side (Colm, Ordanini, and Bornemann 2020). In order to avoid this the parties may temporarily share proprietary, physical assets with each other (Colm, Ordanini, and Bornemann 2020).

2.2.4.2 Resources and Capabilities

Manufacturers need specific resources and capabilities to successfully move towards services (Davies et al. 2001; Raddats et al. 2019; Ulaga and Reinartz 2011). Resources are all tangible and intangible assets that are tied to a company such as machines, brands, and human resources (Amit and Schoemaker 1993; Wernerfelt 1984). Capabilities describe what a company can perform by deploying its resources through organizational processes (Amit and Schoemaker 1993). For instance, a company could have the capability to understand and interpret machine diagnostic data, which comes from its resource of remote monitoring systems (Ulaga and Reinartz 2011). Hence, resources and capabilities are highly interdependent (Amit and Schoemaker 1993; Wernerfelt 1984).

Research identifies a set of resources and according capabilities for servitization (Davies et al. 2001; Kleinaltenkamp et al. 2020; Neu and Brown 2005; Ulaga and Reinartz 2011). Figure 2.12 summarizes the main resources and capabilities needed for servitization. The following paragraphs discusses each category in detail.

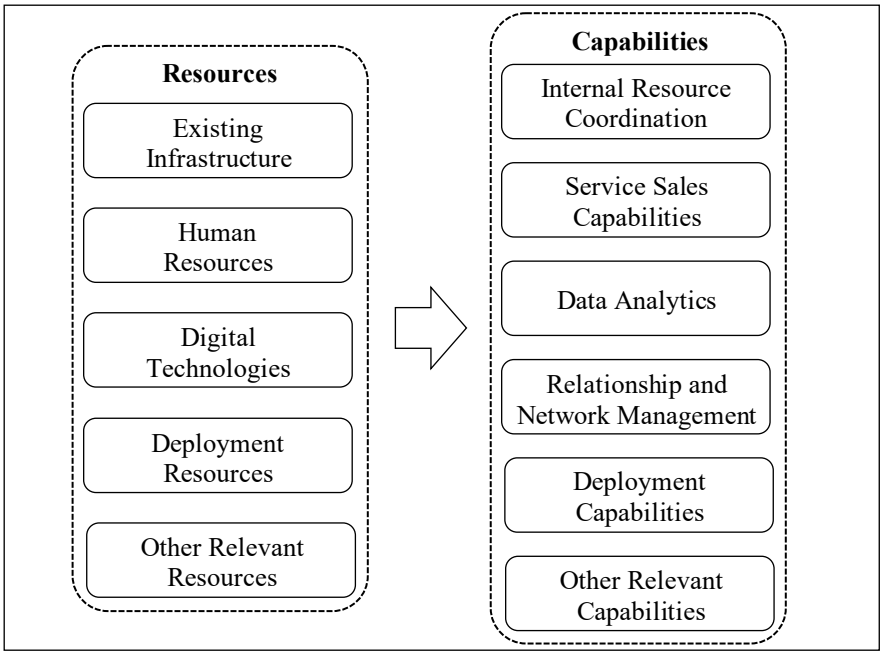

Figure 2.12: Resources and Capabilities required for Services (Adapted from Ulaga and Reinartz 2011)

An infrastructure of exiting organizational resources is a fundamental prerequisite for service provisions (Neu and Brown 2005; Ulaga and Reinartz 2011). This means that the manufacturer has an established manufacturing and product development setting (Ulaga and Reinartz 2011). This setting can create synergies when developing services (Neu and Brown 2005; Ulaga and Reinartz 2011). Moreover, the access to unique manufacturing assets can build a competitive advantage in the market (Neu and Brown 2005; Ulaga and Reinartz 2011). In addition, the manufacturer's installed base represents an important existing resource for services (Oliva and Kallenberg 2003; Wise and Baumgartner 1999). The manufacturer benefits from a large installed base in two ways. First, they have a potential to provide services to their products in use (Oliva and Kallenberg 2003; Wise and Baumgartner 1999). Second, the customers' product usage and process data are a valuable sources for additional services and a differentiating factor (Ulaga and Reinartz 2011).

Service research regards people as one of the key elements for the successful provision of services (Parasuraman, Zeithaml, and Berry 1985). This applies to the servitization context as well (Panagopoulos, Rapp, and Ogilvie 2017; Ulaga and Kohli 2018). The service-orientation of the company's employees (i.e., human resources) represents a critical resource in the servitization process (Bowen and Greiner 1986; Homburg, Fassnacht, and Guenther 2003; Reinartz and Ulaga 2008). This applies to all hierarchical levels in the company. On the one end, top management's commitment to services can positively impact the servitization process (Antioco et al. 2008). On the other end, frontline employees are an important success factor for service provisions (Neu and Brown 2005; Panagopoulos, Rapp, and Ogilvie 2017; Parasuraman, Zeithaml, and Berry 1985). For instance, an established sales force can help "manufacturers to build unique resources that enable privileged access to customers and reinforce ties with key contacts" (Ulaga and Reinartz 2011, p. 10).

A third critical resource for servitization is access to digital technologies (Cenamor, Rönnberg Sjödin, and Parida 2017; Ulaga and Reinartz 2011). Emerging digital technologies such as sensor technology represent new opportunities for service provision (Ardolino et al. 2018; Wise and Baumgartner 1999). A manufacturer needs to implement these new technologies to provide certain services such as remote diagnostics (Ardolino et al. 2018; Wise and Baumgartner 1999). This is also important for collecting data, which then can be used for analytics and other services (Ardolino et al. 2018; Ulaga and Reinartz 2011). This integration of

monitoring and diagnostics capabilities into the physical product is also referred to as embedded services (Wise and Baumgartner 1999).

Deployment resources are essential for a manufacturers' service provision. On the one hand, a manufacturer can leverage its existing distribution network to offer its services (Gebauer et al. 2009). On the other hand, many companies reorganize their service activities in separate field service organizations (Ulaga and Reinartz 2011). In addition, research indicates that manufacturers need a critical mass in service deployment for beneficial financial outcomes (Fang, Palmatier, and Steenkamp 2008; Kastalli and Van Looy 2013).

Other relevant resources are for example the development of key performance indicators (KPIs) for services, and the acquisition of new competencies and market knowledge. KPIs help manufacturers to assess their servitization efforts and its financial impact on the company (Barquet et al. 2013). The acquisition of competencies and market knowledge are essential elements to build up new resources for service provision (Huikkola, Kohtamäki, and Rabetino 2016).

Having the necessary resources is not sufficient to offer services. Manufacturers need the according capabilities to use their resources (Amit and Schoemaker 1993; Ulaga and Reinartz 2011). A key capability is the manufacturer's ability to coordinate its internal resources (Storbacka 2011). Especially in complex services and solutions, a single department may not have all the necessary resources for delivering the service (Foote et al. 2001; Storbacka 2011). Hence, different organizational units within a company must work closely together to jointly develop and deliver services (Foote et al. 2001; Neu and Brown 2005). This collaboration across different organizational units requires a strong coordination for successful outcomes (Storbacka 2011). Manufacturers use different strategies to coordinate their internal resources such as design-to-service capability (Ulaga and Reinartz 2011), knowledge management (Raddats, Burton, and Ashman 2015), and innovation management (Frishammar et al. 2019; Wallin, Parida, and Isaksson 2015). A manufacturer's design-to-service capability enables it to effectively combine tangible and intangible assets into innovative new offerings (Ulaga and Reinartz 2011). Knowledge management means for example that the development process of a service is precisely documented (Raddats, Burton, and Ashman 2015). Innovation management leverages for example the tacit know-how of field service employees to develop new services (Huikkola, Kohtamäki, and Rabetino 2016).

Another critical capability is the service sales capability (Ulaga and Reinartz 2011). The selling approach of services and goods together vary in many ways from the traditional goods-centered sales process (Dubinsky and William 1981; Ulaga and Reinartz 2011). It starts at the very beginning of the sales process, where requirements for a service may not be as clear as in the case of a product (Tuli, Kohli, and Bharadwaj 2007; Ulaga and Reinartz 2011). This requires the salespeople to strongly collaborate with the customer to design the services and products (Tuli, Kohli, and Bharadwaj 2007; Ulaga and Reinartz 2011). At the same time this often means that the salespeople have to work with multiple involved parties of the customer and within their own company (Neu and Brown 2005; Tuli, Kohli, and Bharadwaj 2007; Ulaga and Reinartz 2011). Salespeople must manage effectively those internal and external relationships, and continuously adjust to different sales process settings (Ulaga and Loveland 2014; Ulaga and Reinartz 2011). Along the same line, the skills and traits of salespeople who sell services and products differ from the product-focused salespeople (Ulaga and Kohli 2018; Ulaga and Reinartz 2011). For instance, selling services means to argue based on value and not physical product features (Ulaga and Reinartz 2011). This change in mindset is fundamental since services lack physical evidence and need to be explained communicating the value in use (Ulaga and Kohli 2018). In the context of highly integrated product-service combinations (i.e., business solutions) salespeople play a special role. Business solutions often involve a high degree of uncertainties for the customer and the manufacturer (Ulaga and Kohli 2018). In this context, salespeople need special skills to mitigate some of those uncertainties among the involved parties (Ulaga and Kohli 2018).

Data analytics are a third critical capability for servitization. The resource of digital technologies such as sensor technology generate vast amounts of usage and process data (Opresnik and Taisch 2015). To make use of this data, the manufacturer needs service-focused data processing and interpretation capabilities (Ulaga and Reinartz 2011). The objective is to use the data for customer productivity gains and cost reductions (Ulaga and Reinartz 2011; Wise and Baumgartner 1999). The manufacturer's IT systems and management play a key role for developing data analytics capabilities (Allmendinger and Lombreglia 2005; Neu and Brown 2005; Penttinen and Palmer 2007). For instance, a manufacturer of ATM machines leverages usage data of its ATMs to optimize a bank's cash management processes (Ulaga and Reinartz 2011). This results in significant cost savings for the bank (i.e., the customer) since handling cash is an expensive activity (Ulaga and Reinartz 2011).

Another key capability for services is relationship management. The servitization process changes the interaction between manufacturers and their customers from transaction-based to relationship-based (Penttinen and Palmer 2007; Tuli, Kohli, and Bharadwaj 2007; Vargo and Lusch 2004). Manufacturers need capabilities to cultivate and manage this more intimate relationship to their customers (Baines and Lightfoot 2014). The relevance of relationship building capabilities is supported by research. Tuli et al. (2007) show that especially business solutions represent a set of relational processes between the manufacturer and the customer. Based on a customer's perspective they derive four essential relational processes to deliver solutions successfully (Tuli, Kohli, and Bharadwaj 2007). The close collaboration and relationship between manufacturer and customer are a key element throughout all the four stages (Tuli, Kohli, and Bharadwaj 2007). Baines and Lightfoot (2014) develop a set of skills for service provisions. They determine relationship building capabilities as a critical skill for manufacturers (Baines and Lightfoot 2014).

The next core capability for services is network management. Manufacturers often have to rely on a network of companies to develop their service capabilities (Cova and Salle 2008; Foote et al. 2001). This collaboration can take place between different actors in the network. Manufacturers can work with their downstream network (i.e., customers) (Neu and Brown 2005), upstream network (i.e., suppliers) (Storbacka et al. 2013) and intermediaries (Finne and Holmström 2013) to create jointly service capabilities. Each of these networks needs to be effectively managed (Raddats et al. 2017).

A manufacturer's deployment capabilities are another important element for successful servitization. Manufacturers need to find a balance between standardizing "back-office processes while maintaining front-office customization" (Ulaga and Reinartz 2011, p. 14). There are two mechanisms to achieve this objective. First, economies of scale can be realized through standardization of service processes (Ulaga and Reinartz 2011). Second, modularization of services into packages allows for satisfying different customer needs (Anderson and Narus 1995; Rajala et al. 2019; Ulaga and Reinartz 2011). Using these mechanisms manufacturers can effectively deploy service offerings which strike a balance for standardization and customization (Anderson and Narus 1995; Ulaga and Reinartz 2011).

Two other relevant capabilities are risk assessment and mitigation capabilities, and cultural change management. Especially, highly integrated business solutions involve a risk transfer

from the customer to the manufacturer (Ulaga and Reinartz 2011; Worm et al. 2017). This is especially the case when manufacturers promise a certain performance outcome which may dependent on uncontrollable factors (Ulaga and Reinartz 2011; Worm et al. 2017). To avoid potential hazards, manufacturers must be able to assess the risks and design mitigation measures (Ulaga and Reinartz 2011; Worm et al. 2017). Typical mitigation measures can be for example incorporating a buffer into pricing, risk pooling (which means diluting the risk across a broader base), and analyzing and learning from past contract performance (Kowalkowski and Ulaga 2017). Developing all these capabilities requires a major cultural change within the manufacturer (Homburg, Fassnacht, and Guenther 2003). The ability to change its culture despite internal resistance and refocus it on services is another key capability for servitization (Mathieu 2001b).

2.2.5 Outcomes

This chapter focuses on the outcomes of the servitization process. Subchapter 2.2.5.1 discusses the financial implications of a manufacturer's servitization strategy. The subchapter 2.2.5.2 discusses non-financial outcomes.

2.2.5.1 Financial

First, the subchapter 2.2.5.1.1 discusses the literature about the direct relationship between servitization and financial outcomes. The following subchapter 2.2.5.1.2 focuses on indirect (i.e., moderating, and mediating) factors influencing the financial implications of servitization.

2.2.5.1.1 Direct Effects

The literature about financial implications of servitization presents a variety of different research results. On the one extreme, research shows no impact of servitization on a manufacturer's financial performance (e.g., Sousa and da Silveira 2017). On the other extreme, research suggests a complex non-linear relationship between services and financial outcomes (e.g., Kastalli and Van Looy 2013). These ambiguous research results indicate a complex relationship between servitization and financial outcomes. Research in this area can be categorized along two dimensions, the assumed underlying relationship (linear vs. non-linear) and the used data (survey vs. archival). Hence, there are four groups of research dealing with fi-

nancial implications of servitization. Exhibit 2 gives an overview of the main research articles in each of the four different groups.

The first research group investigates a linear relationship between servitization and financial outcomes using archival data. Most of the research in this group finds a positive linear relationship between servitization and the examined financial outcome variable (Wang, Lai, and Shou 2018). The authors argue with competitive, economic, and demand-based reasons for the positive impact of services in manufacturing (Baines et al. 2009; Oliva and Kallenberg 2003). Research underlines that manufacturers can solidify their competitive position through the addition of services. Specifically, services are harder to imitate and can offer sustainable means of differentiation (Oliva and Kallenberg 2003; Raddats et al. 2016; Raddats, Burton, and Ashman 2015). In addition, services foster a closer customer relationship which increases loyalty and further improve a manufacturer's competitive position (Huikkola and Kohtamäki 2018). From an economic perspective services represent an additional revenue stream and often have higher profit margins (Crozet and Milet 2017; Han, Kuruzovich, and Ravichandran 2013; Wise and Baumgartner 1999). Services can also offer steadier and counter-cyclical income streams compared to manufactured capital goods (Malleret 2006; Wise and Baumgartner 1999). Manufacturers' installed base builds an ideal opportunity to exploit the revenue potential of services (Oliva and Kallenberg 2003). Moreover, the provision of services often requires less investments than manufactured goods making them an attractive growth opportunity (Davies, Brady, and Hobday 2007). Finally, demand-based factors are another reason for the suggested positive impact of servitization. Customers increasingly expect manufacturers to offer a range of services from consulting up to integrated solutions (Han, Kuruzovich, and Ravichandran 2013; Vandermerwe and Rada 1988). For instance, customers in the IT industry increasingly outsource their needs for information technology to the manufacturers of the products (Han, Kuruzovich, and Ravichandran 2013). That means they often opted out for services such as software as a service (SaaS) instead of owning the hardware and software for the specific application (Han, Kuruzovich, and Ravichandran 2013).

However, there is also research indicating a potential negative linear relationship between servitization and financial performance (e.g., Neely 2008). Most prominently, Neely (2008) examines archival data from over 7,000 manufacturing companies and concludes a negative relationship between the extent of servitization and a company's net profit. This is in line with the conceptual idea of a service paradox, which states that manufacturers cannot generate sub-

stantial returns from their service investments (Gebauer, Fleisch, and Friedli 2005). The reasons for this can be manifold and depend often on several contingency factors within the manufacturer (Gebauer, Fleisch, and Friedli 2005). There are three major challenges which hamper manufacturers to exploit the financial benefits of services. First, a major challenge is the required cultural change for servitization (Gebauer, Fleisch, and Friedli 2005; Homburg, Fassnacht, and Guenther 2003). The provision of services cannot be successfully implemented without a service-centric mindset (Homburg, Fassnacht, and Guenther 2003). The entire company from top management to individual salespeople need to overcome their product-centric attitude to turn the servitization process profitable (Antioco et al. 2008; Ulaga and Loveland 2014). The second challenge is the resource allocation between products and services (Fang, Palmatier, and Steenkamp 2008). Limited resources can lead to interorganizational conflicts and therefore impede the success of services (Fang, Palmatier, and Steenkamp 2008). Finally, a third challenge is the task to implement services into the existing business model (Rabetino, Kohtamäki, and Gebauer 2017). This represents often high organizational challenges such as developing service-critical capabilities (Ulaga and Reinartz 2011).

The second group of research uses survey data to investigates a linear relationship between servitization and financial outcomes. Most research in this group confirms a positive linear relationship between services and financial performance (e.g., Antioco et al. 2008; Eggert et al. 2014). The reasons for this are also based on competitive advantage, economic benefits, and customer demand (Raddats et al. 2016). The major difference to archival data is that survey research includes additional variables which are often not available as secondary data such as service orientation of corporate culture (Homburg, Fassnacht, and Guenther 2003) or service type (e.g., SSP vs. SSC) (Eggert et al. 2014).

The third group uses archival data to examine a non-linear relationship between servitization and financial outcomes (e.g., Kastalli and Van Looy 2013; Nezami, Worm, and Palmatier 2018). Most prominently, Fang, Palmatier, and Steenkamp (2008) reveal a u-shaped relationship between service ratio[8] and firm value. Service sales do not have a substantial influence on a manufacturer's firm value until a critical mass of service revenues are generated (Fang, Palmatier, and Steenkamp 2008). Manufacturers' service revenues need to account for at least 20% to 30% of total revenues to improve firm value (Fang, Palmatier, and Steenkamp 2008).

[8] Service ratio is the share of service sales relative to total sales (Fang, Palmatier, and Steenkamp 2008).

A u-shaped relationship between services and financial outcomes is also shown by Nezami, Worm, and Palmatier (2018). They show that services have a u-shaped influence on sales growth, and profitability (Nezami, Worm, and Palmatier 2018). On the one hand, the reasons for the positive effect of service are the same as stated before. Services offer differentiation advantages, and higher customer loyalty through more customer interaction (Fang, Palmatier, and Steenkamp 2008; Nezami, Worm, and Palmatier 2018). In addition, manufacturers can build upon their existing resources and capabilities to expand into services (Fang, Palmatier, and Steenkamp 2008; Ulaga and Reinartz 2011). However, on the other hand servitization can have negative implications as well. Three potential drawbacks of service provision are dilution of resources, organizational conflict (Fang, Palmatier, and Steenkamp 2008), and lack of scale economies (Nezami, Worm, and Palmatier 2018). The addition of services requires a manufacturer to reallocate its limited resources (Fang, Palmatier, and Steenkamp 2008). It has to balance the resources between manufacturing and services (Fang, Palmatier, and Steenkamp 2008). Since a manufacturer's resources are limited this leads to a trade-off situation in which manufacturing and services may not have sufficient resources (Fang, Palmatier, and Steenkamp 2008). This dilution of resources may hamper the entire company to be successful in their servitization efforts. A second drawback is that the introduction of services can lead to organizational conflicts (Fang, Palmatier, and Steenkamp 2008). As pointed out servitization entails a resource reallocation. Hence, the manufacturing and service business part of the manufacturer may compete internally for the limited resources (Fang, Palmatier, and Steenkamp 2008). Moreover, services and manufacturing have different understanding of company's values (Homburg, Fassnacht, and Guenther 2003). Service culture emphasizes people's role in the success of a company, whereas the product culture values technology and innovation as drivers of success (Bharadwaj, Varadarajan, and Fahy 1993; Fang, Palmatier, and Steenkamp 2008). These cultural differences may also lead to tensions among employees. Finally, services are harder to standardize since they involve a higher degree of customization and human resources (Nezami, Worm, and Palmatier 2018). This means that manufacturers cannot easily realize economies of scale with services (Nezami, Worm, and Palmatier 2018). The combination of positive and negative implications of servitization lead to the u-shaped influence on financial outcomes. The u-shaped impact of services on financial outcomes is also confirmed in other studies (e.g., Li et al. 2015; Suarez, Cusumano, and Kahl 2013).

However, there are also other research findings which argue in favor of other non-linear relationships. Kastalli and Van Looy (2013) argue for a cubic relationship between services and profit margins. Kwak and Kim (2016) show an inverted u-shape relationship between servitization and profitability. However, these two research findings are singular and are not confirmed by other studies.

Research on the non-linear relationship between servitization and financial outcomes uses mainly archival data. Only Kohtamäki et al. (2013) conduct a survey with 91 Finnish manufacturers and find a u-shaped relationship between service offerings and sales growth. This also confirms the prior studies based on archival data.

Finally, there are also some research results indicating a non-existing relationship between servitization and financial outcomes. Research shows that the relationship may depend on the type of service. For instance, Antioco et al. (2008) show that a higher focus on SSPs do not significantly increase product sales. Eggert et al. (2014) show also that SSPs not directly improve revenue and profit outcomes, but instead indirectly through SSCs. However, research results with no direct or indirect relationship between services and financial outcomes are rare.

Overall, research about financial outcomes of servitization comes to different results. The majority of research confirms a positive linear or a u-shaped relationship. A possible explanation of the discrepancy between outcomes can be the individual research designs of the different studies. Table 2.6 summarizes the research design characteristics of the main studies focusing on financial outcomes. The studies differ along five major categories, namely the used data, the method of analysis, definition and measurement of the servitization variable, measurement of the financial outcome, and the research result.

Study	Data			Analysis Method	Servitization Variable		Outcome Variable	Result
	Source	#Firms	Type		Measure	Type		
Fang, Palmatier, and Steenkamp (2008)	Archival Data	477	Panel	Fixed Effects Regression	Service Revenue	N/A	Tobin's Q	U-Shaped Positive
Antioco et al. (2008)	Survey Data	137	Cross Sectional	PLS Structural Equation Modeling	Service Orientation	SSP/ SSC	Service Sales, Service Volume	Linear Positive
Skaggs and Droege (2008)	Archival Data	447	Cross-sectional	OLS Regression	Service Revenue	N/A	Return on Assets	Linear Positive
Neely (2008)	Archival Data	7,800	Cross-sectional	OLS Regression	Number of Services	N/A	Net Profit Margin	Linear Negative
Suarez, Cusumano, and Kahl (2013)	Archival Data	399	Panel	Fixed Effects and GMM Regression	Service Revenue	N/A	Operating Profit Margin	U-Shaped Positive
Kastalli and Van Looy (2013)	Archival Data	44	Panel	Fixed Effects Regression	Service Revenue	N/A	Net Profit Margin	Curve-linear Shape
Eggert et al. (2014)	Survey Data	513	Panel	Latent Growth Curve Modeling	Service Orientation	SSP/ SSC	Revenue, Profit	Linear Positive
Eggert, Thiesbrummel, and Deutscher (2015)	Archival and Survey Data	348	Cross-sectional	OLS Regression	Service Innovation Dummy	N/A	Return on Investment	Linear Positive
Visnjic, Wiengarten, and Neely (2016)	Archival Data	522	Panel	Fixed Effects Regression	Service Business Model Dummy	SSP/ SSC	EBIT; Tobin's Q	Linear Positive
Crozet and Milet (2017)	Archival Data	31,603	Panel	Fixed Effects Regression	Service Revenue	N/A	EBITDA, Sales	Linear Positive
Sousa and da Silveira (2017)	Survey	931	Cross Sectional	PLS Structural Equation Modeling	Service Offering	Advanced / Basic Services	Revenue; Return on Sales	No direct effect
Nezami, Worm, and Palmatier (2018)	Archival Data	227	Panel	Fixed Effects and GMM Regression	Service Revenue	N/A	Operating Profit Margin, Sales	U-Shaped Positive
This Study	Archival Data	1,381	Panel	Fixed Effects Regression	Service Keywords	SSP/ SSC	Return on Sales	U-Shaped Positive

Notes: SSP = Services in support of products; SSC = Services in support of customers; EBIT(DA) = Earnings before interest, taxes, (depreciation, and amortization).

Table 2.6: Research on Financial Implications of Servitization (Adapted from Wang, Lai, and Shou 2018)

As stated before, studies rely upon different forms of data to examine the relationship between servitization and financial outcomes. Some research studies use secondary data (e.g., annual reports) while others use surveys to collect data for their research. The nature of these two data formats can be substantially different. For instance, a survey may ask individual managers for their subjective assessment of the company's service portfolio (e.g., Antioco et al. 2008). While this may be a valid measurement instrument, it may differ from the objective and accurate character of secondary data such as service revenues in annual reports (e.g., Fang, Palmatier, and Steenkamp 2008). Another potential source for divergence is the sample size of the different studies. Most studies have a sample size ranging from 200 to 400. There are also some cases with lower sample sizes (e.g., Kastalli and Van Looy 2013) and relatively high sample sizes (e.g., Neely 2008). The sample size may influence the generalizability of research findings (Tipton et al. 2017). Especially, small sample sizes may have low external validity (King and He 2005; Tipton et al. 2017). Their results may differ in terms of statistical power, confidence intervals, significance of effects, and effect size (King and He 2005; Sawyer and Ball 1981). Larger sample sizes increase statistical power (Sawyer and Ball 1981) and decrease confidence intervals (King and He 2005). However, "very large sample sizes usually allow even small effects to be statistically significant" (Sawyer and Ball 1981, p. 278). A third distinguishing feature of data is its type. Research relies upon cross-sectional data (e.g., Eggert, Thiesbrummel, and Deutscher 2015; Neely 2008) and panel data (Fang, Palmatier, and Steenkamp 2008; Visnjic, Wiengarten, and Neely 2016). Specifically, panel data has the advantage to potentially overcome statistical challenges such as endogeneity and deliver more reliable estimations (Semykina and Wooldridge 2010). Hence, differences may also arise from the data type and how different statistical challenges are addressed.

Furthermore, studies also differ in their analysis method. Most studies use regression analysis to examine the relationship between servitization and a financial outcome variable (e.g., Eggert, Thiesbrummel, and Deutscher 2015; Nezami, Worm, and Palmatier 2018). Survey research uses often structural equation modeling (e.g., Antioco et al. 2008; Sousa and da Silveira 2017). These two approaches may also result in different outcomes.

A third factor that can explain different research outcomes is the measurement and differentiation of the servitization variable. The level of servitization is measured differently across studies. For instance, studies use service revenues (e.g., Fang, Palmatier, and Steenkamp 2008; Nezami, Worm, and Palmatier 2018), service offering (e.g., Antioco et al. 2008; Eggert et al.

2014), or other service measures such as number of services (e.g., Neely 2008) to measure servitization. In addition, some studies differentiate between different types of services such as SSP and SSC (e.g., Eggert et al. 2014). These different measures may capture slightly different nuances of a manufacturer's servitization level and therefore lead to different research outcomes.

Finally, studies use different financial outcome measures. Some studies look at highly aggregated financial performance measures such as firm value (e.g., Fang, Palmatier, and Steenkamp 2008). In contrast, other studies look at simple financial outcomes such as revenue or profit (e.g., Kastalli and Van Looy 2013). A third group of studies look at multiple financial outcome variables (e.g., Eggert et al. 2014). Like in the case of the servitization measure, different financial measures can capture different aspects of financial performance and therefore lead to different results.

All in all, the literature review of direct financial effects of servitization is characterized by its diversity. Different data sets, measures and methods are used to determine how services impact the financial position of a manufacturer. However, so far research has rarely focused on the rich source of textual data when analyzing direct effects of servitization. This study takes a new approach to derive insights from textual data of annual reports and link them to a financial outcome variable.

2.2.5.1.2 Indirect Effects

Next to direct effects, there are a variety of moderators and mediators which may indirectly affect the link between servitization and financial outcomes (e.g., Fang, Palmatier, and Steenkamp 2008; Visnjic, Wiengarten, and Neely 2016). Figure 2.13 gives an overview of moderator and mediator variables frequently used in servitization research about financial outcomes. They can be categorized into external and internal relative to the manufacturer's environment.

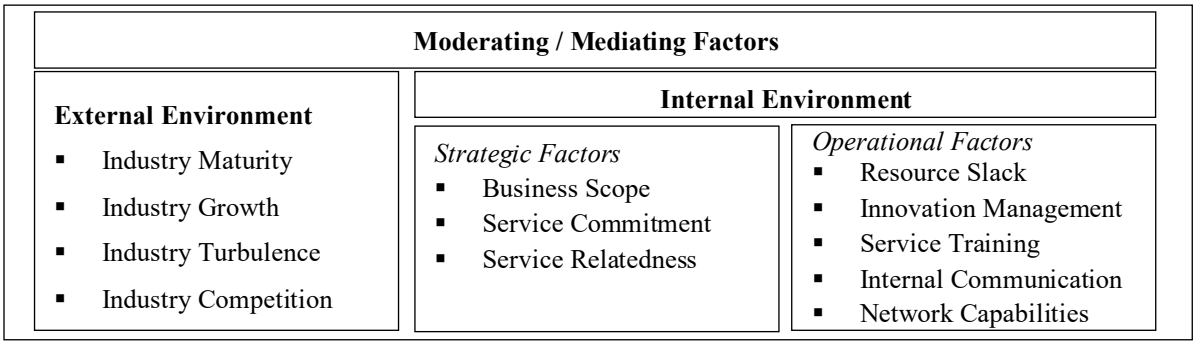

Figure 2.13: Factors affecting Financial Servitization Outcomes

A number of studies investigate how a manufacturer's external environment may affect the financial outcomes of servitization (e.g., Fang, Palmatier, and Steenkamp 2008; Nezami, Worm, and Palmatier 2018). The main moderating variables in this category are industry maturity, industry growth, industry turbulence, and industry competition.

Industries go through three different lifecycle stages which can be characterized with the help of market uncertainty, number of companies, and the product strategy (Cusumano, Kahl, and Suarez 2015). In the first stage, the ferment stage the industry is newly established based on a new technology (Cusumano, Kahl, and Suarez 2015). There is a high uncertainty about the market performance since the players in the market are still experimenting with the new technology (Cusumano, Kahl, and Suarez 2015). There is a high number of new entrants into the industry during this phase (Cusumano, Kahl, and Suarez 2015). The product strategy is based primarily on product innovation (Cusumano, Kahl, and Suarez 2015).

In the second stage, the transition stage, a dominant product design is established and there is a growing demand for the established product (Abernathy and Utterback 1978; Cusumano, Kahl, and Suarez 2015). Hence, there is a decreasing trend in uncertainty in the market (Cusumano, Kahl, and Suarez 2015). With more established firms in the industry and increasing scale economies the number of new entrants decreases (Cusumano, Kahl, and Suarez 2015; Klepper 1997). The product strategy shifts towards process innovation to increase efficiency and decrease costs (Cusumano, Kahl, and Suarez 2015).

In the final stage, the maturity stage, the growth in demand starts to decrease (Cusumano, Kahl, and Suarez 2015). In a mature industry, the market seems to reach a saturation point (Cusumano, Kahl, and Suarez 2015). There is a low level of uncertainty in the industry, and the thread of product commoditization and price-based competition becomes higher (Cusumano, Kahl, and Suarez 2015; Klepper 1997). This is mainly due to reduced competi-

tors in the market which follow the same dominant design in the industry (Cusumano, Kahl, and Suarez 2015). Firms continue to focus on process innovation to drive down costs and realize efficiency gains (Abernathy and Utterback 1978; Cusumano, Kahl, and Suarez 2015).

Nezami, Worm, and Palmatier (2018) find out that industry maturity has a positive moderating impact on two financial performance measures. On the one hand, it strengthens the positive relationship between service ratio and sales growth (Nezami, Worm, and Palmatier 2018). On the other hand, it positively moderates the effect of service ratio on profitability (Nezami, Worm, and Palmatier 2018). Mature industries are characterized by low growth rates and an increasing commoditization of core products (Cusumano, Kahl, and Suarez 2015). Under these conditions, services have a potentially higher differentiating power compared to less mature industries in which product differentiation may still be effective (Cusumano, Kahl, and Suarez 2015; Nezami, Worm, and Palmatier 2018).

Industry growth is another moderating factor in a manufacturer's external environment. The growth of an industry is measured as the growth of total sales of all companies in the particular industry (Fang, Palmatier, and Steenkamp 2008; Finkelstein and Boyd 1998). Fang, Palmatier, and Steenkamp (2008) reveal a negative impact of industry growth on the relationship between service ratio and firm value. They argue with two mechanisms that explain the negative moderating effect. First, reallocating resources from products to services may result in high opportunity costs for the product segment in form of lowered "productivity, motivation, or decision speed due to organizational realignments" (Fang, Palmatier, and Steenkamp 2008, p. 5). This may hamper the company in their reaction to a fast-growing environment (Fang, Palmatier, and Steenkamp 2008). Second, the authors argue that "product-based assets are more valuable in fast-growing industries, and any action that negatively affects the full deployment of these valuable assets undermines the firm's financial performance and overall market value" (Fang, Palmatier, and Steenkamp 2008, p. 5; Mehra 1996).

A third external moderator variable is industry turbulence. It measures the volatility of an industry based on multiple factors such as predictability of sales, customer needs, and volume of technological innovations (Fang, Palmatier, and Grewal 2011; Glazer and Weiss 1993; Nezami, Worm, and Palmatier 2018). Highly turbulent industries face volatile sale levels, changing customer needs, and a high level of technological innovations (Achrol 1991; Calantone, Garcia, and Dröge 2003; Nezami, Worm, and Palmatier 2018). Fang, Palmatier,

and Steenkamp (2008) find out that industry turbulence positively moderates the relationship between service ratio and firm value. There are two main reasons for this interaction. First, manufacturers can leverage their know-how about their customers to anticipate and react to their needs (Fang, Palmatier, and Steenkamp 2008). This is especially in turbulent industries relevant in which customer needs may change more often and are not stable over time (Calantone, Garcia, and Dröge 2003; Fang, Palmatier, and Steenkamp 2008). The second argument is that customers' risk perception is higher when the market offers more rapidly changing products and services (as is the case in turbulent industries) (Fang, Palmatier, and Steenkamp 2008; Worm et al. 2017). In this case a manufacturer can build upon its established customer relationship and brand equity to reduce the customer's uncertainty (Fang, Palmatier, and Steenkamp 2008). Nezami, Worm, and Palmatier (2018) confirm the beneficial impact of industry turbulence in connection with servitization. They show that industry turbulence negatively moderates the relationship between service ratio and earnings volatility (Nezami, Worm, and Palmatier 2018). Hence, in turbulent industries services can generate more stable income streams (Nezami, Worm, and Palmatier 2018; Wise and Baumgartner 1999). To reduce the risk perception in turbulent markets, manufacturers build upon performance guarantees and contractual lock-in mechanisms (Nezami, Worm, and Palmatier 2018).

A final external factor is industry competition, which describes the level of rivalry among firms in the same industry (Porter 1980). Fang, Palmatier, and Steenkamp (2008) assume a positive moderating effect of industry competition on the relationship between service ratio and firm value. The main reason for this is that differentiating advantages become more critical in highly competitive markets (Fang, Palmatier, and Steenkamp 2008). Services can present hard to imitate and sustainable differentiating advantages (Fang, Palmatier, and Steenkamp 2008). However, the authors do not find a significant moderating effect of industry competition on the relationship between service ratio and firm value (Fang, Palmatier, and Steenkamp 2008).

Next to these external factors, there are several internal factors, which moderate the relationship between servitization and financial outcomes. They can be categorized into strategic and operational factors. Strategic factors are moderators and mediators with long-term implications for the company and include business scope, company's service commitment, and service relatedness. Operational factors have a more tactical nature and include resource slack, innovation, service training, and internal communication.

The first strategic factor is business scope, which describes in how many different industries a manufacturer operates (Lee et al. 2015; Nezami, Worm, and Palmatier 2018). Nezami, Worm, and Palmatier (2018) show that business scope negatively moderates the relationship between service ratio and firm profitability. They present two arguments for this effect. First, services require specific resources, capabilities, and tacit know-how (S. Kumar 2009; Nezami, Worm, and Palmatier 2018; Ulaga and Reinartz 2011). These critical elements cannot be easily transferred between different industries (S. Kumar 2009; Nezami, Worm, and Palmatier 2018; Ulaga and Reinartz 2011). Hence, a manufacturer with a higher business scope needs to develop more industry-specific service capabilities and resources (Nezami, Worm, and Palmatier 2018). This hampers its ability to benefit from economies of scale and in return negatively impacts its profitability (Nezami, Worm, and Palmatier 2018). Second, more diversified manufacturers face the risk of overstraining their managerial resources (Morgan, Anderson, and Mittal 2005; Nezami, Worm, and Palmatier 2018). This may result in manufacturers not effectively leveraging service-specific benefits like determining customer needs (Nezami, Worm, and Palmatier 2018).

Another strategic factor is company's commitment to services. Research investigates how the service commitment of top management (Antioco et al. 2008), company culture (Homburg, Fassnacht, and Guenther 2003), and human resource management (Homburg 2003) influence financial outcomes of servitization. Antioco et al. (2008) investigate whether top management's commitment has a moderating effect on service orientation and firm revenue. However, they do not find a significant moderating effect (Antioco et al. 2008). The service orientation of the company culture and human resources management are positive mediators between servitization (in form of number of services and emphasis on services) and service profitability (Homburg, Fassnacht, and Guenther 2003). A high overall service orientation of the company improves service quality which has two beneficial implications (Homburg, Fassnacht, and Guenther 2003). First, higher service quality decreases costs due to less service failures (Homburg, Fassnacht, and Guenther 2003). Second, it delivers more value to the customer which can increase sales (Antioco et al. 2008; Homburg, Fassnacht, and Guenther 2003).

A final strategic factor is the service relatedness which measures the level of complementarity between a manufacturer's core product business and its service business (Fang, Palmatier, and Steenkamp 2008). Fang, Palmatier, and Steenkamp (2008) prove a positive moderating impact of service relatedness on the relationship between service ratio and firm value. They state

three arguments for this effect. First, related services have a higher potential to benefit from knowledge spillovers of the product segment than unrelated services (Fang, Palmatier, and Steenkamp 2008; Varadarajan 1986). Second, ”when customers perceive a higher level of relatedness between a firm’s product and service offerings, they sense lower evaluation and performance risks and display higher loyalty toward the seller” (Fang, Palmatier, and Steenkamp 2008, p. 5). Finally, related services avoid potential tension within the manufacturer since the strategic focus remains around similar organizational objectives (Fang, Palmatier, and Steenkamp 2008).

An operational factor that moderates the relationship between servitization and financial outcomes is resource slack. Excess resources of a company which are discretionary and can be employed flexibly are referred to as resource slack (Bourgeois 1981). It has a positive moderating effect on service ratio and firm value (Fang, Palmatier, and Steenkamp 2008). Slack resources enable a manufacturer to invest into services without sacrificing resources from its other businesses (Fang, Palmatier, and Steenkamp 2008). They also avoid a potential organizational conflict that may arise when different business segments compete for limited resources (Fang, Palmatier, and Steenkamp 2008).

A second operational factor is innovation. It entails two moderating effects, namely product innovation activity, and research and development expenditure. Product innovation activity describes the extent to which manufacturers design new and superior products as means of differentiation (Rangan and Bowman 1992; Utterback and Abernathy 1975). Eggert et al. (2011) show that product innovation activity has a differentiated moderating effect on services and profit growth. On the one side, they show that product innovation activity positively moderates the relationship between SSPs and profit growth (Eggert et al. 2011). A manufacturer’s high level of product innovation activity indicates extensive product-based resources and capabilities (Eggert et al. 2011). These can be leveraged to create and market product-related services (i.e., SSPs) more successfully (Eggert et al. 2011). On the other side, Eggert et al. (2011) find a negative moderating effect of product innovation activity on the relationship between SSCs and profit growth. The reasoning here is that high product innovation activity ties up major resources in the product development capability (Eggert et al. 2011). Hence, there are less resources to invest into the SSC business to make it more efficient (Eggert et al. 2011).

Research and development (R&D) expenditure is another part from the operational factor innovation. R&D is an exploratory process to design and develop new products and services (Djellal et al. 2003). Visnjic, Wiengarten, and Neely (2016) find a differentiated effect of R&D expenditure on the relationship between service business models and firm value. First, R&D expenditure has an curvilinear effect on the relationship between a product-oriented service business model[9] and firm value (Visnjic, Wiengarten, and Neely 2016). The authors argue that product activities and product-related services are highly complementary (Visnjic, Wiengarten, and Neely 2016). The know-how generated in services can be leveraged in R&D to design new or better products and services (Visnjic, Wiengarten, and Neely 2016). However, the positive effect of complementarity and knowledge spillovers may reach a saturation point (Visnjic, Wiengarten, and Neely 2016). Hence, a product and service segment may end up competing for firm resources (Eggert et al. 2011; Kastalli and Van Looy 2013; Visnjic, Wiengarten, and Neely 2016). This turns the initially positive effect of R&D expenditure to negative, creating overall an inverted u-shape effect. Second, Visnjic, Wiengarten, and Neely (2016) show that R&D expenditure has positive moderating effect on customer-oriented service business models[10] and firm value. Customer-oriented services are not limited to product-related services and represent a continuous opportunity for learning (Visnjic, Wiengarten, and Neely 2016). R&D can leverage this know-how stream for new products and services.

A third operational factor is service training of manufacturer's employees. Antioco et al. (2008) find out that service training positively moderates the relationship between SSC business orientation and service volume. This is due to the fact that more training will increase the service quality through lower failure rates (Antioco et al. 2008; Homburg, Fassnacht, and Guenther 2003). Similarly, the authors also investigate the effect of customer treatment on service orientation and service volume (Antioco et al. 2008). However, they do not find a significant moderating effect for this relationship.

Internal communication of service employees is the next operational factor. Research finds out that the level of cross functional communication within the manufacturer positively moderates the relationship between SSC service orientation and product sales (Antioco et al.

[9] The product-oriented service business model focuses on offering services surrounding the physical asset such as maintenance, installation and overhaul services (Visnjic, Wiengarten, and Neely 2016).
[10] The customer oriented service business model offers customer-related services such as consulting, financing, and training (Visnjic, Wiengarten, and Neely 2016).

2008). There are several reasons for this effect. First, a high flow of communication between the service and other departments enhances the dissemination of knowledge, which is an essential element for innovation, product quality, and dynamic reactions to environmental changes (Antioco et al. 2008; Foote et al. 2001). Second, continuous feedback from service employees increases a manufacturer's overall service awareness (Antioco et al. 2008; Neu and Brown 2005). This enables "manufacturers to better integrate, bundle, contextualize, and customize their SSC business orientation to product offers and achieve greater relative product sales" (Antioco et al. 2008, p. 343).

A last operational factor is network capabilities, which describes a manufacturer's ability to manage and learn from its relationships to customer, suppliers and other partners (Ritter, Wilkinson, and Johnston 2004). Kohtamäki et al. (2013) show that network capabilities positively moderate the relationship between service offerings and sales growth. Their core argument is that broader service offerings make the exchange process more complex and therefore require more advanced capabilities in customer relationship (Kohtamäki et al. 2013). For instance, customer solutions are highly integrated service offerings in which the manufacturer jointly creates the value with the customer and potentially other network partners (Foote et al. 2001; Jaakkola and Hakanen 2013). This value co-creation process requires the manufacturer to build and maintain a close relationship to customers (Tuli, Kohli, and Bharadwaj 2007) and its network partners (Jaakkola and Hakanen 2013). Hence, manufacturers will benefit from better network capabilities when they expand their service offerings (Kohtamäki et al. 2013).

This overview of indirect effects shows that servitization and financial outcomes can be affected by many external and internal factors. There are a number of moderating effects which can have a negative, positive, or even a curvilinear effect on the financial implications of servitization. On the one hand, additional research may confirm existing moderating effects. On the other hand, there are potentially other moderating effects which are not examined yet. This study incorporates existing and new moderating factors which will help to better understand financial outcomes of servitization better.

2.2.5.2 Non-Financial

Research into servitization outcomes primarily focuses on financial implications (Wang, Lai, and Shou 2018). Non-financial aspects of services such as differentiation advantages are often key drivers for financial outcomes. Hence, they take either an explanatory role in research

(e.g., services as differentiating factors) (Raddats et al. 2016) or examined as moderating factors (e.g., corporate culture). There are only a few research articles dealing with direct non-financial servitization outcomes (e.g., Hong, Yang, and Dobrzykowski 2014; Oliva, Gebauer, and Brann 2012).

Oliva, Gebauer, and Brann (2012) find a direct positive effect of management's service commitment on non-financial performance measures, i.e., customer relationship, satisfaction, and loyalty. The reason is that a company's management has to support organizational change which is necessary for service provision (Oliva, Gebauer, and Brann 2012). Only with the top managements' commitment a manufacturer can effectively manage and reallocate its resources for service provision (Antioco et al. 2008; Oliva, Gebauer, and Brann 2012). In addition, managements support of services can have a signaling effect and convince a firm's stakeholders from the advantages of a service strategy (Oliva, Gebauer, and Brann 2012).

Hong, Yang, and Dobrzykowski (2014) examine how customer service orientation influences lean manufacturing practices, i.e., human and technical lean practices. Human lean practices refer to the extent of process improvements through behavioral initiatives such as employee empowerment (Hong, Yang, and Dobrzykowski 2014). Technical lean practices refer to the extent of technological process improvements such as computer systems (Hong, Yang, and Dobrzykowski 2014). Hong, Yang, and Dobrzykowski (2014) find a positive effect of customer service orientation on human and technical lean practices. On the one hand, a higher customer service orientation requires the manufacturer to establish effective organizational structures in order to deliver superior service quality (Hong, Yang, and Dobrzykowski 2014). This often leads to the implementation of human lean practices which improve the manufacturer's overall efficiency (Hong, Yang, and Dobrzykowski 2014). On the other hand, higher customer service orientation also requires more technological adjustments of the manufacturer (Hong, Yang, and Dobrzykowski 2014). The reason is that customer services generate high amounts of information and knowledge which requires more technical infrastructure (Hong, Yang, and Dobrzykowski 2014). Hence, manufacturers invest more into technical lean processes when expanding their customer service orientation.

Another non-financial factor is the environmental impact of servitization. This conceptual idea states that the introduction of highly integrated services and products reduces the overall environmental impact (Goedkoop et al. 1999; Lindahl, Sundin, and Sakao 2014; Tukker

2004). The main reason is that resources are used more intensively in a product-service constellation (Goedkoop et al. 1999; Lindahl, Sundin, and Sakao 2014). For instance, a manufacturer can sell a bundle of product and refurbishing services. Hence, the product is refurbished multiple times before it is replaced (Lindahl, Sundin, and Sakao 2014). That mechanism reduces the product's environmental impact since refurbishing uses less resources than producing new products (Lindahl, Sundin, and Sakao 2014).

2.2.6 Summary and Evaluation

The review of the literature reveals servitization as a diverse research field with many different facets. Since its establishment in the late 1980s, servitization attracts increasingly the interest of research (Rabetino et al. 2018). A major driver for this is the relevance of services in developed economies such as Germany, the United States, and Japan (Wise and Baumgartner 1999). Despite the growing number of publications, research is just beginning to understand the underlying mechanisms and interactions of servitization (Raddats et al. 2019). The following paragraphs assess the core research outcomes of the five subchapters in the literature review and outline existing research gaps.

The service-dominant logic (Vargo and Lusch 2004) essentially laid the foundation for the conceptualization of services in manufacturing. Vargo and Lusch (2004) develop eight premises to depict the shift from the traditional goods-centered dominant logic to the service-centered dominant logic. The subsequent research in servitization confirms most of the eight premises (e.g., Mathieu 2001a; Tuli, Kohli, and Bharadwaj 2007; Ulaga and Reinartz 2011). For instance, Tuli, Kohli, and Bharadwaj (2007) show in their qualitative research that business solutions consists of relational processes between a manufacturer and its customer. This confirms the premise of service dominant logic that transactional nature of exchange is replaced by a relational interaction between a firm and its customers (Vargo and Lusch 2004). Although the service-dominant logic presents a solid foundation, there are two main research gaps. First, there is only a limited quantitative research in this field (Raddats et al. 2019). Quantitative data is essential to validate conceptual ideas and to make them generalizable (Park and Park 2016). Hence, there is a need for more research using quantitative data. Second, value creation and co-creation in business markets are still fuzzy concepts (Grönroos and Voima 2013; Ulaga and Eggert 2006) and they are neglected in some areas (e.g., Gersch,

Hewing, and Schöler 2011). There is a need for more research in these areas since they are key elements in servitization and service-dominant logic.

Research identified several different drivers of servitization such as competition, differentiation advantage, and economic benefits (Vandermerwe and Rada 1988). Most of the drivers are rooted in a manufacturer's desire to establish a sustainable competitive advantage in its markets (Bustinza et al. 2015). Services can establish strong means of differentiation since they often entail elements which are hard to imitate (Oliva and Kallenberg 2003). This include for example the tacit know-how of a manufacturer about its products and how customers use them (Ulaga and Reinartz 2011). With innovative sensor technology manufacturers can collect and analyze usage data and build even more knowledge for their services business (Ulaga and Reinartz 2011). In recent years, digitalization has emerged as a driver and enabler of servitization (Coreynen, Matthyssens, and Van Bockhaven 2017). There is already first research on how new digital research influences the servitization process in manufacturing (Raddats et al. 2019). However, driving forces of servitization in a dynamic technological environment are still not sufficiently researched.

The strategy literature of servitization is very diverse with contributions from a variety of research domains such as marketing (e.g., Davies, Brady, and Hobday 2007), management (e.g., Suarez, Cusumano, and Kahl 2013), and production (e.g., Rabetino, Kohtamäki, and Gebauer 2017). Two major topics across many domains are business models (Huikkola and Kohtamäki 2018; Rabetino et al. 2018) and service typologies (Raddats et al. 2019). Research suggests different business models, and it becomes clear that there is no one-size-fits-all solution to find the optimal business model. However, research in servitization business models is mainly based on anecdotal evidence such as case studies (Raddats et al. 2019). Given the strategic importance and far-reaching implications of business models, there is need for more quantitative research into the topic. The literature review reveals that there a number of possible service typologies with varying granularity (Raddats and Kowalkowski 2014). Although the SSP-SSC differentiation is often used in studies, there is no quantitative research investigating the quality of different service typologies.

The implementation process of servitization often refers to resources and capabilities necessary for services (Macdonald, Kleinaltenkamp, and Wilson 2016; Tuli, Kohli, and Bharadwaj 2007; Ulaga and Reinartz 2011). Research shows that manufacturers often possess the neces-

sary resources for services (Ulaga and Reinartz 2011). For instance, they have the know-how about their products and its usage (Ulaga and Reinartz 2011). However, they often lack the service-specific capabilities to capitalize on these resources such as service-related data analytics capabilities (Neu and Brown 2005; Ulaga and Reinartz 2011). On the one hand, research needs quantitative data to confirm the identified service specific resources and capabilities (Ulaga and Reinartz 2011). On the other hand, there is little research on different strategies to implement the necessary service capabilities (Rabetino, Kohtamäki, and Gebauer 2017). A potential research avenue could be the question whether manufacturers build and implement their service capabilities organically or through mergers and acquisitions (Raddats et al. 2019).

The literature review concludes with servitization outcomes. Research focuses on financial implications of servitization while non-financial factors often take an explanatory role in research. There is a wide variety of data, measures, and analysis methods used to explain how services impact a manufacturers' bottom line (Wang, Lai, and Shou 2018). The research designs and results are not consistent, but most studies show a positive linear relationship between servitization and a financial outcome variable (Wang, Lai, and Shou 2018). The research into financial outcomes has more quantitative studies than other research areas of servitization (Raddats et al. 2019; Wang, Lai, and Shou 2018). However, the inconsistent results indicate that there is more research required to reveal how services impact the finances of a manufacturer. Specifically, there is only little research on different types of services and their individual financial impact (Eggert et al. 2014).

Against this backdrop of current servitization research, this study addresses two main research gaps. First, as stated in the initial definition servitization is a transformational process (Baines et al. 2020; Storbacka et al. 2013). It is a phenomenon that evolves over time. So far, only a few research studies capture this dynamic character of servitization by examining service data over time (e.g., Fang, Palmatier, and Steenkamp 2008; Visnjic, Wiengarten, and Neely 2016). In addition, research often uses the term servitization and services in a generic manner (Raddats et al. 2019). Service typologies are seldom used to differentiate service types and find potential differences in their development. This study addresses this research gap by analyzing textual data from annual reports and reveal how different service types develop over time. It closes specifically the gap of missing quantitative data about service typologies and their development over time. Second, the financial implications of servitization are often in-

vestigated without differentiating between different service types. First research already shows that SSPs and SSCs may have different effects on financial outcomes (e.g., Eggert et al. 2014). This study builds upon this differentiation and adds a new quantitative study about financial outcomes of servitization.

3. Descriptive Analysis of Servitization

This chapter presents a comprehensive descriptive analysis of servitization in the manufacturing industry. Subchapter 3.1 describes the data collection process and the final sample. The following subchapter 3.2 defines the used measures, and subchapter 3.3 presents the method employed for the data analysis. The subchapter 3.4 presents the results of the descriptive analysis, which are discussed in the following conclusions chapter (subchapter 3.5).

3.1 Data

This chapter first outlines the steps taken to generate the database for the analysis (subchapter 3.1.1). Subchapter 3.1.2 describe the final sample for the analysis.

3.1.1 Data Collection

The Securities and Exchange Commission (SEC) is a U.S. governmental agency which oversees U.S. stock and security markets (SEC 2020). Its major objective is to maintain transparency, fairness and efficiency in the market (SEC 2020). This is done by offering open access to certain information about publicly traded companies (SEC 2020). Since April 1993, all U.S. public companies are required to electronically file their annual report, known as 10-K form, to the SEC (SEC 2006). The 10-K form is a standardized document with seven items which include for instance the company business description, a management discussion of the company's situation, and financial statements (SEC 2011). Exhibit 3 shows as an example a 10-K excerpt of the construction equipment manufacturer Caterpillar for the year 2018. A 10-K form is a strictly controlled document, which is supposed to present an accurate and objective picture of the company (SEC 2009). It goes through several approval and control stages. The top management of the company approves the content of the 10-K form and an independent auditing company certificates its accuracy (SEC 2002, 2009). The SEC frequently checks whether companies fulfill disclosure requirements of the 10-K form (SEC 2011). Hence, the 10-K form is a reliable, extensive source for information about a company (Bowman 1984; Griffin 2003).

The first item in a 10-K form contains a detailed business description of the firm's operations (SEC 2011). It often describes the operating business segments, the product and service portfolio, the competitive environment and other business-related aspects (SEC 2011). Although

the specific content varies across companies, nearly all business descriptions include information about the company's main products and services. In the context of servitization, especially the textual information about service portfolios is relevant. Item 1 of the 10-K forms is extracted to build a database of company service descriptions.

Prior to the actual data collection, two boundary conditions are defined. First, relevant manufacturing companies are identified using their primary Standard Industrial Classification (SIC) code. This research focuses on two-digit SIC codes between 28 and 39 (Fang, Palmatier, and Steenkamp 2008). Manufacturing industries with these SIC codes include for example chemical products, commercial machinery, and electronic equipment (Fang, Palmatier, and Steenkamp 2008). The second boundary condition is that the study focuses on a 10-year period, from 2009 to 2018. Only the 10-K forms filed in those years are considered. There are two reason for this time frame. On the one hand, it helps to focus the study on the most recent developments in servitization. On the other hand, this timeline does not contain external economic shocks such as the financial crisis of 2008 (Munir 2011), which may bias the results.

The desired database is built through a three-step procedure. Figure 3.1 gives an overview of the individual steps. All operations are implemented using the programming language Python. In the first step, all 10-K forms which fulfill the predefined boundary conditions are downloaded from the SEC website. This returns a total of 11,860 10-K filings.

The second step consists of a cleaning step to filter out irrelevant 10-K forms. Start-up and development stage firms often have no substantial operations, but high expenses for example for research and development (R&D) (Cotei and Farhat 2017; Scott and Bruce 1987). These firms do not represent a typical manufacturer and may bias the study's analysis. Therefore, firms with no revenues (i.e., no operating activity) and firms focusing on R&D (i.e., R&D expenses higher than revenues) are removed from the sample. Revenues and R&D expenses are extracted from the 10-K form to apply the cleaning procedure.

The third step is the extraction of item 1 in the 10-K forms, which contains the business description of the company and the desired service portfolios (Lee and Hong 2016). Furthermore, the number of employees is extracted to get a proxy for the firm size (Brooksbank 1991). The SIC code is extracted as well to differentiate the various manufacturing industries.

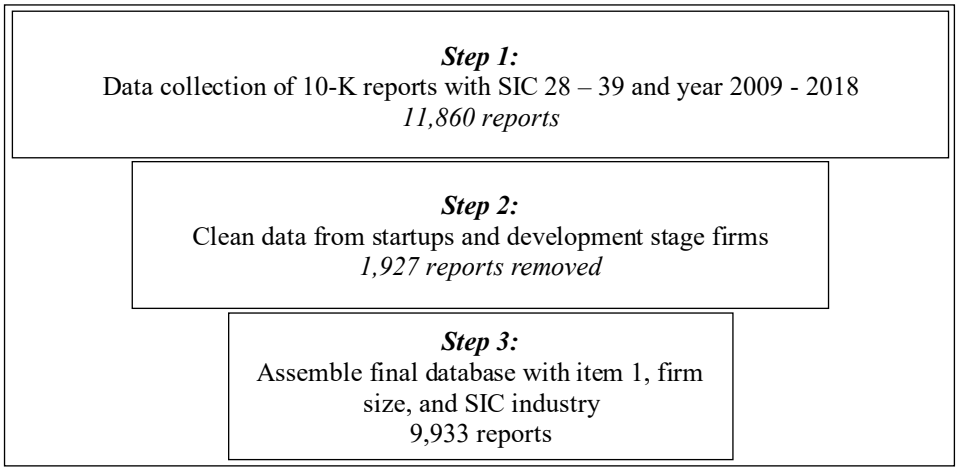

Figure 3.1: Data Collection Process

3.1.2 Sample Description

The final resulting sample consists of 9,933 business descriptions from 1,499 manufacturing companies for the fiscal years 2009 to 2018. The data set has a panel structure, meaning there are multiple observations per company. The average number of 10-K reports per company is 6.6. Figure 3.2 shows the distribution of the number of 10-K reports per company. There are a number of reasons why not all companies have at least 10 reports. The initial public offering (IPO) date, which is the first date when investors can purchase stocks of the company, may have been later than 2009. Another explanation is that the company's stock was discontinued sometime between 2009 and 2018 due to mergers, acquisitions, or bankruptcy.

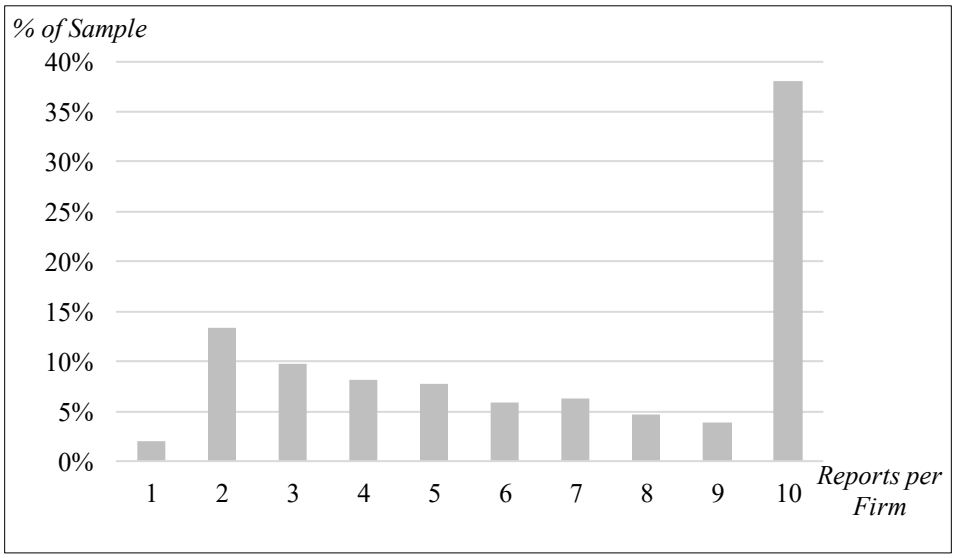

Figure 3.2: Sample Structure by 10-K Reports per Firm

The companies in the sample are from a variety of manufacturing industries. Figure 3.3 depicts the percentage distribution of the 2-digit SIC codes in the sample. The top four industries represent over 80% of the sample and include electronic equipment (SIC 36), chemicals (SIC 28), measuring instruments (SIC 38), and industrial machinery and computer equipment (SIC 35). Typical companies in the electronic equipment industry are for example General Electric Company, Intel Corporation, and Emerson Electric company. The chemicals industry includes amongst others, pharmaceutical companies such as Pfizer, Johnson & Johnson, and Gilead Sciences. The measuring instruments industry consists of a variety of companies such as 3M Company, and Thermo Fischer Scientific, a manufacturer of laboratory equipment. Manufacturers in the industrial machinery and computer equipment industry are IBM, Cisco, and Caterpillar among others. Exhibit 4 presents the number of companies in the more specific 4-digit SIC codes, which amounts to 145 different industries.

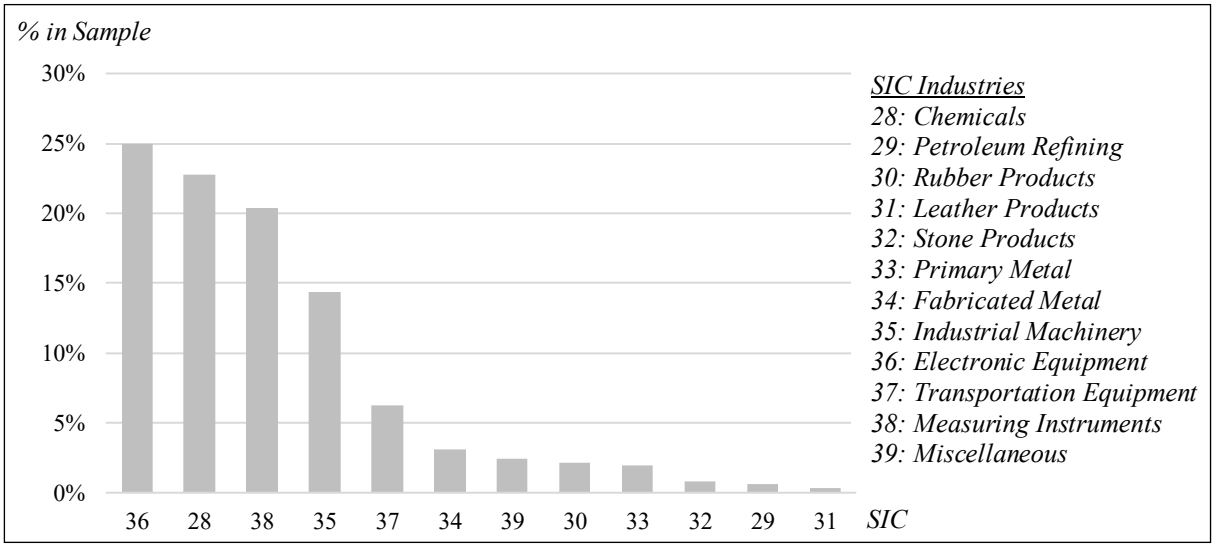

Figure 3.3: Sample Structure by Industry

The sample contains manufacturers of different size. While there are small manufacturers with less than 20 employees, there are also large corporations with thousands of employees. Figure 3.4 shows the percentage distribution of employees in the different companies. The number is calculated using the mean number of employees in a firm between 2009 and 2018. The majority of firms have on average more than 500 employees and therefore can be categorized as mid to large size manufacturers (Hammer 2010). This is in line with the fact that the sample only contains publicly traded manufacturers. Firms often reach a certain size before their initial public offering (Jain and Kini 1999) which explains the tendency of larger firms in the sample.

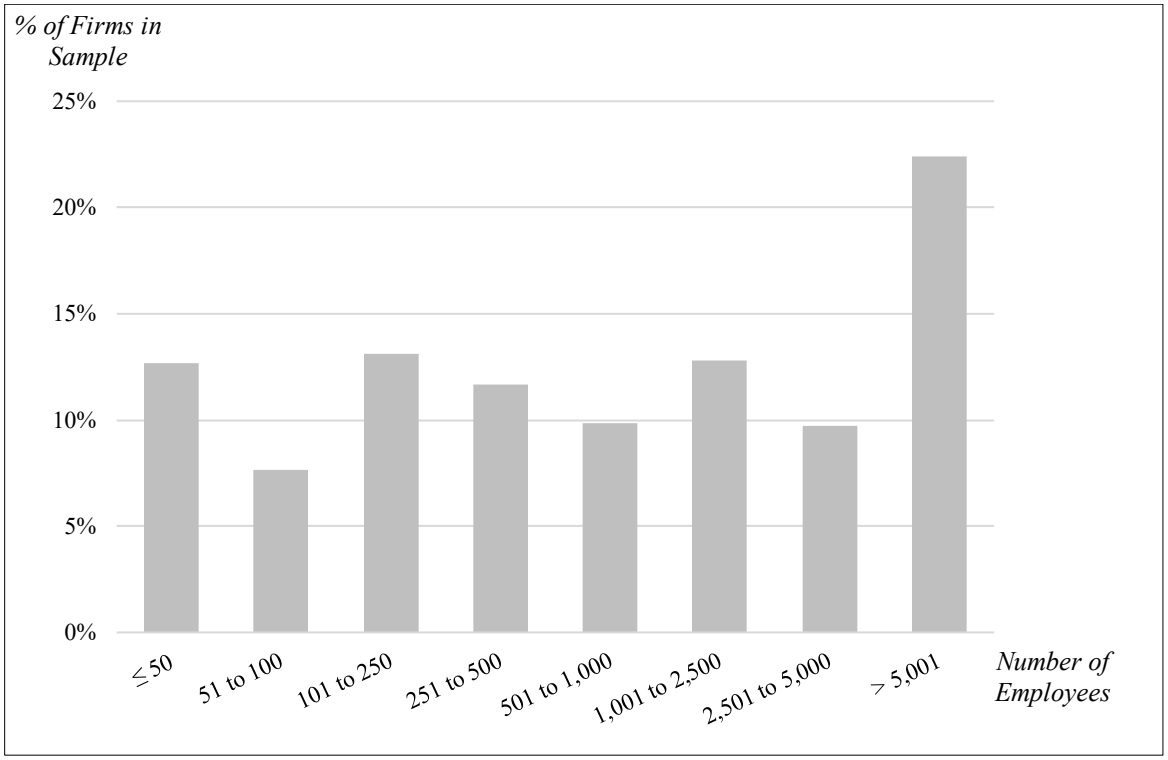

Figure 3.4: Sample Structure by Number of Employees

3.2 Measures

This chapter presents the operationalization of the variables used in the descriptive analysis of the sample. First, subchapter 3.2.1 explains the servitization measurement using a firm's business description (i.e., item 1 of the 10-K form). Subchapter 3.2.2 presents the measurement of industry and firm size.

3.2.1 Servitization Measure

Extant research uses different method to capture the servitization process within manufacturers. The measures can be categorized as accounting-based (e.g., service sales) or text-based (e.g., service keywords). In quantitative servitization research, service sales is a popular accounting-based measure for servitization (e.g., Fang, Palmatier, and Steenkamp 2008; Nezami, Worm, and Palmatier 2018; Suarez, Cusumano, and Kahl 2013). However, driven by advances in natural language processing, text-based data analysis has gained traction in many research fields including marketing (Berger et al. 2020; Hickman et al. 2020). The reason is that a lot of business-related information is in form of text data (Berger et al. 2020). Servitization research has also used text-based measures to analyze industrial services (e.g.,

Benedettini, Swink, and Neely 2017; Neely 2008; Visnjic, Wiengarten, and Neely 2016). This study uses text-based data of the 10-K form to capture a firm's servitization status through the count (subchapter 3.2.1.1) and categorization (subchapter 3.2.1.2) of service-related keywords.

3.2.1.1 Service Keyword Count

Item 1 of the 10-K form gives a detailed description about the business of a company (Bowman 1984; Griffin 2003). In this item, firms usually present their major business segments, their product and services portfolio, and their competitive environment (SEC 2011). Hence, the item 1 narrative provides a detailed insight into how services contribute to a firm's value creation process (Benedettini, Swink, and Neely 2017; SEC 2011). Figure 3.5 shows the business description excerpt of the aviation technology company AAR Corp. for the fiscal year 2017 (AAR Corp. 2018).

"ITEM 1. BUSINESS

General

[…] We are a diversified provider of products and services to the worldwide aviation and government and defense markets. […]

Business Segments

Aviation Services

The Aviation Services segment provides aftermarket support and services for the commercial aviation and government and defense markets […]. In this segment, we also provide inventory management and distribution services, maintenance, repair and overhaul ("MRO"), and engineering services. […] We provide major airframe inspection, maintenance, repair and overhaul, painting services, line maintenance, airframe modifications, structural repairs, avionic service and installation, exterior and interior refurbishment, and engineering services and support for many types of commercial and military aircraft. We also repair and overhaul various components, landing gears, wheels, and brakes for commercial and military aircraft."

Notes: Own highlights

Figure 3.5: Excerpt of Item 1 AAR Corp. (AAR Corp. 2018, pp. 2–3)

The marked service-related keywords in figure 3.5 show that the text contains information about services of the company (Lee and Hong 2016; Visnjic, Wiengarten, and Neely 2016). However, a manual analysis of the textual information is not practical due to the sheer amount of the extracted 10-K forms. Hence, this study employs a computer-aided, automated ap-

proach (Lee and Hong 2016). The following paragraphs describe first the text mining process in general, before outlining the process how service information is extracted from item 1. All computer operations are implemented using the programming language Python.

The methodology of computer-assisted and automated textual analysis in marketing research is called text mining (Berger et al. 2020; Netzer et al. 2012). The advantage of text mining is that large amounts of data can be analyzed in a time-efficient way (Hashimi, Hafez, and Mathkour 2015). Moreover, text mining "allows researchers to rid themselves of measurement straitjackets, such as scales and scripted questions, and to quantify the information contained in textual data as it naturally occurs." (Berger et al. 2020, p. 1). The most popular approach to text mining in marketing research is entity extraction (Berger et al. 2020). It is a simple and easy to understand approach which is the main reason for its popularity in research and practical applications (Berger et al. 2020). Entity extraction essentially means to count specific words (i.e., entities) in a body of text (Berger et al. 2020). Relevant entities (i.e., words) to count are often based on a predefined list of keywords, which is also referred to as a dictionary (Berger et al. 2020). Entity extraction allows researchers to get two information elements from text data. First, extracted entities reveal partly the content of the analyzed text (Berger et al. 2020). Depending on the used dictionary, entity extraction can reveal whether a body of text talks about a certain topic. Second, the frequency of an entity may indicate its relative importance in the text (Aggarwal and Zhai 2012). The more often a certain word is used, the more relevant it may be for the text (Aggarwal and Zhai 2012). Entity extraction is a suitable text mining approach to analyze textual data about services in item 1 as well (Lee and Hong 2016). Specifically, it is possible to identify and count services in the company's business description (Lee and Hong 2016). For instance, in the above AAR Corp. example there are various services (i.e., entities) mentioned (marked grey in figure 3.5).

This entity count approach can capture what kind of services a manufacturers offers (e.g., maintenance and repairs). In addition, the frequency of service mentions can indicate how important (individual) services are within the firm (Lee and Hong 2016). However, the extraction process requires a reliable and valid service dictionary to identify the relevant keywords (i.e., entities) (Berger et al. 2020; Lee and Hong 2016). The following paragraph describes how the study builds its service keyword dictionary.

There are several research studies which identify services in the manufacturing industry (e.g., Neely 2008; Zeithaml and Brown 2014). While some of the studies identify broad categories (e.g., Neely 2008), others define more specific services (e.g., Visnjic, Wiengarten, and Neely 2016). Table 3.1 summarizes a list of ten research studies and the number of identified service keywords. The articles are used to develop a comprehensive dictionary for this study's entity count approach.

Research Study	# Service Keywords	Aggregation Level
Homburg (2003)	31	Individual Services
Neely (2008)	12	Service Categories
Antioco et al. (2008)	20	Individual Services
Kohtamäki et al. (2013)	14	Service Categories
Zeithaml and Brown (2014)	104	Individual Services
Kohtamäki et al. (2015)	13	Service Categories
Kwak and Kim (2016)	8	Service Categories
Visnjic, Wiengarten, and Neely (2016)	108	Individual Services
Lee and Hong (2016)	87	Individual Services
Benedettini, Swink, and Neely (2017)	88	Individual Services

Table 3.1: Extant Research on Service Keywords

In an initial step, all identified keywords are pooled in a single table, which results in a list of 485 service keywords. However, the list contains many duplicates, synonyms, and variations of the same keyword (e.g., singular and plural form). After removing redundancies, the list decreases to 278 service keywords which represents this study's final dictionary (see exhibit 5 for the detailed list of identified service keywords).

The developed dictionary is used to identify and count service-related keywords in a manufacturer's business description. The term frequency (i.e., frequency of a certain keyword) may indicate its importance in the text since more relevant terms occur more often (Salton 1991). However, an absolute term frequency measure may not accurately reflect the importance of a certain word in a text (Singhal, Buckley, and Mitra 2017). In a longer text a certain keyword may naturally occur more often which can bias an absolute count measure as an importance indicator (Singhal, Buckley, and Mitra 2017). To account for this potential bias, the study normalizes the absolute count measure by the text length which is the total word count of the business description without punctuation and stop words (e.g., "and", "a", or "the") (Salton

1991). The study employs following basic normalization formula for the term frequency of service-related keywords:

$$tf_{ij} = \frac{w_{ij}}{l_j}$$

where

tf_{ij} = weighted term frequency for service keyword i in business description j

w_{ij} = frequency of service keyword i in business description j

l_j = total word count of business description j

The weighted keyword counts (i.e., term frequencies) are calculated for the 278 service keywords across the 9,933 business descriptions in the sample.

3.2.1.2 Service Categorization

An individual analysis of all 278 service keywords is not practical and may not give a good overview of a firm's servitization status. In addition, some service keywords are closely related to each other such as "aftersales services" and "aftermarket support". Therefore, it makes sense to aggregate the service keywords into different categories. As pointed out in the literature review (subchapter 2.2.3.3), there are a variety of service typologies with different aggregation levels. The study uses a broad (SSP-SSC typology) and a fine-grained categorization (13 service types) to capture servitization in the manufacturing industry at two levels of granularity.

An established service typology in research is the differentiation between services in support of products (SSPs) and services in support of customers (SSCs) (Antioco et al. 2008; Eggert et al. 2011, 2014; Mathieu 2001a). The first step in applying this typology is to categorize the 278 service keywords as a SSP or SSC. This is primarily done by referring to existing categorizations (Visnjic, Wiengarten, and Neely 2016; Zeithaml and Brown 2014). Service keywords which are not categorized in literature, are manually coded as SSP or SSC. The manual coding process is performed by two independent coders. Twelve cases of inconsistent coding are resolved by discussion (see exhibit 5 for the final classification of service keywords into SSP and SSC). Each business description results finally in a SSP measure and a SSC measure which are the sum of individual SSP and SSC related keywords.

On the one hand, the SSP-SSC typology has the advantage to give a fast overview of manufacturers' service portfolios. On the other hand, research may lose valuable information if data is highly aggregated (Goodfriend 1992). Therefore, this study amends its analysis with an additional more fine-grained service typology by Lee and Hong (2016). Building upon the service classification of Neely (2008), Lee and Hong (2016) use 10-K business descriptions to categorize 13 different service types (see table 2.2). The 278 service keywords are categorized to the different service types which results in 13 service measures.

3.2.2 Supplementary Measures

Two supplementary variables are included in the descriptive analysis to reveal more insights about contingency factors of servitization. First, the firm size is incorporated as a control variable into the analysis. Research indicates that the firm size may influence how services are implemented by a manufacturer (Paiola, Gebauer, and Edvardsson 2012). The firm size is measured as the number of total employees (Brooksbank 1991) and assigned into one of two categories. According to the U.S. Trade Commission firms with less than 500 employees can be categorized as small to mid-sized enterprises (SMEs) (Hammer 2010). Consequently, companies with 500 or more employees are large firms (Hammer 2010). So, the two firm size categories are SMEs and large firms.

The second control variable is the manufacturing industry. The firm's industry is measured by the 2-digit standard industrial classification (SIC) code (Fang, Palmatier, and Steenkamp 2008) which is available in the SEC database. The SIC code may reveal whether and how servitization varies in different manufacturing industries.

3.2.3 Measurement Validity

There are two research articles which use service keywords in business descriptions of 10-K forms as a measure for a manufacturer's servitization status. Lee and Hong (2016) use service keywords to measure 13 service categories. Visnjic, Wiengarten, and Neely (2016) analyze business descriptions and create dummy variables for SSC and SSP business models. Both research articles validate their measurements. Hence, extant research indicates that service

keywords in business descriptions can be an accurate representation of a manufacturer's servitization process.

This study uses a three-step procedure to verify the validity of its servitization measurement. A sample of 15 firms is randomly drawn to perform the following validity checks. The first step is to verify whether the service content of the companies is accurately captured by the entity extraction process. The most frequently mentioned service keywords should present an accurate picture of the company's service activities. For instance, an IT network company like Cisco should mention mostly IT related service keywords such as software, data, and cybersecurity. In contrast, an automotive manufacturer like Ford should mention services like support, financial, and spare part services. The website of the company is used to determine the major service offerings of the company as a reference point. Specifically, it is checked how prominently the website presents the service offerings. The presentation of services on a company's website is a good indicator of its service portfolio (Hsuan et al. 2017). As an example, table 3.2 presents the results of the content validity check for seven firms.

A look at the companies and their major extracted keywords show that the service measures accurately reflect expected services and are consistent with the firm's website presentation. For example, the diversified IT company IBM has the service keywords data, information, software, solutions, and financial. This reflects accurately IBM's main service offerings on its website such as comprehensive data and information management, and financial services (IBM 2019). Overall, the entity extraction procedure seems to accurately capture the service content from the business descriptions (see exhibit 6 for the full table).

Company Name [Fiscal Year]	Service Keywords [#Occurences]	Website Content*
Hewlett Packard (HP) Inc. [2011]	▪ Software [25] ▪ Support [18] ▪ Infrastructure [18] ▪ Information [10] ▪ Data [9]	▪ Consumer page with support services, and software offerings ▪ Business page focuses on software, infrastructure, and data services and solutions
International Business Machines (IBM) Corp. [2014]	▪ Software [22] ▪ Data [15] ▪ Financial [11] ▪ Infrastructure [10] ▪ Information [9]	▪ Dedicated page for software, data, information, and analytics services ▪ Page "IBM Global Financing" presents extensive financing information for customers
Caterpillar Inc. [2014]	▪ Insurance [11] ▪ Financial [10] ▪ Parts [5] ▪ Warranty [4]	▪ Page with financing and insurance options ▪ Extensive parts and warranty section
Qualcomm Inc. [2015]	▪ Data [14] ▪ Support [9] ▪ Solution [7]	▪ Solutions structured by industry such as automotive, healthcare, and mobile computing ▪ Dedicated support page
Logitech International SA [2015]	▪ Solution [11] ▪ Support [10] ▪ Customer Service [5] ▪ Software [3]	▪ Communication solution offerings for businesses ▪ Dedicated customer support page
Jabil Inc. [2016]	▪ Manufacturing [29] ▪ Design [25] ▪ Assembly [10] ▪ Development [8] ▪ Test Services [6]	▪ Homepage present full-service capabilities of company from design and development to final manufacturing and assembly ▪ Solutions overview page with detailed information on each service offering
Emerson Electric Inc. [2018]	▪ Solution [52] ▪ Software [9] ▪ Monitoring [7]	▪ Two main website parts: automation solutions and commercial/residential solutions ▪ Each main part with product, service, and software offerings

Notes: * Website data derived from website archive "wayback machine".

Table 3.2: Service Keywords Content Validity

In the second step the study checks whether the weighted term frequencies (i.e., service keyword counts) precisely measure service levels across different companies. The reference point in this case is the accounting-based measure of service ratio, which measures the fraction of revenues generated by service sales (Fang, Palmatier, and Steenkamp 2008). However, not all firms report their service sales which creates missing values for some cases. The random

sample is extended to have in total 15 firms with service ratios available. Table 3.3 presents the values for the 15 firms for the fiscal year 2016. The service keyword count measure is the sum over all weighted term frequencies in a business description since service ratio does not differentiate individual service types.

Firm	Year	Service Keyword Count*	Service Ratio
Pitney Bowes Inc.	2016	0.035	72.5%
IBM Corp.	2016	0.038	64.1%
NCR Corp.	2016	0.027	58.2%
General Electric Co.	2016	0.037	30.5%
L3 Technologies Inc.	2016	0.010	29.9%
Juniper Networks Inc.	2016	0.010	29.3%
Cisco Systems Inc.	2016	0.018	25.6%
Brooks Automation Inc.	2016	0.022	24.7%
Agilent Technologies Inc.	2016	0.016	23.5%
Mettler-Toledo Intl. Inc.	2016	0.012	21.9%
Faro Technologies Inc.	2016	0.008	21.4%
Honeywell International Inc.	2016	0.021	20.2%
Eastman Kodak Co.	2016	0.030	19.7%
Lockheed Martin Corp.	2016	0.011	14.6%
Navistar International Corp.	2016	0.009	1.7%

Notes: * Sum of all service-related keywords divided by text length.

Table 3.3: Service Keywords Level Validity

A first visual inspection indicates a high correlation between service keyword count and service ratio. This is confirmed by a strong positive correlation coefficient of 0.7 for the sample. Thus, the study's service measure seems to accurately capture the level of services across companies.

The final step is to check whether the service keyword count accurately captures the development of a company's service portfolio over time. The service ratio is again a good proxy for the service development within a company (Fang, Palmatier, and Steenkamp 2008). Therefore, the development of service keyword count values over time is compared with the service ratio development. Table 3.4 presents the results for four companies which have service ratios available for all relevant years (see exhibit 7 for the full list).

Firm	Year	Service Keyword Count*	Service Ratio	Pearson Correlation
General Electric Co.	2009	0.018	25.1%	0.86
	2010	0.016	26.5%	
	2011	0.018	18.8%	
	2012	0.020	18.5%	
	2013	0.018	19.6%	
	2014	0.036	28.5%	
	2015	0.034	29.8%	
	2016	0.037	30.5%	
	2017	0.042	32.4%	
	2018	0.046	34.1%	
IBM Corp.	2009	0.029	57.6%	0.93
	2010	0.030	56.9%	
	2011	0.029	56.8%	
	2012	0.028	57.8%	
	2013	0.028	58.6%	
	2014	0.030	60.0%	
	2015	0.034	61.1%	
	2016	0.038	64.1%	
	2017	0.036	64.1%	
	2018	0.036	64.5%	
Eastman Kodak Co.	2009	0.012	16.9%	0.63
	2010	0.030	17.8%	
	2011	0.021	15.1%	
	2012	0.015	16.7%	
	2013	0.020	17.5%	
	2014	0.027	18.0%	
	2015	0.023	19.5%	
	2016	0.030	19.7%	
	2017	0.029	19.5%	
	2018	0.028	21.2%	
L3 Technologies Inc.	2009	0.015	51.9%	0.92
	2010	0.017	51.6%	
	2011	0.019	50.1%	
	2012	0.014	42.1%	
	2013	0.015	43.0%	
	2014	0.013	43.0%	
	2015	0.010	28.5%	
	2016	0.010	29.9%	
	2017	0.010	29.7%	
	2018	0.012	30.1%	

Notes: * Sum of all service-related keywords divided by text length

Table 3.4: Service Keywords Development Validity

The Pearson correlations show that the development of service keywords and service ratio within a firm are strongly correlated. On average the correlation is 0.6 for the sample with available service ratios (see exhibit 7).

Overall, the three-step validity check shows that the service keyword count is a valid and reliable measure for the content, the level, and the development of industrial services.

3.3 Method

This study analyzes the data using descriptive statistics. It presents a detailed and comprehensive overview of how services evolve in manufacturing over time. The panel structure of the data offers the advantage to reveal dynamic trends (Giesselmann and Windzio 2012; Wooldridge 2002). In order to analyze servitization within manufacturing the data is pooled across firms in each year. Mean values for the different service categories (i.e., SSP, SSC, and 13 service types) are plotted over time using following formula:

$$MTF_{jt} = \frac{stf_{jt}}{N_t}$$

where

MTF_{jt} = mean term frequency for service category j (SSP or SSC or 13 service types) across all firms in year t

stf_{jt} = sum of term frequency of service category j (SSP or SSC or 13 service types) for all firms in year t

N_t = total number of firms in year t

In addition, the influence of industry and company size are analyzed as well.

3.4 Results

This chapter presents the results of the descriptive analysis based on the two chosen service categorization. First, subchapter 3.4.1 focuses on the broad SSP-SSC categorization and its development over time. The subchapters 3.4.1.1 and 3.4.1.2 show how firm size and the specific industry of a manufacturer influences its servitization development. In the second main chapter (subchapter 3.4.2) the study zooms deeper into the servitization of manufacturing with the 13 service type categorization. The following subchapters present the results for firm size (subchapter 3.4.2.2) and specific industries (subchapter 3.4.2.1) for the finer categorization.

3.4.1 Development of Services based on SSP-SSC Classification

Figure 3.6 shows the development of mean SSP and SSC frequencies from 2009 to 2018. First, it can be seen that SSP have generally a higher term frequency than SSC. The average SSP frequency per year and firm is 0.0046 while the value for SSC is 0.0030. Thus, there is a difference in the level of SSP and SSC mentions in business descriptions. A second result is the development path of SSP and SSC from 2009 to 2018. The mean SSP keyword frequency rises slightly till 2014 and decreases to a previous level until 2017 before showing a slight rise in 2018 again. However, overall mean SSP frequencies are relatively stable and have only slight fluctuations. In contrast, the SSC mean frequencies exhibit a consistent growth in the 10-year time span. Until 2014 there is a considerable growth in SSC mentions in business descriptions. The growth rate decreases slightly after 2014 but shows again a strong growth in 2018. Thus, SSC mentions in business descriptions have increased in the past years.

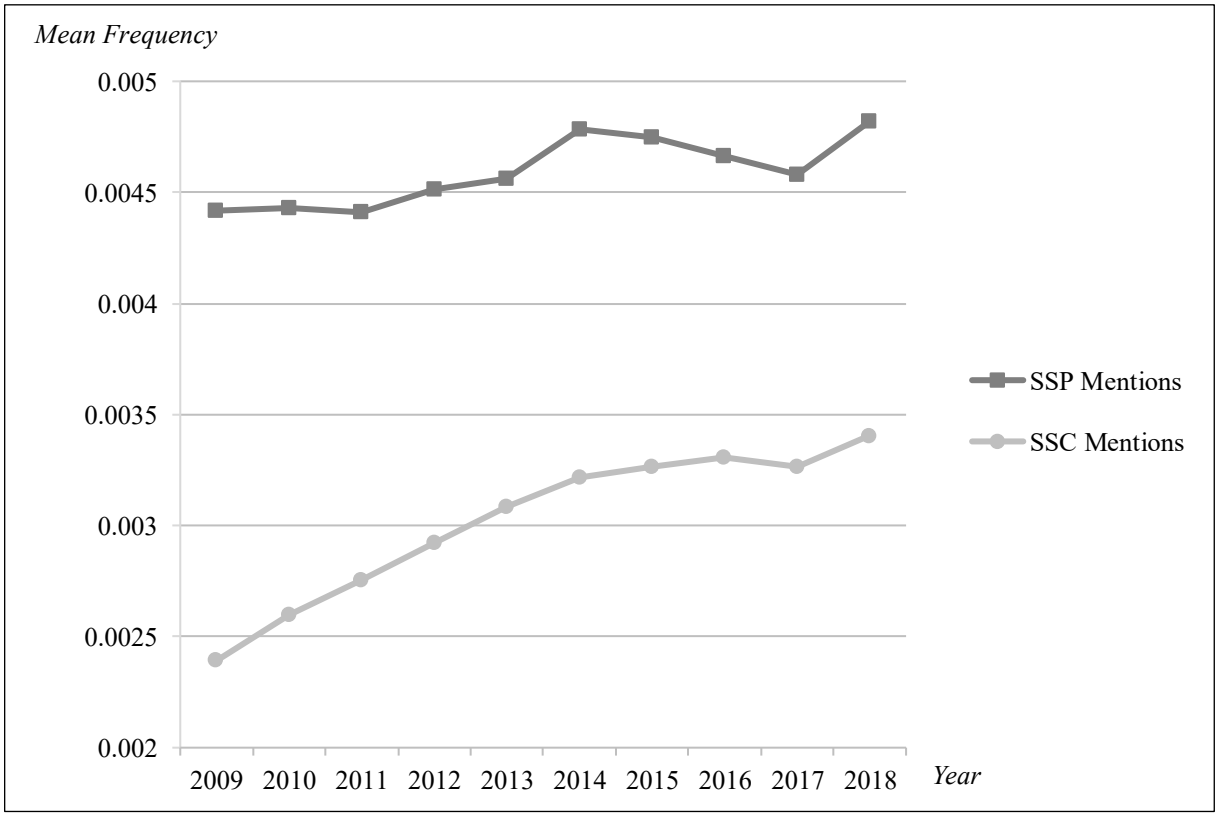

Figure 3.6: SSP-SSC Mean Frequency over Time

Figure 3.7 shows the growth rates of SSP and SSC to better visualize the different developments. The average growth rate for SSP is 1% while SSC frequencies increase on average by 4% per year. This underlines the stronger growth of SSC mentions in the past decade.

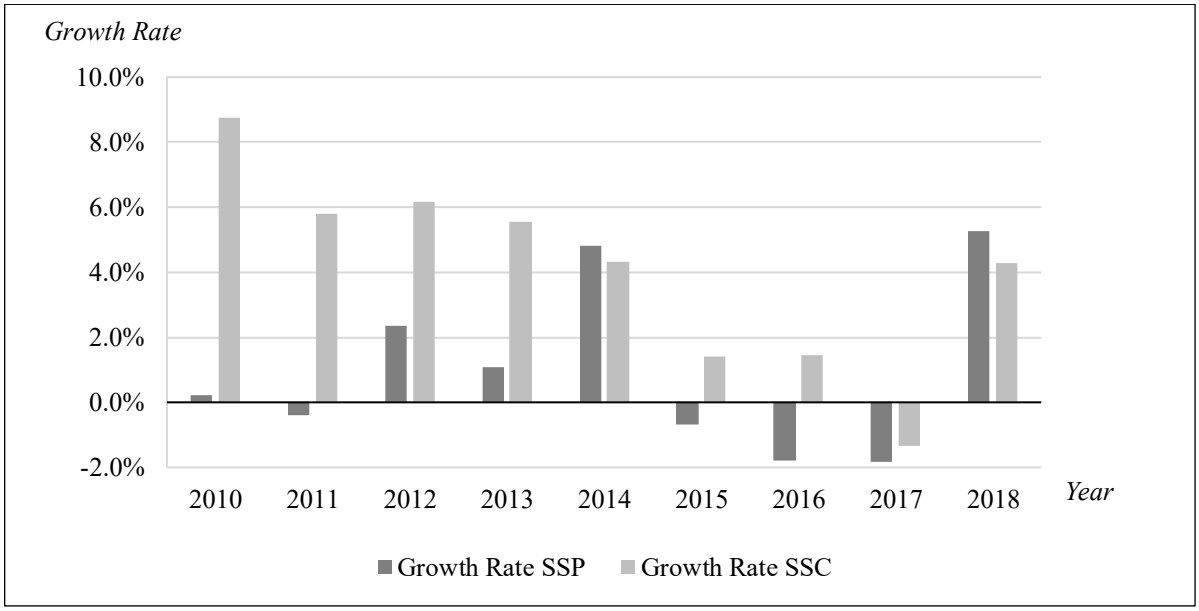

Figure 3.7: SSP-SSC Mean Frequency Growth Rates

3.4.1.1 Influence of Firm Size

Research shows that firm size is a potential factor that may influence the development of services within a manufacturer (Neely 2007). Hence, the SSP and SSC mean values are differentiated between small to mid-sized and large companies. According to the U.S. trade commission a small and medium-sized enterprises (SMEs) are characterized by less than 500 employees (Hammer 2010). Figure 3.8 shows the distribution between SME and large companies in the study's sample. Thus, the majority of firms in the sample are large firms.

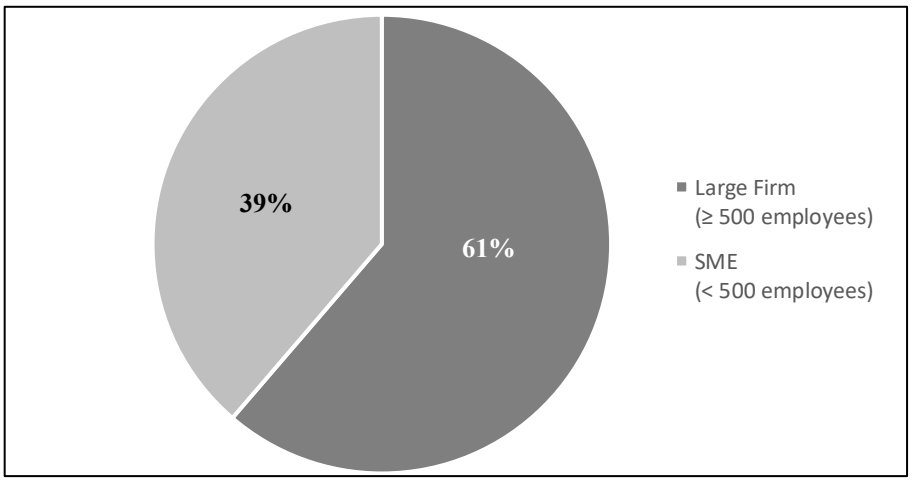

Figure 3.8: Number of SME and Large Firms in Sample

Figure 3.9 presents the resulting plot diagram when differentiating SME and large firms. The graph shows that the level and development of SSP and SSC term frequency for large firms is

consistent with the overall development. It can be seen that SSP in large firms stay relatively stable over the 10-year period while SSC show a continuous and strong growth. In contrast, the SSP and SSC value fluctuate more for SMEs. The mean SSP frequency for SME is stable until 2014 and drops after that before recovering a bit in 2018. The mean SSC frequency for SME increases over time slightly with small fluctuations.

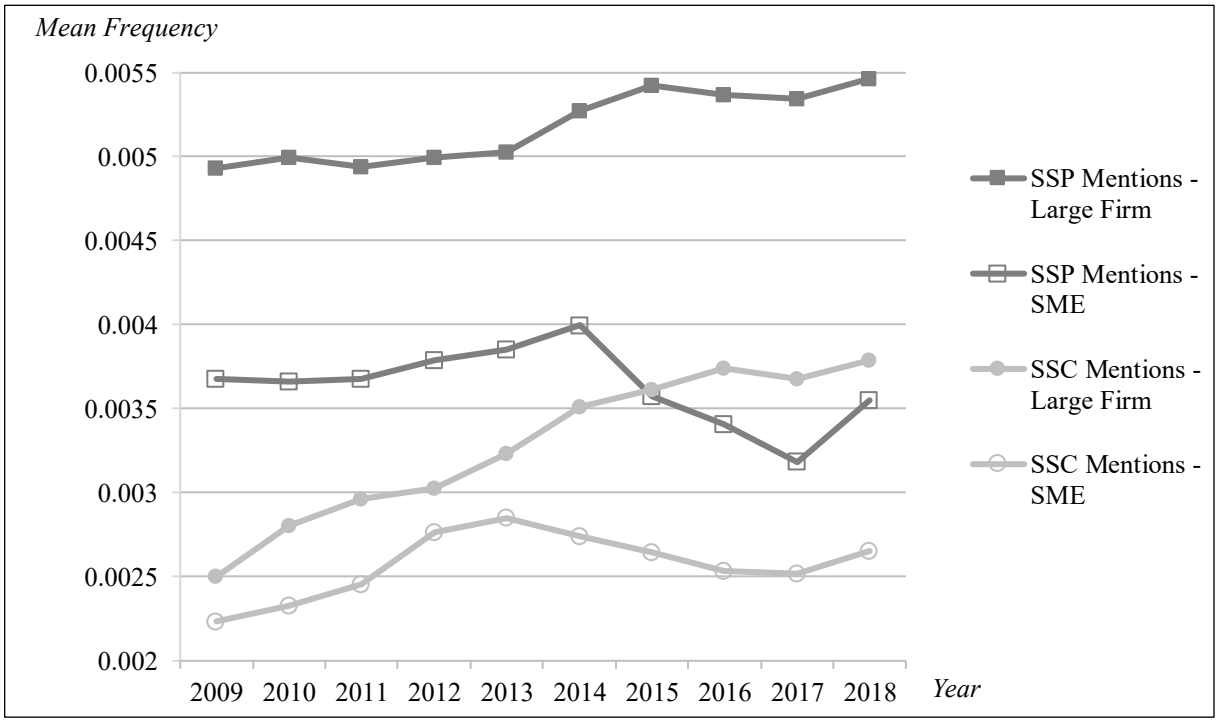

Figure 3.9: SSP-SSC Mean Frequency for Different Firm Sizes

Overall, the differentiation by company size reveals two aspects. First, it shows that large companies' development of SSCs and SSPs roughly follows the general trend presented in figure 3.6. Second, smaller firms have on average lower levels of SSP and SSC and more fluctuations.

3.4.1.2 Influence of Industry

Another differentiating variable is the industry of the firm. The sample includes manufacturing industries with SIC codes 28 to 39 (see exhibit 8 for details about each industry). However, over 80% of firms in the sample belong to the electronic equipment (SIC 36), chemical products (SIC 28), measuring instruments (SIC 38), or commercial machinery (SIC 35) industry (see figure 3.3). Therefore, the industry level analysis focuses on these four main SIC codes.

In order to better visualize the development, the SSP and SSC graphs are plotted separately. Figure 3.10 shows the development of SSP term frequency for the four selected industries.

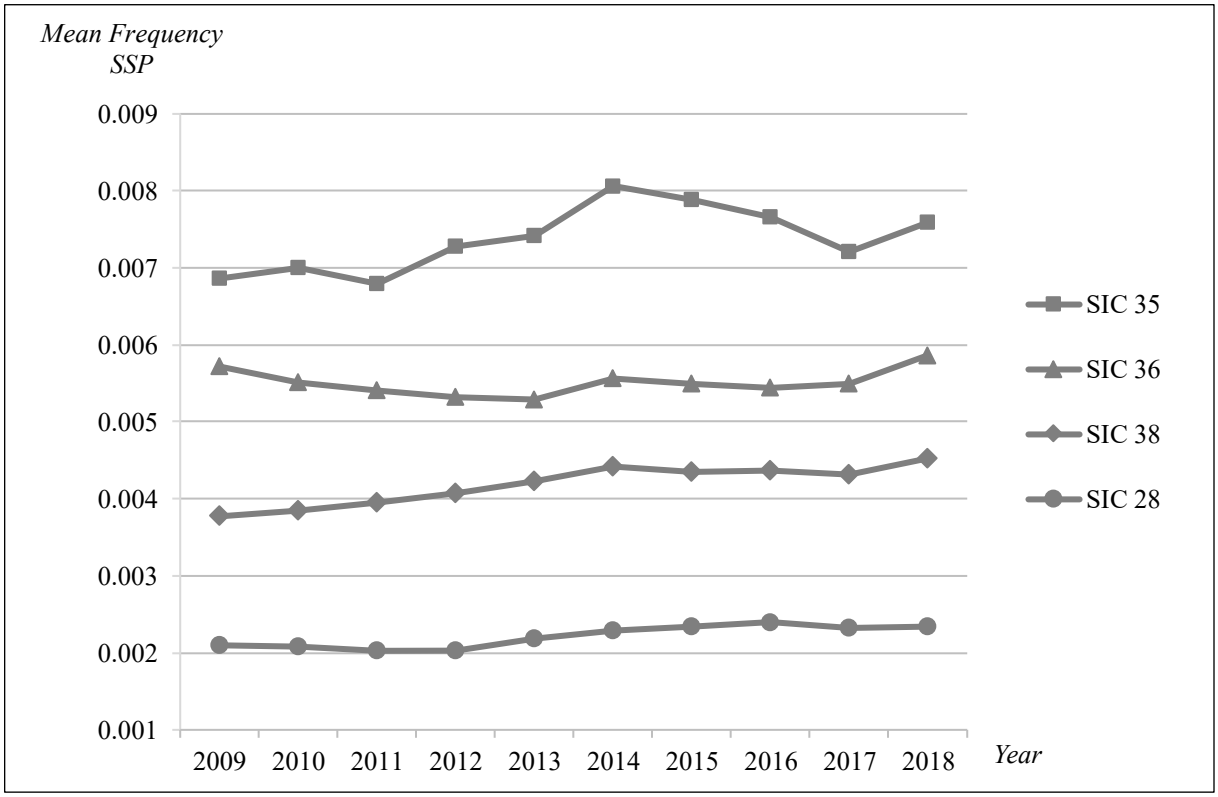

Figure 3.10: SSP Mean Frequency by Industry

The line graphs are consistent with the overall stable trend of SSPs in manufacturing. There are only slight fluctuations in SSP mentions in the past ten years among the four industries with commercial industry (SIC 35) showing the strongest fluctuations. Another insight is that the four industries differ in their SSP level with the chemical product industry (SIC 28) having the lowest values and commercial machinery the highest values (SIC 35).

Figure 3.11 shows the line graph for mean SSC term frequency.

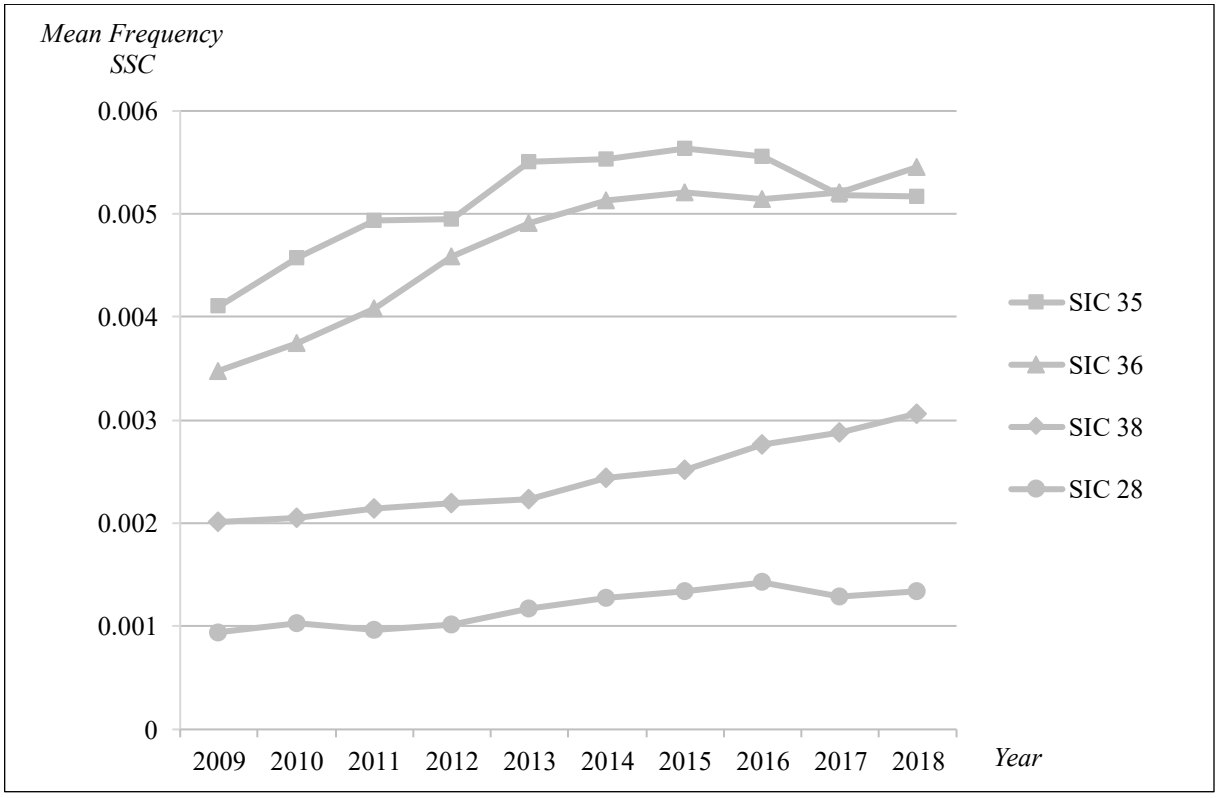

Figure 3.11: SSC Mean Frequency by Industry

The positive general trend seems to be mostly driven by electronic equipment (SIC 36), commercial machinery (SIC 35), and measuring instruments (SIC 38) industries. The chemical products industry (SIC 28) shows only a slight increase during the period. Again, there are differences in the SSC level among the industries. While electronic equipment (SIC 36) and commercial machinery (SIC 35) have similar SSC levels, measuring instruments (SIC 38) and chemical products industry (SIC 28) have lower SSC levels.

All in all, the differentiation by industry shows that SSPs and SSCs develop similarly across the four main industries in the sample. However, they differ in their level of SSP and SSC mentions.

3.4.2 Development of Services based on 13 Service Types

The SSP-SSC service typology is a highly aggregated measure, which makes it difficult to capture which specific services drive the servitization development in manufacturing. Therefore, the study uses the 13 service types developed by Neely (2008) and Lee and Hong (2016). Table 3.5 lists the 13 service types and provides some typical examples for each type.

Service Type	Examples for Typical Services
Design and Development	Design Services , Development Services, Engineering Services
Systems and Solutions	Data Services, Software Services, Solutions, Information Services
Retail and Distribution	Logistics Services, Retail Services, Supply Chain Services
Maintenance and Support	Maintenance Services, Inspection Services, Support Services
Installation and Implementation	Installation Services, Integration Services, Testing Services
Financial Service	Financial Services, Financing Services
Property and Real Estate	Property Services, Real Estate Services
Consulting Service	Advisory Services, Consultancy Services, Supervision Services
Outsourcing and Operating Service	Manufacturing Services, Outsourced Services, Operating Services
Procurement Service	Parts Services, Spare Services, Procurement Services
Leasing Service	Leasing Services, Rental Services
Trucking and Transportation	Delivery Services, Shipping Services, Transportation Services
End-of-Life Support	Lifecycle Services, Refurbishing Services, Remanufacturing Services

Table 3.5: Overview 13 Service Types (Adapted from Neely 2008; Lee and Hong 2016)

First, figure 3.12 shows how often the different service types occur in business descriptions as an average over the 10-year period. It can be seen that maintenance and support services are mentioned in over 70% of business descriptions. Systems and solutions occur in almost every second business description, followed by outsourcing and operating services with a share of 28%. The next set of service types, namely installation and implementation, design and development, retail and distribution, and consulting services, also occur frequently in business description (> 10%).

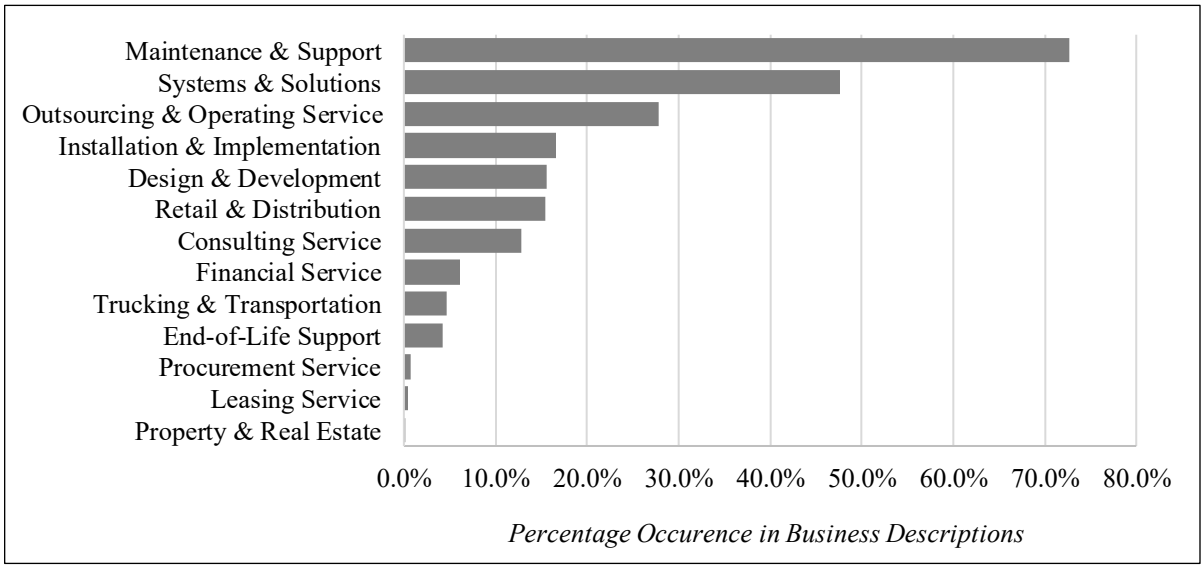

Figure 3.12: Average Occurrence of Service Types in Business Descriptions

Financial, trucking and transportation, end-of-life support, procurement, leasing, and property and real estate services are mentioned in less than 10% of business descriptions. Hence, they play rather a subordinate role in the sample and the following development analysis focuses on the seven most frequently occurring service types.

Figure 3.13 shows how the seven service types develop over time. It can be seen that most service types are stable over time and do not exhibit large fluctuations. Systems and solutions are an exception, they grow by 39% during the ten-year period.

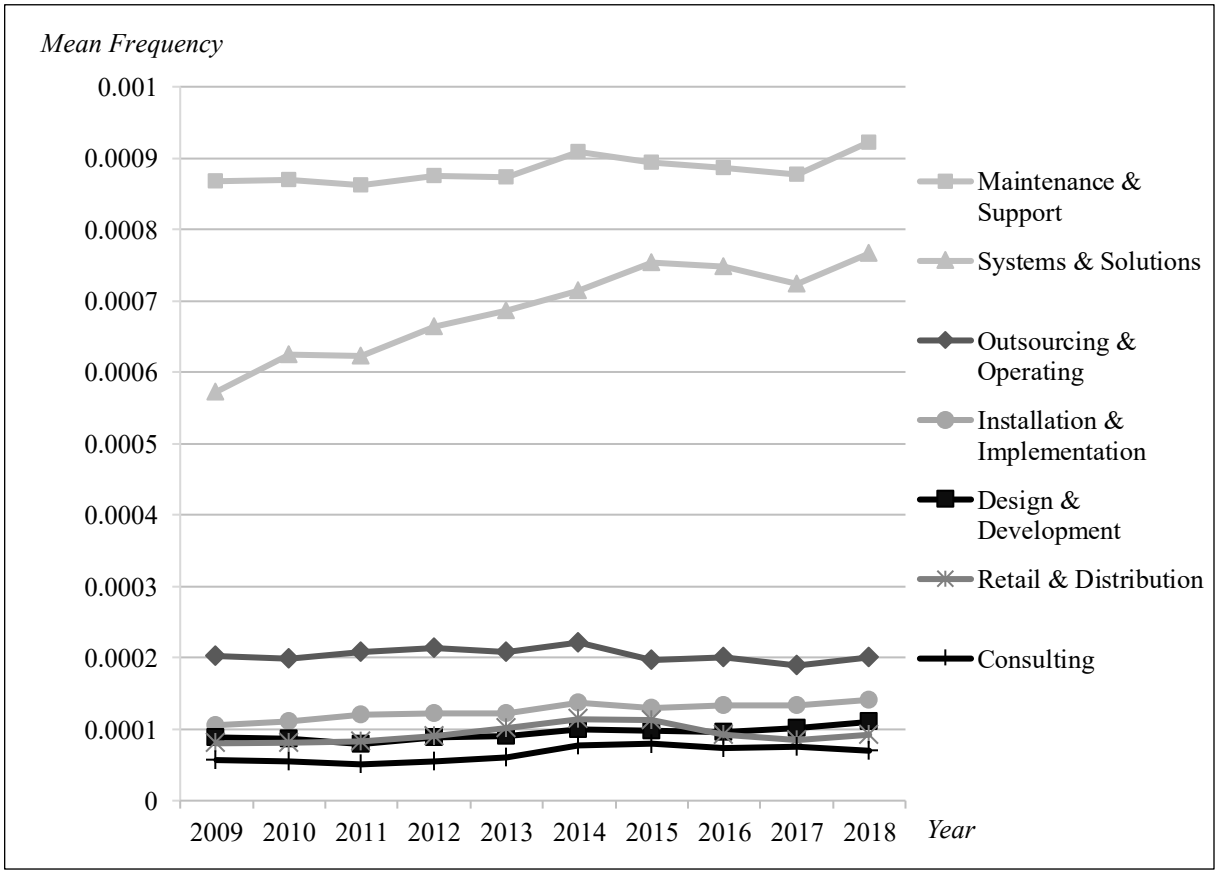

Figure 3.13: Development of Selected Service Types

Overall, service types do not fluctuate much over time and mostly differ in their level. While maintenance and support services are mentioned most often, consulting services are mentioned less frequently in business descriptions. Systems and support exhibit the only significant growth in the past ten years.

3.4.2.1 Influence of Firm Size

The development of the seven service types may be influenced by firm size (Neely 2007). Figure 3.14 and figure 3.15 show the development of the selected service types for large, and

small to mid-sized manufacturers. For large manufacturers, the growth trajectories of the different service types follow almost exactly the overall trend in the sample. Again, only systems and solutions show a considerable growth during the period.

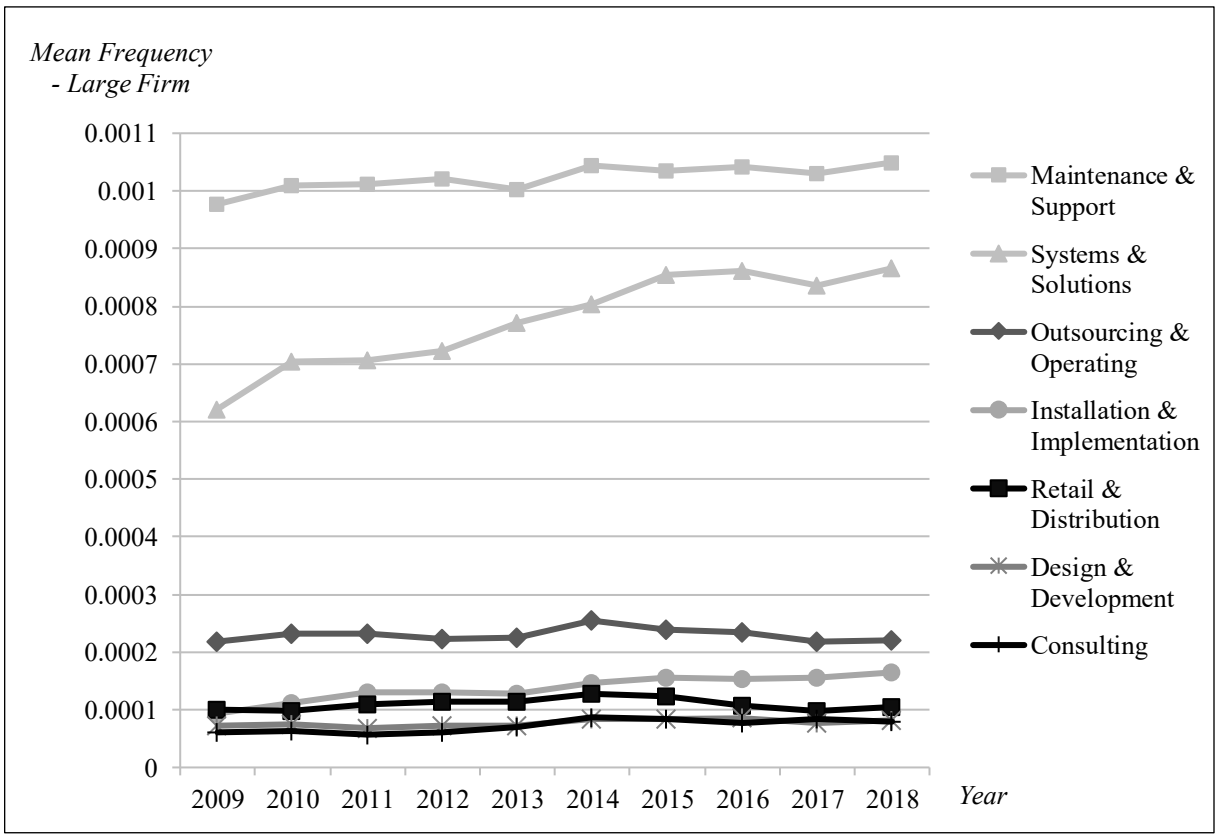

Figure 3.14: Development of Selected Service Types for Large Firms

In contrast, small to mid-sized enterprises (SMEs) shows a different development over time. It can be seen that the individual service types are less constant and instead fluctuate more. Maintenance and support services decreases slightly until 2017 before recovering in 2018. Systems and solutions do not exhibit the strong growth like in larger corporations. Instead, it fluctuates with ups and downs resulting in no considerable change over time.

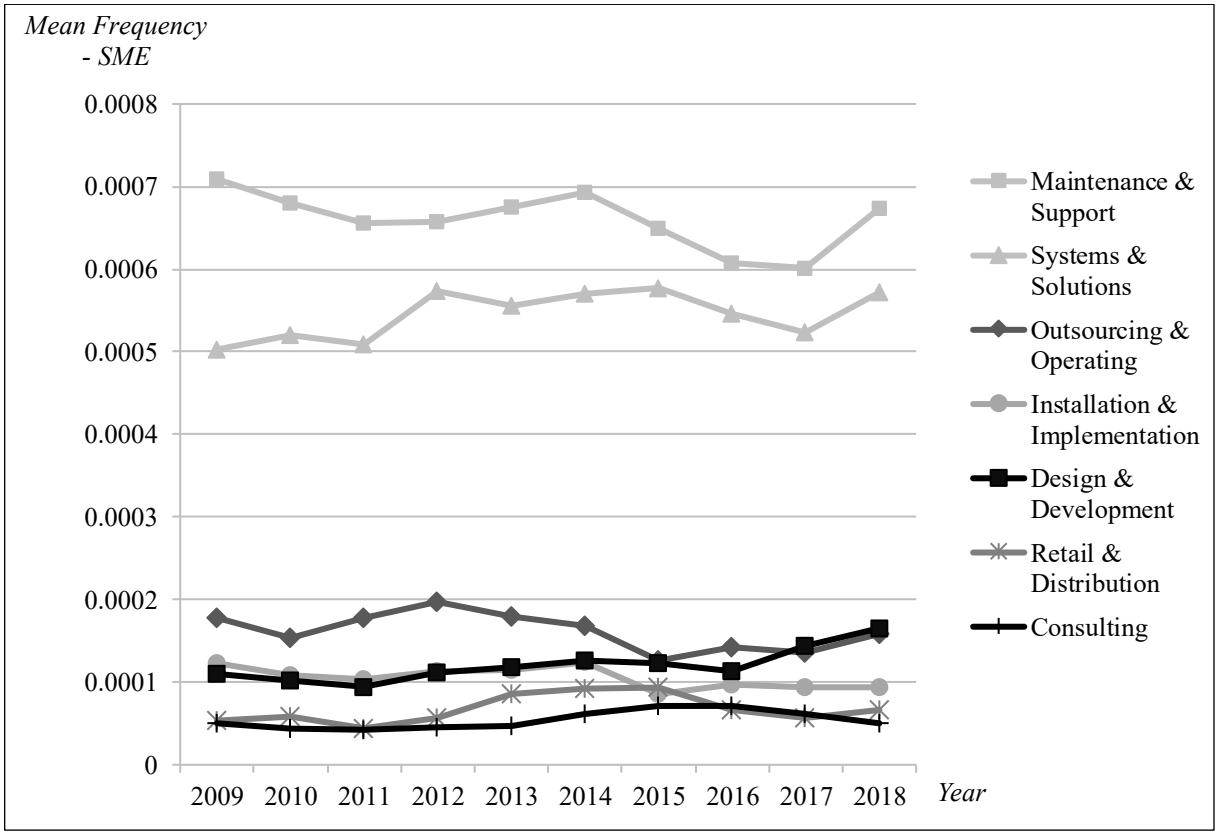

Figure 3.15: Development of Selected Service Types for SMEs

All in all, the development of service types in large corporations is consistent with the overall sample. SMEs exhibit more fluctuations in the service types development and do not show a growth in systems and solutions.

3.4.2.2 Influence of Industry

A manufacturer's industry may influence how services develop over time (Crozet and Milet 2017). Figures 3.16, 3.17, 3.18, and 3.19 show the development of the selected service types in the top 4 industries of the sample (i.e., SIC codes 36, 28, 38, 35).

The level and development of the seven service types vary across the different industries. In the electronic equipment industry, the level of systems and solutions is higher than maintenance and support services. In addition, it shows a strong growth in the past years. The other service types are relatively consistent with the overall sample.

The chemical products industry has only a high level for maintenance and support service, while all other service types are less frequently mentioned in business descriptions including

systems and solutions. Moreover, the individual service types fluctuate over time more compared to the sample average.

Finally, the measuring instruments industry (SIC 38) and commercial machinery industry (SIC 35) follow similar trends like the overall sample. Maintenance and support, and systems and solutions are the most frequent service types. While maintenance and support, and the other service types stay relatively stable over time, systems and solutions show a strong growth.

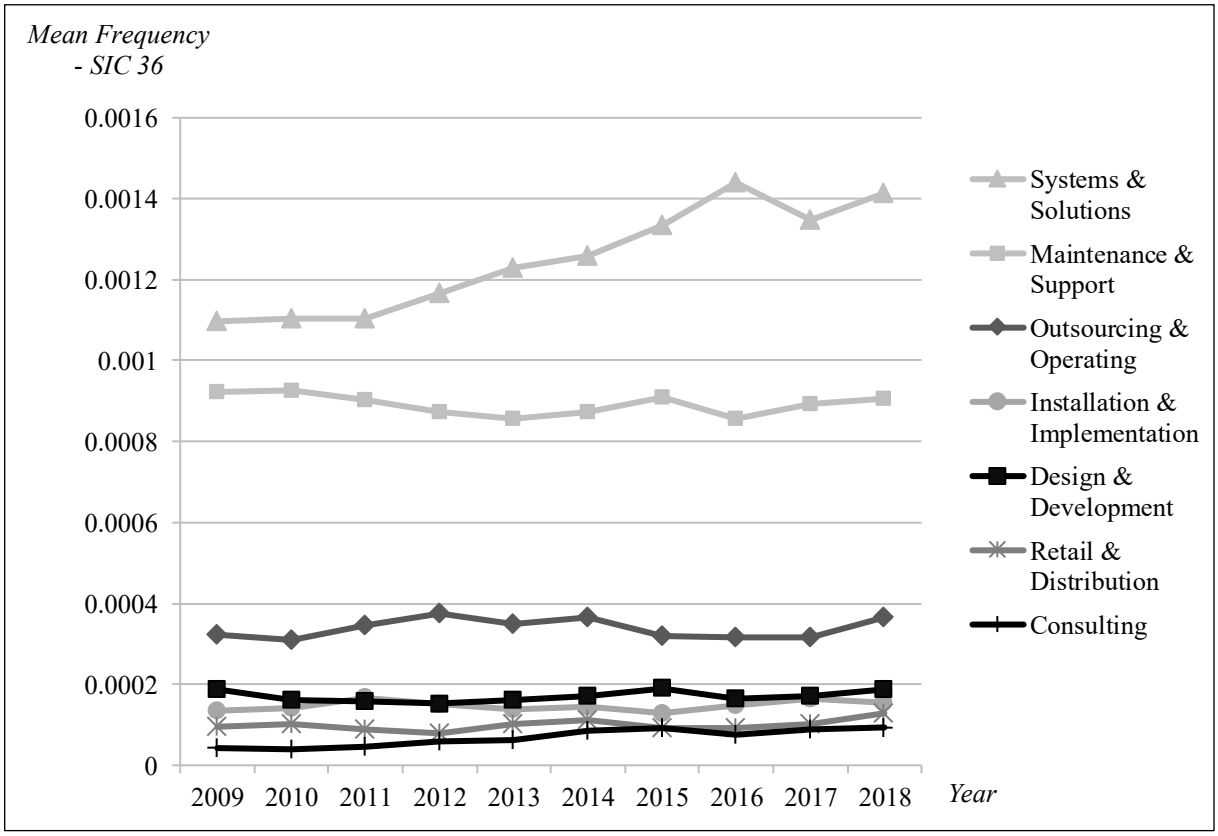

Figure 3.16: Development of Selected Service Types for Electronic Equipment Industry (SIC 36)

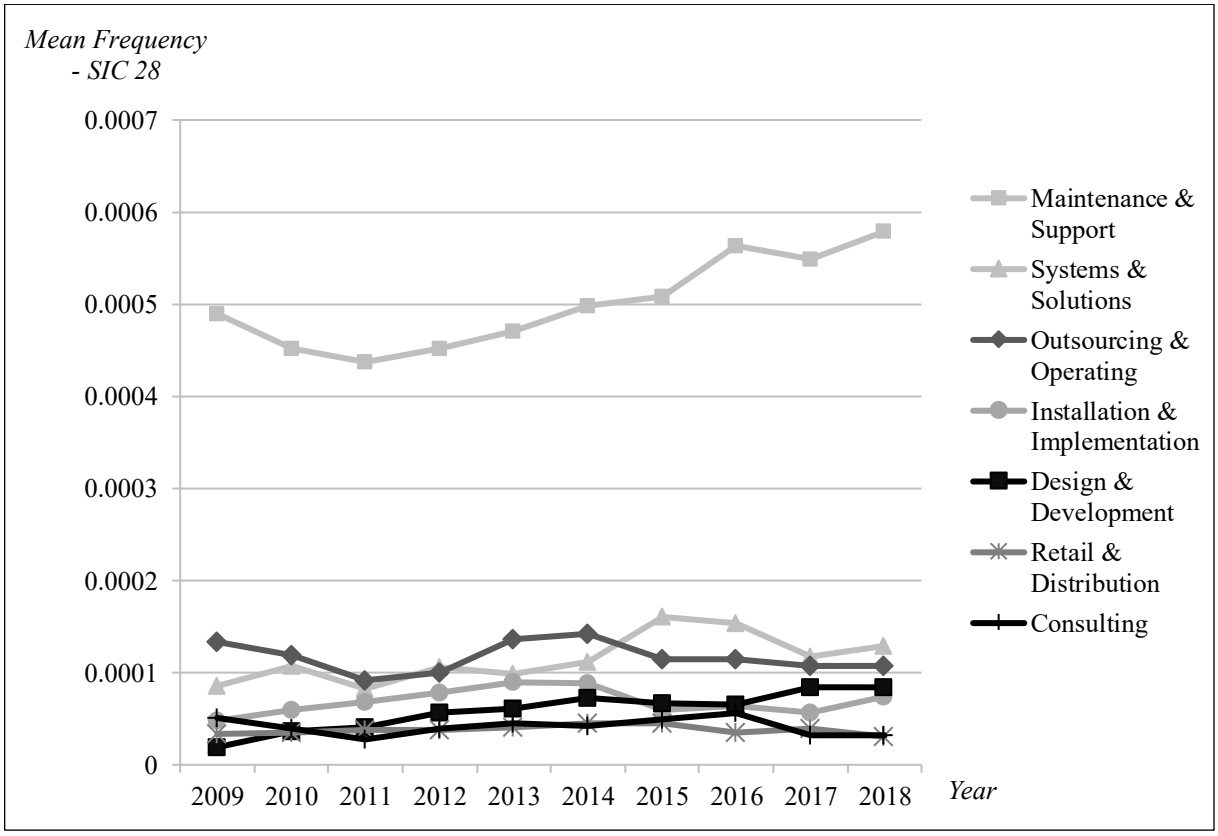

Figure 3.17: Development of Selected Service Types for Chemical Products Industry (SIC 28)

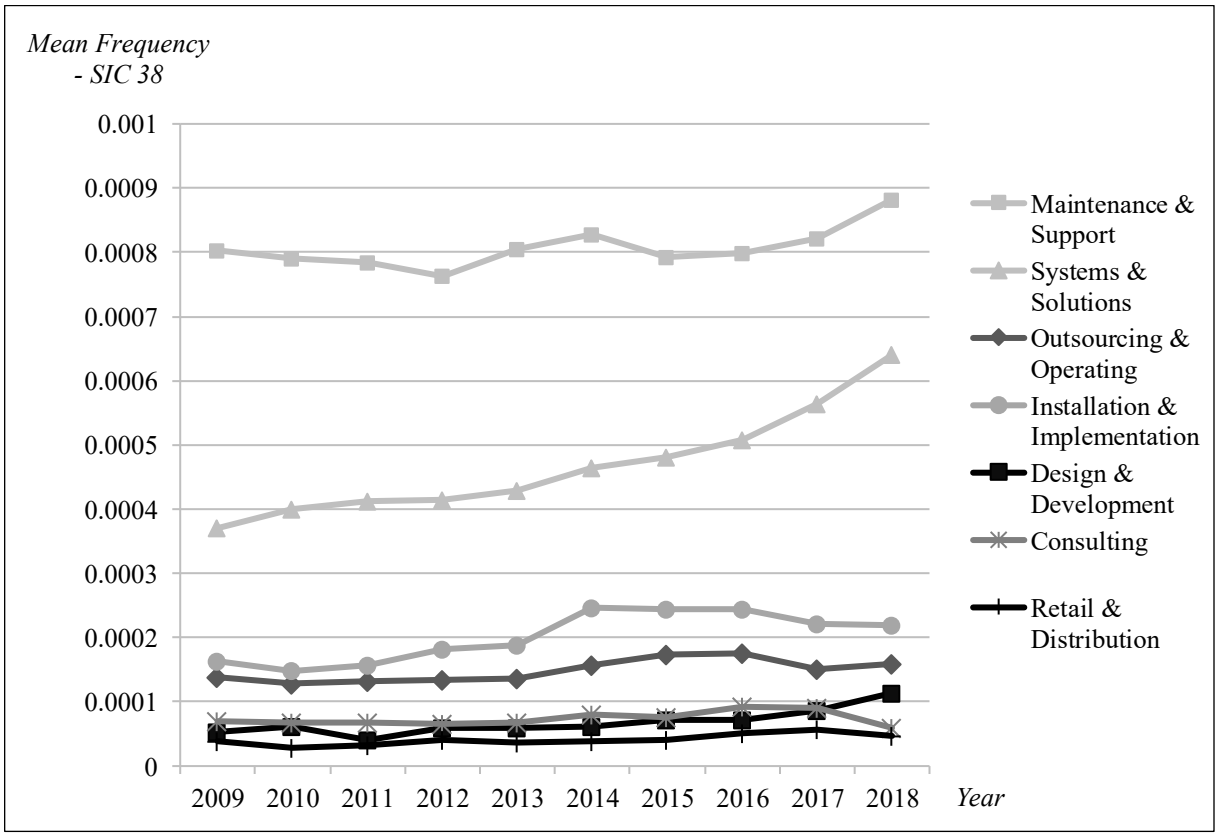

Figure 3.18: Development of Selected Service Types for Measuring Instruments Industry (SIC 38)

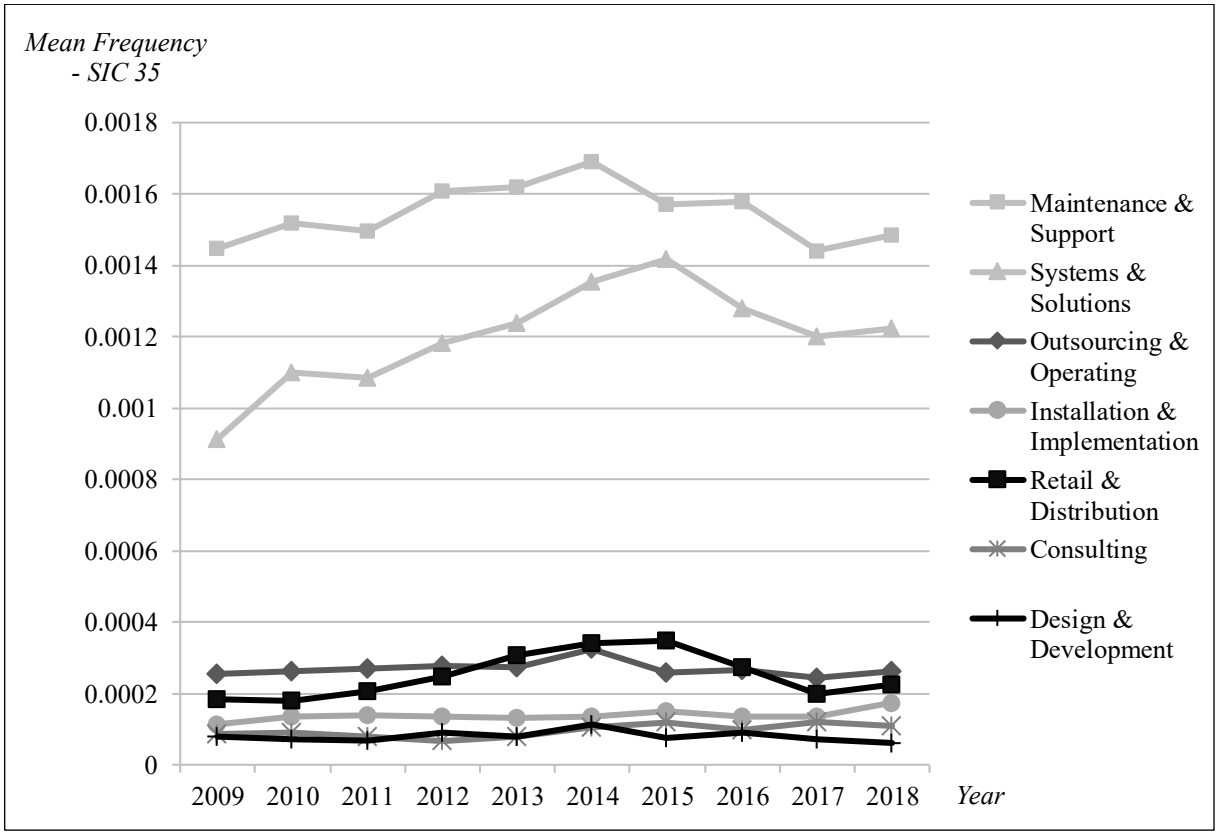

Figure 3.19: Development of Selected Service Types for Commercial Machinery Industry (SIC 35)

All in all, the industry differentiation shows that the level of service types may differ within industries. In addition, the development of individual service types also differs among manufacturing industries.

3.5 Conclusions

This initial descriptive analysis of the data reveals several interesting insights about the development and status-quo of servitization in manufacturing. The data is analyzed using simple mean measures, and plot diagrams. Hence, the outcomes do not claim to establish causal relationships, but rather uncover potential trends in the data and be purely descriptive in nature. That is also the reason why the study neither establishes a theoretical basis nor tests any hypotheses. Nevertheless, there are multiple descriptive results which are worthwhile to discuss.

First, the descriptive analysis reveals differences in the level and development of SSP and SSC keywords over time. It can be seen that SSP keywords occur more often in business descriptions than SSC keywords. This indicates that product-related services play a predominant role in manufacturing. The fine-grained view on service types confirms that maintenance and support services are mentioned most frequently in business descriptions. However, SSP re-

main relatively constant over time while SSC exhibit a strong growth over the past ten years. The fine-grained view on service types reveals that this growth is mainly driven by systems and solutions. This trend towards solutions is also observed by marketing research (e.g., Macdonald, Kleinaltenkamp, and Wilson 2016; Worm et al. 2017). In addition, it indicates that manufacturers increasingly focus on comprehensive service offerings incorporating digital components such as data and software (Coreynen, Matthyssens, and Van Bockhaven 2017).

The differences in SSP and SSC keywords show the need for distinguishing service categories in servitization. The generic classification of "services" which is often used in research may not effectively capture the underlying developments in servitization. Thus, the descriptive analysis supports the approach to differentiate service categories as done in some research studies (e.g., Eggert et al. 2014; Visnjic, Wiengarten, and Neely 2016).

Another insight of the descriptive analysis is that firm size and industry influence the servitization process in manufacturing. Large manufacturers generally follow the same pattern as the total sample, which means that SSP have the highest level and are constant, while SSC show the strongest growth. However, small to mid-sized enterprises (SMEs) deviate from the sample's general pattern and show more fluctuations. Moreover, the growth of SSC in SMEs is less pronounced. A potential explanation of this divergent development might be the fact that SMEs may compete with larger companies. Given a fixed market volume, an increase in services from large companies may result in a service decrease in smaller companies. Another possible reason is that SSC require manufacturers to acquire new and often unfamiliar resources and capabilities (Ulaga and Reinartz 2011). Acquiring these new competencies may be harder for SMEs because they often have less resources than larger firms.

At the industry level, the results show that industries mostly differ in their level of SSP and SSC. The electronic equipment (SIC 36) and commercial machinery (SIC 35) industry have the highest SSP and SSC levels. In contrast, the chemical products industry (SIC 28) shows the lowest levels of SSP and SSC. This underlines that the importance of servitization differs between manufacturing industries. There are two possible meanings of this observation. On the one hand, it can mean that the servitization process in some industries is more advanced than in others. Thus, the other industries may catch up with time. On the other hand, it can mean that servitization plays a less important role in that particular industry per se and prod-

ucts are the predominant source for value creation. Which explanation applies to the current results requires more research.

The third insight is that a more fine-grained view on servitization can help to better understand the results of the broad SSP-SSC classification. A key insight is that the driving forces for SSP are maintenance and support services. In most manufacturing markets, firms need a minimum level of service offerings to stay competitive (Gebauer and Fleisch 2007; Zeithaml and Brown 2014). Maintenance and support services ensure the smooth operation of the product and have become a long-established part of a manufacturer's portfolio (Zeithaml and Brown 2014). The constant level of maintenance and support services throughout the past decade has two causes. First, the potential for innovations in basic maintenance and support services is rather low which limits growth by innovative offerings (Gebauer and Fleisch 2007). Second, the U.S. manufacturing market is in the mature stage of its industry lifecycle (Miles 2018), which means growth rates decrease due to increasing market saturation. Hence, the market volume for maintenance and support services stays relatively stable limiting growth.

The fine-grained analysis shows that the driving force for SSC are systems and solutions. They show a substantial growth in the past decade, which is also reflected in the increasing interest into solution research (e.g., Macdonald, Kleinaltenkamp, and Wilson 2016; Worm et al. 2017). Gebauer and Fleisch (2007) point out that manufacturers should increasingly invest into customer-focused services (i.e., SSC) since traditional product-focused services (i.e., SSC) cannot guarantee a sustainable competitive edge. The descriptive analysis confirms that manufacturer increasingly focus on systems and solutions which belong to the SSC category.

The final insight is that differentiating service types by firm size and industry is mostly consistent with the results of the SSP-SSC categorization. However, interestingly it can be seen that in the electronic equipment industry (SIC) systems and solutions are mentioned more often than maintenance and support service. In other industries (e.g., commercial machinery) systems and solutions get close to the level of maintenance and support services. This underlines that systems and solutions is the emerging service type in manufacturing.

All in all, the descriptive analysis reveals that industrial services in manufacturing are dominated by SSPs, which consists mainly of maintenance and support services. However, the

development of SSPs is stagnant and seem to have reached a saturation point. In contrast, SSCs are an emerging category driven by systems and solution offerings.

4. Theoretical Foundation

As initially mentioned, this study has two major parts. In the first part (chapter 3), the focus lays on the descriptive analysis of servitization. The second part focuses on understanding the financial outcomes of servitization. This chapter builds the theoretical foundation for the second part of this study. Subchapter 4.1 presents the resource-based view as the fundamental theory to understand servitization implications. Based on that theory subchapter 4.2 develops hypotheses about financial outcomes of servitization.

4.1 The Resource-based View

One of the most frequently used theoretical approaches to understand the mechanisms of servitization is the resource-based view (Wang, Lai, and Shou 2018). The resource-based view is the underlying theory for this study as well. The following paragraphs presents the core concept of the resource-based view theory.

Companies need a competitive advantage in their market to sustain profitable returns from their operations (Porter 1985). Strategic management research presents two alternative explanations for building competitive advantages in the marketplace.

First, research states that an organization's external environment of competitors, suppliers, customers, and other stakeholders determines opportunities and threats in an industry (Porter 1985). A company's ability to exploit these opportunities while fending off threats presents a sustainable competitive advantage (Porter 1985). There are two alternative assumptions of this environmental model of competitive advantage. First, companies in an industry are more or less homogenous in terms of their resources and strategies (Barney 1991; Porter 1981). Second, a potential resource heterogeneity among companies may last only a short time, because all resources can be acquired in factor markets (Barney 1986b). The environmental model provides a solid initial conceptualization of how competitive advantages are established within industries (Barney 1991).

The second alternative explanation of competitive advantage is the resource-based model, which takes an internal perspective. A company can build a competitive advantage based on its internal strengths and weaknesses (Barney 1991). The company-specific resources essentially determine those strengths and weaknesses (Wernerfelt 1984). There are two key as-

sumptions of this model. First, resources across companies in the same industry can be heterogenous (Barney 1991). Second, not all resources can be acquired easily in factor markets (Barney 1991). These assumptions are in a stark contrast to the environmental model's view of homogenous and easily accessible resources (Barney 1991). Figure 4.1 summarizes the two alternative models.

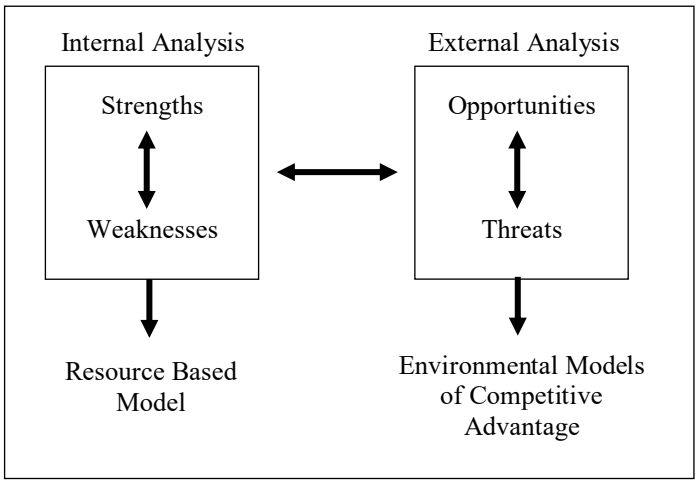

Figure 4.1: External vs. Internal Model of Competitive Advantage (Barney 1991)

Throughout the 1980s strategic management research focuses on environmental models to understand how companies can build competitive advantages (Barney 1991; Porter 1980). However, starting in the early 1990s, the resource-based model gains traction and establishes itself as a widely accepted conceptualization of competitive advantages (Barney 2001; Wernerfelt 1995).

Before explaining the resource-based view theory in detail, the following paragraphs define the three key terms "resources", "capabilities", and "competitive advantage". Firm resources comprise of all tangible and intangible assets, which are owned or controlled by the firm (Amit and Schoemaker 1993; Barney 1991; Wernerfelt 1984). These include for examples physical assets such as machinery and properties, and intangible elements such as tacit know-how, and organizational processes (Amit and Schoemaker 1993; Barney 1991; Wernerfelt 1984).

Capabilities refer to a firm's ability to deploy its resources (Amit and Schoemaker 1993). They consist of "information-based, tangible or intangible processes that are firm-specific and are developed over time through complex interactions among the firm's Resources." (Amit and Schoemaker 1993, p. 35). A key difference to resources is that capabilities are closely tied to the firm's human capital (Amit and Schoemaker 1993). The interaction and exchange of

information among employees can create capabilities to effectively exploit firm resources (Amit and Schoemaker 1993). This is especially true for cross-functional departments such as product management, which synthesize multiple corporate resources (Amit and Schoemaker 1993). Examples of capabilities are frequent product and process innovations, data processing and interpretation capabilities, and flexible responsiveness to market trends (Amit and Schoemaker 1993; Ulaga and Reinartz 2011).

The final key term is competitive advantage, which can have two variations. First, a firm has a "competitive advantage" in a market if its value creating strategy is not duplicated by any current or potential competitor (Barney 1991). The second variation is the "sustained competitive advantage" which adds the characteristic that current and potential competitors are incapable to copy the firm's value creating strategy (Barney 1991). The term "sustained" does not refer to the timeframe a competitive advantage lasts before it is copied by competitors (Barney 1991). Instead, it underlines the competitor's inability to duplicate a firm's strategy (Barney 1991). For instance, competitors may not have access to a certain technology that creates the competitive edge. A sustained competitive advantage may last a long time, but it cannot be assumed to last forever in a dynamic environment (Barney 1991).

Figure 4.2 visualizes the relationship between these three key terms. The firm employs its resources and capabilities to implement its strategies, to build a sustained competitive advantage, and to improve its performance through gains in operational efficiency (Barney 1991).

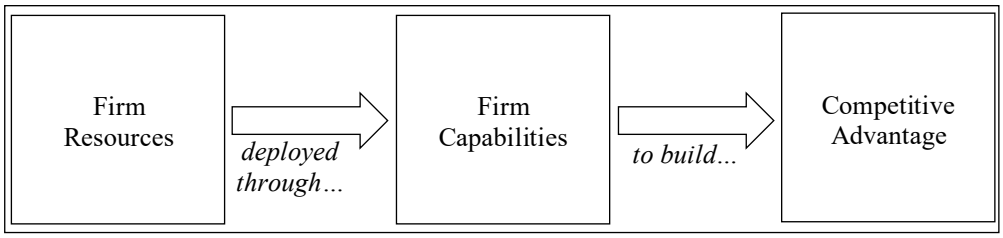

Figure 4.2: Relationship between Resources, Capabilities, and Competitive Advantage (Adapted from Porter 1985)

The core idea of the resource-based view (RBV) theory is that firms are essentially an idiosyncratic bundle of resources and capabilities (Amit and Schoemaker 1993). On the one hand, those resources and capabilities can be heterogenous and differ from firm to firm (Barney 1991). On the other hand, resources and capabilities can be immobile and may not be traded between firms (Barney 1991; Wernerfelt 1984). A firm's resources and capabilities

determines its strengths and weaknesses in a market (Wernerfelt 1984). The RBV states four main characteristics of resources and capabilities which constitute a sustained competitive advantage in the marketplace (Amit and Schoemaker 1993; Barney 1991). The resources and capabilities need to be valuable, rare, imperfectly imitable, and non-substitutable (VRIN) (Amit and Schoemaker 1993; Barney 1991). The following paragraphs discuss each of these RBV characteristics.

First, only valuable resources and capabilities can help firms to build a competitive advantage in a market (Barney 1991). A resource or capability is valuable if it enables the firm to implement more effective or efficient strategies (Barney 1991). The value characteristic is the fundamental prerequisite for any firm attribute to be even considered a resource or capability (Barney 1991).

The second characteristic is that a firm's resources and capabilities must be rare to render a competitive advantage (Amit and Schoemaker 1993; Barney 1991). This captures the very essence of a competitive advantage, which is its strategic uniqueness (Porter 1985). If many firms possess the same valuable resources or capabilities, they all will implement the same strategy (Barney 1991). The consequence is that none of the firms will be able to create a competitive advantage in the market (Barney 1991). Therefore, scarcity of valuable resources and capabilities is another necessary characteristic for a competitive advantage (Amit and Schoemaker 1993; Barney 1991). However, the level of scarcity of a resource or capability in order to render a competitive advantage may vary (Barney 1991). Rare might not mean that only a single firm possess the resource or capability (Barney 1991). There can be a few firms with the rare resource or capability, allowing each of them to build a competitive advantage around it (Barney 1991). Moreover, scarcity does not imply that the common valuable resources and capabilities become unimportant (Barney 1991). They are still relevant for the firm to sustain a competitive parity in the industry (Barney 1989, 1991).

Valuable and rare resources and capabilities can help firms to build a competitive advantage (Barney 1991; Newbert 2008). However, firms striving for a sustained competitive advantage need their resources and capabilities also to be inimitable (Amit and Schoemaker 1993; Barney 1991). Hence, the third key characteristic for a sustained competitive advantage is imperfectly imitable resources and capabilities (Amit and Schoemaker 1993; Barney 1991). Barney (1991) lists three explanations on how imperfectly imitable resources and capabilities

can evolve. First, the historical background and development of a firm can create imperfectly imitable resources and capabilities (Barney 1991). The reason is that some resources and capabilities are space- and time-dependent (Barney 1991). Only firms in that particular era and (geographic) space are able to obtain the resources and capabilities (Barney 1991). Consequently, firms can exploit those unique resources and capabilities to implement strategies that cannot be duplicated by competitors (Barney 1991). For instance, a firm acquires a piece of real estate which evolves to a highly valuable physical asset due to its location (Barney 1991). Competitors cannot simply copy the advantages of that resource's location (Barney 1991). Another example is a company's organizational culture. A valuable company culture may have established itself in the early stages of the company's creation (Barney 1991). This intangible resource is hard to imitate by any new company entering the market (Barney 1991).

A second source for imperfectly imitable resources and capabilities is causal ambiguity of a firm's sustained competitive advantage (Barney 1991). This means it is unclear (for the firm itself and all its competitors) which resources and capabilities create a firm's sustained competitive advantage in the market (Barney 1991). This situation arises through the firm's complex interaction between resources, capabilities, and strategies (Barney 1991). Thus, competitors are unsure which strategic elements to imitate (Barney 1991). However, this might not be a sustainable protection against imitations. Competitor may clarify the causal ambiguity over time by for example systematically analyzing the focal firm or enticing away the firm's knowledgeable employees (Barney 1991).

A final source for imperfectly imitable resources and capabilities is social complexity (Barney 1991). Complex social phenomena such as company culture, management's intrapersonal relationships, and reputation are very hard to copy (Barney 1991). It is often clear how these social elements contribute to the firm's efficiency. However, due to their intangible, social nature, it is not easy to artificially copy them (Barney 1991).

Next to valuable, rare, and imperfectly imitable, resources and capabilities need to be non-substitutable (Amit and Schoemaker 1993; Barney 1991). That means there must not be two valuable resources or capabilities which can be exploited separately to implement the same strategy (Barney 1991). If a substitute resource or capability is not rare or imitable, competitors are able to undermine the focal firm's competitive advantage (Amit and Schoemaker 1993; Barney 1991). Competitors can implement the same strategy as the focal firm by de-

ploying substitute resources or capabilities (Barney 1991). There are two forms of substitutes. First, a company can use similar resources and capabilities to copy a competitive advantage (Barney 1991). For instance, a management team cannot be duplicated exactly, but a competitor can build a team with similar background and experiences (Barney 1991). The second form of substitutability occurs when different resources and capabilities result in the same strategic outcome (Barney 1991). For example, a visionary management style in one firm might be substituted by a formal planning process in another firm (Barney 1991). Both means lead to the same end, namely a forward-looking organization (Barney 1991).

Overall, the RBV theory states that a firm with a sustained competitive advantage is a bundle of resources and capabilities, which are valuable, rare, imperfectly imitable, and non-substitutable (Amit and Schoemaker 1993; Barney 1991). A sustained competitive advantage enables the firm to implement more effective and efficient strategies, which in turn improve firm performance (Amit and Schoemaker 1993; Barney 1991; Eisenhardt and Martin 2000; Powell 2001). Newbert (2008) proves this RBV hypothesis by empirically showing a positive relationship between resources, competitive advantage, and firm performance. Specifically, the author proves that a firm's valuable and rare resources and capabilities positively impact its competitive advantage (Newbert 2008). The competitive advantage translates into improved performance outcomes, which are measured in terms of financial performance such as sales and non-financial performance such as market share (Newbert 2008). Figure 4.3 summarizes the core idea of the RBV theory.

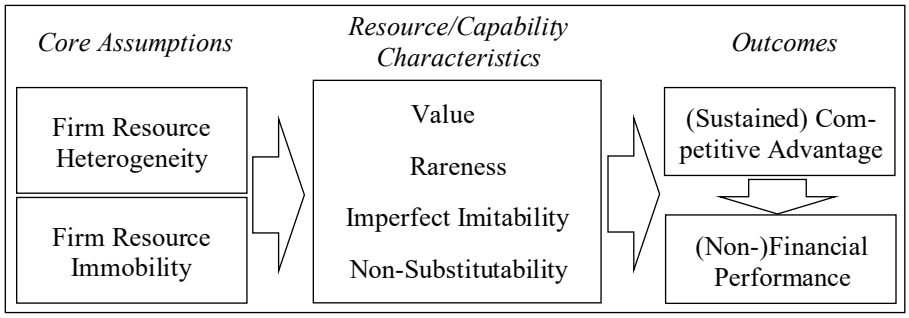

Figure 4.3: Core Idea of Resource-based View Theory (Adapted from Barney 1991; Newbert 2008)

4.2 A Resource-based Perspective on Servitization

Servitization means for manufacturers a strategic change towards the provision of services (Vandermerwe and Rada 1988). The objective of this strategic change is to gain a sustained competitive advantage in the market and generate superior performance outcomes (Newbert

2008; Ulaga and Reinartz 2011). From a resource-based perspective this implies a major reconfiguration of the firm's resources and capabilities (Fang, Palmatier, and Steenkamp 2008; Ulaga and Reinartz 2011). On the positive side, this reconfiguration gives the manufacturer the opportunity to build a sustainable competitive advantage with its servitization strategy (Bustinza et al. 2015). There are several positive mechanisms of services which support manufacturers to build resources and capabilities with VRIN characteristics (Amit and Schoemaker 1993; Barney 1991). On the other hand, a substantial change of a firm's established resource-capability configuration can also have negative organizational consequences (Fang, Palmatier, and Steenkamp 2008; Zhang and Banerji 2017). For instance, a servitization strategy can dilute limited resources and capabilities resulting in diminishing operational efficiency (Fang, Palmatier, and Steenkamp 2008). The following subchapters 4.2.1 and 4.2.2 discuss the positive (i.e., sustained competitive advantage) and negative (i.e., organizational tensions) implications of a servitization strategy from an RBV perspective.

4.2.1 Positive Implications through Sustained Competitive Advantage

The RBV theory states that resources and capabilities need to be valuable, rare, imperfectly imitable, and non-substitutable (VRIN) to create a sustainable competitive advantage in a market (Amit and Schoemaker 1993; Barney 1991). A servitization strategy can help manufacturers to build and gain service-related resources and capabilities, which fulfill these VRIN characteristics. The following paragraphs discuss each characteristic in detail.

Services can create valuable resources and capabilities through four positive mechanisms. First, services can help manufacturers to establish strong customer relationships (Neu and Brown 2005; Oliva and Kallenberg 2003; Tuli, Kohli, and Bharadwaj 2007). Traditionally, product sales have a transactional character (Baines and Lightfoot 2013; Günter and Bonaccorsi 1996). The interaction between manufacturer and customer often ends with the final delivery or installation of the product. Servitization adds a new, relationship-focused dimension to this process (Tuli, Kohli, and Bharadwaj 2007; Vargo and Lusch 2004). The sale of the product is an essential prerequisite for building an installed base for services (Wise and Baumgartner 1999). Entitlement services such as maintenance and support ensure a regular interaction between the manufacturer and its customers (Brax and Visintin 2017). This can already strengthen the relational ties between them. However, more advanced services such as business solutions can create even stronger customer relationships (Tuli, Kohli, and

Bharadwaj 2007). For instance, Tuli, Kohli, and Bharadwaj (2007) show that business solutions consist of several relational processes between the supplier and its customer. The value of the solution is essentially co-created with the customer which requires a close collaboration of the involved parties (Tuli, Kohli, and Bharadwaj 2007).

There are several advantages of strong manufacturer-customer relationships. Services lack tangible quality signals and exhibit therefore higher perceived purchase risks for customers (Fang, Palmatier, and Steenkamp 2008). Therefore, customers seek to minimize these risks by increasingly relying on relationships (Fang, Palmatier, and Steenkamp 2008). They often remain loyal to a manufacturer which they have built strong relational ties with (Fang, Palmatier, and Steenkamp 2008). Hence, a strong relationship can reduce a customer's perceived risk of services and ultimately enhance customer loyalty and service sales (Fang, Palmatier, and Steenkamp 2008; Palmatier et al. 2006). In addition, an intimate relationship can help manufacturers to become and defend a key supplier status with its customers (Ulaga and Eggert 2006).

A second valuable resource in a servitization context is a manufacturer's installed base, which refers to the cumulated number of physical assets in customers' operations (Oliva and Kallenberg 2003). Wise and Baumgartner (1999) show that in many manufacturing industries the major part of revenues is generated during the lifecycle of a physical asset. The initial sale of a physical asset represents only a fraction of the lifetime-revenue potential (Wise and Baumgartner 1999). Servitization enables manufacturers to tap into this revenue-potential by offering services throughout the lifetime of the product such as maintenance, parts, and support services (Oliva and Kallenberg 2003; Wise and Baumgartner 1999).

Another value element of servitization is its contribution to a more effective resource and capability utilization (Oliva and Kallenberg 2003; Ulaga and Reinartz 2011). On the one hand, manufacturers can effectively leverage their existing resources and capabilities when venturing into certain services such as spare part or repair services (Ulaga and Reinartz 2011). This puts them in the pole position to realize economies of scale, scope, and learning as well as synergy effects (Ulaga and Reinartz 2011; Wise and Baumgartner 1999). For instance, the established sales force and distribution channels can be used to sell services. On the other hand, certain services require manufacturers to extend their existing resources and capabilities which can create new revenue opportunities (Ulaga and Reinartz 2011). For instance, a manu-

facturer offering fleet solutions needs data processing resources and data analysis capabilities (Ulaga and Reinartz 2011). A manufacturer can use the data and its know-how to offer additional services such as consulting services or energy management services (Ulaga and Reinartz 2011). Moreover, certain services penetrate deeply into customer processes (i.e., business solutions) (Tuli, Kohli, and Bharadwaj 2007). They can help manufacturers to anticipate new customer needs firsthand, and swiftly react to them (Tuli, Kohli, and Bharadwaj 2007). Overall, servitization can increase the productivity of existing resources and capabilities and promote the creation of new valuable resources and capabilities. More effective resource and capability utilization can result in higher financial performance as well as higher firm value (Ramaswami, Srivastava, and Bhargava 2009).

The fourth value element of servitization consists of two side effects. Services are often countercyclical and provide a steady revenue stream (Wise and Baumgartner 1999). This especially benefits manufacturers which offer products with long sales cycles (Wise and Baumgartner 1999). Finally, servitization can help manufacturers to build a strong reputation as a service provider (Nenonen, Ahvenniemi, and Martinsuo 2014; Ulaga and Reinartz 2011). Research indicates that a company's image plays a crucial role in the customer's selection process for a service provider (Nenonen, Ahvenniemi, and Martinsuo 2014). In complex buying situations customers use a firm's reputation as an assessment criteria (Aarikka-Stenroos and Makkonen 2014). Hence, customers often favor manufacturers which successfully ventured into services and have a positive image in the market. Such a reputation can result in higher firm valuation (Lee and Roh 2012).

The second VRIN condition requires service resources and capabilities to be rare to constitute a sustainable competitive advantage (Barney 1991). Manufacturers often have the necessary resources for service provision, which means that basic service resources are often not rare (Ulaga and Reinartz 2011). However, manufacturers often lack the service-specific capabilities to effectively utilize their resources (Neu and Brown 2005; Ulaga and Reinartz 2011). For instance, it is challenging for manufacturers to acquire a design-to-service capability, which describes the manufacturer's ability to combine its products and services synergistically to create superior value (Ulaga and Reinartz 2011). Most firms combine their products and services in an additive manner (Anderson and Narus 1995). Hence, service capabilities can fulfill the rarity characteristic if they are challenging to implement by most manufacturers.

The heterogenous nature of services makes them imperfectly imitable (Parasuraman, Zeithaml, and Berry 1985), which is another VRIN characteristic. Compared to products services have a larger intangible component (Shostack 1977), require more cocreation (Bitner et al. 1997), are harder to standardize (Lovelock 1992), and are more knowledge intensive (Vandermerwe and Rada 1988). Intangibility is an important quality criterion for services (Parasuraman, Zeithaml, and Berry 1985). In addition, it makes it harder for competitors to determine which service components are value-creating and how to exactly duplicate those intangible value elements. Value in services is often co-created with the manufacturer and customer (Bitner et al. 1997). The co-creation process requires a close relationship between the involved parties (Tuli, Kohli, and Bharadwaj 2007), which makes it harder for competitors to imitate it. Services have also a larger customization part and are less standardized (Bowen, Siehl, and Schneider 1989). This means competitors may not be able to exactly copy a service due to its customized part. Finally, services often require know-how that goes beyond product-related information (Ulaga and Reinartz 2011; Vandermerwe and Rada 1988). Manufacturers need to have a deep understanding how customers use the product in their specific situation (Ulaga and Reinartz 2011). This specific knowledge requirement makes services less imitable. From an internal perspective, spillover effects between existing manufacturing assets and services can enhance a manufacturer's unique resource endowment (Fang, Palmatier, and Steenkamp 2008; Reed and DeFillippi 1990). This prevents competitors to easily duplicate or substitute the value offered by the manufacturer's products and services (Fang, Palmatier, and Steenkamp 2008; Reed and DeFillippi 1990).

Finally, a service needs to be non-substitutable resource or capability to constitute a sustained competitive advantage (Barney 1991). Services often entail a large knowledge and information component (Ulaga and Reinartz 2011). This know-how is based on the manufacturers' long-time experience and its intimate relationship with its customers (Neu and Brown 2005; Ulaga and Reinartz 2011). Competitors often do not have a strategically equivalent alternative to the knowledge and information component of certain services such as product usage data (Ulaga and Reinartz 2011).

From a theoretical perspective, service resources and capabilities have the potential to be valuable, rare, imperfectly imitable, and non-substitutable. This can create a sustained competitive advantage in the market, which can lead to improved firm performance and ultimately

higher financial performance (Fang, Palmatier, and Steenkamp 2008; Hunt and Morgan 1996; Newbert 2008).

4.2.2 Negative Implications of Resource-Capability Reconfiguration

A servitization strategy creates fundamental organizational changes for a manufacturer (Baines et al. 2017; Davies, Brady, and Hobday 2006). From a RBV perspective this means a change of established resource-capability configurations which can have negative implications in form of organizational tensions and loss of strategic focus (Fang, Palmatier, and Steenkamp 2008).

First, servitization can create organizational tensions in form of internal rivalry, internal resistance, and cultural conflicts (Fang, Palmatier, and Steenkamp 2008; Krishnamurthy, Johansson, and Schlissberg 2003; Vandermerwe and Rada 1988). This is especially the case if manufacturers integrate their new service business into an existing product-focused organization (Fang, Palmatier, and Steenkamp 2008).

Services may cause internal rivalry for scarce resources and capabilities among different departments (Fang, Palmatier, and Steenkamp 2008). Manufacturers have only a limited set of resources and capabilities (Peteraf 1993). Increasing service offerings will require the manufacturer to reallocate some of its resources and capabilities to its service business (Huikkola, Kohtamäki, and Rabetino 2016). For instance, a manufacturer can use its established sales force to sell service as well. Given a fixed capacity of each sales manager, this means that the sales force will have less time to sell products. This can potentially create an internal conflict about how the limited resources and capabilities are divided between products and services.

Another potential issues arises from internal resistance towards changing the status quo (Hou and Neely 2013; Pană and Kreye 2021; Vandermerwe and Rada 1988). Services can change some of the established employee roles in manufacturing (Pană and Kreye 2021). For instance, the sales force needs to acquire new service-related sales capabilities (Ulaga and Reinartz 2011). Seasoned sales managers may be reluctant to change their established sales approach (Ulaga and Loveland 2014). Internal resistance often stems from redistribution of power (Antioco et al. 2008), poor understanding of servitization (Baines and Lightfoot 2013), and reluctance to change familiar processes (Lenka et al. 2018a; Pană and Kreye 2021). Servitization affects a manufacturer's power structures and can reassign them to other organiza-

tional levels and departments (Antioco et al. 2008; Lenka et al. 2018b). For instance, the product development department may have no longer absolute authority about product design anymore. Instead, it must consider suggestions from the service department to ensure easy service operations on the final product (Rabetino, Kohtamäki, and Gebauer 2017). The loss of some control of individuals and departments can create tensions and even internal power struggles. Another source for resistance is a poor understanding of servitization (Ziaee Bigdeli et al. 2021). Traditionally, manufacturers have been focusing on the production of physical assets (Lightfoot, Baines, and Smart 2013; Wise and Baumgartner 1999). Services have played only a minor role in the manufacturer's business and has been often categorized as a necessary evil (Kyj 1987). Servitization increases the importance of services tremendously (Vandermerwe and Rada 1988). Employees may not understand this shift from a product to a service-centric business model. A lack of transparency and clear communication of service strategies can make employees skeptical and reluctant to accept changing processes (Rese and Maiwald 2013). Finally, internal resistance can be caused by a general reluctance to change established processes (Pană and Kreye 2021). Departments and employees may refuse to adapt to servitization since they value their familiar processes more (Lenka et al. 2018b; Pană and Kreye 2021).

Another source of organizational tensions arises from the sweeping cultural changes that come with a servitization strategy (Gebauer, Edvardsson, and Bjurko 2010; Homburg, Fassnacht, and Guenther 2003). Corporate cultures evolve over years and are often challenging to change (Barney 1986a). In the servitization context, cultural conflicts are mostly due to a new understanding of value creation and customer relationships (Lenka et al. 2018b). Traditionally, manufacturers assume that the value of a product is embedded in the physical matter (Vargo and Lusch 2004). Customers on their own realize that value by using the product independently from the manufacturer. Based on the service-dominant logic, servitization creates a new understanding of value creation and realization (Vargo and Lusch 2004). First, servitization does not assume that value is embedded in products (Macdonald et al. 2011; Vargo and Lusch 2004). Instead, value can only be created in the specific use situation of the customer, which is also referred to as value in use (Macdonald et al. 2011; Vargo and Lusch 2004). In addition, value is often co-created by the manufacturer and the customer (Macdonald et al. 2011; Vargo and Lusch 2004). This is especially true for services which require at least some cooperation with the customer (Grönroos and Voima 2013; Tuli, Bharadwaj, and Kohli 2010).

Essentially, this new understanding of value degrades physical products worthless until they are actually used (Gummesson 1998). This can cause cultural conflicts since employees (e.g., engineers) are very proud of their products and see the value as embedded (Kindström and Kowalkowski 2009). This attitude has been inherited from years of focus on product attributes in the manufacturing sector. Hence, shifting this mentality can cause tensions between product and service departments (Kindström and Kowalkowski 2009).

Next to this new value interpretation, servitization also emphasizes customer relationships much stronger (Vargo and Lusch 2004). Successful servitization strategies require the manufacturer to build strong relational ties with its customers (Tuli, Kohli, and Bharadwaj 2007; Wise and Baumgartner 1999). The sale of a products is supposed to be the beginning of a long-term relationship with the customer in which the manufacturer continuously delivers services (Wise and Baumgartner 1999). This attitude is often unfamiliar for employees in the manufacturing sector who are used to transactional customer interactions (Baines and Lightfoot 2013; Günter and Bonaccorsi 1996). This cultural shift towards a more intimate relationship with customers may clash with the traditional transactional mindset of manufacturers. All in all, organizational tensions hinder the effective implementation of a servitization strategy. They can undermine employee motivation, result in higher costs, and reduce productivity (Fang, Palmatier, and Steenkamp 2008). This in turn results in lower financial performance (Fang, Palmatier, and Steenkamp 2008).

A second potentially negative effect of servitization on firm performance exists on a strategic level. Manufacturers adopting a servitization strategy may suffer the loss of strategic focus (Fang, Palmatier, and Steenkamp 2008). The reason is that the addition of services "may dilute firm resources, such that neither business has sufficient resources to achieve the critical mass to succeed" (Fang, Palmatier, and Steenkamp 2008, p. 3). Hence, neither the product business nor the service business has sufficient resources to develop or sustain a competitive advantage in its market (Dess and Davis 1984; Porter 1980). This translates into lower financial performance until the firm has sufficient resources for both its strategic segments (Fang, Palmatier, and Steenkamp 2008).

4.2.3 Role of Contingency Factors

A resource-based view on servitization shows that it can be a double-edged sword for manufacturers. On the positive side, services have the potential to create a sustainable competitive

advantage (Fang, Palmatier, and Steenkamp 2008; Vandermerwe and Rada 1988; Wise and Baumgartner 1999). Considering commoditization and fierce global competition (Fischer, Gebauer, and Fleisch 2012; Wise and Baumgartner 1999), such a competitive edge helps manufacturers to successfully defend their market position (Wise and Baumgartner 1999). However, on the negative side a servitization strategy can upset established routines of a manufacturer and create organizational resistance (Fang, Palmatier, and Steenkamp 2008; Pană and Kreye 2021). These internal tensions can substantially decrease a firm's operational efficiency (Fang, Palmatier, and Steenkamp 2008). Overall, an out-of-context RBV lens on servitization does not reveal a clear net effect of services on firm performance. Instead, the RBV theory indicates that the net effect of servitization depends on internal (i.e., organizational) as well as external (i.e., environmental) contingencies.

At the internal level, research suggests that a firm's financial performance depends upon the fit between firm strategy and extant resources and capabilities (Black and Boal 1994; Fang, Palmatier, and Steenkamp 2008; Hansen and Wernerfelt 1989). This means that service resources and capabilities do not constitute a sustainable competitive advantage per se. Instead, they need to be considered within a greater organizational context. Specifically, the financial performance of a manufacturer's servitization strategy depends on its ability to align strategic choices with organizational factors (Powell 1992). Three key strategic decisions among others are how to establish valuable resources and capabilities and how to defend them against competition (Wernerfelt 1984). First, early RBV theory considers mergers and acquisitions (M&A) as a strategy to gain valuable resources and capabilities (Wernerfelt 1984). Wernerfelt (1984) points out that M&As give a firm the unique "opportunity to trade otherwise non-marketable resources" (Wernerfelt 1984, p. 175). Second, as a defensive strategy, Wernerfelt (1984) underlines that establishing a technological lead can help firms to protect their valuable resources and capabilities against imitation. Especially, a firm's research and development capabilities can help to grow its technological advantage towards competitors (Wernerfelt 1984). All strategic decisions need to be considered in light of a manufacturer's limited resources and capabilities (Bower 2017). Thus, a third important choice is how much resources and capabilities are allocated to a servitization strategy.

At the external level, research shows that environmental factors can influence the relationship between strategy and performance (Amit and Schoemaker 1993; Hansen and Wernerfelt 1989; Porter 1980; Prescott 1986). Extant research shows that especially industry-related fac-

tors can affect the success of a manufacturer's servitization strategy (Fang, Palmatier, and Steenkamp 2008; Jaworski and Kohli 1993; Russo and Fouts 1997; Suarez, Cusumano, and Kahl 2013). Industry growth, dynamism, and competition are three environmental factors which capture the dynamic developments within an industry and the competitive intensity (Fang, Palmatier, and Steenkamp 2008; Nezami, Worm, and Palmatier 2018).

All in all, servitization from an RBV perspective presents itself as a strategy with many facets. There are potentially positive and negative consequences of a servitization strategy which depend on internal and external contingency factors. The following chapter develops hypotheses about the net effect of servitization on a firm's profitability.

4.3 Hypotheses

Based on the RBV theory, this chapter derives several hypotheses about the relationship between a firm's servitization strategy and its profitability. First, the subchapter 4.3.1 describes the hypothesized direct effect of servitization strategy on firm profitability. The following subchapter 4.3.2 adds hypotheses about the moderating effect of internal and environmental factors. Finally, 4.3.3 summarizes the insights of the prior subchapters into a conceptual model.

4.3.1 Direct Effect of Strategic Intensity on Servitization

Strategic intensity captures how strongly a firm pursues a specific strategy to create customer value and sustain a competitive advantage. Thus, a manufacturer's strategic intensity on servitization captures the extent to which firms recognize services as important sources for value creation and competitive advantage. Prior research suggests that industrial services are not a homogenous mass (e.g., Antioco et al. 2008; Eggert et al. 2014; Visnjic, Wiengarten, and Neely 2016). Instead, there are various service types which have different financial implications (Antioco et al. 2008; Eggert et al. 2014; Visnjic, Wiengarten, and Neely 2016). To account for this heterogeneity, services are categorized into services in support of products (SSPs) and services in support of customers (SSCs) (Eggert et al. 2014; Mathieu 2001a). SSPs focus on the manufacturer's physical product and ensure its smooth operation during its lifecycle through services like maintenance and repairs (Mathieu 2001a). In contrast, SSCs go beyond product-based services and focus on the optimization of customer processes surrounding the manufacturer's product (Mathieu 2001a). For instance, a manufacturer may consult its

customers on optimized energy management (Ulaga and Reinartz 2011). Adopting this SSP-SSC classification, this study differentiates between the direct profitability effect of strategic intensity on SSPs and SSCs. The subchapter 4.3.1.1 discusses how strategic intensity on SSPs directly affects a firm's profitability. Subchapter 4.3.1.2 examines the direct profitability effect of strategic intensity on SSCs.

4.3.1.1 Profitability Effect of Strategic Intensity on SSPs

Services in support of products (SSPs) exhibit characteristics which can have positive as well as negative effects on firm profitability. The following paragraphs discuss beneficial implications before examining the downsides of SSPs.

A manufacturer's strategic intensity on SSPs can have several positive implications. First, SSPs are closely related to the physical product of the manufacturer (Mathieu 2001a). Hence, there will be a large overlap between product-related and SSP-related resources and capabilities (Mathieu 2001a; Neu and Brown 2005). This has multiple positive effects. On the one hand, manufacturers need to acquire only a limited number of new service-specific competencies (Eggert et al. 2014; Kowalkowski, Brehmer, and Kindström 2009). On the other hand, they can leverage their existing resources and capabilities when offering SSPs (Ulaga and Reinartz 2011). For instance, a manufacturer will be able to easily offer maintenance and repair services for their own products since they have all the necessary know-how. In addition, the standardized character of SSPs makes it easier to scale them up (Mathieu 2001a; Ulaga and Reinartz 2011). This strong foundation of existing resources and capabilities benefits manufacturers in form of resource spillover effects and economies of scale and scope (Fang, Palmatier, and Steenkamp 2008; Varadarajan 1986). The resulting efficiency gains can increase the productivity and profitability of a manufacturer's SSP strategy.

Another advantage for manufacturers is the easy access to the SSP market. Established manufacturers have a large installed base, which represents a high potential for SSPs (Wise and Baumgartner 1999). This also means that the manufacturer can build upon existing business relationships (Wise and Baumgartner 1999). Offering SSPs can effectively strengthen customer relationships which increase mutual trust and customer loyalty (Palmatier et al. 2006; Wise and Baumgartner 1999). At the same time, SSPs help manufacturers to establish a positive reputation as a service provider in the market (Ulaga and Reinartz 2011). Since services possess less tangible quality elements, other quality signals such as reputation play an im-

portant role in customers' purchase decisions (Aarikka-Stenroos and Makkonen 2014). These advantages of SSPs further strengthen their positive effect on firm profitability.

A third advantage of firm's strategic intensity on SSPs is the organizational learning effect (Eggert et al. 2014). General service characteristics of intangibility, heterogeneity, inseparability, and perishability (IHIP) makes them substantially different from manufactured goods (Lovelock and Gummesson 2004). Basic SSPs help manufacturers to acknowledge and effectively manage these differences (Eggert et al. 2014; Ulaga and Reinartz 2011). Manufacturers can benefit from this initial service experience when venturing into more complex service offerings (Eggert et al. 2014).

The final positive implication is that SSPs are unlikely to cause either organizational tensions or a loss of strategic focus. In general, SSPs can be integrated into a manufacturer's existing organizational structure (Huikkola and Kohtamäki 2018). They do not require a major reallocation of resources and capabilities (Huikkola and Kohtamäki 2018) which avoids potential internal conflicts and loss of strategic focus which could decrease operational efficiency and firm profitability.

However, from an RBV perspective SSP resources and capabilities do not fulfill all the VRIN conditions to create a sustainable competitive advantage in a market. In general, SSP resources and capabilities can meet the conditions of being valuable and rare, but they are often not safe from imitation by competitors (Kowalkowski et al. 2013). Thus, SSPs often provide only a temporary competitive advantage. They cannot help manufacturer to sustain a long-term competitive edge and therefore SSPs should not positively impact firm profitability over a long period of time.

Another important aspect is the role of SSPs in today's manufacturing markets. Customers often expect manufacturers to offer a minimum level of SSPs such as installation, maintenance, and repair services (Ulaga and Reinartz 2011). Thus, SSPs has become a matter of course for customers, and manufacturers cannot compete without them. This also means that SSPs are less likely to become a differentiating factor and contribute to a sustainable competitive advantage (Ulaga and Reinartz 2011).

Overall, SSPs have the advantage of being closely related to the physical product of the manufacturer. This makes SSPs cost-efficient through economies of scale effects. Therefore, an increasing strategic intensity on SSPs should not decrease profitability through higher costs.

However, SSPs lack the ability to create a sustainable competitive advantage. On the one hand, they often cannot be protected from imitation by competitors. On the other hand, nowadays customers take SSPs as granted, which makes it hard to position them as a differentiating factor. Therefore, the level of strategic intensity on SSPs cannot improve firm profitability in the long run. Based on these two factors, this study assumes that the level of strategic intensity on SSPs should have no direct effect on a firm's profitability.

4.3.1.2 Profitability Effect of Strategic Intensity on SSCs

Services in support of customers (SSCs) focus on the optimization of customer processes and depend less on product-related resources and capabilities (Mathieu 2001a; Ulaga and Reinartz 2011). This can have negative as well as positive implications for the profitability effect of strategic intensity on SSCs. The following paragraphs first discuss the negative and positive implications before concluding with a hypothesized net effect.

There are three SSC characteristics, which can negatively influence SSCs' effect on firm profitability. First, SSCs focus on customer processes instead of the manufacturer's physical product. This means that manufacturers cannot fully capitalize on their existing product-related resources and capabilities when expanding their SSC business (Ulaga and Reinartz 2011). Instead, SSCs require manufacturers to gain new resources and capabilities, which often go beyond the manufacturer's familiar territory (Ulaga and Reinartz 2011). Especially, complex SSC offerings such as business solutions demand new capabilities such as customer data processing and analysis (Ulaga and Reinartz 2011). This lack of overlap between a manufacturer's product and SSC resources and capabilities reduces the potential for synergies and economies of scale. In addition, the acquisition of new competencies for complex SSCs may become challenging due to a steep learning curve (Ulaga and Reinartz 2011; Valtakoski 2017). Overall, SSCs new resource and capability requirement create initial costs which cannot be reduced with efficiency gains. Therefore, manufacturers venturing into SSCs should experience initially reduced firm profitability.

Another SSC characteristic is the penetration into customer processes (Ulaga and Reinartz 2011), which has two implications. First, it requires manufacturers to gain significant knowledge of customer operations (Tuli, Kohli, and Bharadwaj 2007). Especially, SSCs in which manufacturers take operational responsibility for a customer outcome (i.e., business solutions) require deep customer knowledge (Tuli, Kohli, and Bharadwaj 2007). However,

obtaining the necessary knowledge about customer processes depends on a trustful customer relationship and the customer's willingness to share information (Grönroos and Helle 2010). Building strong customer relationships takes time and may be influenced by numerous factors (Palmatier et al. 2006). Therefore, external knowledge dependency makes SSCs risky and their implications on firm profitability uncertain. The second implication of a deep penetration into customer processes is high levels of customization (Mathieu 2001a). Since customer have often specialized processes, the resources and capabilities for one customer cannot be easily redeployed at another customer (Bond et al. 2020). Hence, this high customization significantly limits the possibility to scale up SSCs and realize economies of scale (Jagstedt, Hedvall, and Persson 2018). Missing efficiency gains may reduce potential profits.

The third characteristics applies especially to business solutions in which manufacturers take full responsibility for customer outcomes (Kowalkowski and Ulaga 2017; Ulaga and Reinartz 2011). Such an agreement transfers some of the customer's operational risks to the manufacturer (Sawhney 2006). Without appropriate governance mechanisms (Colm, Ordanini, and Bornemann 2020), and risk management capabilities certain SSCs may expose manufacturers to inadequately high risks (Kowalkowski and Ulaga 2017; Ulaga and Reinartz 2011). This can create high costs for manufacturers reducing profitability.

Next to these inherent challenges, SSCs may potentially create issues at the organizational level. SSCs are more detached from the manufacturer's physical assets and products which creates a high potential for organizational tensions and a loss of strategic focus. The provision of SSCs such as business solutions requires significant organizational changes (Baines et al. 2017; Davies, Brady, and Hobday 2006). Manufacturers need to build up new SSC-specific resources and capabilities (Ulaga and Reinartz 2011). This diverts scarce resources into the SSC business which can create internal rivalries (Fang, Palmatier, and Steenkamp 2008). In addition, SSC may change some of the established employee roles (Pană and Kreye 2021). For instance, the salesperson's role is to become a consultant for customer's process optimization efforts instead of just selling physical assets (Sheth and Sharma 2008). The unfamiliarity of SSC tasks may cause internal resistance (Pană and Kreye 2021). Moreover, SSCs can cause more cultural conflicts since its focus is not the physical asset anymore (Kindström and Kowalkowski 2009). Instead, SSCs underscore the importance of relational value-creation with the customer (Vargo and Lusch 2004). This understanding of value may oppose the established product-focused company culture of a manufacturer and hamper its adoption (Lenka

et al. 2018b). In addition, SSCs can also cause manufacturers to lose strategic focus. The resource and capability requirements of complex SSCs such as business solutions are significantly higher than in the case of SSPs (Ulaga and Reinartz 2011). Hence, SSCs dilute a manufacturer's resources and capabilities much more, risking an insufficient allocation to other business areas (Fang, Palmatier, and Steenkamp 2008). Organizational tensions and loss in strategic focus decreases a manufacturer's operational efficiency which can reduce its profitability (Fang, Palmatier, and Steenkamp 2008).

Overall, there are numerous potentially negative profitability implications of increasing strategic intensity on SSCs. However, a closer look at each negative factor reveals that most of them will occur at the start-up phase of establishing SSCs. After challenges of introducing SSCs are overcome, the initially negative factors convert into positive characteristics. The following paragraphs discuss the positive characteristics of an established SSC business.

First, the unique resources and capabilities required by SSCs have the advantage to build an effective entry barrier (Vandermerwe and Rada 1988). Unlike SSP competencies, SSC resources and capabilities require a more intensive organizational learning process (Ulaga and Reinartz 2011). A steep learning curve will prevent competitors from easily entering the market.

A second advantage is the deep penetration into customer processes through SSCs. It offers the manufacturer first-hand access to knowledge about customer processes and data (Ulaga and Reinartz 2011; Tuli, Kohli, and Bharadwaj 2007). On the one hand, this can be used to anticipate customer needs and develop new service offerings (Tuli, Kohli, and Bharadwaj 2007). On the other hand, it prevents competitors to easily imitate the SSC offering. The high integration of supplier and customer processes makes value-elements less transparent to external parties which can create causal ambiguity and will hamper imitation attempts (Barney 1991). In addition, high customization of SSCs can have a lock-in effect on customers, which will increase customer loyalty (Blut et al. 2016; Rabetino, Kohtamäki, and Gebauer 2017). Access to customer knowledge, unclear value-creation processes, and loyal customers represent additional entry barriers for competition.

The third advantage of increasing SSC intensity is the higher experience with services in which manufacturers assume some operational risk of customers. The manufacturer can use

their experience to develop appropriate governance structures and manage asymmetric risk structures better (Colm, Ordanini, and Bornemann 2020).

At the organizational level, SSCs require a sweeping organizational change process through the entire firm (Baines et al. 2017; Davies, Brady, and Hobday 2006). This reconfiguration of established resources and capabilities represents a major risk (Josephson et al. 2016) that can represent another entry barrier for competitors.

From an RBV perspective, SSC resources and capabilities can fulfill the VRIN characteristics. Especially, the above-mentioned entry barriers can reduce the threat of imitation and substitution by competitors. Hence, manufacturers surpassing an initial threshold of strategic intensity on SSCs can gain a sustained competitive advantage and increase profitability.

Overall, at low levels of strategic intensity on SSCs (i.e., manufacturers entering the SSC business) negative implications will result in low or no impact on a firm's profitability. After a strategic intensity threshold is surpassed (i.e., SSC business is established) SSCs exhibit increasingly positive implications for firm profitability. Thus, the first hypothesis states:

> *H_1: At low levels of strategic intensity the effect of SSCs on profitability is low; after a strategic intensity threshold is surpassed, SSCs exhibit an increasingly positive effect on firm profitability.*

4.3.2 Moderating Effect of Internal and Environmental Factors

RBV theory states that the financial impact of a firm's strategic choice can be influenced by organizational (i.e., internal) as well as environmental (i.e., external) factors (Barney 1991). This study investigates internal and external contingency factors influencing the relationship between servitization and firm profitability. The internal factors are service scope (subchapter 4.3.2.1), and corporate growth strategy (subchapter 4.3.2.2). Subchapter 4.3.2.3 focuses on the environmental factors at the industry-level, namely industry growth, dynamism, and competition.

4.3.2.1 Service Scope

Strategic intensity on SSPs and SSCs is a single dimension view which focuses on the depth of a manufacturer's servitization strategy. A second dimension is the scope (i.e., breadth) of a manufacturer's service portfolio (Eggert et al. 2014). Service scope refers to the number of

different services offered by the firm (Eggert et al. 2014; Visnjic, Neely, and Wiengarten 2012). Hence, service scope as a moderating factor puts strategic intensity into relation to the breadth of a firm's service portfolio. Strategic intensity and scope together capture a manufacturers relative focus on individual services. Extant research indicates that SSP and SSC breadth affect a firm's financial performance (Eggert et al. 2014). Hence, it should also influence the link between servitization intensity and firm profitability. Service scope is differentiates between SSP and SSC breadth. The following paragraphs develop hypotheses about their moderating effect on the link between servitization intensity and profitability.

An increase in SSP breadth can have positive and negative implications on the relationship between strategic intensity on SSP and firm profitability. On the positive side, SSPs are closely related to a manufacturer's product-based resources and capabilities (Mathieu 2001a; Neu and Brown 2005). Thus, manufacturers can often leverage their existing resources and capabilities when introducing additional SSP services (Kowalkowski, Brehmer, and Kindström 2009; Ulaga and Reinartz 2011). This eases the implementation of new SSPs and offers higher potential to realize economies of scale and scope, and synergy effects. These efficiency gains can help manufacturers to reduce costs which should result in a higher firm profitability of strategic intensity on SSPs.

However, increasing SSP breadth has also numerous negative effects on the relationship between strategic intensity on SSP and firm profitability. First, economies of scale and scope are not unlimited (Stigler 1958) which means that cost-advantages by adding SSPs will eventually vanish. This also means that there will be no positive profitability effect through reduced costs. Instead, an increasing number of individual SSPs may dilute scarce resources and capabilities which can reduce a manufacturer's operational efficiency and profitability (Fang, Palmatier, and Steenkamp 2008).

Another downside of a high SSP breadth is the higher potential for organizational tensions. A manufacturer's product-focused employees may accept a moderate number of SSPs as a necessary evil (Kyj 1987). For instance, SSPs such as warranty, installation and maintenance will usually not create any organizational tensions. However, if the management pushes more and more SSPs into its portfolio, it will likely create several organizational issues. First, manufacturers have only limited resources and capabilities (Bower 2017). Adding more SSPs can create an internal rivalry for scarce resources and capabilities, which may result in overall less

productivity (Fang, Palmatier, and Steenkamp 2008). For instance, a manufacturer's sales force has only limited time for selling products and services. Having to promote a large SSP portfolio may decrease the time to sell physical products. Another potential issue is internal resistance towards changing established processes. The more SSPs a manufacturer introduces, the more traditional employee roles will change. This creates a higher potential for resistance from employees who often oppose change of familiar processes (Pană and Kreye 2021). Finally, a higher SSP scope will increase the importance of services within the firm. A traditional product-focused culture may oppose such a fundamental shift of the manufacturer's focus (Lenka et al. 2018b). Employees may hold on to the product-focused firm culture, which may hamper the effective implementation of SSPs (Homburg, Fassnacht, and Guenther 2003). These intra-organizational tensions can reduce overall productivity and hamper the effective implementation of new SSPs. This can negatively influence the relationship between strategic intensity on SSP and firm profitability.

A third negative effect of higher SSP breadth is the increasing complexity and coordination costs. A higher number of SSP offerings will increase the complexity of a firm's operations. New processes must be implemented such as hiring and training employees, and managing a new supply chain network (Antioco et al. 2008; Kohtamäki et al. 2013; Ulaga and Kohli 2018). These new elements and processes in the manufacturer's business can increase costs (e.g., coordination costs) (Hou and Neely 2013). For instance, managers need to oversee more individual SSPs, or new management structures have to be established for the coordination process. This creates costs which will reduce the profitability effect of strategic intensity on SSPs (Hou and Neely 2013).

The advantage of a broader SSP portfolio is that a manufacturer may become more cost-efficient at a given level of strategic intensity on SSPs. However, these cost-savings may not translate into additional profits, because broader SSP portfolios may dilute and undermine a manufacturer's strategic intensity on SSPs. Therefore, SSP breadth should have overall a negative effect on the relationship between strategic intensity on SSPs and firm profitability. Thus, the study states the following hypothesis:

> *H_{2a}: SSP breadth has a negative moderating effect on the relationship between strategic intensity on SSPs and firm profitability.*

An increasing breadth of a firm's SSC portfolio should overall have a diminishing impact on the relationship between strategic intensity on SSCs and firm profitability due to several reasons. First, SSC resources and capabilities are more independent from a manufacturer's existing resource-capability endowment. SSCs focus on customer process optimization and rely less on product related resources and capabilities (Eggert et al. 2014; Kowalkowski, Brehmer, and Kindström 2009). Moreover, SSCs are often highly customized (Mathieu 2001a) which means that individual SSCs will also have less overlap with existing SSC-based competencies. Hence, increasing SSC breadth often requires manufacturers to acquire new resources and capabilities (Ulaga and Reinartz 2011). This implies that a higher SSC breadth does not translate into higher economies of scale and cost-efficiencies (Nezami, Worm, and Palmatier 2018). Instead, a broader SSC portfolio can cause implementation costs for new resources and capabilities. In addition, challenges gaining new SSC-related resources and capabilities, such as a steep learning curve, can further increase costs and hamper profit generation (Ulaga and Reinartz 2011).

Next to these operational challenges, higher SSC breadth can trigger similar intra-organizational tensions like SSPs. Increasing SSC breadth will cause more changes to a manufacturers' established resource-capability configuration (Ulaga and Reinartz 2011). At the firm-level, this means that certain limited resources and capabilities need to be allocated to more service offerings (Fang, Palmatier, and Steenkamp 2008). This can cause internal rivalries for scarce resources and capabilities which in turn can hamper organizational efficiency (Fang, Palmatier, and Steenkamp 2008). At the employee-level, a broader SSC portfolio can affect more employee roles (Pană and Kreye 2021). Employees may resist changing their familiar processes which can impede the implementation of new SSCs (Pană and Kreye 2021; Ulaga and Kohli 2018). Higher SSC breadth also puts more pressure on a manufacturer's company culture. A traditional product-focused company culture may oppose a fast transition to SSCs (Antioco et al. 2008). The successful implementation of SSCs requires a service-focused mindset across the entire company (Homburg, Fassnacht, and Guenther 2003). Hence, SSCs will face stark internal opposition and resistance without a service-oriented change of the company culture.

All in all, SSCs are resource-intensive and limited in their scalability, which makes efficiency gains harder to realize. In addition, a high SSC breadth can cause organizational tensions leading to ineffective SSC implementation and decreasing productivity. Therefore, SSC

breadth should have a negative moderating effect on the link between strategic intensity on SSCs and firm profitability. Accordingly, the study states the following hypothesis:

> *H_{2b}: SSC breadth has a negative moderating effect on the relationship between strategic intensity on SSCs and firm profitability.*

4.3.2.2 Corporate Growth Strategy

In general, firms can follow internal and external strategies to grow (Bahadir, Bharadwaj, and Parzen 2009; Guth 1980). Internal growth strategies are also referred to as organic growth (Bahadir, Bharadwaj, and Parzen 2009). They focus on growth using resources and capabilities within the firm boundaries (Bahadir, Bharadwaj, and Parzen 2009). Organic growth strategies can include for instance product and service innovations, and process optimizations (Bahadir, Bharadwaj, and Parzen 2009). In contrast, external growth strategies (i.e., inorganic growth) go beyond firm boundaries as a source of growth. Inorganic growth strategies essentially refer to a firm's merger and acquisition (M&A) activity (Bahadir, Bharadwaj, and Parzen 2009). The acquirer or merged company gains new resources and capabilities for its growth from the acquired firm (i.e., the target) (Bahadir, Bharadwaj, and Parzen 2009).

The strategic decision between organic and inorganic growth has significant implications on a firm's performance (Hitt and Ireland 1985). It especially influences a firm's set of resources and capabilities to create customer value and build a sustainable competitive advantage (Wernerfelt 1984). Therefore, a firm's growth strategy should also affect profitability implications of a manufacturer's servitization efforts. Subchapter 4.3.2.2.1 discusses the moderating effect of organic growth and subchapter 4.3.2.2.2 examines the moderating effect of an inorganic growth strategy.

4.3.2.2.1 Organic Growth

Organic growth strategies use internal resources and capabilities to either improve existing products, services, and processes, or to develop new ones (Bahadir, Bharadwaj, and Parzen 2009). Thus, organic growth refers primarily to a firm's ability to develop and market innovations (Bahadir, Bharadwaj, and Parzen 2009). The fundamental resources and capabilities for innovations are in general concentrated in a manufacturer's research and development (R&D) department (Penner-Hahn and Shaver 2005). Therefore, the level of R&D investments can

indicate how intensely a firm follows an organic growth strategy. The following paragraphs discuss how the focus on organic growth (i.e., level of R&D investments) affect the relationship between firm profitability and strategic intensity on SSPs and SSCs.

Higher focus on organic growth should positively impact the link between strategic intensity on SSPs and profitability due to several reasons. Resources and capabilities of SSPs usually cannot fulfill the VRIN characteristics to become a source of sustained competitive advantage (Eggert et al. 2014). Typical SSPs like installation, maintenance, and repair services are often imitable by competitors (Kowalkowski et al. 2013). In this situation a higher focus on organic growth can help manufacturers on three levels. First, intense organic growth can create innovative SSP offerings which can be differentiated from competitive offerings. For instance, German automobile manufacturer BMW develops proprietary tools and equipment for its vehicles (Kininmonth 2019). The access to these proprietary products is strictly limited which prevents easy imitation by competitors and protects BMW's SSP business (Kininmonth 2019).

The second potential outcome of high organic growth are process innovations which can increase operational efficiency. A manufacturer's process optimization can reduce its costs to deliver SSPs. This can improve firm profitability through reduced costs and create a competitive advantage (Schroeder 1990).

A third positive effect of high organic growth is its positive signaling effect. Manufacturers developing continuously new innovative SSPs can benefit from a positive image in the market (Levitas and McFadyen 2009).

Higher focus on organic growth should not intensify negative mechanisms of servitization like organizational tensions and loss of strategic focus. The main reason is that SSPs are closely related to the physical product of the manufacturer (Mathieu 2001a). SSP-related organic growth and resulting innovations will indirectly support the manufacturer's product business as well. Therefore, SSPs should not reduce operational efficiency due to internal resistance, cultural conflicts, or a loss of strategic focus.

Overall, increasing focus on organic growth has a positive effect on the link between strategic intensity on SSP and firm profitability. R&D induced SSP innovations can create differentiation and cost advantages which translate into lower costs and higher profitability. Accordingly, the study states following hypothesis:

H_{3a}: Organic growth has a positive moderating effect on the relationship between strategic intensity on SSPs and firm profitability.

The effect of organic growth on the link between SSC intensity and firm profitability is influenced by various factors. On the positive side, organic growth can create differentiation and cost advantages, which are beneficial for the entire company including the SSC business. For instance, process innovations can increase operational efficiency and free up additional resources for SSC offerings. Next to this general effect, SSCs offer a unique opportunity for organic growth. Certain SSC offerings such as business solutions penetrate deeply into customer processes (Tuli, Kohli, and Bharadwaj 2007). Manufacturers gain access to valuable customer information and usage data (Ulaga and Reinartz 2011). This knowledge enables manufacturers to anticipate customer needs and create new innovative product and service offerings (Tuli, Kohli, and Bharadwaj 2007) which can translate into new revenue and profit streams.

However, on the negative side a high focus on organic growth may not lead to profitable SSC innovations due to two reasons. First, SSCs go beyond a manufacturer's familiar know-how and are often complex which makes it harder to find and implement innovations (Ulaga and Reinartz 2011). Thus, there is a higher risk of R&D investments becoming sunk costs instead of creating a differentiation advantage. Second, the customized character of SSCs may limit the scalability of potential innovations. This decreases potential benefits from economies of scale and scope. Overall, the complex and customized nature of SSCs may render organic growth strategies ineffective.

Another implication of high focus on organic growth is that more resources and capabilities are committed (Kraatz and Zajac 2001). Manufacturers may invest certain limited resources such as financial reserves into their organic growth efforts. These resources are not available for other areas (e.g., the provision of SSCs) anymore and can decrease a firm's overall flexibility (Selznick 1957).

At the organizational level, increasing focus on organic growth of SSCs can cause organizational tensions. SSCs create customer value through intangible resources and capabilities such as knowledge and information (Ulaga and Reinartz 2011). Physical assets often play a secondary role in SSCs' value proposition (Martinez et al. 2010; Ulaga and Reinartz 2011). Hence, high focus on organic growth of SSCs opposes a manufacturer's product-focused

company culture (Lenka et al. 2018b). This can cause internal resistance against more organic growth efforts into SSCs, which decreases the firm's productivity.

Overall, the moderating effect of organic growth on the link between strategic intensity on SSCs and firm profitability are mostly negative. Thus, the study formulates following hypothesis:

> *H_{3b}: Organic growth has a negative moderating effect on the relationship between strategic intensity on SSCs and firm profitability.*

4.3.2.2.2 Inorganic Growth

Firms following an inorganic growth strategy rely on external resources and capabilities to expand their business (Bahadir, Bharadwaj, and Parzen 2009). This means that new resources and capabilities are not developed within the firm but gained through acquisition of other firms (Bahadir, Bharadwaj, and Parzen 2009). An acquisition strategy can have advantages and disadvantages for a manufacturer. On the one hand, acquisitions offer manufacturers to quickly gain access to new resources and capabilities which might be hard to develop internally (Wernerfelt 1984). In addition, acquisitions can help firms to realize efficiency gains in form of economies of scale and scope, and synergy effects (Harrison et al. 1991; N. Kumar 2009). This can improve operational efficiency and firm profitability (Shaver 2006). However, on the other hand acquisitions come with major management challenges. An integration of the acquired firm into the manufacturer's organizational structure can cause issues due to divergent company cultures, and internal resistance (Stahl and Voigt 2008; Steigenberger 2017). This increases integration costs and makes it difficult to realize expected synergy gains (Stahl and Voigt 2008; Steigenberger 2017). Against this backdrop, the following paragraphs discuss how a manufacturer's focus on inorganic growth affect the relationship between strategic intensity of SSPs and SSCs, and firm profitability.

Inorganic growth can have various positive implications for strategic intensity on SSPs. First, high focus on inorganic growth can increase a firm's customer base and access to new markets (Fogg 1976; Lee and Lieberman 2010). This offers new opportunities for expanding a manufacturer's SSP business and establish additional profit streams. In addition, existing and acquired SSP competencies can be consolidated to realize synergies and save costs (Harrison et al. 1991). An integration of SSP resources and capabilities is simplified by the fact that

SSPs are closely related to a firm's familiar product-based competencies (Eggert et al. 2014). This means that the addition or expansion of SSPs will not require fundamental changes to a firm's established organizational structures which also minimizes the risk of internal tensions (Pană and Kreye 2021).

Second, inorganic growth increases the chances to create SSP resources and capabilities that fulfill the VRIN characteristics and constitute a sustainable competitive advantage. Especially, if a manufacturer acquires resources and capabilities which are not easily imitable such as brand equity (Wernerfelt 1984).

However, increasing inorganic growth will also increase the risk of failures (Perry and Herd 2004). Research shows that acquisition experience can improve acquisition performance only under certain conditions (Hayward 2002). Acquisitions are complex transactions that can be influenced by many internal and external contingency factors (King et al. 2004).

Overall, inorganic growth can have beneficial implications on the profitability effect of strategic intensity on SSPs. However, increasing focus on inorganic growth also poses more risks which may diminish the expected positive effects. Therefore, this study proposes the following nondirectional moderating hypothesis:

> *H_{4a}: Inorganic growth has a moderating effect on the relationship between strategic intensity on SSPs and firm profitability.*

The relationship between strategic intensity on SSCs and profitability is influenced by inorganic growth as well. SSCs often require new resources and capabilities which are different from a manufacturer's product-based competencies (Ulaga and Reinartz 2011). A key advantage of inorganic growth in this context is that they can help a manufacturer to quickly gain critical SSC-related resources and capabilities (Wernerfelt 1984). This saves substantial time and avoids challenges such as a steep learning curve when building new resources and capabilities inhouse. In addition, some resources such as brand reputation cannot be easily build up internally. Acquisitions can help manufacturer to gain these non-attainable resources (Wernerfelt 1984).

Another advantage of inorganic growth is that the manufacturer can tap into the SSC experience of the target (i.e., acquired firm). This enhances manufacturer's organizational learning and eases the entry into the SSC business (Pennings, Barkema, and Douma 1994).

On the negative side, high focus on inorganic growth may create organizational tensions. SSCs introduce substantial organizational changes to a firm which can cause internal rivalry, resistance, and cultural conflicts (Fang, Palmatier, and Steenkamp 2008; Lenka et al. 2018b; Pană and Kreye 2021). Adding a new firm with a new cultural background to this tense situation can make the existing organizational issues even worse. The firm may face internal competition for scarce resources, uncooperative employees, and two isolated company cultures (Fang, Palmatier, and Steenkamp 2008; Lenka et al. 2018b; Pană and Kreye 2021). This can significantly undermine the manufacturer's integration efforts and decrease productivity and profitability.

The positive effect of inorganic growth, namely gaining new SSC-related resources and capabilities can create a sustainable competitive edge (Wernerfelt 1984). Risks of inorganic growth such as integration issues can often be managed with time (Shrivastava 1986). Therefore, this study assumes an overall positive effect of inorganic growth on the link between strategic intensity on SSCs and profitability:

H_{4b}: Inorganic growth has a positive moderating effect on the relationship between strategic intensity on SSCs and firm profitability.

4.3.2.3 Environmental Factors

The RBV theory suggests that the financial impact of a strategy is also contingent on environmental factors (Barney 1991). The following chapters focus on industry growth (subchapter 4.3.2.3.1), industry dynamism (subchapter 4.3.2.3.2), and industry competition (subchapter 4.3.2.3.3) as three frequently used factors describing a firm's environment (Fang, Palmatier, and Steenkamp 2008).

4.3.2.3.1 Industry Growth

Industry growth refers to the growth in demand within a specific industry (Porter 1979). Fast growing industries offers manufacturers several advantages during their servitization process (Cusumano, Kahl, and Suarez 2015). First, a high industry growth indicates that the technology in a market is not yet matured (Klepper 1997). This means that manufacturers still have the opportunity to establish a leading standard in the market and capture significant market share (Klepper 1997). In an SSP and SSC context this represents an opportunity to create services

and solutions which can become the industry standard. This can help manufacturers to establish a service reputation in the industry which can become a valuable intangible asset (Ulaga and Reinartz 2011). Thus, from an RBV perspective, fast growing industries create opportunities to develop SSP- and SSC-related resources and capabilities which can fulfill VRIN characteristics. Manufacturers creating valuable and hard to imitate service competencies can build a sustainable competitive advantage which translates into superior firm performance and profitability (Barney 1991; Newbert 2008).

Another advantage of a fast-growing industry is the increasing market potential for SSP and SSC offerings (Klepper 1997). The opening of new markets increases the opportunities to establish new customer relationships and sell more SSPs and SSCs. This helps manufacturers also to increase their operational efficiency by realizing economies of scale and scope.

A third advantage of high industry growth is a manufacturer's opportunity to specialize on a narrower set of SSP and SSC-related resources and capabilities (Gebauer and Binz 2018). This specialization helps manufacturers to improve quality and productivity of its service offerings and enables more innovations (Gebauer and Binz 2018). These efficiency gains can help manufacturers to create a competitive edge, which improves overall firm performance and profitability.

Finally, a high industry growth can decrease the competitive pressure in an industry (McDougall et al. 1994; Miller and Camp 1985; Porter 1980). In high-growth industries, firms can sustain their financial performance and growth despite new competitors entering the market (McDougall et al. 1994; Miller and Camp 1985; Porter 1980).

Overall, based on these positive implications of industry growth the study states the following two moderating hypotheses:

> *H_{5a}: Industry growth has a positive moderating effect on the relationship between strategic intensity on SSPs and firm profitability.*
>
> *H_{5b}: Industry growth has a positive moderating effect on the relationship between strategic intensity on SSCs and firm profitability.*

4.3.2.3.2 Industry Dynamism

Industry dynamism refers to the "rate of change and the degree of unpredictability and turbulence in the environment" (Farjoun and Levin 2011, p. 827). From an RBV perspective a high industry dynamism requires firm resources and capabilities to be highly flexible in order to adjust to a volatile environment (Lin and Wu 2014). This creates several challenges for manufacturers' servitization efforts. First, investments into SSPs and SSCs will create various committed resources and capabilities (Eggert et al. 2014). A firm's commitment to a certain set of resources and capabilities reduces its strategic flexibility (Kraatz and Zajac 2001; Selznick 1957). This means that a manufacturer is not able to quickly adjust to unexpected changes in its environment (Kraatz and Zajac 2001; Selznick 1957). Hence, highly volatile markets expose SSP and SSC-related competencies to a higher risk of becoming irrelevant which can result in the loss of a competitive advantage and diminishing firm performance.

Another negative implication of high industry dynamism is its effect on organizational learning. The unpredictable character of change in the environment reduces the advantages of organizational learning (Farjoun and Levin 2011). Thus, the experience and learning effects in the servitization process may not be useful for the future (Farjoun and Levin 2011). This reduces a firm's productivity and its performance (Farjoun and Levin 2011).

Finally, a high industry dynamism will limit a firm's ability to plan its strategic choices for the future (Farjoun and Levin 2011). Some firms may try to reduce this environmental volatility through questionable strategies like cartel building or collusive actions (Farjoun and Levin 2011). This can lead to unfair competitive conditions in a market (Farjoun and Levin 2011).

These negative implications of industry dynamism will reduce the profitability effect of a manufacturer's SSP and SSC strategy. Thus, the study states the following moderating hypotheses:

H_{6a}: Industry dynamism has a negative moderating effect on the relationship between strategic intensity on SSPs and firm profitability.

H_{6b}: Industry dynamism has a negative moderating effect on the relationship between strategic intensity on SSCs and firm profitability.

4.3.2.3.3 Industry Competition

Industry competition captures the amount of rivalry among existing firms (i.e., competitive pressure) within an industry (Porter 1980). There are several advantages of high industry competition for a manufacturer's servitization strategy. First, SSP and SSC resources and capabilities that fulfill the VRIN characteristics and constitute a sustainable competitive advantage become more valuable in highly competitive markets (Fang, Palmatier, and Steenkamp 2008; Hunt and Morgan 1995). Thus, a manufacturer can most effectively capitalize on a service-based competitive advantage if there is enough competition in the market (Fang, Palmatier, and Steenkamp 2008; Hunt and Morgan 1995).

Another advantage of SSPs and SSCs is their relationship building effect. Unlike product sales, services require a closer interaction between the manufacturer and its customers (Mathieu 2001a; Tuli, Kohli, and Bharadwaj 2007). This intimate relationship builds trusts between the involved parties and increases customer loyalty (Palmatier et al. 2006; Wise and Baumgartner 1999). This customer loyalty effect becomes particularly valuable in highly competitive markets which are characterized by a large choice of suppliers and product commoditization (Wise and Baumgartner 1999). Thus, SSP and SSC offerings can help to establish a loyal customer base which solidifies a manufacturer's market position in competitive environments.

Finally, SSPs and SSCs help manufacturers to benefit from differentiate-based advantages in competitive markets (Baines et al. 2009; Ulaga and Reinartz 2011; Wise and Baumgartner 1999). Services differentiate commoditized physical products and helps to avoid price-based competition which protects a manufacturer's profit margins (Wise and Baumgartner 1999). In less competitive markets, the lack of competitive pressure makes differentiation advantages less effective (Fang, Palmatier, and Steenkamp 2008; Hunt and Morgan 1995).

Overall, high competition enables manufacturers to use SSP and SSC related resources and capabilities for creating a sustainable competitive advantage. This enhances a firm's profitability. Thus, the study formulates following positive moderating hypotheses:

H_{7a}: Industry competition has a positive moderating effect on the relationship between strategic intensity on SSPs and firm profitability.

H_{7b}: Industry competition has a positive moderating effect on the relationship between strategic intensity on SSCs and firm profitability.

4.3.3 Summary of Conceptual Model

Figure 4.4 present the conceptual model summarizing the study's seven hypotheses on the link between strategic intensity on servitization and firm profitability. The first hypothesis argues for a direct effect of a manufacturer's SSC strategy on firm profitability (H_1). SSCs require specific service-related resources and capabilities which are often unfamiliar to a manufacturer (Ulaga and Reinartz 2011). Thus, initially SSCs will create costs to acquire the necessary competencies (Ulaga and Reinartz 2011). These start-up costs will limit a positive profitability effect of SSCs. However, once necessary resources and capabilities are gained, SSCs can create a sustainable competitive advantage and improve firm profitability.

The direct effect of strategic intensity of SSPs and SSCs on firm profitability is contingent on organizational (i.e., internal) and environmental (i.e., external) factors. At the organizational level the study focuses on the moderating effect of service scope and corporate growth strategy. Service scope should overall have a negative moderating effect on the link between strategic intensity on SSPs and SSCs and firm profitability (H_{2a} and H_{2b}). The main reason is that a broader service scope may dilute scarce resources and capabilities and lead to more organizational tensions (Fang, Palmatier, and Steenkamp 2008). In addition, gains from economies of scale and scope are limited (Stigler 1958).

A firm's corporate growth strategy can be characterized by organic and inorganic growth (Bahadir, Bharadwaj, and Parzen 2009). A proxy for organic growth is a firm's research and development (R&D) efforts, while inorganic growth is captured by a firm's acquisition activity. Organic growth is expected to have a positive moderating effect on the link between strategic intensity on SSPs and firm profitability (H_{3a}). The main reason is that R&D induced innovations can turn SSPs into a sustainable competitive advantage. In contrast, organic growth should have overall a negative moderating effect on the link between strategic intensity on SSCs and firm profitability (H_{3b}). High R&D investments into SSCs may not be profitable since SSCs' customized character limits economies of scale and scope (Nezami, Worm, and Palmatier 2018).

A firm's focus on inorganic growth moderates the link between SSPs and firm profitability (H_{4a}). There are positive effects of inorganic growth such as gaining a larger customer base for SSP offerings (Fogg 1976). However, there are also negative implications such as challenges of integrating the acquired company into the existing organizational structure (Stahl

and Voigt 2008; Steigenberger 2017). These positive and negative consequences warrant a non-directional moderating effect.

Inorganic growth should have overall a positive effect on the link between SSCs and profitability (H_{4b}). SSCs require very specific resources and capabilities which go beyond manufacturers' familiar product-based competencies (Eggert et al. 2014; Ulaga and Reinartz 2011). Inorganic growth can help to quickly gain the necessary resources and capabilities and avoid challenges like a steep learning curve (Wernerfelt 1984). Therefore, inorganic growth can be a critical success factor when venturing into the SSC business.

At the environmental level, the study investigates the moderating effects of three characterizing industry variables, namely growth, dynamism, and competition (Fang, Palmatier, and Steenkamp 2008). Industry growth should overall have a beneficial effect on the link between SSPs and SSCs and firm profitability (H_{5a} and H_{5b}). Growing markets allow manufacturers to sustain their profitability despite new competitors entering the market (McDougall et al. 1994; Miller and Camp 1985; Porter 1980). In contrast, a high industry dynamism should have a negative moderating impact on the profitability effect of SSPs and SSCs (H_{6a} and H_{6b}). Volatile and unpredictable market conditions can render SSP and SSC-related resources and capabilities irrelevant, which decreases firm performance and profitability. Finally, industry competition is expected to have a positive moderating effect on the relationship between strategic intensity on servitization and firm profitability (H_{7a} and H_{7b}). Sustainable competitive advantages created by services are more effective in highly competitive markets, which improves firm profitability (Fang, Palmatier, and Steenkamp 2008; Hunt and Morgan 1995).

Finally, the study includes also firm size, market share, SSP and SSC growth, industry advertising intensity, and fiscal year as control variables.

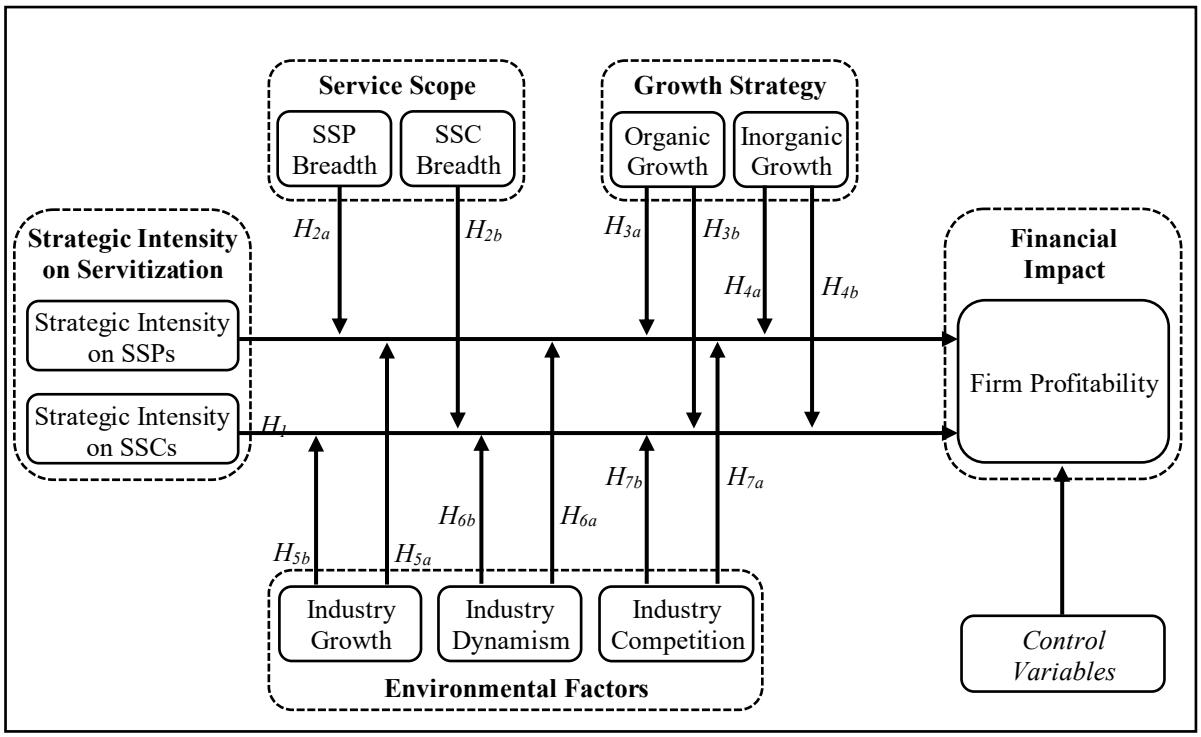

Figure 4.4: Conceptual Model on the Link between Servitization and Firm Profitability

5. Empirical Analysis

This chapter empirically tests the prior developed conceptual model about servitization and firm profitability. Subchapter 5.1 describes the quantitative data used for the analysis. The following subchapter 5.2 operationalizes the measures. Subchapter 5.3 explains the fixed-effect panel regression as the applied method. Finally, subchapter 5.4 presents the results of the analysis.

5.1 Data

This chapter describes the data collection process (subchapter 5.1.1) and the final sample (subchapter 5.1.2).

5.1.1 Data Collection

The study collects its data in two stages. In the first stage the servitization data (e.g., strategic intensity on SSPs and SSCs) of manufacturers is derived from 10-K forms (subchapter 5.1.1.1). In the second stage, the servitization data is matched with financial data from the Compustat database (subchapter 5.1.1.2).

5.1.1.1 Servitization Data

The servitization data is identical to the data collected in the descriptive analysis (subchapter 3.1.1). Therefore, this chapter recapitulates only the main aspects of the collection process.

The 10-K form is a compulsory annual report for public U.S. firms which contains financial and non-financial information in a standardized text format (SEC 2009). A central element of the 10-K form is the business description at the beginning of the report. The business description outlines a firm's strategic choices regarding its business model, products, services, and markets (SEC 2011). It reflects top management's view on strategic choices important for the firm's stakeholders (Ditlevsen 2012). Prior research underlines the validity of 10-K content as a source of firm activities and strategic choices (Benedettini, Swink, and Neely 2017; Bowman 1984; Neely 2008; Visnjic, Wiengarten, and Neely 2016). Servitization has significant strategic implications for manufacturers. Thus, the 10-K business description will contain information about a firm's servitization activities (Lee and Hong 2016). This text-based information is collected to create database about a manufacturer's servitization strategy.

The U.S. Securities and Exchange Commission (SEC) maintains a database of 10-K forms for all public U.S. firms (SEC 2006). The study uses two boundary conditions to identify relevant 10-K forms. First, the Standard Industrial Classification (SIC) codes 28 to 39 identifies relevant manufacturing firms (Fang, Palmatier, and Steenkamp 2008). Second, the timeline is limited to the fiscal years 2009 to 2018, which covers a 10-year period.

As a third step, the data is cleaned by removing firms with no revenues, no employees, or no assets. Moreover, companies with no operations, which are often referred to as development stage companies (FASB 2014), are removed as well. In addition, the study excludes firms focusing on research and development (R&D) (e.g., biotechnology firms) since they do not represent a typical manufacturer. Firms with R&D expenses (i.e., R&D costs divided by revenues) above three standard deviations of the sample mean (i.e., three-sigma rule) are removed (Hekimoglu and Koch 2000). Finally, following the approach of Suarez, Cusumano, and Kahl (2013) the study removes firms with losses greater than 300% of revenues. This prevents a potential bias caused by the fact that profitability has an upper limit (i.e., 100%) but no lower bound (Suarez, Cusumano, and Kahl 2013). After this cleaning procedure, the business description of the 10-K form is extracted using the programming software Python. The resulting final servitization database consists of 9,385 business descriptions from 1,381 U.S. manufacturing firms.

5.1.1.2 Financial Data

Compustat is a database for financial data and is frequently used to get secondary data in research (e.g., Fang, Palmatier, and Steenkamp 2008; Nezami, Worm, and Palmatier 2018). It draws its data mainly from firms' SEC filings such as the 10-K form (WRDS 2020). The database contains mainly financial data such as revenues, profits, and expenses (WRDS 2020). In addition, it has also some non-financial information such as number of employees, ticker name, and SIC code (WRDS 2020). The study obtains following data from Compustat: operating income, revenues, number of employees, total assets, research and development expenses, advertising expenses, acquisition expenses, and SIC code.

5.1.2 Sample Description

The servitization database is matched with the Compustat data (i.e., financial data) using the identifier Central Index Key (CIK), which unambiguously identifies each firm in the two da-

tabases. All 9,385 business descriptions are successfully matched with the according financial data from Compustat. A random sample of 120 observations is drawn and manually checked for correctness. The test confirms the servitization data (i.e., business descriptions) has been correctly extracted and the financial data correctly matched. The following paragraphs present basic descriptive features of the final sample. First, the number of observations per firm is described. The second paragraph reveals the distribution of the observations across the different industries. Firm size is the final descriptive variable to characterize the sample.

The collected data has a panel structure, which means that firms have observations for multiple years. The sample contains 1,381 manufacturing firms with 9,385 business descriptions for the fiscal years 2009 to 2018. The mean number of business descriptions per firm (i.e., average panel length) is 6.8, the median value is 7. Figure 5.1 shows how the number of business descriptions per firm is distributed in the sample. In the 10-year timeframe some firms enter the sample (e.g., initial public offering) or drop out (e.g., bankruptcy or acquisitions) which explains observations with less than ten filings in the sample.

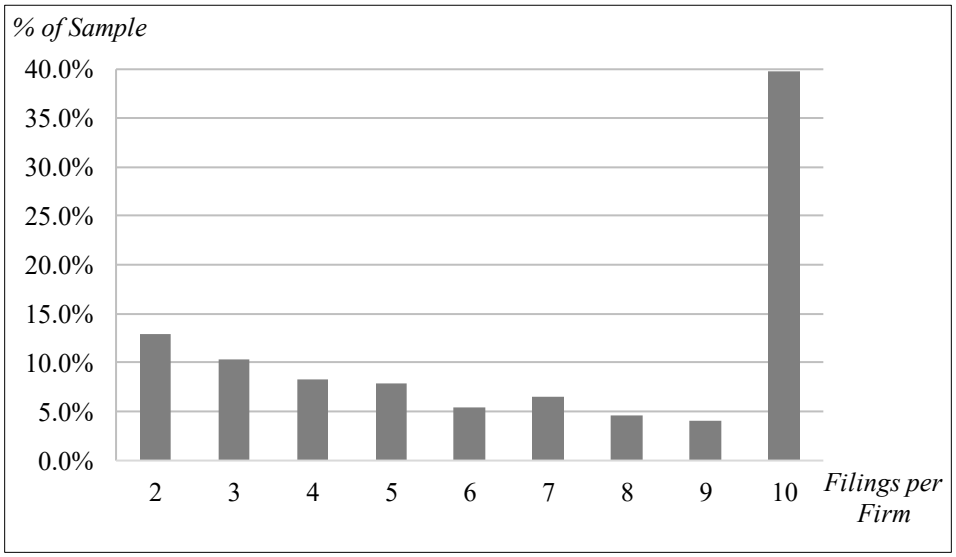

Figure 5.1: 10-K Filings per Firm

The sample covers the manufacturing industries with the 2-digit SIC codes 28 to 39. The five industries electronic equipment (SIC 36), measuring instruments (SIC 38), chemicals (SIC 28), commercial machinery (SIC 35), and transportation equipment (SIC 37) represent 88% of the sample. A finer grade perspective using 4-digit SIC codes reveals the top five industries being pharmaceutical preparations (SIC 2834), semiconductor products (SIC 3674), medical instruments (SIC 3841), communications equipment (SIC 3663), and electromedical appa-

ratus (SIC 3845). Figures 5.2 and 5.3 present the distribution of the different industries based on number of observations in each industry.

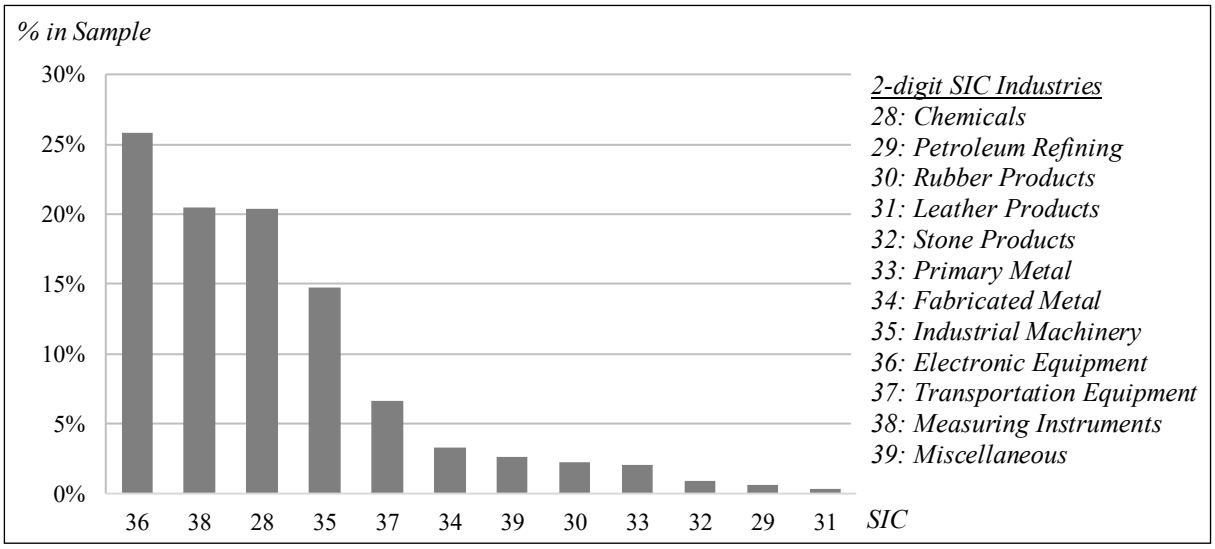

Figure 5.2: 2-digit SIC Industries in Sample

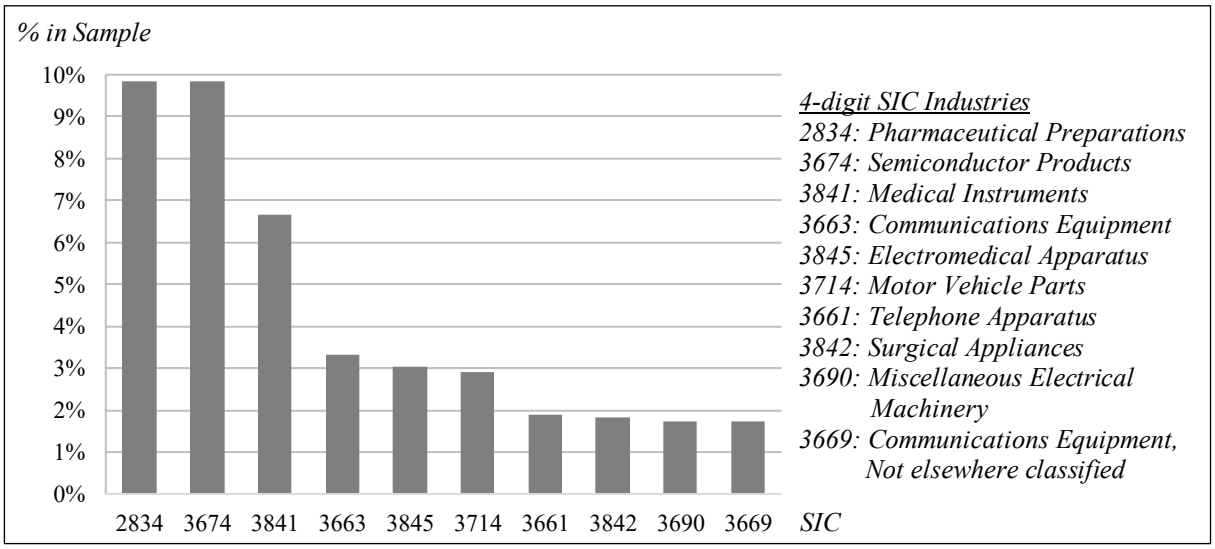

Figure 5.3: Major 4-digit SIC Industries in Sample

The firm size of the manufacturers in the sample can be measured with financial numbers such as total assets and revenues, or with the number of employees (Brooksbank 1991). The mean total asset in the sample is $4.9 billion, while the median is $336.6 million. This indicates that the sample has some very big companies (e.g., IBM, Cisco, Apple). Figure 5.4 presents the percentage distribution of average total assets per firm. It can be seen that about two-thirds of the firm in the sample have on average more than $100 million in total assets. This indicates that the sample has mostly mid to large sized firms.

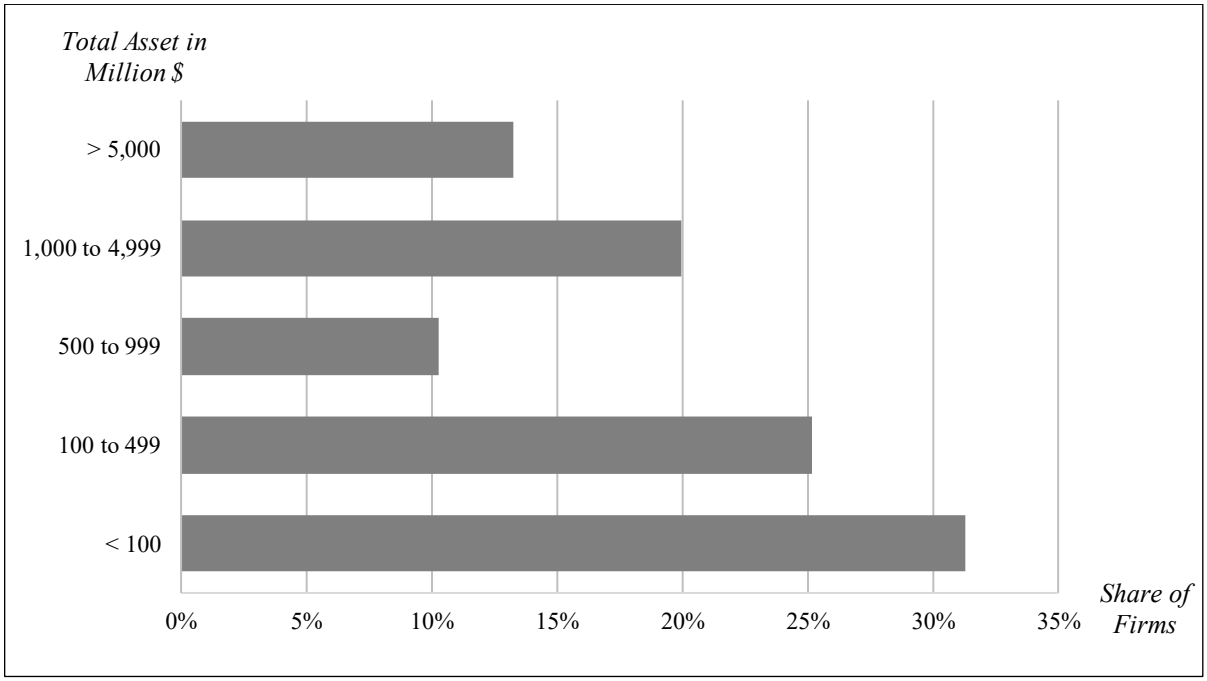

Figure 5.4: Firm Size by Average Total Assets

The mean number of employees is 7,454 while the median is 862. This is consistent with the total assets structure. Thus, a few firms have very large employee numbers (e.g., IBM).

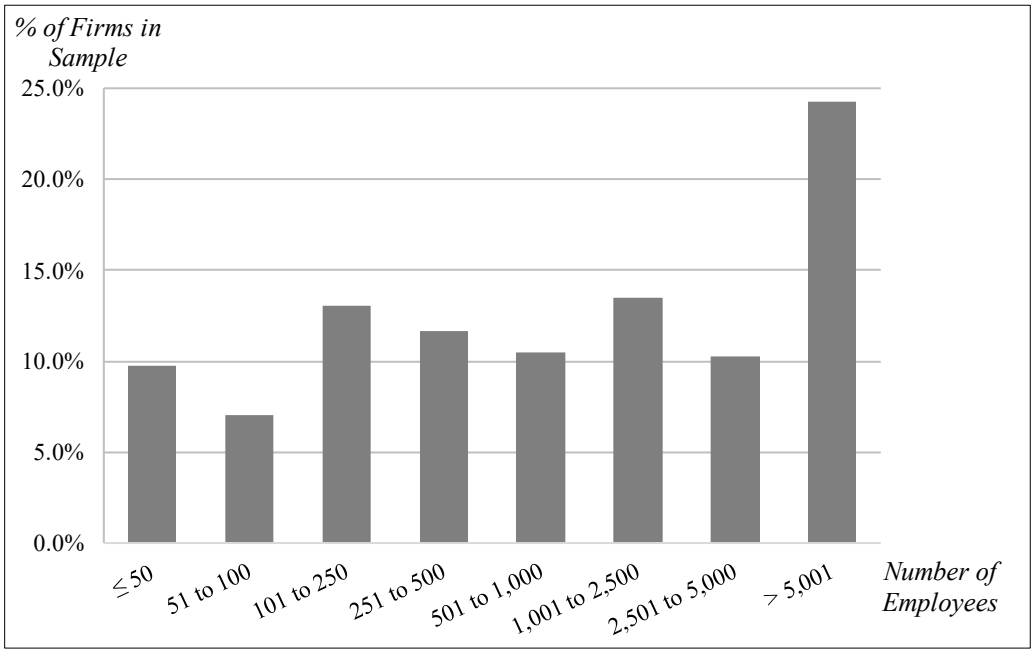

Figure 5.5: Firm Size by Number of Employees

The number of employees as seen in Figure 5.5 confirms this impression, since most companies have more than 500 employees. The sample only includes public companies. Most firms

reach a certain size before their initial public offering (Jain and Kini 1999), what explains the mid to large firm sizes in the sample.

5.2 Measures

This chapter operationalizes the variables used for the analysis. Subchapter 5.2.1 describes the measurement of the dependent variable firm profitability. Subchapter 5.2.2 explains the measurements for the independent variables strategic intensity on SSPs and SSCs, service scope, corporate growth strategy , industry growth, industry dynamism, and industry competition. The subchapter also includes the measurement of the control variables firm size, market share, industry advertising intensity, SSPs and SSCs growth, and fiscal year.

5.2.1 Dependent Variable

This study's dependent variable is a manufacturer's profitability, which is frequently used in research to measure the financial impact of servitization (e.g., Eggert et al. 2014; Nezami, Worm, and Palmatier 2018; Suarez, Cusumano, and Kahl 2013). A firm's profitability is operationalized with return on sales (also referred to as operating margin) which is calculated by dividing operating income by total sales (Suarez, Cusumano, and Kahl 2013). The advantage of return on sales (ROS) as profitability measurement is its robustness towards non-operating influences such as extraordinary items or taxation (Suarez, Cusumano, and Kahl 2013). Instead, it is sensitive to operational and strategic changes within a firm (Suarez, Cusumano, and Kahl 2013). Thus, ROS can effectively capture the financial implications of a firm's servitization strategy.

5.2.2 Independent Variables

The study uses the 10-K business descriptions to operationalize manufacturers' strategic intensity on SSPs and SSCs. Business descriptions inform stakeholders such as investors and customers about the firm's sources of customer value and sustainable competitive advantage (SEC 2011). They outline top management's view on core market offerings (i.e., products and services) and their strategic role for a firm's value creation process and competitive edge (SEC 2011). Thus, business descriptions will also contain information about a firm's SSP and SSC portfolio (Lee and Hong 2016). Therein, the extent of information and discussion about service-related offerings reflects a firm's strategic intensity on SSPs and SSCs. From a tech-

nical text analysis perspective, the amount of SSP and SSC-related keywords positively correlates with a firm's strategic intensity on SSPs and SSCs (Lee and Hong 2016). Therefore, counting the frequency of SSP and SSC related keywords is an appropriate measurement for a manufacturer's strategic intensity on SSPs and SSCs. Exhibit 5 presents the used SSP and SSC-related keywords which are derived from prior research studies (see table 3.1).

Business descriptions may vary in their text length which can influence keyword occurrences (Singhal, Buckley, and Mitra 2017). Thus, an absolute frequency measurement can be biased by business description text length. To account for this potential bias, the SSP and SSC keyword frequencies are divided by the total number of words in the business description excluding stop words (Salton 1991). The final measurement of strategic intensity on SSPs and SSCs is as follows:

$$\text{Strategic Intensity on SSPs} = \frac{\text{Sum of SSP Keyword Occurrences}}{\text{Total Words in Business Description}}$$

$$\text{Strategic Intensity on SSCs} = \frac{\text{Sum of SSC Keyword Occurrences}}{\text{Total Words in Business Description}}$$

Text-based approaches has been used in prior research to operationalize service typologies (Neely 2008), service-based business models (Visnjic, Wiengarten, and Neely 2016), and servitization strategies (Benedettini, Swink, and Neely 2017). This suggests a high validity of text-based servitization measurements. To further verify the validity and reliability of this study's servitization measurement, it is compared to service ratio, a common financial based measurement (Fang, Palmatier, and Steenkamp 2008; Nezami, Worm, and Palmatier 2018). Service ratio measures the share of service sales within a firm's total revenues (Fang, Palmatier, and Steenkamp 2008). However, service ratio does not differentiate between SSPs and SSCs. Therefore, it is compared to the sum of strategic intensity on SSPs and SSCs. Service ratio and strategic intensity of 15 randomly drawn firms show a high positive correlation ($r = .69$, $p < .01$) between the measurements (see table 3.3). This indicates that strategic intensity on SSPs and SSCs accurately captures a manufacturer's servitization activity.

The following paragraphs explain the measurements for the moderating variables. Service scope refers to the breadth of a manufacturer's service portfolio (Eggert et al. 2014). SSP and SSC breadth are measured by counting the number of distinct SSP and SSC offerings in the

10-K business description (Eggert et al. 2014). The study identifies distinct service offerings based on the SSP and SSC keyword list in exhibit 5.

The next two moderating variables focus on a manufacturer's corporate growth strategy. First, an organic growth strategy is reflected in the firm's level of research and development (R&D) activity (Penner-Hahn and Shaver 2005). A measure for R&D activity is research and development intensity, which puts R&D expenses in relation to total revenues (Rountree, Weston, and Allayannis 2008). Second, inorganic growth strategies refer primarily to the acquisition of firms (Bahadir, Bharadwaj, and Parzen 2009). Similar to R&D intensity, acquisition intensity is measured by dividing acquisition expenses by total revenues (Chen, Crossland, and Huang 2016).

The final set of moderating variables focus on environmental factors. To measure industry growth, the study first obtains the slope coefficient of industry revenues for the past five years (Fang, Palmatier, and Steenkamp 2008). This coefficient is divided by mean industry revenues in the same period, which returns the industry growth value (Fang, Palmatier, and Steenkamp 2008). Industry dynamism, a measure for unpredictable volatility within an industry, is measured by first calculating the standard error of the regression coefficient of industry revenues for the past five years (Baron and Tang 2011). In a second step, the value is divided by mean industry revenues over the same period, to get the value for industry dynamism (Baron and Tang 2011). Finally, industry competition is measured with a Herfindahl index and is calculated by subtracting the cumulative squared market share in the industry from 1 (Fang, Palmatier, and Steenkamp 2008).

The study includes five control variables to rule out alternative explanations of firm profitability. First, extant research shows that firm's size can have a substantial impact on profitability (Eggert et al. 2014; Nezami, Worm, and Palmatier 2018). Thus, firm size is controlled by adding the log-transformed number of employees into the study's model (Eggert et al. 2014). Next, market share is another factor that may influence firm profitability. Research indicates a positive relationship between market share and profitability (Szymanski, Bharadwaj, and Varadarajan 1993). Thus, market share is added to the model and measured as the ratio of firm revenues to industry revenues (Szymanski, Bharadwaj, and Varadarajan 1993). The third control variable is the growth of SSPs and SSCs. A quantitative increase of industrial services may also have an impact on firm performance including profitability (Fang, Palmatier, and

Steenkamp 2008). The study includes SSP and SSC growth by calculating the growth rate of strategic intensity on SSPs and SSCs between subsequent years. The fourth control variable is the industry advertising intensity. Fang, Palmatier, and Steenkamp (2008) point out that intense industry advertising can create a differentiation advantage and superior profit margins. Industry advertising intensity is measured as industry mean of advertising expenses normalized by revenues (Fang, Palmatier, and Steenkamp 2008). Finally, the study includes the fiscal year of the 10-K report to control for influential time effects (Nezami, Worm, and Palmatier 2018). The base year for this categorical variable is 2009. Table 5.1 summarizes the operationalization of all variables in the conceptual model.

Variable	**Operationalization (Reference)**
Return on Sales (ROS)	Operating income divided by total sales (Suarez, Cusumano, and Kahl 2013)
Strategic Intensity on SSPs	Sum of SSP keyword occurrences divided by total words in business description
Strategic Intensity on SSCs	Sum of SSC keyword occurrences divided by total words in business description
SSP Breadth	Number of distinct SSP keywords (Eggert et al. 2014)
SSC Breadth	Number of distinct SSC keywords (Eggert et al. 2014)
Organic Growth	R&D Intensity: R&D expenses divided by total revenues (Rountree, Weston, and Allayannis 2008)
Inorganic Growth	Acquisition Intensity: Acquisition expenses divided by total revenues (Chen, Crossland, and Huang 2016)
Industry Growth	Slope coefficient of industry revenues in past 5 years divided by mean industry revenues in past 5 years (Fang, Palmatier, and Steenkamp 2008)
Industry Dynamism	Standard error of regression coefficient of industry revenues in past 5 years divided by mean industry revenues in past 5 years (Baron and Tang 2011)
Industry Competition	Cumulative squared market share in the industry subtracted from 1 (Fang, Palmatier, and Steenkamp 2008)
Firm Size	Logarithm of number of employees (Eggert et al. 2014)
Market Share	Ratio of firm revenues to industry revenues (Szymanski, Bharadwaj, and Varadarajan 1993)
Growth Rate SSPs	Growth rate of strategic intensity on SSPs
Growth Rate SSCs	Growth rate of strategic intensity on SSCs
Industry Advertising Intensity	Industry mean of advertising expenses normalized by revenues (Fang, Palmatier, and Steenkamp 2008).
Fiscal Year	Categorical year variable with base year 2009

Table 5.1: Operationalization of Variables

5.2.3 Descriptive Statistics

Table 5.2 presents descriptive statistics and correlations of all variables, pooled across firms and time.

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
1. Firm Profitability	1.000														
2. SI on SSPs	.041	1.000													
3. SI on SSCs	.025	.517	1.000												
4. SSP Breadth	.062	.657	.459	1.000											
5. SSC Breadth	.025	.566	.766	.666	1.000										
6. Organic Growth	-.346	-.041	.009	.023	.089	1.000									
7. Inorganic Growth	.052	-.002	.002	.027	.030	.037	1.000								
8. Industry Growth	.019	-.032	-.034	-.019	-.021	.051	.007	1.000							
9. Industry Dynamism	.015	.052	.014	.021	-.010	-.124	-.039	-.109	1.000						
10. Industry Competition	-.008	-.218	-.118	-.153	-.121	.219	.061	.084	-.179	1.000					
11. Firm Size	.431	.159	.171	.204	.207	-.280	.090	.022	.021	-.026	1.000				
12. Market Share	.147	.151	.133	.103	.115	-.246	.010	-.106	.235	-.447	.455	1.000			
13. SSP Growth	-.011	.025	.011	.017	.005	.003	.051	-.001	-.015	.030	-.029	-.015	1.000		
14. SSC Growth	.014	.060	.163	.079	.153	.036	.012	-.018	.003	-.016	.043	.005	.099	1.000	
15. Industry Advertising	-.039	-.112	-.105	-.117	-.098	.083	.081	-.040	-.089	.151	-.058	-.084	.006	-.027	1.000
Mean	.004	.005	.001	3.557	2.824	.091	.045	.016	.093	.696	.185	.101	.061	.046	.083
Standard Deviation	.326	.005	.002	2.701	3.051	.102	.175	.111	.094	.240	2.223	.213	.513	.522	.256

Notes: SI = Strategic Intensity; $p < .05$ if $|r| > .02$

Table 5.2: Descriptive Statistics and Correlations

The strongest correlations exist among the servitization variables (i.e., strategic intensity and service scope). This makes sense since a broader service portfolio will lead to a more intense discussion of services in the 10-K form. All other absolute values of the correlation matrix are below 0.5 which means that there is no particularly strong correlation between two variables.

5.3 Method

This chapter presents the method used to analyze the data. First, subchapter 5.3.1 outlines the special characteristics and advantages of panel data. Subchapter 5.3.2 focuses on the chosen method of fixed-effects panel regression.

5.3.1 Panel Data

In general, research data can be categorized as cross-sectional data, time-series data, or panel data (Giesselmann and Windzio 2012). These three data categories differ in their fundamental structure. Cross-sectional data contains information about multiple units of observations (e.g., firms, individuals, countries etc.) at a single point of time (e.g., for the year 2021). Hence, cross-sectional data is one-time snapshot about the units of observation (Giesselmann and Windzio 2012). Time-series data focuses on a single unit of observation (e.g., single firm) at multiple points of time (e.g., for three consecutive years) (Giesselmann and Windzio 2012). Thus, time series data allow researchers to see how the observed unit develops over time. Finally, panel data contains information about multiple units of observation (e.g., firms, individuals, countries) at multiple points of time (e.g., for three consecutive years) (Giesselmann and Windzio 2012; Wooldridge 2002). Thus, panel datasets combine the cross section and time series structure of data (Wooldridge 2002). This study's data has a panel structure. Therefore, the following paragraphs discuss characteristics of panel data in more detail.

A key characteristic of panel data is the repeated observation of the same variables over a certain period of time (Wooldridge 2010). The time period in panels is usually successive and uniform, which means that the repeated observations are collected in consecutive and constant time intervals (Giesselmann and Windzio 2012). Panel datasets are classified as balanced or unbalanced depending on missing data at some time periods (Wooldridge 2002). A panel dataset with data on all observation units at all time periods is called a balanced panel dataset (Wooldridge 2002). In contrast, an unbalanced panel has missing observations on some of the time points (Wooldridge 2002). In research a panel data is often unbalanced due to many factors which can cause units of observations dropping out or joining the sample (Giesselmann and Windzio 2012). For instance, if firms are the unit of observation, they can go bankrupt, decide not to share data anymore, or merge with another company. Moreover, new firms may enter the sample at later time periods. The result of these dynamic changes is an unbalanced panel dataset, which is also the case for this study's sample.

Another characteristic of panel data is the possible decomposition of total variable variances into within-individual variance and between-individual variance (Mertens, Pugliese, and Recker 2017). Within-individual variance captures the part of the variance that occurs within a single observed unit over time (Mertens, Pugliese, and Recker 2017). For example, the variability of operating income of the manufacturer Caterpillar from 2010 to 2018 represents within-individual variance. In contrast, between-individual variance captures the variance between different observed units at the same point of time (Mertens, Pugliese, and Recker 2017). For instance, the differences between operating income in 2018 between Ford and General Motors represents between-individual variance. These variance components play a key role in panel regression models (Mertens, Pugliese, and Recker 2017; Wooldridge 2002).

Finally, there are multiple advantages of collecting panel data. First, panel data represents a richer dataset compared to cross-sectional or time-series data (Hsiao 2007). This leads to more efficient parameter estimations increasing a study's reliability and validity (Hsiao 2007). Another advantage is that panel data allows to better deal with some endogeneity challenges such as omitted variable bias (Hsiao 2007; Wooldridge 2002). A third advantage is that the time dimension of panel data allows to capture dynamic developments which may uncover interesting relationships (Hsiao 2007).

Overall, panel data has some unique characteristics and some advantages over cross-sectional or time-series data. There are different methods to analyze panel data which are discussed in the following chapter.

5.3.2 Analysis of Panel Data

Frequently mentioned methods to analyze panel data are pooled ordinary least squares regression (subchapter 5.3.2.1), fixed-effects panel regression (subchapter 5.3.2.2), and random-effects panel regression (5.3.2.3). After discussing these three methods, subchapter 5.3.2.4 presents statistical tests to identify the appropriate method for a given panel dataset.

5.3.2.1 Pooled Ordinary Least Squares Regression

Pooled ordinary least squares (POLS) regression refers to the application of ordinary least squares (OLS) regression on panel data. In a first step, the concept of OLS regression will be explained. As a second step, the chapter discusses POLS as a special case of OLS application.

In research OLS regression is a very popular method to estimate linear regression models (Backhaus et al. 2016; Baltagi 2011). A typical regression function establishes a linear relationship between a dependent variable y and a single or multiple independent variables x (Backhaus et al. 2016; Baltagi 2011). A simple regression function is depicted in formula 1.0 where y_i can be for example profitability of firm i, and x_i the market share of that firm i. In addition, the OLS regression includes an error term e_i which captures the differences between observed and expected y values (Backhaus et al. 2016; Baltagi 2011). The error term (also known as residuals) captures the cumulated effect of all factors which are not in the regression model such as omitted variables, measurement error, or nonlinear relationship of observed variables (Giesselmann and Windzio 2012).

(1.0) $y_i = \alpha + \beta * x_i + e_i \qquad i = 1, 2, ...,n$

where

y_i = dependent variable

α = intercept

β = slope (i.e., influence of independent variable)

x_i = independent variable

e_i = error term

The parameters α and β cannot be observed but need to be estimated (Backhaus et al. 2016; Baltagi 2011). In order to find the optimal linear line through the observed data, one must minimize the error term e_i (Backhaus et al. 2016; Baltagi 2011). Since positive and negative residuals would cancel each other out the error term is squared before minimizing it (see formula 1.1). This approach is referred to as ordinary least squares estimation (Backhaus et al. 2016; Baltagi 2011).

(1.1) $\sum_{i=1}^{n} e_i^2 \rightarrow \min!$

The OLS approach returns reliable parameter estimations under certain assumptions. First, the expected value of e_i is zero, which implies that on average the residuals cancel each other out (Backhaus et al. 2016; Baltagi 2011). Second, the variance of the residuals is constant, i.e., $var(e_i) = \sigma^2$ for every i = 1, 2, ...,n (Backhaus et al. 2016; Baltagi 2011). Finally, the residuals should not be correlated with each other or the independent variables (Backhaus et al. 2016;

Baltagi 2011). Thus, the error term for one observation does not tell something about the error of another observation (Backhaus et al. 2016; Baltagi 2011). If these assumptions are violated, the OLS regression may be biased (Backhaus et al. 2016; Baltagi 2011).

Pooled OLS regression ignores the longitudinal character of panel data and regards the entire sample as a cross sectional dataset (Wooldridge 2010). Theoretically, this approach can generate unbiased parameter estimations if the variance of the observed individuals is similar in the entire dataset (Wooldridge 2010). If individual variances do not differ, the panel structure can be ignored to use POLS regression.

5.3.2.2 Fixed-Effects Panel Regression

The POLS approach is often not suitable to analyze panel data due to three reasons. First, the POLS regression would ignore the panel structure and handle the data as a cross-sectional sample (Giesselmann and Windzio 2012). This contradicts the very objective of a panel data structure to capture dynamic effects over time. Second, POLS regression has the strong assumption that the error terms in the equation vary randomly and are not correlated with the independent variables (Chumney and Simpson 2006; Giesselmann and Windzio 2012). Only under this condition, the POLS regression returns reliable parameter estimations (Chumney and Simpson 2006; Giesselmann and Windzio 2012). However, in a panel data set the variation of error terms is usually not random (Giesselmann and Windzio 2012). The repeated measurements of the same observation unit, e.g., a specific firm, will lead to correlated error terms within the same observation unit (Giesselmann and Windzio 2012). The reason is that within the same observation unit there are unobserved time invariant factors which cause the error terms to be similar within the same observation unit (Giesselmann and Windzio 2012). Hence, the application of a POLS regression on panel data violates a key assumption and can lead to biased estimations. A third factor that often causes problems in POLS regressions is omitted variable bias (Chumney and Simpson 2006; Giesselmann and Windzio 2012). That means the relationship between the dependent and independent variables might be influenced by an unobserved third variable (Chumney and Simpson 2006; Giesselmann and Windzio 2012). Regression models that consider the panel structure of the data can overcome these challenges of POLS regression.

A popular approach to analyze panel data in marketing research is the fixed-effects (FE) panel regression (e.g., Fang, Palmatier, and Steenkamp 2008; Visnjic, Wiengarten, and Neely

2016). The idea of FE panel regression is to transform the data in a way that eliminates all time invariant (observed and unobserved) variables (Wooldridge 2002). For example, in this study's sample a firm's industry would be a time invariant variable within each individual firm. This transformation has two advantages. First, unobserved time invariant variables drop out of the regression model which reduces a potential omitted variable bias (Wooldridge 2002). Second, the POLS assumption of error terms and independent variables being uncorrelated becomes less restrictive since all time-invariant variables are eliminated (Wooldridge 2010).

The FE transformation is performed by demeaning the data (Wooldridge 2002). Within each observed individual (i.e., observations within the same firm) the data is subtracted by the mean value of the variable. The following generic equations demonstrate how the demeaning of variables eliminate observed and unobserved time invariant variables. Equation 2.0 shows the initial regression model. For simplicity, the intercept is omitted and there is only a single time varying dependent variable x_{it} and a single time constant variable z_i. The error term w_{it} consists of the cumulated effect of time constant and time varying residuals.

(2.0) $y_{it} = \beta_1 * x_{it} + \beta_2 * z_i + w_{it}$, $w_{it} = e_{it} + u_i$

where

y_{it} = dependent variable

β_1 = slope (i.e., time varying influence of independent variable)

β_2 = slope (i.e., time constant influence of independent variable)

x_{it} = time varying independent variable

z_i = time constant independent variable

w_{it} = error term with time varying (e_{it}) and time constant (u_i) part

The mean values are subtracted from the variables which leads to equation 2.1. The transformed equation results in equation 2.2 which shows that time constant observed (i.e., z_i) and unobserved variables (i.e., u_i) drop out of the regression model (Giesselmann and Windzio 2012).

(2.1) $y_{it} - \overline{y_i} = \beta_1 * (x_{it} - \overline{x_i}) + \beta_2 * (z_i - z_i) + w_{it}$, $w_{it} = (e_{it} + u_i) - (\overline{e_i} + u_i)$

(2.2) $y_{it} - \overline{y_i} = \beta_1 * (x_{it} - \overline{x_i}) + w_{it}$, $w_{it} = (e_{it} - \overline{e_i}) = (e_{it} - 0) = e_{it}$

The final error term consists only of the random part e_{it}, which varies with time and observation unit. The mean error term of e_i is zero because the idiosyncratic average error within each observation unit is zero (Wooldridge 2002). Hence, the fixed-effects transformation addresses all three previously mentioned issues of a POLS regression. First, the introduction of the time index ensures that the panel structure is considered. Second, the error terms in the transformed data vary randomly. The condition that the error terms must be uncorrelated with the independent variable corr (u,x) = 0 is less restrictive, since u_i drops out of the equation (Wooldridge 2010). Finally, the demeaned data eliminates all (observed and unobserved) time invariant variables which makes an omitted variable bias less likely (Wooldridge 2002).

In a second step, OLS can be used to estimate the parameters of the transformed regression model (Wooldridge 2010). The parameter estimations (i.e., β_1) are not affected by demeaning the data and can be interpreted like in a regular OLS regression analysis (Wooldridge 2002). A condition for unbiased parameter estimates is that the independent variables (e.g., x_{it}) and the error term e_{it} are uncorrelated (Wooldridge 2002).

All in all, the fixed-effects panel regression discards unobserved time constant heterogeneity in data. This reduces the risk of omitted variable bias and focuses the analysis on the dynamic (i.e., time varying) aspects of the data. Moreover, fixed-effects models focus on the variation within each unit of observation (Wooldridge 2002). That is why it is also referred to as the "within-estimator" (Wooldridge 2002).

5.3.2.3 Random-Effects Panel Regression

In social sciences there is a second popular model to analyze panel data, the random-effects (RE) panel regression. Similar to the FE approach, the RE panel regression also transforms the data before using OLS for estimation (Giesselmann and Windzio 2012). However, the transformation process is different since RE has other underlying assumptions (Giesselmann and Windzio 2012). The key difference is that RE model assumes that unobserved variables are random and not correlated with the observed variables (Allison 2009; Giesselmann and Windzio 2012). If this assumptions holds, the RE has two advantages over the FE model. First, it is a more efficient regression model, i.e., the standard errors estimated coefficients are lower compared to the FE panel regression (Giesselmann and Windzio 2012). Second, the RE panel regression can also quantify the effect of observed time-invariant factors, which is not possible in the FE regression model (Giesselmann and Windzio 2012).

The RE model transforms the data using a combination of two mean values, namely the variable mean at the individual level (e.g., firm-level) and the variable mean at the sample level (i.e., across all firms) (Giesselmann and Windzio 2012). Equation 3.0 depicts the demeaning of the dependent variable y as an example:

(3.0) $\hat{y}_{it} = \lambda*(\hat{y}_i) + (1-\lambda)*(\bar{y}_{it})$

where

$\hat{y}_{it}$ = (RE transformed) dependent variable

$\hat{y}_i$ = mean value of y across entire sample

$\bar{y}_{it}$ = mean value of y within individual unit of observation

λ = weight

The λ is a factor for the intra-individual correlation in the data (i.e., correlation within a firm) and can take values between 0 and 1. Formula 3.1 shows how λ is calculated (Giesselmann and Windzio 2012). It puts the variance of the time varying residuals e in relation to the total variance of the error term (Giesselmann and Windzio 2012). Hence, the smaller the intra-individual correlation within the sample is, the more important the overall mean becomes for transforming the data (Giesselmann and Windzio 2012).

(3.1) $\lambda = 1-\sqrt{\frac{Var(e)}{T*Var(u)+Var(e)}}$

where

λ = weight

Var(e) = Variance induced by time varying residuals

Var(u) = Variance induced by time constant residuals

T = Number of observations per individual

Hence, in the RE transformation not all time-constant variables drop out, and they can be estimated. All in all, RE can be a better alternative to FE if the unobserved and observed variables are statistically independent from each other (Giesselmann and Windzio 2012). However, this is a strong assumption and is often unrealistic (Giesselmann and Windzio 2012). If the

assumption is violated, the RE estimator is inconsistent (while FE is in any case consistent) (Giesselmann and Windzio 2012).

5.3.2.4 Choice of Regression Model

The choice of an appropriate regression model depends primarily on the underlying research questions and theoretical considerations (Giesselmann and Windzio 2012). In addition, statistical tests can serve as confirmation for the suitability of a chosen regression model (Giesselmann and Windzio 2012; Wooldridge 2002).

The first decision is whether the panel structure of the data is relevant for answering the study's research questions. In this study the main question is how manufacturers' servitization process influences its financial profitability. Thus, the main research question puts a strong focus on firm-level implications. In addition, the sample consists of very different manufacturers which creates a lot of inter-individual variance. Therefore, the study should consider the panel structure of the dataset. From a theoretical perspective, a POLS approach will likely fail to analyze the data and answer the study's research questions.

The Breusch-Pagan test can check whether the panel structure of a dataset should be considered in the analysis (Mertens, Pugliese, and Recker 2017). The test checks the similarity of intra-individual variances (i.e., variance within a firm) across the sample (Mertens, Pugliese, and Recker 2017). The null hypothesis is that the variances are similar and POLS an appropriate method. In this study's case, however, the null hypothesis is rejected ($\chi^2 = 5147.24$, $p < .01$) which confirms that POLS is not appropriate method in this study's case.

The second choice is between the FE and RE panel regression model. This study's sample most likely violates the assumptions needed for the RE model. For instance, the unobserved variable "management's future orientation" is most likely correlated with the firm's research and development expenditure. Thus, if the RE assumption of statistical independence of observed and unobserved variables is violated, the model will return inconsistent estimations (Giesselmann and Windzio 2012). In contrast, the FE panel regression returns consistent estimates regardless of the relationship between observed and unobserved variables (Giesselmann and Windzio 2012). Moreover, prior servitization research relies on FE models as well (e.g., Fang, Palmatier, and Steenkamp 2008; Nezami, Worm, and Palmatier 2018; Visnjic, Wiengarten, and Neely 2016) which underlines its appropriateness in this study's

context. Therefore, the study employs a FE panel regression model to analyze the data and answer the research questions.

This choice can be confirmed using the Hausman (specification) test which compares the coefficients of FE and RE panel regression models (Giesselmann and Windzio 2012; Wooldridge 2002). The Hausman test checks whether the FE and RE parameter estimates differ significantly from each other (Giesselmann and Windzio 2012; Wooldridge 2002). The test results indicate that the estimates of the models differ significantly from each other (χ^2 = 55.94, $p < .01$). Hence, the RE estimator is inconsistent and the Hausman test verifies the theoretical argument in favor of the fixed-effects model.

5.3.3 Model Specification

This study employs a fixed-effects panel regression to analyze the impact of servitization on firm profitability. The following paragraphs first address three potential estimation issues prior to the final model specification.

First, the question is whether time-fixed effects should be included in the regression model. A Wald test checks whether time fixed effects are jointly equal to zero which would imply that they can be ignored (Ozkan 2001). The Wald test indicates that time-fixed effects are jointly not equal to zero ($F_{(8,5894)} = 2.38$, $p < .05$). Hence, the study's regression model includes year dummies to account for time-fixed effects.

A second estimation question is whether the independent variables in the model correlate with the variance of the error terms. Such a correlation is known as heteroskedasticity and may bias the estimation of standard errors (Giesselmann and Windzio 2012). In a panel dataset, the error terms within an observation unit (i.e., on individual firm level) are likely correlated with each other (Giesselmann and Windzio 2012). If the model does not control for this form of heteroskedasticity, it can lead to biased estimations for the standard errors (Wooldridge 2002). Thus, the study employs a modified Wald statistic to test for heteroskedasticity of the error terms within individual observation units (Greene 2008). The test confirms the suspected heteroskedasticity issues of the error terms ($\chi^2_{(1326)} = 1.1*10^{36}$, $p < .01$). Like prior research (Fang, Palmatier, and Steenkamp 2008), the study employs the generalized estimator of White (1980, 1984) to control for heteroskedasticity and get robust standard errors.

A third potential estimation issue arises from the dependent variable firm profitability. If the variable is nonstationary, it can cause biased estimates (Baltagi 2021; Cuthbertson and Gasparro 1995; Mollick and Faria 2009). The study employs a fisher-type panel unit root test to check for nonstationary behavior of firm profitability in the regression model (Choi 2001). The test results indicate that profitability within individual observation units (i.e., firms) do not have a unit root (see exhibit 9). Thus, profitability at the firm-level is stationary and no further model adjustment is needed. Another potential issue of firm profitability is serial correlation. The Wooldridge test for autocorrelation checks for potential serial correlation issues in the panel (Born and Breitung 2016; Drukker 2003; Wooldridge 2002). The test statistics ($F_{(1,989)} = 22.66$, $p < .01$) indicate that there is serial correlation in this study's sample. However, using robust standard errors will also solve a potential bias caused by serial correlation (Arellano 1987; Drukker 2003)

After controlling potential estimation issues, the final model can be estimated. The main advantage of the fixed-effects model is that it controls for time invariant unobserved heterogeneity in the data (Wooldridge 2002). This may reduce potential omitted variable bias and associated endogeneity issues (Wooldridge 2002). Equation 4.0 present the final fixed-effects panel regression model for this study using a matrix notation (Baltagi 2021).

(4.0) $$y_{it} = \alpha + X_{it}' \beta + \gamma_t + \delta_i + e_{it}$$

where

y_{it} = profitability of firm i at time t

α = overall constant

X_{it}' = independent variables (including interactions and controls)

β = vector for the influence of independent variables

γ_t = time-specific effect

δ_i = firm-specific effect

e_{it} = error term with $E(e_{it})=0$

The parameter of interest is β which quantifies the influence of the independent variables in the model. The independent variables include strategic intensity on SSPs and SSCs, service scope (i.e., SSP and SSC breadth), organic growth, inorganic growth, industry growth, indus-

try dynamism, and industry competition. Based on theoretical considerations, the study expects a profitability effect of strategic intensity on SSCs after a threshold is reached (Fang, Palmatier, and Steenkamp 2008). Thus, the variable strategic intensity on SSCs is squared and added as an additional variable. Next to the direct effects, the interaction terms are also included. In addition, the following control variables are in the model: year dummies, firm size, market share, industry advertising intensity, and SSP and SSC growth.

Consistent with prior research the study builds a final model containing all independent variables and their interactions successively (Fang, Palmatier, and Steenkamp 2008). The initial model (Model 1) focuses on the main direct effects without the interaction terms. In a second model (Model 2) the interaction terms are included to test the full model and the study's hypotheses.

5.4 Results

This chapter presents the results of the fixed-effects panel regression analysis. Subchapter 5.4.1 tests the prior stated hypotheses. The subchapter 5.4.2 verifies the validity and robustness of the results.

5.4.1 Hypotheses Test

Before focusing on the hypotheses test, the study first evaluates the overall model fit. The F statistics indicates whether all coefficients in the model are different from zero (Ramsey and Schmidt 1976). In this case, the F test is significant which implies that the coefficients are not jointly zero and the model is significant. The second statistic for model fit is the R^2 value, which measures how much of the dependent variable's variance is explained by the independent variables in the model (Miles 2005). The value needs to be adjusted for the number of independent variables to avoid a bias (Miles 2005). The model has an adjusted R^2 value of 0.32 which means that about a third of variance in profitability can be explained by the chosen independent variables. Compared to other servitization studies (e.g., Suarez, Cusumano, and Kahl 2013; Visnjic, Wiengarten, and Neely 2016) this is an adequate adjusted R^2 value. Overall, the model fits the data reasonably well. The following paragraphs test the study's hypotheses by interpreting the results of the regression coefficients. Table 5.3 summarizes the results of the fixed effect panel regression with Model 1 being the main-effects-only model, and Model 2 representing the full model.

Variables and Hypotheses		Firm Profitability (ROS) Model 1	Model 2
Intercept		.18 (.02)**	.17 (.03)**
Direct Effects – Strategic Intensity			
Strategic Intensity on SSPs	H_1	.43 (1.36)	2.51 (2.77)
Strategic Intensity on SSCs		-8.53 (4.75)	-18.16 (10.30)
(Strategic Intensity on SSCs)^2		796.91 (366.70)*	2247.35 (911.12)*
Moderating Effects – Service Scope			
Strategic Intensity on SSPs × SSP Breadth	H_{2a}		-.33 (.17)*
Strategic Intensity on SSCs × SSC Breadth	H_{2b}		2.05 (.71)**
(Strategic Intensity on SSCs)^2 × SSC Breadth			-205.01 (59.77)**
Moderating Effects – Corporate Growth Strategy			
Strategic Intensity on SSPs × Organic Growth	H_{3a}		18.54 (16.36)
Strategic Intensity on SSCs × Organic Growth	H_{3b}		-117.77 (56.63)*
(Strategic Intensity on SSCs)^2 × Organic Growth			7008.58 (3223.37)*
Strategic Intensity on SSPs × Inorganic Growth	H_{4a}		4.22 (2.94)
Strategic Intensity on SSCs × Inorganic Growth	H_{4b}		-24.51 (13.59)
(Strategic Intensity on SSCs)^2 × Inorganic Growth			2459.11 (1221.74)*
Moderating Effects – Environmental Factors			
Strategic Intensity on SSPs × Industry Growth	H_{5a}		7.28 (3.56)*
Strategic Intensity on SSCs × Industry Growth	H_{5b}		12.38 (20.01)
(Strategic Intensity on SSCs)^2 × Industry Growth			-3359.05 (2541.60)
Strategic Intensity on SSPs × Industry Dynamism	H_{6a}		-6.22 (3.16)*
Strategic Intensity on SSCs × Industry Dynamism	H_{6b}		45.43 (19.39)*
(Strategic Intensity on SSCs)^2 × Industry Dynamism			-7351.31 (2844.36)*
Strategic Intensity on SSPs × Industry Competition	H_{7a}		-1.94 (2.82)
Strategic Intensity on SSCs × Industry Competition	H_{7b}		-.03 (12.07)
(Strategic Intensity on SSCs)^2 × Industry Competition			621.90 (947.28)
Controls			
SSP Breadth		$9.35x10^{-6}$ (.002)	.002 (.002)
SSC Breadth		-.003 (.002)	-.004 (.003)
Organic Growth		-2.01 (.16)**	-2.01 (.21)**
Inorganic Growth		-.02 (.02)	-.02 (0.2)
Industry Growth		-.002 (.021)	-.04 (.03)
Industry Dynamism		-.01 (.02)	-.003 (.027)
Industry Competition		.04 (.03)	.06 (.03)
Firm Size		.04 (.01)**	.04 (.01)**
Market Share		-.02 (.03)	-.02 (.03)
SSP Growth		-.004 (.004)	-.006 (.004)
SSC Growth		.003 (.003)	.005 (.003)
Industry Advertising Intensity		-.01 (.01)	-.01 (.01)
Fiscal Year Dummies		*Included*	*Included*
Adjusted R^2		*.31*	*.32*
F-statistics		*10.38***	*12.31***

Notes: Values are unstandardized coefficients with robust standard errors in parentheses. *$p \leq .05$, **$p < .01$

Table 5.3: Fixed Effects Panel Regression Results

In addition, significant relationships are visualized graphically in figures 5.6 to 5.13 to aide interpretation. Significant moderating variables are plotted using a low and a high value (i.e., one standard deviation below and above the variable mean[11]) for the moderator (Fang, Palmatier, and Steenkamp 2008). Other values of the model are hold constant at their mean values.

In support of the study's first hypothesis (H_1), Model 1 and 2 shows that the squared value of strategic intensity on SSCs has a significant positive effect on firm profitability (b = 2247.35, $p < .05$). Thus, a firm's strategic intensity on SSCs needs to reach a critical mass before it has a beneficial impact on a firm's profitability. This critical mass requirement of SSCs becomes evident in figure 5.6 which visualizes the curvilinear relationship between strategic intensity on SSCs and firm profitability. The graph shows that firms with low levels of strategic intensity on SSCs (<.005) struggle to increase their profitability. After a threshold intensity (≥ .005) is reached, firms experience increasingly positive profitability effects of their strategic focus on SSC.

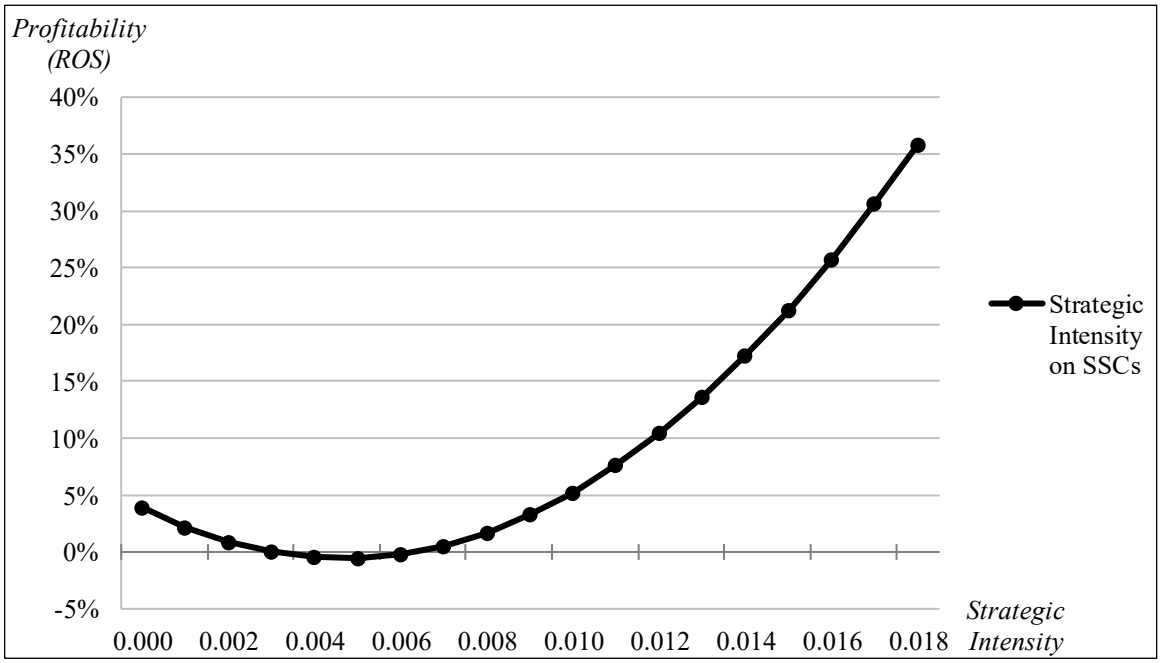

Figure 5.6: Relationship between Strategic Intensity on SSCs and Firm Profitability

[11] If the calculation exceeds the value range of the observed variable, the mean, minimum, or maximum observed value is used instead.

In addition, the study tests whether strategic intensity on SSPs has also a curvilinear effect on firm profitability. Consistent with the theoretical considerations, strategic intensity on SSPs remains not significant.

The second set of hypotheses focus on the moderating effect of service scope, i.e., SSP and SSC breadth. SSP breadth has a negative moderating effect on the link between strategic intensity on SSPs and profitability (b = -.33, $p \leq .05$). This supports the study's expectations expressed in hypothesis 2a (H_{2a}). Figure 5.7 visualizes the moderating effect of SSP breadth for high and low values. With increasing strategic intensity on SSPs high breadth has a negative effect on profitability while low breadth exhibits a strongly positive moderating effect.

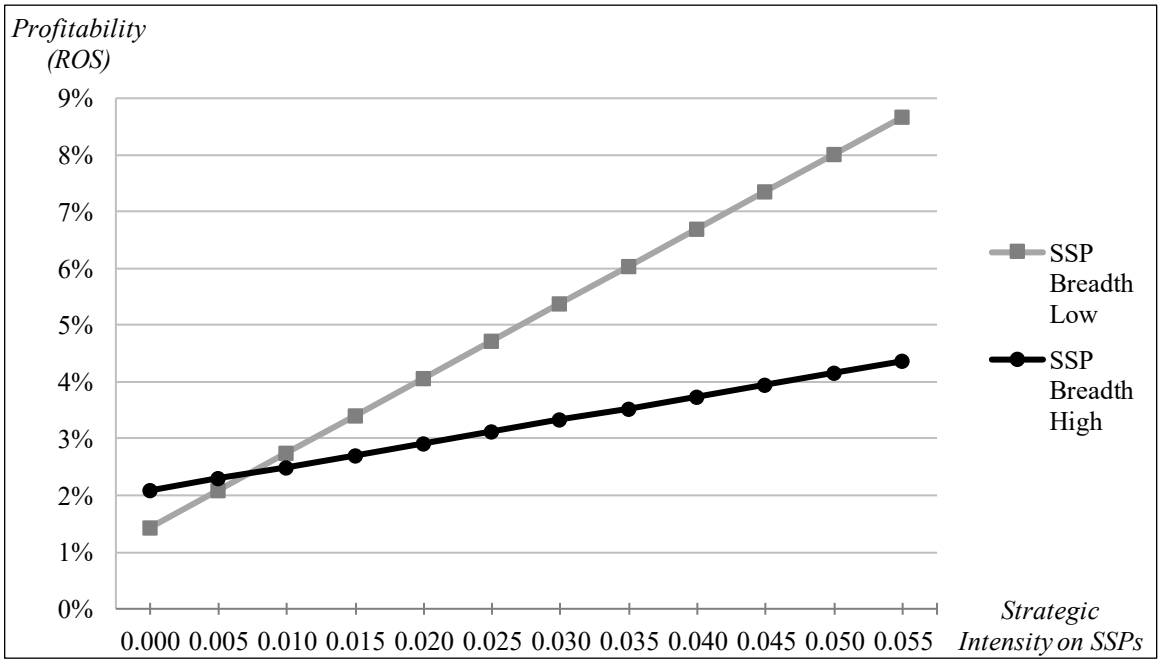

Figure 5.7: Relationship between Strategic Intensity on SSPs and SSP Breadth

SSC breadth has a significant effect on the relationship between strategic intensity on SSCs and profitability. The interaction term of squared strategic intensity on SSCs and SSC breadth is negative and significant (b = -205.01, $p < .01$) which supports hypothesis 2b (H_{2b}). This implies that SSC breadth makes strategic intensity on SSCs less profitable as seen in figure 5.8. Firms with a lower SSC breadth experience a stronger profitability effect when increasing their strategic intensity on SSCs.

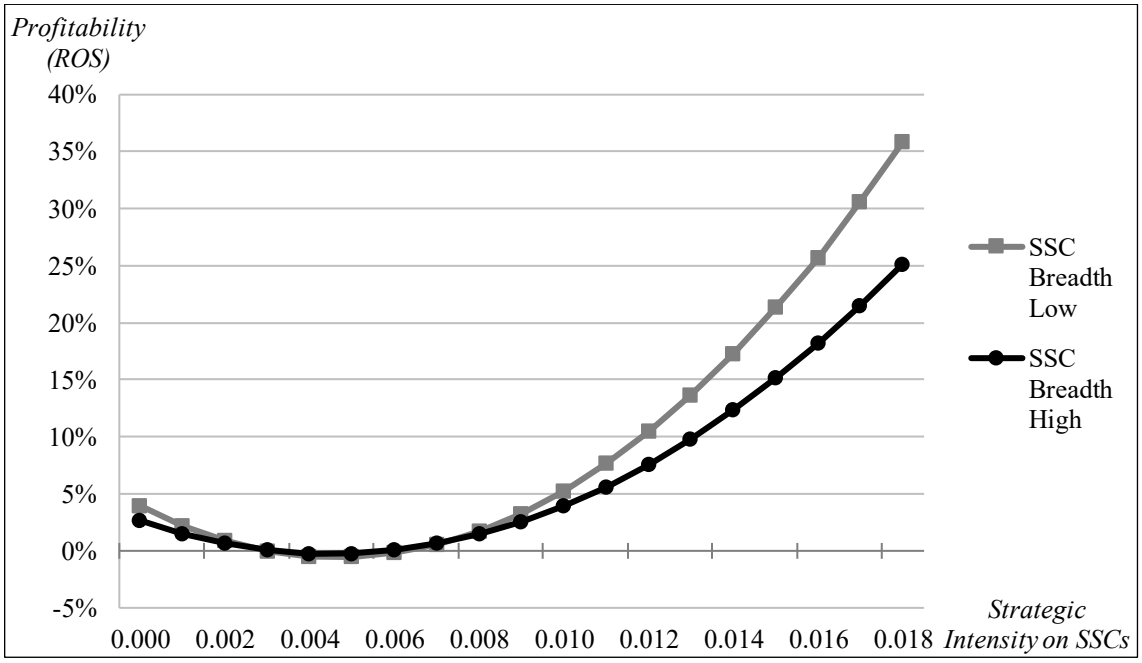

Figure 5.8: Relationship between Strategic Intensity on SSCs and SSC Breadth

The next set of moderators focus on a manufacturer's corporate growth strategy in form of organic growth (i.e., R&D intensity) and inorganic growth (i.e., acquisition intensity). The results show no significant moderating effect of organic growth on the link between strategic intensity on SSPs and profitability. Thus, the study rejects hypothesis 3a (H_{3a}).

Organic growth has a significant moderating effect on the relationship between strategic intensity on SSCs and profitability (b = 7008.58, $p < .05$). Figure 5.9 shows that organic growth makes strategic intensity on SSCs overall less profitable, which supports hypothesis 3b (H_{3b}). Higher organic growth accelerates the profitability effect of strategic intensity on SSCs (i.e., increases the slope). However, in the relevant (i.e., observed) value range of strategic intensity on SSCs, it cannot reach the profitability level of low organic growth.

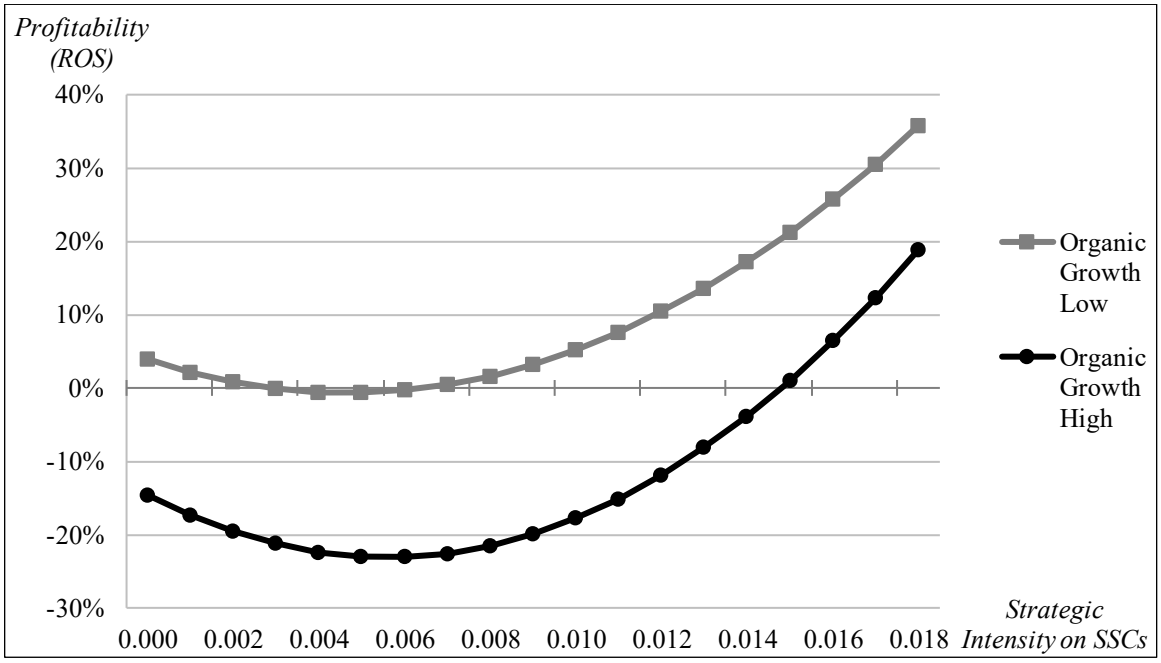

Figure 5.9: Relationship between Strategic Intensity on SSCs and Organic Growth

Inorganic growth is a second corporate growth strategy. The results show that inorganic growth does not have a moderating effect on strategic intensity on SSPs and profitability. Thus, hypothesis 4a (H_{4a}) is rejected.

However, there is a significant moderating effect of inorganic growth on the relationship between strategic intensity on SSCs and profitability (b = 2459.11, $p < .05$). As seen in figure 5.10 inorganic growth improves the profitability effect of increasing strategic intensity on SSCs. This supports hypothesis 4b (H_{4b}).

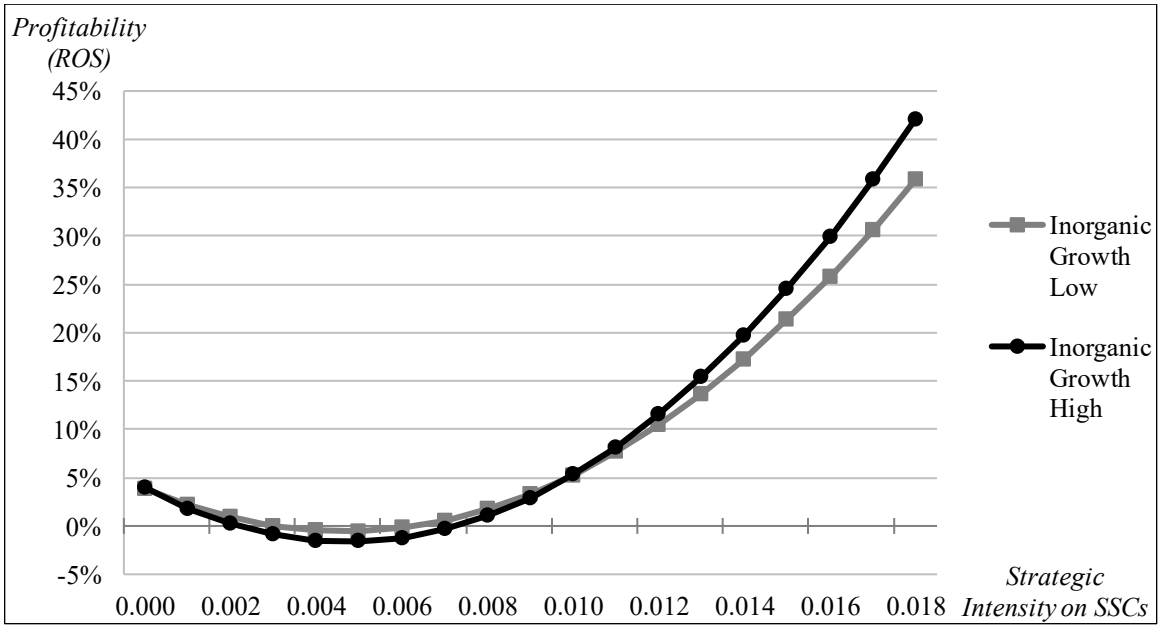

Figure 5.10: Relationship between Strategic Intensity on SSCs and Inorganic Growth

The next set of interactions shift the focus from internal to three external moderating effects. Industry growth has a positive moderating impact on the profitability effect of strategic intensity on SSPs (b = 7.28, $p < .05$). Hence, there is support for hypothesis 5a (H_{5a}) which is also visualized in figure 5.11. However, there is no significant moderating effect of industry growth on the link between strategic intensity on SSCs and profitability, which rejects hypothesis 5b (H_{5b}).

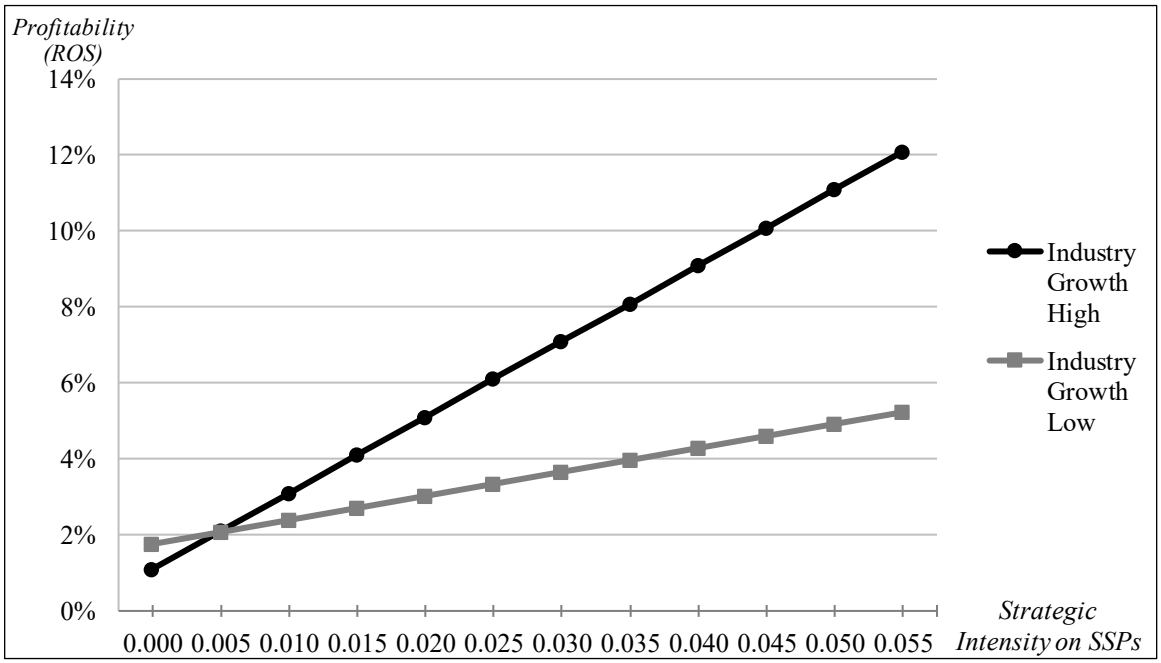

Figure 5.11: Relationship between Strategic Intensity on SSPs and Industry Growth

In support of hypothesis 6a (H_{6a}), industry dynamism has a significant negative effect on the link between strategic intensity on SSPs and profitability (b = -6.22, $p < .05$). Figure 5.12 shows that stable industry environments (i.e., low dynamism) benefits the profitability impact of increasing strategic intensity on SSPs.

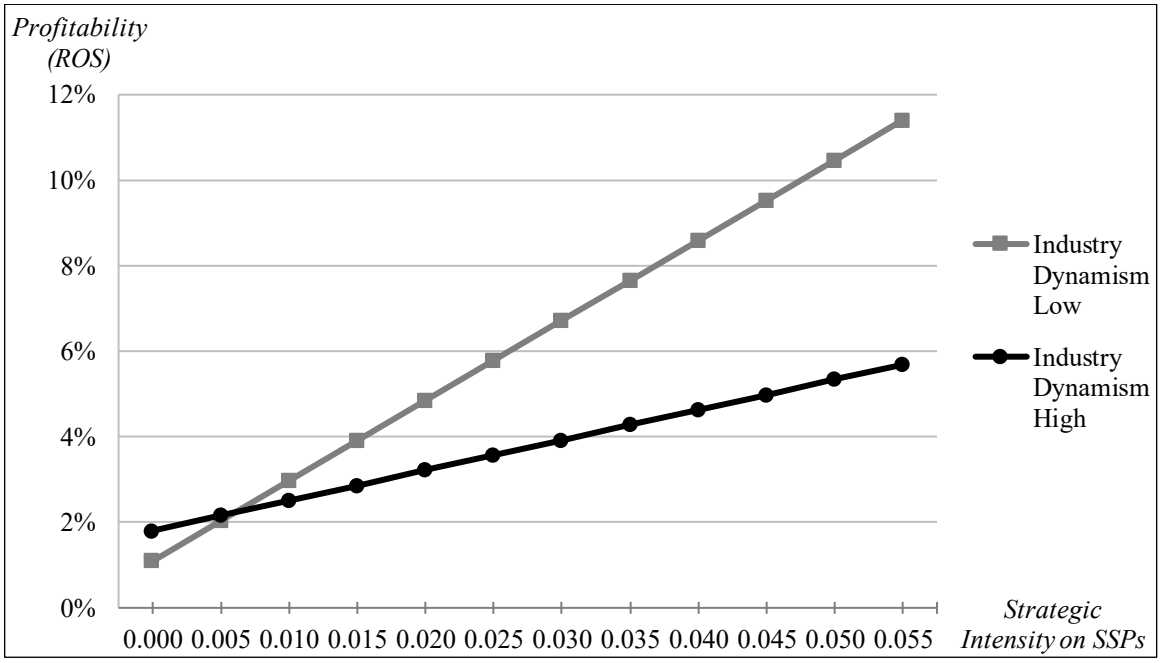

Figure 5.12: Relationship between Strategic Intensity on SSPs and Industry Dynamism

This negative moderating effect of industry dynamism is also valid for SSCs (b = -7351.31, $p < .05$) which supports hypothesis 6b (H_{6b}). As seen in figure 5.13, low industry dynamism improves the profitability impact of increasing strategic intensity on SSCs.

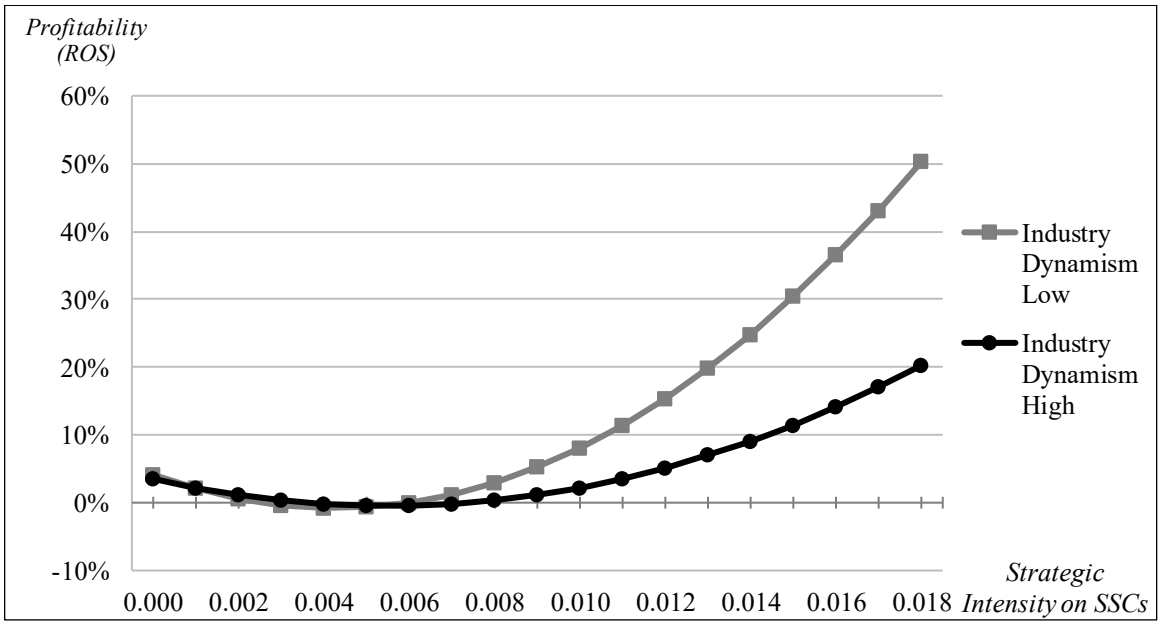

Figure 5.13: Relationship between Strategic Intensity on SSCs and Industry Dynamism

Finally, there is no significant moderating effect of industry competition on the link between strategic intensity on SSPs or SSCs and profitability. This is consistent with prior research (Fang, Palmatier, and Steenkamp 2008). The study rejects hypotheses 7a (H_{7a}) and 7b (H_{7a}). Organic growth has also a direct negative influence on firm profitability (b = -2.01, $p < .01$)

since higher R&D expenses will decrease operating income. Firm size has a positive significant effect on profitability (b = .04, $p < .01$) which may be caused by higher efficiency.

5.4.2 Validity of Results

The following paragraphs discuss different aspects concerning the validity of the study's results. A first potential bias of the results may arise from multicollinearity of the variables in the study's model (Backhaus et al. 2016). Therefore, the study examines the correlation between the coefficients in the model (Allison 1999). The correlations between the coefficients is in all cases below the threshold value of 0.6 (Allison 1999), except for interaction terms as expected (see exhibit 10 for detailed results). Thus, multicollinearity is no major concern in the study's model.

Another validity concern may arise from omitted variable bias as a source of endogeneity (Wooldridge 2002). The advantage of the fixed effects panel regression is that all time-invariant variables are dropped out (Wooldridge 2002). This substantially reduces time invariant heterogeneity and the risk of omitted variable bias.

Finally, the study performs an outlier influence test to confirm that the results are not merely driven by extreme values. Following a data winsorizing approach, the 1st and 99th percentiles of the dependent variable (i.e., firm profitability) are removed (Homburg, Vollmayr, and Hahn 2014). A new fixed effects panel regression is performed on the modified sample. The prior results of Model 1 and Model 2 remain robust at the 10% significance level. Exhibit 11 presents the detailed results for the modified sample.

6. Discussion

The final chapter starts with a summary of the study's most important insights (subchapter 6.1). Subchapter 6.2 present the implications of the results for marketing research as well as marketing managers. Subchapter 6.3 points out limitations of this study and concludes with an outlook of future servitization research avenues.

6.1 Summary

The manufacturing industry is under pressure to sustain profitability and growth under conditions of accelerating product commoditization and intense global competition (Miles 2018; Wise and Baumgartner 1999). In the past decades servitization has evolved to become one of the central strategies for sustainable growth in industrial markets (Raddats et al. 2019). Manufacturers' expansion into services has proven not to be a mere hype during the 1980s and 1990s (e.g., Vandermerwe, Matthews, and Rada 1989; Vandermerwe and Rada 1988; Wise and Baumgartner 1999) but a continuous trend within the industry (Lightfoot, Baines, and Smart 2013; Rabetino et al. 2018). Servitization of manufacturing becomes evident in numerous real-world settings such as IBM's shift from a hardware manufacturer to a consulting service provider, or Rolls Royce innovative power-by-the-hour service model (Gerstner 2002; Smith 2014). Real world applications continue to fuel the academic interest into the topic of servitization (Baines et al. 2009; Emerald 2020). However, to date two important aspects of servitization require more research attention. First, there is no quantitative research that portrays the development of today's service landscape. Second, despite first research studies, there is only a limited understanding about the complex topic of financial servitization outcomes (Wang, Lai, and Shou 2018). This study's objective is to close both of these gaps in servitization research.

The study's first part focuses on the development of the service landscape, which refers to the growth of different service categories within the manufacturing industry. Neely (2008) offers first insights about the state of servitization and service categories in different countries. However, the author does not take a longitudinal view and focuses on a single point of time. Moreover, the research study has been conducted in 2007 which may not reflect today's dynamic servitization reality. Against this backdrop, this study offers not only an update on the current state of servitization but traces the development of service categories over time. The

following research questions guide the study's descriptive analysis of industrial service categories:

(1.1) How do service categories develop over time?

(1.2) How do service categories develop in different manufacturing industries?

(1.3) How do service categories develop depending on firm size?

Extant research offers different levels of granularity to categorize services (e.g., Mathieu 2001a; Neely 2008; Ulaga and Reinartz 2011). The study uses two service categorizations, Mathieu's broad SSP-SSC classification (Mathieu 2001a) and Neely's fine-grained 13 service categories (Lee and Hong 2016; Neely 2008). This dual perspective allows to detect broad trends within servitization and to zoom into finer categories to reveal underlying drivers. The first research question 1.1 aims to draw an overall picture on how industrial services develop during the past decade. The SSP-SSC classification of industrial services shows that in the last ten years manufacturers' focus on SSPs remains relatively constant. On the one hand, this stable development underlines that SSPs are a staple in a manufacturer's portfolio (Ulaga and Reinartz 2011). Typical SSPs such as repair, maintenance, and spare part services are often a basic prerequisite to compete in the market (Ulaga and Reinartz 2011). On the other hand, the constant trend indicates that the SSPs growth in the last ten years has reached a plateau. This stagnant development can be seen also in the fine-grained service categories such as maintenance and support services or installation and implementation services. Overall, manufacturers' focus on SSPs has remained about the same in the past ten years.

In contrast, SSCs experience a continuous growth during the same period. A fine-grained view on different SSC-related categories reveals an increase in solution, consulting, and outsourcing services. A possible explanation is that new technological trends (e.g., digitalization) allow manufacturers to offer innovative SSCs. For instance, manufacturers can use digital platforms to collect insights from customer usage data and offer consulting services (Cenamor, Rönnberg Sjödin, and Parida 2017). While SSCs experience a strong growth, they are still below the level of SSPs. This underlines that base services (i.e., SSPs) such as repairs, spare parts, maintenance, and installation are still a predominant part of manufacturers' service business. Nevertheless, there is a clear trend towards offering more and more SSCs.

The second research question 1.2 looks at how service categories develop within the four major manufacturing industries of the sample. It can be seen that industries differ especially in

their level of SSP and SSC offering. While the electronic equipment (SIC 36) and the commercial machinery (SIC 35) have the highest service levels, the chemical industry (SIC 28) has the lowest SSP and SSC level. This underlines that the relevance or development level of servitization differs in manufacturing industries.

The third research question 1.3 investigates how the firm size influences the development of service categories. The results show that large companies (i.e., firms with more than 500 employees) follow the general trend of the sample. That means SSPs stay at a constant level, while SSCs grow continuously in the past decade. In contrast, small to mid-sized enterprises (SMEs) have more fluctuations in their SSP and SSC development. SSC grow less strong in SMEs which may be caused by the complex resource and capability requirements for SSCs. Hence, a larger firm size fosters a more stable SSP and SSC development over time.

The study's second part focuses on the financial outcome of a firm's servitization process. Prior research about financial outcomes of services is inconclusive (Wang, Lai, and Shou 2018). Thus, the following research questions aim to shed more light on the topic:

(2.1) How do services influence a firm's profitability?

(2.2) How do contingency factors influence the effect of services on profitability?

The investigation of the first research question 2.1 reveals that a manufacturer's strategic intensity on SSPs does not have a direct effect on a firm's profitability. SSPs are closely related to a manufacturer's product-related competencies which makes them easy to implement and cost efficient due to scale economies (Fang, Palmatier, and Steenkamp 2008; Ulaga and Reinartz 2011; Varadarajan 1986). However, the critical downside of SSPs is that they often cannot fulfill the VRIN conditions because they are easily imitable by competitors (Kowalkowski et al. 2013). In addition, SSP offerings such as installation and maintenance are regarded as standard services by customers which degrades a potential differentiation advantage of SSPs. The study's empirical results support the RBV-based argument that SSP-related resources and capabilities often cannot create a sustainable competitive advantage in the market (Eggert et al. 2014). Therefore, a manufacturer's strategic focus on SSPs will not contribute to a superior profit generation per se.

In contrast, strategic intensity on SSCs exhibits a curvilinear direct effect on profitability. This is due to the inherently different resource-capability characteristics of SSCs compared to SSPs (Mathieu 2001a). SSC-related resources and capabilities are focused on customer pro-

cesses and more detached from the manufacturers existing product-based competencies (Eggert et al. 2014; Mathieu 2001a). This can explain the curvilinear relationship between strategic intensity on SSCs and firm profitability. An initially low to negative profitability effect of strategic intensity on SSCs is mainly caused by high start-up costs. Manufacturers building or expanding their SSC business need to acquire new and often complex resources and capabilities (Ulaga and Reinartz 2011). This will create challenges such as high costs and a steep learning curve (Ulaga and Reinartz 2011; Valtakoski 2017). In addition, high customization of SSC resources and capabilities and low overlap with existing competencies limits efficiency gains through economies of scale. At the organizational level, a higher strategic focus on SSCs will require fundamental organizational adjustments (Baines et al. 2017; Davies, Brady, and Hobday 2006). This can create internal tension and resistance from employees which can hamper the implementation of SSC resources and capabilities (Fang, Palmatier, and Steenkamp 2008). Hence, increasing strategic intensity on SSCs will initially face substantial challenges (e.g., costs and resistance) which hampers the profitability effect of SSCs. The study's empirical results support this argument and show that strategic intensity on SSCs has at low levels a negative effect on firm profitability.

However, the negative effects of strategic intensity on SSCs occur primarily at an initial phase. Once the manufacturer overcomes challenges at the beginning and successfully implements an SSC strategy, the profitability effect is increasingly positive. The critical advantage of SSC-related resources and capabilities is that they can fulfill the VRIN conditions and represent a sustainable competitive advantage (Eggert et al. 2014; Peteraf 1993). In particular, value in SSC offerings (e.g., customer solutions) is co-created with the customer (Mathieu 2001a). This creates intimate customer relationships and customer loyalty (Palmatier et al. 2006) which can serve as an effective entry barrier and protection against imitations. Hence, once a manufacturer surpasses a threshold of strategic intensity on SSCs it can reap the profits of a sustainable competitive advantage. Overall, the study's results provide quantitative evidence for a u-shaped relationship between strategic intensity on SSCs and firm profitability.

The second research question 2.2 examines how various internal and environmental factors influence servitization profitability. The study investigates service scope and corporate growth strategy as two internal contingency factors. The environmental contingency factors include industry growth, industry dynamism, and industry competition.

The first result is that service scope (i.e., SSP and SSC breadth) has a negative moderating effect on the relationship between strategic intensity on servitization and firm profitability. This is consistent with the study's theoretical considerations which present two key arguments for an overall negative moderating effect of service scope. First, a higher service scope will not automatically lead to higher economies of scale and according cost savings. In case of SSPs a higher breadth may initially result in economies of scale and higher cost efficiency. However, scale economies are not unlimited (Stigler 1958) which means increasing SSP breadth will eventually not lead to cost reductions anymore. For SSCs, scale economies are even harder to achieve, since they are often highly customized to customer needs and require new resources and capabilities (Mathieu 2001a; Ulaga and Reinartz 2011). A second negative implication of higher service scope is that manufacturers need to allocate its set of limited resources and capabilities across more activities. On the one hand, this can results in a dilution of scarce resources (Fang, Palmatier, and Steenkamp 2008). On the other hand, it can lead to internal rivalries for limited resources (Fang, Palmatier, and Steenkamp 2008). These organizational tensions can hamper a firm's operational efficiency and financial performance. The study's results about the moderating effect of service scope underline that servitization is most profitable if it is implemented as a focused strategy.

The second internal factor is a firm's corporate growth strategy which consists of organic and inorganic growth. The study's results show a negative moderating effect of organic growth on the link between strategic intensity on SSCs and firm profitability. This is in line with the prior theoretical arguments which point out two reasons for the negative effect. First, SSC-related resources and capabilities often go beyond a manufacturer's familiar product-based competencies (Ulaga and Reinartz 2011). Hence, focusing organic growth (i.e., R&D resources) on SSCs means venturing into unknown territory which represents a substantial risk of creating sunk costs. In addition, even if the organic growth strategy is successful in finding SSC innovations, the customized character of SSCs may hamper scalability and positive profitability effects (Nezami, Worm, and Palmatier 2018). A second downside of organic growth is that it creates committed resources and capabilities (Kraatz and Zajac 2001). Committed resources decrease a firm's overall flexibility and can slow down change processes which are especially relevant for the SSC business (Eggert et al. 2014; Kraatz and Zajac 2001; Selznick 1957). Overall, the empirical results provide quantitative evidence for the negative moderat-

ing effect of organic growth on the relationship between strategic intensity on SSCs and profitability.

In contrast, the study shows a positive moderating effect of inorganic growth on the link between strategic intensity on SSCs and profitability. The main reason for this positive effect is that inorganic growth (i.e., acquisitions) can help manufacturers to quickly gain SSC-critical resources and capabilities (Wernerfelt 1984). The acquisition of a firm with existing SSC-based resources and capabilities can help manufacturers to avoid the challenges (e.g., steep learning curve) when developing SSC competencies inhouse. In addition, some resources and capabilities such as brand reputation may not be developed organically. Acquisitions can help manufacturers to gain these "otherwise non-marketable resources" (Wernerfelt 1984, p. 175). This can aide the manufacturer's SSC business to fulfill the VRIN conditions and constitute a sustainable competitive advantage.

A firm's corporate growth strategy does not have a significant effect on the link between strategic intensity on SSPs and firm profitability. The study has argued for a positive moderating effect of organic growth since innovations may help SSPs to fulfill the VRIN conditions through cost or differentiation advantages (H_{3a}). However, the empirical results do not support this claim. A possible reason is that high organic growth may not be sufficient to create a sustainable competitive advantage. Competitors often need to invest less resources to copy an innovation (Wernerfelt 1984). Hence, manufacturers are under constant pressure to invest into organic growth to keep up "a technological lead" (Wernerfelt 1984, p. 174). This creates high R&D expenses which can reduce profit gains from the innovations. Thus, there is no significant effect on a firm's bottom line. However, there is more research needed to shed light on the relationship between SSPs and organic growth strategies.

Inorganic growth also does not have a significant effect on the relationship between strategic intensity on SSPs and firm profitability. The study has argued for a non-directional moderating effect since there are positive and negative implications of inorganic growth (H_{4a}). These positive and negative mechanism may cancel each other out if they are investigated at a highly aggregated level. Therefore, future research should try to have a more fine-grained view on inorganic growth strategies and for instance look at the target properties. This may reveal whether the acquired resources and capabilities are similar or complementary to the firm's existing service resources and capabilities. Extant research underlines that resource alignment

between the acquirer and target is crucial for financial success of an acquisition (Harrison et al. 1991). Overall, the study's insignificant result calls for more detailed research on the link between inorganic growth and financial outcomes of strategic intensity on SSPs.

Two environmental contingency factors moderate the link between strategic intensity on servitization and profitability. First, industry growth has a positive moderating effect on the relationship between strategic intensity on SSPs and profitability. This supports the study theoretical argument that industry growth presents two key advantages for manufacturer's SSP business. A first benefit is that high growth markets do not have an established technology in the marketplace (Klepper 1997). This offers manufacturers the potential to develop and establish SSPs which can become the industry standard in the market. Moreover, manufacturers can choose to specialize in a niche market and develop superior SSP offerings in that area (Gebauer and Binz 2018). The second advantage is that a growing industry reduces competitive pressure (McDougall et al. 1994; Miller and Camp 1985; Porter 1980). This is critical for sustaining the profitability of SSPs since they often cannot be protected against imitation (Kowalkowski et al. 2013).

The second relevant environmental factor is industry dynamism which negatively moderates the relationship between strategic intensity on servitization and profitability. In general, instable environments exhibit a higher operational risk for manufacturers (Josephson et al. 2016) which can result in higher costs and reduced profitability. However, particularly services may not fare well under volatile market conditions due to two reasons. First, a strategic focus on SSPs and SSCs creates various committed resources and capabilities which limits a firm's strategic flexibility (Eggert et al. 2014; Kraatz and Zajac 2001; Selznick 1957). This means a firm cannot react to sudden environmental changes and quickly adjust their service competencies (Kraatz and Zajac 2001; Selznick 1957). Thus, volatile market conditions expose manufacturers service resources and capabilities to a high risk of becoming less relevant which will reduce firm profitability. Second, high industry dynamism may diminish benefits from organizational learning in services. The unpredictability of the market development may render the current service knowledge irrelevant in the future (Farjoun and Levin 2011). Hence, manufacturers may not fully benefit from knowledge spillovers which could improve operational and financial performance. The study's empirical results provide quantitative evidence to these theoretical considerations regarding industry dynamism.

In contrast to the study's expectations, industry growth does not have a positive moderating effect on the link between strategic intensity on SSCs and firm profitability (H_{5b}). A possible explanation is that high-growth markets offer not only opportunities but also entail risks (Aaker and Day 1986). An inherent risk factor in fast growing industries is the change of technological or other key factors (Aaker and Day 1986; Klepper 1997). That means for instance a manufacturer may invest into a technology or business model that may not establish itself in the market (Aaker and Day 1986). This is especially risky for SSC offerings which are often less flexible to adjust to changing environmental conditions. SSCs such as solutions are often highly customized to a customer need, and the resources and capabilities cannot be easily redeployed elsewhere (Bond et al. 2020). Thus, SSCs often create a commitment to a certain resource-capability configuration which reduces a manufacturer's strategic flexibility (Kraatz and Zajac 2001; Selznick 1957). This might be a reason for industry growth having overall no positive moderating effect. However, there is more research needed to understand the underlying mechanisms between industry growth, strategic intensity on SSCs, and firm profitability.

Finally, the study results do not show a significant moderating effect of industry competition on strategic intensity on servitization (H_{7a} and H_{7b}). Based on theoretical considerations the study expected services to fare particularly well in highly competitive environments. In addition, most servitization research underlines competitive pressure as a key driver for the emergence of services in manufacturing (e.g., Eggert et al. 2014; Ulaga and Reinartz 2011; Vandermerwe and Rada 1988). A possible explanation for this counterintuitive result might be that servitization is not purely driven by competitive pressure but also by other important factors such as developing new revenue streams or improving profit margins (Wise and Baumgartner 1999). Moreover, the descriptive part of this study and prior research (Fang, Palmatier, and Steenkamp 2008) underline that manufacturers increasingly focus on services. This general trend might render services more and more as a common standard to compete in the market. Hence, services might not be regarded as a particularly differentiating factor in highly competitive environments which explains the missing moderating effect. While prior research also did not find a moderating effect of industry competition (Fang, Palmatier, and Steenkamp 2008) it is worthwhile to conduct more research in this area. A more focused study on industry competition may reveal mechanism which explain the link between competitive pressure in the market, servitization, and financial performance.

All in all, the study results offer three main insights regarding moderating effects. First, a firm's servitization strategy is most profitable if it focuses on a narrow set of services. High service scope seems to diminish the profitability of service offerings. Second, the profitability effect of strategic intensity on SSPs depends mostly on environmental factors. Under certain environmental industry conditions, namely high growth and low dynamism, a strategic intensity on SSPs returns the highest profitability. The third insight is that the profitability effect of strategic intensity on SSCs depends primarily on organizational parameters. Manufacturers focusing on inorganic growth instead of organic growth reap the highest returns from their SSC strategy.

6.2 Implications

The study results have several implications for marketing research (subchapter 6.2.1) and management (subchapter 6.2.2) which are discussed in the following chapters.

6.2.1 Theoretical Implications

In the past years there has been a large amount of research conducted about services in the manufacturing industry (Rabetino et al. 2018). These research studies have significantly contributed to the better understanding of the complex mechanisms behind a manufacturers' servitization process. However, there is still need for additional servitization research for two main reasons. First, dynamic changes in industries and the environment will change servitization processes and implications. Thus, researchers need to analyze up-to-date data to get valid insights about servitization. Second, extant research returns inconclusive results about important aspects of servitization such as financial outcomes (Wang, Lai, and Shou 2018). Additional research can help to clarify these ambiguities. Against this backdrop, this study offers several theoretical implications for marketing research.

The first descriptive part of this study gives an overview of the current service landscape in the manufacturing industry. The main theoretical implication is that services are not a homogenous mass (Mathieu 2001a). Instead, there are distinctive service categories which develop differently over time and are influenced by manufacturing industry and firm size. This provides quantitative evidence for the need of a differentiated view on industrial services. On the one hand, this supports extant servitization research which differentiates service categories in their analyses (e.g., Eggert et al. 2014; Visnjic, Wiengarten, and Neely 2016). On the other

hand, it cautions researchers about a potential bias in studies which regard services as a homogenous entity.

The second part of this study focuses on the profitability effect of SSP and SSC offerings and how it is affected by internal and external contingencies. The results of the direct SSP and SSC effects provide further evidence for the heterogenous character of industrial services. Again, the implication for marketing research is that analyzing services requires a differentiated approach.

Another insight is that strategic intensity on SSCs has a curvilinear effect on firm profitability while SSPs exhibit a linear effect. On the one side, this supports extant servitization research which also observes a non-linear relationship between servitization and financial outcomes (Fang, Palmatier, and Steenkamp 2008; Nezami, Worm, and Palmatier 2018; Suarez, Cusumano, and Kahl 2013). On the other side, it can explain the contradictions in extant research about financial outcomes of services. If research fails to acknowledge different service categories, it may mix up different financial trajectories leading to different outcomes. This study's result help to disentangle the profitability effect of services and reduce uncertainty caused by inconclusive research results.

An internal contingency factor in this study is service scope, which refers to the breadth of a firm's SSP or SSC portfolio. Prior research has employed either the level of services (e.g., service ratio) (Fang, Palmatier, and Steenkamp 2008) or service breadth (Eggert et al. 2014) to measure a firm's servitization efforts. This study combines both perspective (i.e., service level and breadth) to investigate financial outcomes. This is a unique approach and yields new insights on how the level of service intensity and breadth interact with each other. In addition, the negative profitability effect of service scope supports similar results of extant studies (Eggert et al. 2014).

The second internal contingency factor is a firm's corporate growth strategy, which consists of organic and inorganic growth. So far, servitization research has not extensively investigated on how manufacturers gain service-related resources and capabilities (Kowalkowski, Gebauer, and Oliva 2017). Some researchers assume that firms build up their service competencies primarily inhouse (Böhm, Eggert, and Thiesbrummel 2017; Kowalkowski, Gebauer, and Oliva 2017). However, real world examples show that firms also gain service resources and capabilities externally through acquisitions (Kowalkowski, Gebauer, and Oliva 2017;

Oberle 2020). This strategic decision between organic and inorganic service growth strategies is a major research gap in servitization (Kowalkowski, Gebauer, and Oliva 2017; Raddats et al. 2019). This study offers first insights on how R&D activities (i.e., organic growth) and acquisitions (i.e., inorganic growth) influence the profitability effect of SSPs and SSCs. It may guide marketing research to further investigate the relationship between a firm's corporate growth strategy and servitization.

The environmental contingency factors, industry growth and industry dynamism, influence the profitability effects of SSPs and SSCs. This supports extant research insights about the important role of environmental factors for the financial success of services (Fang, Palmatier, and Steenkamp 2008; Suarez, Cusumano, and Kahl 2013; Worm et al. 2017). In addition, the study's SSP-SSC differentiation helps to better understand industry variables' influence on different service types.

The study has also two methodological implications for marketing research. First, servitization research is primarily based on qualitative data and there is only a limited number of quantitative research studies (Raddats et al. 2019). Thus, this study is a valuable contribution to expand servitization insights based on large quantitative data. In addition, it can help to increase the validity of qualitative research insights.

Second, the study employs a unique approach to collect and analyze its servitization data. Prior research has used the 10-K form as a source for servitization data (e.g., Benedettini, Swink, and Neely 2017; Neely 2008; Visnjic, Wiengarten, and Neely 2016). However, extant studies use a limited service-keyword dictionary to measure their servitization variable, which can lead to measurement errors. In addition, the variable is measured on a categorical scale, which may lead to information loss. This study overcomes both shortcomings of extant research. It employs a comprehensive service-keyword dictionary to accurately measure its servitization variable (Lee and Hong 2016). In addition, the servitization variables are measured on a continuous scale. Future servitization research can employ this study's approach to get reliable servitization data from text-based sources.

Overall, the study's results have several implications for marketing research. First, they add quantitative evidence for extant servitization research and help to clarify inconclusive research results. Second, the study offers new insights about the impact of corporate growth

strategies on servitization. Finally, the study's unique method to collect and analyze servitization data can be employed in new servitization studies.

6.2.2 Managerial Implications

Manufacturers increasingly rely on servitization to escape harsh market conditions such as intense competition and rapid product commoditization (Wise and Baumgartner 1999). Servitization is a major strategic choice for manufacturers with sweeping organizational changes and challenges (Baines et al. 2017; Davies, Brady, and Hobday 2006). Therefore, managers are interested in the financial outcomes of a servitization strategy. This study offers multiple insights on servitization and can help managers to better understand under which conditions services are most profitable.

The descriptive part (chapter 3) of this study has several implications for managers in manufacturing industries. First, the development of SSPs and SSCs shows that industrial services are not a homogenous mass (Mathieu 2001a). Thus, managers need to acknowledge this heterogenous character of services when making service-related decisions. Otherwise, it can lead to an ineffective management of a firm's servitization strategy.

Second, the SSP-SSC descriptive analysis gives managers a good overview about the servitization landscape in their industry. This enables management to compare the firm's servitization status against the industry average. The insights of such a benchmark analysis help managers to better evaluate the firm's competitive position in servitization. Based on that information management can take appropriate actions to improve the firm's competitiveness in services. For instance, the comparison may reveal that a firm's SSC business is below the industry average. Thus, managers may decide to invest more into SSCs to keep up with industry standards.

A third valuable insight results from the fine-grained view on service categories. The longitudinal analysis helps managers to detect long-term positive or negative trends in service categories. For instance, in the past ten years the focus on services in support of customers (SSCs) have experienced a strong growth. Managers can use that information for strategic decision about their service portfolio such as service investment or divestment decisions.

The study's second part (chapter 5) can help managers to better understand and anticipate profitability implications of servitization. The first insight confirms the need for a differenti-

ated view on industrial services. The study results show that strategic intensity on SSPs and SSCs have a substantially different effect on a firm's profitability. Therefore, managers need to have a differentiated service perspective to ensure the right strategic decisions for SSPs and SSCs.

The second insight is that strategic intensity on SSPs does not have a direct effect on a firm's profitability. For managers, this means that expanding the SSP business will not improve firm profitability per se. Instead, the profitability effect of increasing strategic intensity on SSPs depends mostly on environmental contingencies. The firm management needs to evaluate its industry environment before increasing its strategic intensity on SSPs. The study results show that two industry-level factors play a crucial role in this context. On the one hand, a high industry growth will increase the profitability effect of strategic intensity on SSPs. On the other hand, high industry dynamism will have a detrimental effect on the link between profitability and SSPs. From a management perspective, this implies that growing and stable industries offer the best conditions for a profitable increase of strategic intensity on SSPs.

Another insight of the study is the negative moderating effect of SSP breadth on the link between strategic intensity on SSPs and profitability. This implies that managers should concentrate their resources and capabilities to a low number of SSPs to maintain firm profitability. It also cautions management not to dilute their SSP competencies and create organizational tensions by adding more and more SSP offerings (Fang, Palmatier, and Steenkamp 2008).

The next research result shows a curvilinear relationship between strategic intensity on SSCs and firm profitability. When manufacturers venture into the SSC business they need to acquire several new resources and capabilities which can create challenges like a steep learning curve (Ulaga and Reinartz 2011). This will initially hamper profit generation. However, once the manufacturer acquired critical SSC competencies it can build a sustainable competitive advantage and improve profitability. The implication for management is that an initial investment into SSCs will not immediately translate into higher profits. However, managers need to stay resilient and continue increasing their strategic focus on SSCs to reach the threshold to improved profitability. This is an important insight which can help managers to defend an initially sluggish SSC business against internal critics. In addition, it cautions firms not to give up too soon on their SSC business but accumulate enough resources and capabilities before a final evaluation.

The relationship between strategic intensity on SSCs and profitability is primarily moderated by internal contingency factors. First, a high SSC breadth has a negative moderating effect which suggest managers to focus on a small set of SSCs. Resources and capabilities required for SSCs are often unknown to traditional manufacturers (Ulaga and Reinartz 2011) which complicates their implementation. Manufacturers who deal with a large SSC portfolio will face more implementation challenges which hamper profit generation. Therefore, managers can improve the successful implementation of an SSC strategy if they concentrate their efforts on a small portfolio.

A second internal contingency factor is a firm's corporate growth strategy. Research and development expenses as an organic growth strategy have a negative moderating effect on the profitability of an SSC business. In contrast, an inorganic growth strategy has a positive moderating effect. For managers, this means that acquisitions offer a better way to improve the profitability effect of an SSC business. The key advantage of acquisitions is that firms can gain critical SSC-related resources and capabilities, which are hard to build up internally (Wernerfelt 1984). Therefore, managers should look out for suitable acquisition targets when increasing strategic intensity on SSCs.

The next contingency factor focuses on a manufacturer's external environment, namely industry dynamism. The study results show that industry dynamism has a negative moderating effect on the link between strategic intensity on SSCs and profitability. Therefore, managers must evaluate the market environment of their SSC business to avoid profitability losses. Management should avoid entering turbulent and unpredictable markets with SSC offerings which perform better under stable conditions.

All in all, the study results have numerous implications for management. The three key insights of this study for practitioners are as follows. First, a servitization strategy is most profitable if it focuses on a narrow service portfolio. Second, services are not a homogenous mass but consists of SSPs and SSCs which have different effects on firm profitability. Third, the profitability effect of an SSP strategy is primarily affected by environmental contingency factors, while the SSC strategy depends mostly on organizational factors. Managers can use these three insights to optimize their servitization strategy and guide important management decisions.

6.3 Limitations and Future Research Directions

Like all empirical work this research study has its limitations, which offer new research opportunities. A first limitation is that the analyzed sample consist exclusively of U.S. public manufacturers. This offers advantages such as high data availability and consistency, but also creates two limitations. First, servitization is an international phenomenon (Neely 2008) that is not limited to the United States. Country-level differences of servitization may limit the validity of the study's results in other countries. This is most likely the case for developing countries such as China, which exhibit substantial differences to the United States (Ralston et al. 1997). Second, the sample focuses on public companies. Research indicates that in certain cases public and private firms differ significantly in their strategies (Sheen 2020). Hence, the study results may not always apply to privately owned manufacturers. These two limitations offer new research avenues in the future. Researchers can examine an international sample of manufacturers and include private companies to draw a more comprehensive view on servitization.

A second limitation of the study is the direct effect perspective of servitization on profitability. While prior research also models a direct financial effect of servitization (e.g., Fang, Palmatier, and Steenkamp 2008; Suarez, Cusumano, and Kahl 2013), there might be underlying mediating mechanism which are ignored. For instance, the management team may play an important role in servitization processes and influence outcomes (Antioco et al. 2008). Therefore, future research can investigate mediating factors and reveal underlying mechanism for the financial impact of servitization.

A third limitation of the study is the measurement of strategic intensity on SSPs and SSCs. The text-based measurement offers an accurate and fine-grained view on a firm's servitization strategy. Its validity and reliability are also confirmed in this study. However, from a management perspective a text-based measurement is hard to grasp. Unlike accounting-based figures, text-based numbers are not directly visible in a balance sheet and cannot be easily identified by managers. Thus, future research can try to translate text-based servitization measurements into easy to identify key performance indices (KPIs).

Another limitation is caused by the method of fixed-effects (FE) panel regression. The FE panel regression has the advantage to eliminate all time invariant heterogeneity, which minimizes the risk of omitted variable bias. However, the method cannot control for unobserved

time varying influences (Giesselmann and Windzio 2012). This means that there are potentially other variables which could further explain the profitability impact of SSPs and SSCs. Therefore, future research could look at more time varying contingency factors and improve the understanding for servitization.

Overall, this study helps to better understand servitization and its financial implications. With an innovative text-based method the study presents new insights about profitability effects of SSPs and SSCs. The study hopes that future research can use this method to add to the knowledge about servitization in the manufacturing industry. The prior limitations present possible starting points for new promising research studies.

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Exhibit

Term [Year]	Core Definition	Key Characteristics	Selected Authors
Systems Selling [1964]	"[…] in systems selling the seller provides, through a combination of products and services, a fulfillment of a more extended customer need than is the case in product selling" (Mattsson 1973, p. 108)	▪ Different levels of systems selling along a continuum (single subsystem vs. full system) ▪ Individual parts can be sold separately ▪ High standardization of systems ▪ Customization to a certain degree (Mattsson 1973)	Murray (1964) Mattsson (1973)
Servitization [1988]	"Modern corporations are increasingly offering fuller market packages or 'bundles' of customer-focussed combinations of goods, services, support, self-service, and knowledge. […] This movement is termed the 'servitization of business'[…]" (Vandermerwe and Rada 1988, p. 314)	▪ Strategic realignment towards services ▪ Modules within a bundle are flexible and can be sold separately ▪ Standardization or customization of modules depending on the situation ▪ Focus on building close customer relationships (Vandermerwe and Rada 1988)	Vandermerwe and Rada (1988)
Naked Solution [1995]	"[…] bare-bones-minimum number of services uniformly valued by all customers in a given segment […]. These naked solutions should then be 'wrapped' with options - particular services valued by individual customers within the segment." (Anderson and Narus 1995, p. 76)	▪ Bundle consisting of essential services and supplementary services ▪ High flexibility in design of bundles for individual customers (Anderson and Narus 1995)	Anderson and Narus (1995)
Product-Service Systems [1999]	"A Product Service system (PS system) is a marketable set of products and services capable of jointly fulfilling a user's need." (Goedkoop et al. 1999, p. 18)	▪ Strategic, long-time perspective ▪ Lowered environmental impact ▪ Higher sustainability (Goedkoop et al. 1999)	Goedkoop et al. (1999) Mont (2002)
[…] Solutions [1999]	"A third effective business model is to combine products and services into a seamless offering that addresses a pressing customer need." (Wise and Baumgartner 1999, p. 138)	▪ Solutions address often complex customer needs ▪ High integration of products and services within a solution ▪ High customization of solutions (Wise and Baumgartner 1999)	Wise and Baumgartner (1999) Davies et al. (2001) Tuli, Kohli, and Bharadwaj (2007) Macdonald, Kleinaltenkamp, and Wilson (2016)

Service Infusion [2000]	"We describe the process of adding these increasingly complex services and solutions as infusing them into the company's business model […]" (Zeithaml and Brown 2014, p. 5)	▪ Tactical addition of services to the business model ▪ Infused services can be categorized along a continuum (SSP vs. SSC) (Zeithaml and Brown 2014)	Edvardsson et al. (2000) Zeithaml and Brown (2014) Ostrom et al. (2015) Forkmann et al. (2017)
Full Service [2001]	"Based on the industrial service literature, we define full service as 'a comprehensive bundle of products and/or services, that fully satisfies the needs and wants of a customer related to a specific event or problem.'" (Stremersch, Wuyts, and Frambach 2001, p. 2)	▪ Comprehensive bundle of physical products and services ▪ Objective to solve an entire customer problem (Stremersch, Wuyts, and Frambach 2001)	Stremersch, Wuyts, and Frambach (2001)
Hybrid Service Bundles (Hybride Leistungsbündel) [2005]	A hybrid service bundle is an integrated set of services, products, and software components. (Meier and Uhlmann 2012)	▪ Software as a key element of the bundle ▪ Focus on industrial applications setting (Meier and Uhlmann 2012)	Meier, Uhlmann, and Kortmann (2005) Meier and Uhlmann (2012)
Service Transition [2008]	"Studies in both marketing and strategy literature argue that manufacturing firms should shift to 'solution' and/or 'service' offerings […].We refer to these strategic redirections as 'service transition strategies.'" (Fang, Palmatier, and Steenkamp 2008, p. 2)	▪ Offering of services and/or solutions ▪ Strategic refocus of manufacturers to services (Fang, Palmatier, and Steenkamp 2008; Kowalkowski et al. 2015)	Fang, Palmatier, and Steenkamp (2008) Kowalkowski et al. (2015)
Hybrid Offerings [2009]	"[…]products and services combined into innovative offerings - can help companies attract new customers and increase demand among existing ones by providing superior value." (Shankar, Berry, and Dotzel 2009, p. 95)	▪ Categorization into four forms ▪ Innovative character of the offering ▪ (Shankar, Berry, and Dotzel 2009; Ulaga and Reinartz 2011)	Shankar, Berry, and Dotzel (2009) Ulaga and Reinartz (2011)

Exhibit 1: Overview of Extant Service Definitions

Relationship / Data Type	*Linear*	*Non-Linear*
Archival Data	Skaggs and Droege (2004) Neely (2008) Han, Kuruzovich, and Ravichandran (2013) Crozet and Milet (2017) Eggert, Thiesbrummel, and Deutscher (2015) Visnjic, Wiengarten, and Neely (2016) Benedettini, Swink, and Neely (2017)	Fang, Palmatier, and Steenkamp (2008) Kastalli and Van Looy (2013) Suarez, Cusumano, and Kahl (2013) Li et al. (2015) Kwak and Kim (2016) Nezami, Worm, and Palmatier (2018)
Survey	Homburg, Fassnacht, and Guenther (2003) Vickery et al. (2003) Gebauer (2007) Gebauer and Fleisch (2007) Gebauer and Pütz (2007) Antioco et al. (2008) Gebauer (2009) Grawe, Chen, and Daugherty (2009) Eggert et al. (2011) Gebauer, Gustafsson, and Witell (2011) He and Lai (2012) Oliva, Gebauer, and Brann (2012) Tian (2012) Lin and Wu (2013) Eggert et al. (2014) Eggert, Thiesbrummel, and Deutscher (2014) Hong, Yang, and Dobrzykowski (2014) Hong, Kim, and Cin (2015) Eggert, Thiesbrummel, and Deutscher (2015) He et al. (2015) Kohtamäki et al. (2015) Jia et al. (2016) Szász et al. (2017) Sousa and da Silveira (2017) Worm et al. (2017) Ruiz-Alba et al. (2018) Ambroise, Prim-Allaz, and Teyssier (2018) Lin et al. (2019) Moreno, Marques, and Arkader (2019) Martín-Peña, Sánchez-López, and Díaz-Garrido (2019) Abou-foul, Ruiz-Alba, and Soares (2021) Queiroz et al. (2020) Hao, Liu, and Goh (2021)	Kohtamäki et al. (2013) Zhang et al. (2020) Lexutt (2020) Kohtamäki et al. (2020) Zhou et al. (2020)

Exhibit 2: Extant Research on Financial Implications of Servitization (Adapted from Wang, Lai, and Shou 2018)

UNITED STATES
SECURITIES AND EXCHANGE COMMISSION

Washington, D.C. 20549

CATERPILLAR®

FORM 10-K

(Mark One)

☒ **ANNUAL REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934**

For the fiscal year ended December 31, 2018

OR

☐ **TRANSITION REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934**

For the transition period from to .

Commission File No. 1-768

CATERPILLAR INC.

(Exact name of Registrant as specified in its charter)

Delaware	**37-0602744**
(State or other jurisdiction of incorporation)	(IRS Employer I.D. No.)
510 Lake Cook Road, Suite 100, Deerfield, Illinois	**60015**
(Address of principal executive offices)	(Zip Code)

Registrant's telephone number, including area code: **(224) 551-4000**

Securities registered pursuant to Section 12(b) of the Act:

Title of each class	**Name of each exchange on which registered**
Common Stock ($1.00 par value) [1]	New York Stock Exchange
9 3/8% Debentures due March 15, 2021	New York Stock Exchange
8% Debentures due February 15, 2023	New York Stock Exchange
5.3% Debentures due September 15, 2035	New York Stock Exchange

[1] In addition to the New York Stock Exchange, Caterpillar common stock is also listed on stock exchanges in France and Switzerland.

Securities registered pursuant to Section 12(g) of the Act: **None**

Indicate by check mark if the Registrant is a well-known seasoned issuer, as defined in Rule 405 of the Securities Act. Yes ☒ No ☐

Indicate by check mark if the Registrant is not required to file reports pursuant to Section 13 or Section 15(d) of the Act. Yes ☐ No ☒

Indicate by check mark whether the Registrant (1) has filed all reports required to be filed by Section 13 or 15(d) of the Securities Exchange Act of 1934 during the preceding 12 months (or for such shorter period that the Registrant was required to file such reports), and (2) has been subject to such filing requirements for the past 90 days. Yes ☒ No ☐

Indicate by check mark whether the Registrant has submitted electronically every Interactive Data File required to be submitted pursuant to Rule 405 of Regulation S-T (§232.405 of this chapter) during the preceding 12 months (or for such shorter period that the registrant was required to submit such files). Yes ☒ No ☐

Indicate by check mark if disclosure of delinquent filers pursuant to Item 405 of Regulation S-K is not contained herein, and will not be contained, to the best of Registrant's knowledge, in definitive proxy or information statements incorporated by reference in Part III of this Form 10-K or any amendment to this Form 10-K. ☐

Indicate by check mark whether the Registrant is a large accelerated filer, an accelerated filer, a non-accelerated filer, or a smaller reporting company. See the definitions of "large accelerated filer," "accelerated filer" and "smaller reporting company" in Rule 12b-2 of the Exchange Act. (Check one):

Large accelerated filer	☒	Accelerated filer	☐
Non-accelerated filer	☐	Smaller reporting company	☐
		Emerging growth company	☐

If an emerging growth company, indicate by check mark if the registrant has elected not to use the extended transition period for complying with any new or revised financial accounting standards provided pursuant to Section 13(a) of the Exchange Act. ☐

Indicate by check mark whether the Registrant is a shell company (as defined in Rule 12b-2 of the Exchange Act). Yes ☐ No ☒

As of June 30, 2018, there were 594,325,388 shares of common stock of the Registrant outstanding, and the aggregate market value of the voting stock held by non-affiliates of the Registrant (assuming only for purposes of this computation that directors and executive officers may be affiliates) was approximately $81.2 billion.

As of December 31, 2018, there were 575,542,738 shares of common stock of the Registrant outstanding.

Documents Incorporated by Reference

Portions of the documents listed below have been incorporated by reference into the indicated parts of this Form 10-K, as specified in the responses to the item numbers involved.

Part III	2019 Annual Meeting Proxy Statement (Proxy Statement) to be filed with the Securities and Exchange Commission (SEC) within 120 days after the end of the calendar year.

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PART I

Item 1. Business.

General

Originally organized as Caterpillar Tractor Co. in 1925 in the State of California, our company was reorganized as Caterpillar Inc. in 1986 in the State of Delaware. As used herein, the term "Caterpillar," "we," "us," "our" or "the company" refers to Caterpillar Inc. and its subsidiaries unless designated or identified otherwise.

Overview

With 2018 sales and revenues of $54.722 billion, Caterpillar is the world's leading manufacturer of construction and mining equipment, diesel and natural gas engines, industrial gas turbines and diesel-electric locomotives. The company principally operates through its three primary segments - Construction Industries, Resource Industries and Energy & Transportation - and also provides financing and related services through its Financial Products segment. Caterpillar is also a leading U.S. exporter. Through a global network of independent dealers and direct sales of certain products, Caterpillar builds long-term relationships with customers around the world.

Currently, we have six operating segments, of which four are reportable segments and are described below.

Categories of Business Organization

1. **Machinery, Energy & Transportation** — Represents the aggregate total of Construction Industries, Resource Industries, Energy & Transportation and All Other operating segments and related corporate items and eliminations.

2. **Financial Products** — Primarily includes the company's Financial Products Segment. This category includes Caterpillar Financial Services Corporation (Cat Financial), Caterpillar Insurance Holdings Inc. (Insurance Services) and their respective subsidiaries.

Other information about our operations in 2018, including certain risks associated with our operations, is included in Part II, Item 7 "Management's Discussion and Analysis of Financial Condition and Results of Operations."

Construction Industries

Our Construction Industries segment is primarily responsible for supporting customers using machinery in infrastructure, forestry and building construction. The majority of machine sales in this segment are made in the heavy and general construction, rental, quarry and aggregates markets and mining.

The nature of customer demand for construction machinery varies around the world. Customers in developing economies often prioritize purchase price in making their investment decisions, while customers in developed economies generally weigh productivity and other performance criteria that contribute to lower owning and operating costs over the lifetime of the machine. To meet customer expectations in developing economies, Caterpillar developed differentiated product offerings that target customers in those markets, including our SEM brand machines. We believe that these customer-driven product innovations enable us to compete more effectively in developing economies. The majority of Construction Industries' research and development spending in 2018 focused on the next generation of construction machines.

The competitive environment for construction machinery is characterized by some global competitors and many regional and specialized local competitors. Examples of global competitors include CASE (part of CNH Industrial N.V.), Deere Construction & Forestry (part of Deere & Company), Doosan Infracore Co., Ltd., Hitachi Construction Machinery Co., Ltd., Hyundai Construction Equipment Co., Ltd., J.C. Bamford Excavators Ltd., Kobelco Construction Machinery (part of Kobe Steel, Ltd), Komatsu Ltd., Kubota Farm & Industrial Machinery (part of Kubota Corporation), and Volvo Construction Equipment (part of the Volvo Group). As an example of regional and local competitors, our competitors in China also include Guangxi LiuGong Machinery Co., Ltd., Longking Holdings Ltd., Sany Heavy Industry Co., Ltd., XCMG Group, Shandong Lingong Construction Machinery Co., Ltd. (SDLG, part of the Volvo Group) and Shantui Construction Machinery Co., Ltd., (part of Shandong Heavy Industry Group Co.). Each of these companies has varying product lines that compete with Caterpillar products, and each has varying degrees of regional focus.

[…]

STATEMENT 1 — **Caterpillar Inc.**

Consolidated Results of Operations for the Years Ended December 31

(Dollars in millions except per share data)

	2018	2017	2016
Sales and revenues:			
Sales of Machinery, Energy & Transportation	$ **51,822**	$ 42,676	$ 35,773
Revenues of Financial Products	**2,900**	2,786	2,764
Total sales and revenues	**54,722**	45,462	38,537
Operating costs:			
Cost of goods sold	**36,997**	31,260	28,044
Selling, general and administrative expenses	**5,478**	4,999	4,383
Research and development expenses	**1,850**	1,842	1,853
Interest expense of Financial Products	**722**	646	596
Goodwill impairment charge	**—**	—	595
Other operating (income) expenses	**1,382**	2,255	1,904
Total operating costs	**46,429**	41,002	37,375
Operating profit	**8,293**	4,460	1,162
Interest expense excluding Financial Products	**404**	531	505
Other income (expense)	**(67)**	153	(518)
Consolidated profit before taxes	**7,822**	4,082	139
Provision (benefit) for income taxes	**1,698**	3,339	192
Profit (loss) of consolidated companies	**6,124**	743	(53)
Equity in profit (loss) of unconsolidated affiliated companies	**24**	16	(6)
Profit (loss) of consolidated and affiliated companies	**6,148**	759	(59)
Less: Profit (loss) attributable to noncontrolling interests	**1**	5	8
Profit (loss) [1]	$ **6,147**	$ 754	$ (67)
Profit (loss) per common share	$ **10.39**	$ 1.27	$ (0.11)
Profit (loss) per common share — diluted [2,3]	$ **10.26**	$ 1.26	$ (0.11)
Weighted-average common shares outstanding (millions)			
- Basic	**591.4**	591.8	584.3
- Diluted [2,3]	**599.4**	599.3	584.3

[2] Diluted by assumed exercise of stock-based compensation awards, using the treasury stock method.
[3] In 2016, the assumed exercise of stock-based compensation awards was not considered because the impact would be antidilutive.

See accompanying notes to Consolidated Financial Statements.

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Exhibit 3: Excerpt of 10-K Form Caterpillar Inc. for Fiscal Year 2018 (Caterpillar 2019)

2-digit SIC	4-digit SIC	Share within 2-digit SIC	Share of Sample
36: Electronic and Other Electrical Equipment and Components, except Computer Equipment	3674: Semiconductors and Related Devices	38.2%	9.8%
	3663: Radio and Television Broadcasting and Communications Equipment	12.9%	3.3%
	3661: Telephone and Telegraph Apparatus	7.3%	1.9%
	3669: Communications Equipment, Not Elsewhere Classified	6.7%	1.7%
	3690: Miscellaneous Electrical Machinery, Equipment, and Supplies	6.7%	1.7%
	3679: Electronic Components, Not Elsewhere Classified	6.5%	1.7%
	3640: Electric Lighting And Wiring Equipment	3.9%	1.0%
	3670: Electronic Components And Accessories	3.9%	1.0%
	3621: Motors and Generators	2.5%	0.7%
	3672: Printed Circuit Boards	2.2%	0.6%
	3620: Electrical Industrial Apparatus	1.7%	0.4%
	3651: Household Audio and Video Equipment	1.7%	0.4%
	3634: Electric Housewares and Fans	1.1%	0.3%
	3678: Electronic Connectors	1.1%	0.3%
	3613: Switchgear and Switchboard Apparatus	0.8%	0.2%
	3630: Household Appliances	0.8%	0.2%
	3652: Phonograph Records and Prerecorded Audio Tapes and Disks	0.6%	0.1%
	3677: Electronic Coils, Transformers, and Other Inductors	0.6%	0.1%
	3600: Electrical Equipment And Components	0.3%	0.1%
	3695: Magnetic And Optical Recording Media	0.3%	0.1%
28: Chemicals and Allied Products	2834: Pharmaceutical Preparations	48.4%	9.8%
	2836: Biological Products, Except Diagnostic Substances	7.8%	1.6%
	2860: Industrial Organic Chemicals	6.4%	1.3%
	2835: In Vitro and In Vivo Diagnostic Substances	5.7%	1.2%
	2810: Industrial Inorganic Chemicals	5.0%	1.0%
	2821: Plastics Materials, Synthetic Resins, and Nonvulcanizable Elastomers	4.3%	0.9%
	2844: Perfumes, Cosmetics, and Other Toilet Preparations	3.9%	0.8%
	2833: Medicinal Chemicals and Botanical Products	3.6%	0.7%
	2890: Miscellaneous Chemical Products	3.6%	0.7%
	2870: Agricultural Chemicals	2.8%	0.6%
	2820: Plastics Materials And Synthetic Resins, Synthetic	2.1%	0.4%
	2851: Paints, Varnishes, Lacquers, Enamels, and Allied Products	2.1%	0.4%
	2840: Soap, Detergents, And Cleaning Preparations; Perfumes, Cosmetics, and Other Toilet Preparations	1.4%	0.3%
	2842: Specialty Cleaning, Polishing, and Sanitation Preparations	1.1%	0.2%
	2891: Adhesives and Sealants	1.1%	0.2%
	2819: Industrial Inorganic Chemicals, Not Elsewhere Classified	0.4%	0.1%
	2899: Chemicals and Chemical Preparations, Not Elsewhere Classified	0.4%	0.1%

38: Measuring, Analyzing, and Controlling Instruments; Photographic, Medical and Optical Goods; Watches and Clocks	3841: Surgical and Medical Instruments and Apparatus	32.5%	6.7%
	3845: Electromedical and Electrotherapeutic Apparatus	14.8%	3.0%
	3842: Orthopedic, Prosthetic, and Surgical Appliances and Supplies	8.8%	1.8%
	3829: Measuring and Controlling Devices, Not Elsewhere Classified	7.8%	1.6%
	3826: Laboratory Analytical Instruments	7.4%	1.5%
	3825: Instruments for Measuring and Testing of Electricity and Electrical Signals	6.4%	1.3%
	3823: Industrial Instruments for Measurement, Display, and Control of Process Variables; and Related Products	6.0%	1.2%
	3812: Search, Detection, Navigation, Guidance, Aeronautical, and Nautical Systems and Instruments	3.5%	0.7%
	3861: Photographic Equipment and Supplies	2.5%	0.5%
	3827: Optical Instruments and Lenses	2.1%	0.4%
	3843: Dental Equipment and Supplies	2.1%	0.4%
	3821: Laboratory Apparatus and Furniture	1.8%	0.4%
	3851: Ophthalmic Goods	1.8%	0.4%
	3822: Automatic Controls for Regulating Residential and Commercial Environments and Appliances	1.1%	0.2%
	3844: X-Ray Apparatus and Tubes and Related Irradiation Apparatus	0.7%	0.1%
	3824: Totalizing Fluid Meters and Counting Devices	0.4%	0.1%
	3873: Watches, Clocks, Clockwork Operated Devices, and Parts	0.4%	0.1%
35: Industrial and Commercial Machinery and Computer Equipment	3576: Computer Communications Equipment	11.3%	1.7%
	3559: Special Industry Machinery, Not Elsewhere Classified	10.8%	1.6%
	3577: Computer Peripheral Equipment, Not Elsewhere Classified	10.8%	1.6%
	3572: Computer Storage Devices	6.4%	0.9%
	3510: Engines And Turbines	5.4%	0.8%
	3533: Oil and Gas Field Machinery and Equipment	5.4%	0.8%
	3571: Electronic Computers	5.4%	0.8%
	3561: Pumps and Pumping Equipment	3.9%	0.6%
	3531: Construction Machinery and Equipment	3.4%	0.5%
	3560: General Industrial Machinery And Equipment	3.4%	0.5%
	3578: Calculating and Accounting Machines, Except Electronic Computers	3.4%	0.5%
	3564: Industrial and Commercial Fans and Blowers and Air Purification Equipment	2.9%	0.4%
	3569: General Industrial Machinery and Equipment, Not Elsewhere	2.9%	0.4%
	3570: Computer And Office Equipment	2.9%	0.4%
	3580: Refrigeration And Service Industry Machinery	2.9%	0.4%
	3590: Miscellaneous Industrial And Commercial Machinery And Equipment	2.9%	0.4%
	3523: Farm Machinery and Equipment	2.5%	0.4%
	3537: Industrial Trucks, Tractors, Trailers, and Stackers	2.0%	0.3%
	3550: Special Industry Machinery, Except Metalworking	2.0%	0.3%

	3585: Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment	2.0%	0.3%
	3540: Metalworking Machinery And Equipment	1.5%	0.2%
	3555: Printing Trades Machinery and Equipment	1.5%	0.2%
	3530: Construction, Mining, And Materials Handling	1.0%	0.1%
	3532: Mining Machinery and Equipment, Except Oil and Gas Field Machinery and Equipment	1.0%	0.1%
	3541: Machine Tools, Metal Cutting Types	1.0%	0.1%
	3524: Lawn and Garden Tractors and Home Lawn and Garden Equipment	0.5%	0.1%
	3562: Ball and Roller Bearings	0.5%	0.1%
	3579: Office Machines, Not Elsewhere Classified	0.5%	0.1%
37: Transportation Equipment	3714: Motor Vehicle Parts and Accessories	43.5%	2.9%
	3711: Motor Vehicles and Passenger Car Bodies	16.3%	1.1%
	3728: Aircraft Parts and Auxiliary Equipment, Not Elsewhere Classified	7.6%	0.5%
	3760: Guided Missiles And Space Vehicles And Parts	6.5%	0.4%
	3730: Ship And Boat Building And Repairing	4.3%	0.3%
	3790: Miscellaneous Transportation Equipment	4.3%	0.3%
	3743: Railroad Equipment	3.3%	0.2%
	3751: Motorcycles, Bicycles, and Parts	3.3%	0.2%
	3713: Truck and Bus Bodies	2.2%	0.1%
	3720: Aircraft And Parts	2.2%	0.1%
	3721: Aircraft	2.2%	0.1%
	3724: Aircraft Engines and Engine Parts	2.2%	0.1%
	3715: Truck Trailers	1.1%	0.1%
	3716: Motor Homes	1.1%	0.1%
34: Fabricated Metal Products, Except Machinery And Transportation Equipment	3490: Miscellaneous Fabricated Metal Products	26.1%	0.9%
	3420: Cutlery, Handtools, And General Hardware	15.2%	0.5%
	3480: Ordnance And Accessories, Except Vehicles And Guided Missiles	10.9%	0.4%
	3440: Fabricated Structural Metal Products	8.7%	0.3%
	3433: Heating Equipment, Except Electric and Warm Air Furnaces	6.5%	0.2%
	3443: Fabricated Plate Work (Boiler Shops)	6.5%	0.2%
	3460: Metal Forgings And Stampings	6.5%	0.2%
	3411: Metal Cans	4.3%	0.1%
	3430: Heating Equipment, Except Electric And Warm Air	4.3%	0.1%
	3442: Metal Doors, Sash, Frames, Molding, and Trim Manufacturing	4.3%	0.1%
	3470: Coating, Engraving, And Allied Services	4.3%	0.1%
	3448: Prefabricated Metal Buildings and Components	2.2%	0.1%
39: Miscellaneous Manufacturing Industries	3990: Miscellaneous Manufacturing Industries	44.4%	1.2%
	3949: Sporting and Athletic Goods, Not Elsewhere Classified	27.8%	0.7%
	3944: Games, Toys, and Children's Vehicles, Except Dolls and Bicycles	16.7%	0.4%
	3910: Jewelry, Silverware, And Plated Ware	5.6%	0.1%
	3950: Pens, Pencils, And Other Artists Materials	2.8%	0.1%
	3942: Dolls and Stuffed Toys	2.8%	0.1%

30: Rubber And Miscellaneous Plastics Products	3089: Plastics Products, Not Elsewhere Classified	32.3%	0.7%
	3060: Fabricated Rubber Products, Not Elsewhere	16.1%	0.4%
	3081: Unsupported Plastics Film and Sheet	16.1%	0.4%
	3086: Plastics Foam Products	12.9%	0.3%
	3011: Tires and Inner Tubes	9.7%	0.2%
	3021: Rubber and Plastics Footwear	6.5%	0.1%
	3080: Miscellaneous Plastics Products	3.2%	0.1%
	3050: Gaskets, Packing, And Sealing Devices And Rubber	3.2%	0.1%
33: Primary Metal Industries	3350: Rolling, Drawing, And Extruding Of Nonferrous	25.0%	0.5%
	3310: Steel Works, Blast Furnaces, And Rolling And Finishing Mills	14.3%	0.3%
	3312: Steel Works, Blast Furnaces (Including Coke Ovens), and Rolling Mills	14.3%	0.3%
	3357: Drawing and Insulating of Nonferrous Wire	10.7%	0.2%
	3390: Miscellaneous Primary Metal Products	7.1%	0.1%
	3317: Steel Pipe and Tubes	7.1%	0.1%
	3341: Secondary Smelting and Refining of Nonferrous Metals	7.1%	0.1%
	3320: Iron And Steel Foundries	3.6%	0.1%
	3334: Primary Production of Aluminum	3.6%	0.1%
	3360: Nonferrous Foundries (castings)	3.6%	0.1%
	3330: Primary Smelting And Refining Of Nonferrous	3.6%	0.1%
32: Stone, Clay, Glass, And Concrete Products	3270: Concrete, Gypsum, And Plaster Products	16.7%	0.1%
	3220: Glass And Glassware, Pressed Or Blown	16.7%	0.1%
	3290: Abrasive, Asbestos, And Miscellaneous	16.7%	0.1%
	3231: Glass Products, Made of Purchased Glass	8.3%	0.1%
	3221: Glass Containers	8.3%	0.1%
	3241: Cement, Hydraulic	8.3%	0.1%
	3260: Pottery And Related Products	8.3%	0.1%
	3272: Concrete Products, Except Block and Brick	8.3%	0.1%
	3211: Flat Glass	8.3%	0.1%
29: Petroleum Refining And Related Industries	2911: Petroleum Refining	75.0%	0.4%
	2990: Miscellaneous Products Of Petroleum And Coal	25.0%	0.1%
31: Leather And Leather Products	3140: Footwear, Except Rubber	100.0%	0.3%

Exhibit 4: 4-digit SIC Industries in Sample

Service Keyword	SSP/SSC Classification	13 Service Types Classification
24/7 customer care	SSP	Maintenance & Support
accessories	SSP	Maintenance & Support
accidental asset protection	SSP	Maintenance & Support
accidental damage protection	SSP	Maintenance & Support
accounting	SSC	Outsourcing & Operating Service
administrative	SSC	Outsourcing & Operating Service
advanced technology	SSC	Systems & Solutions
advertising and sales promotions	SSC	Retail & Distribution
advisory	SSC	Consulting Service
after-market parts and supplies	SSP	Maintenance & Support
after-sales	SSP	Maintenance & Support
analytical	SSC	Installation & Implementation
application development	SSC	Design & Development
application management	SSC	Maintenance & Support
application support	SSP	Maintenance & Support
artificial intelligence	SSC	Systems & Solutions
assembly	SSP	Installation & Implementation
asset management	SSC	Systems & Solutions
attachments	SSP	Maintenance & Support
auditing	SSC	Installation & Implementation
audits	SSC	Installation & Implementation
automated systems upgrades	SSP	Maintenance & Support
automation	SSC	Systems & Solutions
break-fix	SSP	Maintenance & Support
brokerage	SSC	Retail & Distribution
business analytics	SSC	Installation & Implementation
business consulting	SSC	Consulting Service
business process outsourcing	SSC	Outsourcing & Operating Service
business solutions	SSC	Systems & Solutions
business strategy	SSC	Consulting Service
calibration	SSP	Installation & Implementation
call centers	SSP	Maintenance & Support
centralized computing	SSC	Outsourcing & Operating Service
certification	SSC	Installation & Implementation
cleaning	SSP	Maintenance & Support
cloud computing	SSC	Systems & Solutions
cloud-based	SSC	Systems & Solutions
collection	SSC	Retail & Distribution
commissioning	SSP	Installation & Implementation
communication	SSP	Systems & Solutions
component procurement	SSC	Procurement Service

comprehensive technical customer training	SSC	Maintenance & Support
configuration	SSP	Installation & Implementation
connectivity	SSP	Systems & Solutions
consultancy	SSC	Consulting Service
consultation	SSC	Consulting Service
consulting	SSC	Consulting Service
conversion	SSP	Maintenance & Support
credit	SSC	Financial Service
customer billing	SSC	Maintenance & Support
customer consulting and support by phone	SSC	Consulting Service
customer data management	SSC	Systems & Solutions
customer payments	SSC	Systems & Solutions
customer seminars	SSC	Maintenance & Support
customer service	SSP	Maintenance & Support
customer service agreements	SSP	Maintenance & Support
customer solutions	SSC	Systems & Solutions
customer support	SSP	Maintenance & Support
cutting	SSP	Installation & Implementation
data	SSC	Systems & Solutions
data analytics or diagnostics	SSC	Systems & Solutions
data collection	SSC	Systems & Solutions
data processing	SSC	Systems & Solutions
data storage and backup	SSC	Systems & Solutions
decommissioning	SSP	End-of-Life Support
de-installation	SSP	End-of-Life Support
delivery	SSP	Trucking & Transportation
design	SSP	Design & Development
detection	SSP	Systems & Solutions
development	SSP	Design & Development
diagnosis	SSP	Systems & Solutions
diagnostic	SSP	Systems & Solutions
digital	SSC	Systems & Solutions
direct selling	SSC	Retail & Distribution
dismantling	SSP	End-of-Life Support
disposal	SSP	End-of-Life Support
distribution	SSC	Retail & Distribution
documentation	SSP	Installation & Implementation
drilling	SSP	Installation & Implementation
E-business	SSC	Systems & Solutions
educational	SSC	Maintenance & Support
electronic ordering/order processing	SSC	Systems & Solutions
embedded	SSP	Systems & Solutions
employee benefits	SSC	Maintenance & Support

employee travel	SSC	Maintenance & Support
end-of-life	SSP	End-of-Life Support
energy	SSC	Systems & Solutions
engineering	SSP	Design & Development
engineering and electrical contracting	SSC	Outsourcing & Operating Service
enhancement	SSP	Maintenance & Support
enterprise	SSP	Maintenance & Support
entitlement	SSP	Maintenance & Support
environment	SSC	Systems & Solutions
equipment delivery and pick up	SSP	Trucking & Transportation
extended warranty	SSP	Maintenance & Support
facility operations	SSC	Outsourcing & Operating Service
feasibility studies	SSC	Installation & Implementation
field	SSP	Maintenance & Support
finance/HR/accounting/payroll	SSC	Outsourcing & Operating Service
financial	SSC	Financial Service
financial administration	SSC	Financial Service
financing	SSC	Financial Service
financing of operations	SSC	Financial Service
fleet	SSC	Systems & Solutions
fleet management	SSC	Systems & Solutions
fulfillment	SSC	Retail & Distribution
helpdesk	SSP	Maintenance & Support
hosting	SSC	Systems & Solutions
human resources	SSC	Outsourcing & Operating Service
hybrid solutions	SSC	Systems & Solutions
implementation	SSP	Installation & Implementation
import	SSC	Retail & Distribution
improvement	SSC	Outsourcing & Operating Service
industrial	SSP	Maintenance & Support
information	SSC	Systems & Solutions
information technology	SSC	Systems & Solutions
information-based	SSC	Systems & Solutions
infrastructure	SSC	Systems & Solutions
infrastructure as a service	SSC	Systems & Solutions
inspection	SSP	Maintenance & Support
installation	SSP	Installation & Implementation
insurance	SSC	Maintenance & Support
insurance of operations	SSC	Maintenance & Support
integrated product–service solutions	SSC	Systems & Solutions
integrated solutions	SSC	Systems & Solutions
integration	SSC	Installation & Implementation
intellectual property management	SSC	Maintenance & Support

Internet of things	SSC	Systems & Solutions
Internet-based platforms	SSC	Systems & Solutions
inventory	SSC	Maintenance & Support
inventory control	SSC	Maintenance & Support
inventory management	SSC	Maintenance & Support
iot	SSC	Systems & Solutions
IT infrastructure	SSC	Systems & Solutions
IT outsourcing	SSC	Outsourcing & Operating Service
just-in-time-delivery	SSC	Trucking & Transportation
laboratory	SSC	Outsourcing & Operating Service
leasing	SSC	Leasing Service
legal	SSC	Maintenance & Support
lifecycle	SSP	End-of-Life Support
logistical	SSC	Retail & Distribution
logistics	SSC	Retail & Distribution
machine-to-machine technologies	SSP	Systems & Solutions
maintenance	SSP	Maintenance & Support
managed	SSC	Outsourcing & Operating Service
managed print	SSC	Outsourcing & Operating Service
manual	SSP	Maintenance & Support
manufacturing	SSC	Outsourcing & Operating Service
marketing	SSC	Retail & Distribution
material handling	SSC	Retail & Distribution
materials logistics and quality management	SSC	Outsourcing & Operating Service
measurement	SSP	Installation & Implementation
measuring	SSP	Installation & Implementation
mobility	SSP	Systems & Solutions
modernization	SSP	End-of-Life Support
monitoring	SSC	Maintenance & Support
network	SSC	Systems & Solutions
network security	SSC	Systems & Solutions
offshore contracting	SSC	Outsourcing & Operating Service
online remote diagnostic	SSP	Maintenance & Support
online support	SSP	Maintenance & Support
on-site support	SSP	Maintenance & Support
operating	SSC	Outsourcing & Operating Service
operational	SSC	Outsourcing & Operating Service
optimization	SSC	Outsourcing & Operating Service
order fulfilment	SSC	Retail & Distribution
order-entry and tracking systems and an annual restocking program	SSC	Maintenance & Support
outsourced	SSC	Outsourcing & Operating Service
outsourcing	SSC	Outsourcing & Operating Service

overhaul	SSP	End-of-Life Support
packaging	SSP	Outsourcing & Operating Service
parts	SSP	Procurement Service
payroll	SSC	Outsourcing & Operating Service
platform as a service	SSC	Systems & Solutions
predictive maintenance	SSP	Maintenance & Support
preventive repairs	SSP	Maintenance & Support
problem analyses	SSC	Systems & Solutions
problem analysis	SSC	Systems & Solutions
processing	SSC	Outsourcing & Operating Service
process-oriented engineering (testing, optimizing and simulating)	SSP	Design & Development
procurement	SSC	Procurement Service
product demonstration/sample delivery	SSP	Maintenance & Support
product demonstrations	SSP	Maintenance & Support
product engineering to prototype construction	SSP	Design & Development
product launch coordination	SSC	Retail & Distribution
product modification	SSP	Design & Development
product recycling/machine brokering	SSP	End-of-Life Support
product related education/training	SSP	Maintenance & Support
production commissioning	SSC	Installation & Implementation
professional	SSP	Maintenance & Support
project	SSC	Systems & Solutions
project management/prime contractorship	SSC	Systems & Solutions
property	SSC	Property & Real Estate
prototype design and development	SSP	Design & Development
prototyping	SSP	Design & Development
purchasing	SSC	Retail & Distribution
quality assurance	SSC	Maintenance & Support
real estate management	SSC	Property & Real Estate
real estate	SSC	Property & Real Estate
rearmament	SSP	End-of-Life Support
reconditioning	SSP	End-of-Life Support
recovery	SSP	End-of-Life Support
recycling	SSP	End-of-Life Support
reengineering	SSP	End-of-Life Support
refurbishing	SSP	End-of-Life Support
refurbishment	SSP	End-of-Life Support
regulatory compliance qualification	SSC	Installation & Implementation
remanufacturing	SSP	End-of-Life Support
remote monitoring and troubleshooting	SSC	Maintenance & Support
remote sensing	SSC	Maintenance & Support
remote service support	SSC	Maintenance & Support

renewal	SSP	End-of-Life Support
renovation construction planning	SSP	End-of-Life Support
rental	SSC	Leasing Service
rental equipment	SSC	Leasing Service
repair	SSP	Maintenance & Support
replacement	SSP	Maintenance & Support
research	SSC	Design & Development
research and development	SSC	Design & Development
retail	SSC	Retail & Distribution
retrofit	SSP	End-of-Life Support
rig returns	SSP	Maintenance & Support
safety or security	SSC	Maintenance & Support
safety or security of operations	SSC	Maintenance & Support
sales aid/advertising/marketing support	SSC	Retail & Distribution
service solutions	SSP	Systems & Solutions
service strategy	SSC	Consulting Service
servicing	SSP	Maintenance & Support
shipping	SSP	Trucking & Transportation
single-service to full service contracts	SSP	Maintenance & Support
smart	SSC	Systems & Solutions
smarter commerce	SSC	Systems & Solutions
software	SSC	Systems & Solutions
software as a service	SSC	Systems & Solutions
software as service	SSC	Systems & Solutions
software licenses	SSP	Systems & Solutions
software maintenance	SSP	Systems & Solutions
software on demand	SSP	Systems & Solutions
software upgrade or protection	SSP	Systems & Solutions
solution	SSC	Systems & Solutions
sourcing	SSC	Retail & Distribution
spare	SSP	Procurement Service
specialized training programs	SSC	Maintenance & Support
staffing	SSC	Outsourcing & Operating Service
storage	SSC	Retail & Distribution
supervision	SSC	Consulting Service
supplementary	SSP	Maintenance & Support
supply chain	SSC	Retail & Distribution
support	SSP	Maintenance & Support
surveillance	SSC	Consulting Service
system integration	SSC	Installation & Implementation
systems and solutions	SSC	Systems & Solutions
technical	SSP	Maintenance & Support
technical consulting	SSC	Consulting Service

technical support	SSP	Maintenance & Support
technical user training	SSP	Maintenance & Support
technical and operational support	SSP	Maintenance & Support
test	SSC	Installation & Implementation
testing	SSC	Installation & Implementation
toll-free telephone support	SSP	Maintenance & Support
trading	SSC	Retail & Distribution
training	SSC	Maintenance & Support
training of staff	SSC	Maintenance & Support
transportation	SSP	Trucking & Transportation
troubleshooting	SSP	Maintenance & Support
trucking	SSP	Trucking & Transportation
turn-key power solutions	SSC	Systems & Solutions
update	SSP	Maintenance & Support
upgrade	SSP	Maintenance & Support
value-added	SSP	Maintenance & Support
vendor management	SSC	Retail & Distribution
virtualization	SSP	Installation & Implementation
warehousing	SSC	Retail & Distribution
warranty	SSP	Maintenance & Support
website security	SSC	Systems & Solutions
work over	SSP	Maintenance & Support
workflow	SSC	Outsourcing & Operating Service
work-force accommodation	SSC	Maintenance & Support

Notes: If possible, keywords are combined with “service(s)” and “solution(s)” to ensure accuracy of measurement (Lee and Hong 2016).

Exhibit 5: List of Service Keywords and Classifications

Company Name [Fiscal Year]	**Main Service Keywords [#Occurences]**	**Website Content**
Apple Inc. [2018]	▪ Cloud Services [10] ▪ Software [9] ▪ Parts [8] ▪ Support [4]	▪ Dedicated page for cloud service offerings (Apple 2018a) ▪ App Store as online platform for software (Apple 2018b) ▪ Webpage for replacement parts and support services (Apple 2018c)
Brooks Automation Inc. [2013]	▪ Solution [13] ▪ Manufacturing [4] ▪ Support [2]	▪ Solution page for life sciences and semiconductor industry customers (Brooks 2013a) ▪ Service page focusing on repairs, upgrades, and field services (Brooks 2013b)
Caterpillar Inc. [2014]	▪ Insurance [11] ▪ Financial [10] ▪ Parts [5] ▪ Warranty [4]	▪ Page with financing and insurance options (Caterpillar 2014a) ▪ Extensive parts and warranty section (Caterpillar 2014b; c)
Cisco Systems Inc. [2012]	▪ Solution [27] ▪ Software [15] ▪ Advanced Service [6] ▪ Technical Support [4]	▪ Dedicated solutions webpage focusing on network and data center solutions (Cisco 2012a) ▪ Services focusing on advanced services to increase efficiency and technical support to ensure product availability (Cisco 2012b)
Emerson Electric Inc. [2018]	▪ Solution [52] ▪ Software [9] ▪ Monitoring [7]	▪ Two main website parts: automation solutions and commercial/residential solutions ▪ Each main part with product, service, and software offerings (Emerson 2018)
Ford Motor Company [2014]	▪ Parts [11] ▪ Warranty [9] ▪ Financial [7]	▪ Separate Webpage for OEM parts (Ford 2014a) ▪ Warranty and service plan page (Ford 2014b) ▪ Ford Credit Services with financing options (Ford 2014c)
General Electric (GE) Co. [2018]	▪ Solution [35] ▪ Software [13] ▪ Digital Solutions [6] ▪ Repair [6] ▪ Maintenance [6]	▪ Dedicated “industrial solutions” and “digital” services page on website (GE 2018a) ▪ Software offerings in different business units (GE 2018b)

Hewlett Packard (HP) Inc. [2011]	▪ Software [25] ▪ Support [18] ▪ Infrastructure [18] ▪ Information [10] ▪ Data [9]	▪ Consumer page with support services, and software offerings (HP 2011a; b) ▪ Business page focuses on software, infrastructure, and data services and solutions (HP 2011c; d)
Honeywell International Inc. [2017]	▪ Solution [19] ▪ Software [10] ▪ Process Solution [4] ▪ Aftermarket [3]	▪ Industrial webpage focusing on business solutions to improve operations ▪ Service focus also on energy efficiency solutions (Honeywell 2017)
International Business Machines (IBM) Corp. [2014]	▪ Software [22] ▪ Data [15] ▪ Financial [11] ▪ Infrastructure [10] ▪ Information [9]	▪ Dedicated page for software, data, information and analytics services (IBM 2014a) ▪ Page "IBM Global Financing" presents extensive financing information for customers (IBM 2014b)
Juniper Networks Inc. [2013]	▪ Software [17] ▪ Solution [16] ▪ Cloud-based [2] ▪ Customer Service [2]	▪ Extensive software services focusing on computer network management (Juniper 2013a) ▪ Enterprise solutions for cloud-based services (Juniper 2013b)
Jabil Inc. [2016]	▪ Manufacturing [29] ▪ Design [25] ▪ Assembly [10] ▪ Development [8] ▪ Test Services [6]	▪ Homepage present full-service capabilities of company from design and development to final manufacturing and assembly (Jabil 2016a) ▪ Solutions overview page with detailed information on each service offering (Jabil 2016b)
Logitech International SA [2015]	▪ Solution [11] ▪ Support [10] ▪ Customer Service [5] ▪ Software [3]	▪ Communication solution offerings for businesses (Logitech 2015a) ▪ Dedicated customer support page (Logitech 2015b)
Motorola Solutions Inc. [2018]	▪ Solution [34] ▪ Software [32]	▪ Dedicated, extensive pages for communication solutions for each customer segment ▪ Dedicated software offerings page (Motorola 2018)
Qualcomm Inc. [2015]	▪ Data [14] ▪ Support [9] ▪ Solution [7]	▪ Solutions structured by industry such as automotive, healthcare, and mobile computing ▪ Dedicated support page (Qualcomm Homepage 2015)

Exhibit 6: Service Keywords and Website Content

Firm	Year	Service Key-word Count*	Service Ratio	Pearson Correlation
General Electric Co.	2009	0.018	25.1%	0.86
	2010	0.016	26.5%	
	2011	0.018	18.8%	
	2012	0.020	18.5%	
	2013	0.018	19.6%	
	2014	0.036	28.5%	
	2015	0.034	29.8%	
	2016	0.037	30.5%	
	2017	0.042	32.4%	
	2018	0.046	34.1%	
IBM Corp.	2009	0.029	57.6%	0.93
	2010	0.030	56.9%	
	2011	0.029	56.8%	
	2012	0.028	57.8%	
	2013	0.028	58.6%	
	2014	0.030	60.0%	
	2015	0.034	61.1%	
	2016	0.038	64.1%	
	2017	0.036	64.1%	
	2018	0.036	64.5%	
Eastman Kodak Co.	2009	0.012	16.9%	0.63
	2010	0.030	17.8%	
	2011	0.021	15.1%	
	2012	0.015	16.7%	
	2013	0.020	17.5%	
	2014	0.027	18.0%	
	2015	0.023	19.5%	
	2016	0.030	19.7%	
	2017	0.029	19.5%	
	2018	0.028	21.2%	
L3 Technologies Inc.	2009	0.015	51.9%	0.92
	2010	0.017	51.6%	
	2011	0.019	50.1%	
	2012	0.014	42.1%	
	2013	0.015	43.0%	
	2014	0.013	43.0%	
	2015	0.010	28.5%	
	2016	0.010	29.9%	
	2017	0.010	29.7%	
	2018	0.012	30.1%	
Pitney Bowes Inc.	2009	0.035	76.0%	0.38
	2010	0.036	75.3%	
	2011	0.039	75.5%	
	2012	0.043	70.7%	
	2013	0.029	69.6%	
	2014	0.029	72.0%	
	2015	0.035	72.5%	
	2016	0.035	72.5%	
	2017	0.037	73.7%	
	2018	0.039	81.6%	

NCR Corp.	2009	0.026	51.5%	0.59
	2010	0.021	51.1%	
	2011	0.022	51.0%	
	2012	0.021	50.2%	
	2013	0.021	52.4%	
	2014	0.024	56.1%	
	2015	0.022	57.5%	
	2016	0.027	58.2%	
	2017	0.027	60.4%	
	2018	0.024	63.4%	
Juniper Networks Inc.	2009	0.009	22.6%	0.71
	2010	0.009	20.4%	
	2011	0.010	21.8%	
	2012	0.010	25.3%	
	2013	0.008	24.6%	
	2014	0.008	26.3%	
	2015	0.009	26.7%	
	2016	0.010	29.3%	
	2017	0.011	31.4%	
	2018	0.012	33.1%	
Cisco Systems Inc.	2009	0.014	19.0%	0.76
	2010	0.015	20.1%	
	2011	0.015	21.1%	
	2012	0.012	21.8%	
	2013	0.015	23.3%	
	2014	0.015	23.2%	
	2015	0.017	24.4%	
	2016	0.018	25.6%	
	2017	0.017	25.6%	
	2018	0.019	24.9%	
Agilent Technologies Inc.	2009	0.014	20.4%	0.71
	2010	0.015	18.0%	
	2011	0.015	17.1%	
	2012	0.015	17.5%	
	2013	0.014	20.8%	
	2014	0.015	21.3%	
	2015	0.015	22.1%	
	2016	0.016	23.5%	
	2017	0.018	24.0%	
	2018	0.019	23.8%	
Brooks Automation Inc.	2009	0.018	23.4%	0.60
	2010	0.017	10.3%	
	2011	0.019	11.2%	
	2012	0.019	16.8%	
	2013	0.019	19.6%	
	2014	0.021	19.8%	
	2015	0.020	17.2%	
	2016	0.022	24.7%	
	2017	0.025	22.8%	
	2018	0.027	23.6%	

Mettler-Toledo International Inc.	2009	0.014	24.5%	0.31
	2010	0.013	22.6%	
	2011	0.013	21.0%	
	2012	0.013	20.9%	
	2013	0.013	21.8%	
	2014	0.013	22.3%	
	2015	0.012	22.1%	
	2016	0.012	21.9%	
	2017	0.012	21.7%	
	2018	0.014	21.6%	
Honeywell International Inc.	2009	0.029	23.4%	0.17
	2010	0.034	22.0%	
	2011	0.027	21.3%	
	2012	0.031	20.8%	
	2013	0.037	20.1%	
	2014	0.027	19.6%	
	2015	0.027	20.4%	
	2016	0.021	20.2%	
	2017	0.021	20.3%	
	2018	0.020	21.4%	
Faro Technologies Inc.	2009	0.003	20.3%	0.78
	2010	0.003	18.0%	
	2011	0.003	16.3%	
	2012	0.005	16.6%	
	2013	0.005	18.1%	
	2014	0.004	16.9%	
	2015	0.004	18.2%	
	2016	0.008	21.4%	
	2017	0.007	23.0%	
	2018	0.008	22.9%	
Lockheed Martin Corp.	2009	0.010	18.6%	0.31
	2010	0.010	20.3%	
	2011	0.015	20.6%	
	2012	0.013	19.8%	
	2013	0.015	21.3%	
	2014	0.015	20.8%	
	2015	0.015	14.0%	
	2016	0.011	14.6%	
	2017	0.010	14.1%	
	2018	0.011	16.3%	
Navistar International Corp	2009	0.007	1.8%	0.40
	2010	0.007	1.8%	
	2011	0.007	1.4%	
	2012	0.006	1.3%	
	2013	0.007	1.5%	
	2014	0.008	1.4%	
	2015	0.009	1.4%	
	2016	0.009	1.7%	
	2017	0.011	1.7%	
	2018	0.010	1.6%	

Notes: *Sum of all service-related keywords divided by text length

Exhibit 7: Complete List Service Keywords Development Validity

Standard Industrial Classification (SIC)	Industry Profile	Example Firms
SIC 28 Chemicals and Allied Products	Firms in this industry produce three types of chemicals. First, they produce basic chemical products such as acids, salts, and alkalies. Second, they produce chemicals for downstream manufacturing processes such as synthethic fibers and color pigments. Finally, firms in this industry produce chemical products for the end-consumer such as drugs and cosmetics.	Johnson & Johnson Inc., Procter & Gamble Plc, Gilead Sciences Inc., Pfizer Inc., Linde Plc
SIC 29 Petroleum Refining and Related Industries	Firms in this industry refine petroleum, produce paving and roofing materials, and make lubricating oils.	Exxon Mobil Corp., Chevron Corp., Valero Energy Corp., Hess Corp., Quaker Chemical Corp.
SIC 30 Rubber and Miscellaneous Plastic Products	Firms in this industry produce goods from rubber and other synthetic plastics. They primarily engage in the production of tires and miscellaneous rubber products such as rubber gaskets and seals.	Goodyear Tire & Rubber Co., Cooper Tire & Rubber Co., UFP Technologies Inc., Tupperware Brands Corp., Crocs Inc.
SIC 31 Leather and Leather Products	Firms in this industry produce genuine and synthetic leather. They also manufacture finished leather products such as footwear and handbags.	Skechers USA Inc., Madden Steven Ltd., Rock Brands Inc., Tapestry Inc., Tandy Leather Factory Inc.
SIC 32 Stone, Clay, Glass, and Concrete Products	Firms in this industry manufacture goods made of glass, stone, clay, or concrete materials. They usually source their input materials from naturally occurring elements such as sand and stones.	U.S. Concrete Inc., Eagle Materials Inc., Carbo Ceramics Inc., Owens Corning Inc., Continental Materials Corp.
SIC 33 Primary Metal Industries	Firms in this industry engage in the manufacturing of ferrous and nonferrous metals. Products in this industry are basic metal products such as iron castings, nails, wires, and cables.	Universal Stainless & Alloy Products Inc., AK Steel Corp., Century Aluminum Co., Mueller Industries Inc., Northwest Pipe Co.
SIC 34 Fabricated Metal Products, except Machinery and Transportation Equipment	Firms in this industry manufacture a variety of metal products such as cans, general hardware, fabricated structural elements, and forgings.	McDermott International Ltd., Stanley Black & Decker Inc., NCI Building Systems Inc., Parker Hannifin Corp., Ball Corp.
SIC 35 Industrial and Commercial Machinery and Computer Equipment	Firms in this industry manufacture a variety of machinery and equipment products. Industrial machinery includes products like engines, turbines, farm equipment, metalworking equipment, and commercial service industry machinery. The computer equipment industry includes electronic computers and other computer-related products.	Deere & Company, Caterpillar Inc., Baker Hughes, Cisco Systems Inc., IBM Corp.

SIC 36 Electronic and Other Electrical Equipment and Components, except Computer Equipment	Firms in this industry manufacture products which utilize electrical energy in various forms. Typical products in this industry include electrical motors, household appliances, lighting equipment, communication equipment, and electronic components.	General Electric Co., Emerson Electric Co., Texas Instruments Inc., Qualcomm Inc., Intel Corp.
SIC 37 Transportation Equipment	Firms in this industry manufacture vehicles to transport goods and people across land, air, and water. Major products include automobiles, aircraft, and vessels.	General Motors Inc., Paccar Inc., General Dynamics Corp., Lockheed Martin Corp., Boeing Co.
SIC 38 Measuring, Analyzing, and Controlling Instruments; Photographic, Medical and Optical Goods; Watches and Clocks	Firms in this industry manufacture measuring, analyzing, and controlling products for a variety of applications. The main product categories are navigation equipment, laboratory instruments, and medical apparatus.	Thermo Fisher Scientific Inc., Boston Scientific Corp., Northrop Grumman Corp., Danaher Corp., 3M Co.
SIC 39 Miscellaneous Manufacturing Industries	Firms in this industry are manufacturers which are not classified into other SIC codes. They produce many different goods such as musical instruments, jewelry, toys, pens, and costumes.	Hasbro Inc., Mattel Inc., Johnson Outdoors Inc., Callaway Golf Co. Brady Corp.

Exhibit 8: Industry Descriptions for SIC 28 – 39 (OSHA 2021)

	Statistic	p-Value
Inverse χ^2(2118)	3830.71	< .01
Inverse normal	-2.34	< .01
Inverse logit t(3669)	-14.08	< .01
Modified inverse χ^2	26.32	< .01

Notes: All four test statistics reject the null hypothesis of all panels containing unit roots.

Exhibit 9: Fisher-Type Unit Root Test to Check Nonstationary Behavior of ROS

Coefficient	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1. SI SSP	1.00												
2. SI SSC	-.36	1.00											
3. SSP Breadth	.19	-.08	1.00										
4. SSC Breadth	-.09	.06	-.13	1.00									
5. Organic Growth	.23	.19	-.16	.16	1.00								
6. Inorganic Growth	.03	-.01	.02	.05	-.10	1.00							
7. Industry Growth	.08	-.02	.09	-.10	-.22	.17	1.00						
8. Industry Dynamism	-.06	.13	-.05	.04	.01	-.08	.13	1.00					
9. Industry Competition	.34	-.30	-.05	-.11	-.09	-.03	.04	-.16	1.00				
10. Firm Size	-.17	-.01	.04	.04	-.15	-.22	-.19	.19	.12	1.00			
11. Market Share	.02	-.03	-.04	.04	.04	.13	.21	-.09	.02	-.37	1.00		
12. SSP Growth	-.16	.05	-.27	-.04	.02	.04	.11	.01	.05	-.12	.08	1.00	
13. SSC Growth	-.14	-.17	-.06	-.26	.01	-.09	-.03	.11	.09	.10	-.07	.00	1.00
14. Industry Advertising	-.13	-.04	-.17	-.03	-.05	.05	-.07	.01	-.10	-.03	-.04	-.05	.07

Notes: SI = Strategic Intensity

Exhibit 10: Correlation Matrix of Coefficients of FE Regression Model

Variables and Hypotheses		Firm Profitability (ROS) Model 1	Model 2
Intercept		.17 (.02)***	.16 (.03)***
Direct Effects – Strategic Intensity			
Strategic Intensity on SSPs	H_1	.51 (1.14)	2.84 (2.57)
Strategic Intensity on SSCs	H_1	-6.38 (4.58)	-13.74 (10.04)
(Strategic Intensity on SSCs)^2	H_1	724.58 (372.59)*	1880.77 (863.25)**
Moderating Effects – Service Scope			
Strategic Intensity on SSPs × SSP Breadth	H_{2a}		-.27 (.16)*
Strategic Intensity on SSCs × SSC Breadth	H_{2b}		2.14 (.69)***
(Strategic Intensity on SSCs)^2 × SSC Breadth	H_{2b}		-195.19 (58.25)***
Moderating Effects – Corporate Growth Strategy			
Strategic Intensity on SSPs × Organic Growth	H_{3a}		15.35 (14.09)
Strategic Intensity on SSCs × Organic Growth	H_{3b}		-150.52 (51.31)***
(Strategic Intensity on SSCs)^2 × Organic Growth	H_{3b}		8842.19 (2987.43)***
Strategic Intensity on SSPs × Inorganic Growth	H_{4a}		1.48 (2.17)
Strategic Intensity on SSCs × Inorganic Growth	H_{4b}		-14.09 (8.98)
(Strategic Intensity on SSCs)^2 × Inorganic Growth	H_{4b}		1424.77 (864.82)*
Moderating Effects – Environmental Factors			
Strategic Intensity on SSPs × Industry Growth	H_{5a}		6.95 (3.36)**
Strategic Intensity on SSCs × Industry Growth	H_{5b}		6.69 (19.00)
(Strategic Intensity on SSCs)^2 × Industry Growth	H_{5b}		-2672.32 (2445.03)
Strategic Intensity on SSPs × Industry Dynamism	H_{6a}		-4.98 (2.81)*
Strategic Intensity on SSCs × Industry Dynamism	H_{6b}		40.05 (17.99)**
(Strategic Intensity on SSCs)^2 × Industry Dynamism	H_{6b}		-6776.12 (2651.07)**
Strategic Intensity on SSPs × Industry Competition	H_{7a}		-2.73 (2.61)
Strategic Intensity on SSCs × Industry Competition	H_{7b}		2.28 (11.40)
(Strategic Intensity on SSCs)^2 × Industry Competition	H_{7b}		423.52 (884.92)
Controls			
SSP Breadth		-5x10^{-4} (.002)	.001 (.002)
SSC Breadth		-.003 (.002)**	-.01 (.003)**
Organic Growth		-1,79 (.15)***	-1.75 (.20)***
Inorganic Growth		-.01 (.01)	-.004 (0.01)
Industry Growth		-.002 (.021)	-.04 (.03)
Industry Dynamism		-.01 (.01)	-.001 (.024)
Industry Competition		.04 (.02)	.05 (.03)
Firm Size		.03 (.01)***	.03 (.01)***
Market Share		-.02 (.02)	-.02 (.03)
SSP Growth		-.004 (.004)	-.005 (.004)
SSC Growth		.002 (.002)	.004 (.003)
Industry Advertising Intensity		-.01 (.01)*	-.01 (.01)*
Fiscal Year Dummies		*Included*	*Included*
Adjusted R^2		*.29*	*.30*
F-statistics		*9.49***	*12.52***

Notes: Values are unstandardized coefficients with robust standard errors in parentheses; *$p \leq .10$, **$p \leq .05$, ***$p < .01$

Exhibit 11: Panel Regression Robustness Check through Data Winsorizing

Summary

Manufacturing industries across developed countries such as Germany, Japan, and USA face stiff competition and rapid product commoditization. As a reaction, manufacturers are looking for new ways to gain and sustain a competitive edge in their markets. In the past decades, industrial services have become the central element around which manufacturers build a sustainable competitive advantage. Firms increasingly shift their strategic focus from producing physical goods to providing services. This fundamental transition from goods-based to service-based business models is known in research as "servitization". Real world examples such as IBM's shift from a hardware manufacturer to a consulting and software company has fueled the continuous interest in servitization from researchers as well as practitioners. Extant research studies provide first valuable insights into the conceptualization, contingencies, and outcomes of servitization. However, there are two existing research gaps in the literature. First, there is no recent research study that takes stock of the servitization landscape and its development over time. Servitization is a very dynamic trend which requires an up-to-date look at developments. Second, research about the financial impact of servitization remains inconclusive. The majority of studies link servitization with positive financial outcomes. However, the type of link (i.e., linear vs. non-linear) as well as contingency factors vary significantly between studies. Against this backdrop, this study compiles a dataset consisting of panel data for over 1,000 U.S. manufacturers for the years 2009 to 2018. The first part of this dissertation draws a picture of the U.S. servitization landscape and its development during the past decade. The second part of the study investigates the profitability effect of industrial services.

The first part of the study reveals the importance of distinguishing different types of industrial services, namely services in support of products (SSPs) (e.g., maintenance and installation) and services in support of customers (SSCs) (e.g., consulting and outsourcing). The analysis of the servitization landscape has three main results. First, SSPs and SSCs develop differently over time. While SSPs stay relatively constant over the 10-year period, SSCs exhibit a strong growth during that period. Hence, manufacturers are especially expanding their SSC offerings which means that they get more and more involved in customer processes. Second, a look at the absolute level of the two service types shows that SSPs are still predominant in the manufacturing industry. This underlines that most services of manufacturers still surround the physical product such as machine maintenance. While SSPs remain a strong pillar in manu-

facturers' service business, SSCs are the growth engine of industrial services. The third insight is that the servitization landscape and development differs depending on firm size and specific manufacturing industry. For instance, small to mid-sized firms show more fluctuations in their SSP and SSC development, and the growth of SSCs is less pronounced. At the industry level, the study shows that certain industries such as commercial machinery have a stronger focus on services than other industries such as the chemical products industry. This underlines that servitization evolves differently in individual manufacturing industries. Overall, the first descriptive part of this study provides an overview of the current servitization landscape of U.S. manufacturing.

The second part of the study focuses on the profitability effect of SSPs and SSCs. The empirical results show that SSPs do not have a direct effect on return on sales (ROS) while SSCs exhibit a u-shaped effect on ROS. Hence, firms need to surpass a threshold in their strategic intensity on SSCs in order to gain a positive profitability effect. The study examines three groups of moderators to further disentangle the underlying mechanism between servitization and firm profitability. First, service scope (i.e., number of different SSP and SSC offerings) has a negative moderating effect on the profitability effect of SSPs and SSCs. This means that a broad SSP or SSC portfolio will diminish profitability. Manufacturers have limited resources and a high number of different service offerings may dilute these resources and decrease operational efficiency. The second group of moderators focus on the firm's growth strategy. An organic growth strategy has a negative moderating effect on the profitability of SSCs, while an inorganic growth strategy has a positive impact. SSCs often require new resources and capabilities which can be hard to develop inhouse. An acquisition strategy can represent a fast and efficient way to gain critical SSC competencies. The third group of moderators focus on industry-level environmental factors. High industry growth and low industry dynamism are beneficial for the profitability effect of SSPs. Growing and stable markets offer new opportunities for service contracts (e.g., for maintenance and installation). A low industry dynamism is also beneficial for the SSC business since it offers a more predictable business environment. Overall, the empirical analysis underlines that the link between industrial services and profitability is complex and depends on several contingency factors.

The insight of this study offers several contributions to marketing research and practice. First, it offers an update on the servitization landscape in U.S. manufacturing which can help researchers to gain a quick overview of how industrial services evolved in the past decade.

Practitioners benefit from this descriptive part by seeing how services evolve in their specific industry. This can be the basis for a benchmark analysis in which managers can decide whether their servitization efforts are ahead or behind the industry standard. The study's second part presents a new quantitative analysis about the financial impact of servitization. This helps marketing research to better understand how industrial services affect financial performance. Practitioners can use the insights to better manage their servitization strategy. Especially the moderating effects of service scope and corporate growth strategy offer managers opportunities to optimize the financial outcomes of services. All in all, the study results are a new contribution to better understand servitization.

Zusammenfassung

Industrieunternehmen in entwickelten Staaten wie Deutschland, Japan, oder USA sind zunehmend hohem Wettbewerbsdruck und Kommodifizierung ausgesetzt. Als Reaktion auf diese Entwicklung suchen Unternehmen neue Strategien, um in ihren Absatzmärkten wettbewerbsfähig zu bleiben. In den letzten Jahren haben sich industrielle Dienstleistungen zu einem zentralen Wettbewerbsvorteil in Industriemärkten entwickelt. Unternehmen fokussieren ihre strategische Ausrichtung zunehmend auf die Erbringung von Dienstleistungen. Die strategische Neuorientierung von Produktion zu Dienstleistungen wird in der Marketingforschung als „Servitization“ bezeichnet. Das Interesse an Servitization in der Forschung als auch Praxis ist durchgehend hoch und wird in der Realität zum Beispiel durch IBMs Transformation vom Hardwarehersteller zum Softwareanbieter veranschaulicht. Bestehende Forschung liefert bereits erste wertvolle Ergebnisse in Bezug auf Konzeptualisierung, Einflussfaktoren, und Folgen von Servitization. Jedoch gibt es zwei Forschungslücken in der Servitization Literatur. Zum einem gibt es keine aktuelle Forschung über die gegenwärtige Servitization-Landschaft und wie sich diese über die Zeit entwickelt hat. Servitization ist ein sehr dynamischer Prozess, der stets einen aktuellen Blick darauf erfordert. Zum anderen sind die finanziellen Folgen einer Servitization Strategie immer noch nicht abschließend geklärt. Zwar weisen die meisten Studien auf positive finanzielle Auswirkungen industrieller Dienstleistungen hin, aber die genauen Zusammenhänge sind noch relativ unklar. Zum Beispiel werden lineare als auch nicht-lineare Zusammenhänge zwischen Dienstleistungen aufgezeigt. Diese Studie hat zum Ziel diese beiden Forschungslücken zu schließen. Dazu werden Paneldaten von über 1.000 U.S. Unternehmen für die Jahre 2009 bis 2018 untersucht. Im ersten Teil der Studie wird ein Überblick über die Servitization Landschaft in amerikanischen Industrieunternehmen gegeben. Der zweite Teil der Arbeit fokussiert sich auf die Profitabilitätseffekte industrieller Dienstleistungen.

Im ersten Teil der Arbeit wird zunächst verdeutlicht, dass die Unterscheidung von Dienstleistungen eine wichtige Rolle spielt. Es gibt zwei grundsätzliche Arten von industriellen Dienstleistungen, nämlich produktbezogene Dienstleistungen (services in support of products (SSPs)) und kundenbezogene Dienstleistungen (services in support of customers (SSCs)). SSPs sind zum Beispiel Wartungs- und Installationsleistungen, wohingegen SSCs zum Beispiel Beratung und Datenverarbeitung sein können. Die deskriptive Analyse der Servitization Landschaft führt zu drei Kernergebnissen. Erstens, SSPs und SSCs entwickeln sich unter-

schiedlich über die Zeit hinweg. Während SSPs relativ stabil über den 10-Jahres-Zeitraum bleiben, weisen die SSCs ein erhebliches Wachstum in diesem Zeitraum auf. Das heißt Industrieunternehmen weiten insbesondere ihre kundebezogenen Dienstleistungen aus und sind mehr und mehr in Kundenprozesse involviert. Das zweite Ergebnis ist, dass trotz ihrer stagnierenden Entwicklung die SSPs immer noch die vorherrschende Dienstleistungsart in der U.S. Industrie sind. Das heißt die meisten Dienstleistungsangebote sind immer noch produktbezogen wie z.B. Wartung und Instandhaltung einer Maschine. SSPs sind ein Kernbestandteil industrieller Dienstleitungen, aber der Wachstumsmotor sind SSCs. Das dritte Ergebnis der Untersuchung ist, dass die Entwicklung von Dienstleistungen von der Firmengröße und der individuellen Industrie abhängt. Zum Beispiel weisen kleine und mittelständische Unternehmen eine höhere Fluktuation in der Entwicklung von SSPs and SSCs auf und haben auch ein geringeres Niveau bei den SSCs als größere Unternehmen. Bei den verschiedenen Industrien haben einige Sektoren (wie z.B. Hersteller kommerzieller Maschinen) einen stärkeren Fokus auf Dienstleistungen als andere Sektoren (wie z.B. die Chemiebranche). Insgesamt präsentiert die Studie einen umfassenden Überblick über den Stand und die Entwicklung der Servitization unter U.S. Industrieunternehmen.

Der zweite Teil der Studie fokussiert sich auf die Profitabilitätseffekte industrieller Dienstleistungen. Die empirischen Ergebnisse zeigen, dass SSPs keinen direkten Effekt auf die Umsatzrendite eines Unternehmens haben. Im Gegensatz dazu ist der Zusammenhang zwischen SSCs und Umsatzrendite nicht linear und folgt einer U-Form. Dies bedeutet Unternehmen müssen ein bestimmtes Level an SSCs erreichen, um positive Profitabilitätseffekte zu realisieren. Im nächsten Schritt untersucht die Studie den Einfluss von drei Moderationsfaktoren auf den Zusammenhang zwischen Dienstleistungen und Umsatzrendite. Zunächst wird gezeigt, dass die Breite des Dienstleistungsportfolio sich negativ auf die Umsatzrendite auswirkt. Eine hohe Anzahl verschiedener SSP and SSC Angebote könnte sich negativ auswirken, da Unternehmen nur begrenzte Ressourcen haben und dadurch weniger effizient werden. Der zweite moderierende Faktor ist die Wachstumsstrategie des Unternehmens. Die Studienergebnisse zeigen, dass organisches Wachstum einen negativen Moderationseffekt auf die Beziehung zwischen SSCs und Umsatzrendite hat. Demgegenüber hat anorganisches Wachstum als alternative Wachstumsstrategie einen positiven Moderationseffekt auf die Beziehung. Der Grund für diese Wirkung könnte sein, dass SSCs viele neue Ressourcen und Fähigkeiten voraussetzen. Eine Akquisition könnte eine effektive Möglichkeit sein diese Kompetenzen schnell zu erlan-

gen. Der dritte Moderationsfaktor ist die Umwelt des Unternehmens. Die Ergebnisse zeigen, dass wachsende und stabile Industrien sich positive auf die Beziehung zwischen SSPs und Umsatzrendite auswirken. Dies folgt der Logik, dass stabil wachsende Märkte neue Möglichkeiten für den Absatz von SSPs anbieten wie z.B. Installations- und Wartungsarbeiten. Stabile Industrieverhältnisse haben auch einen positiven Moderationseffekt auf die Beziehung zwischen SSCs und Umsatzrendite, da es weniger unvorhergesehene Veränderungen im Markt gibt. Zusammenfassend zeigt die Analyse, dass der Zusammenhang zwischen industriellen Dienstleistungen und Umsatzrendite komplex ist und von diversen Einflussgrößen abhängt.

Die Forschungsergebnisse der Studie haben mehrere Implikationen für die Marketingforschung und -praxis. Die im ersten Teil präsentierte Servitization Landschaft bietet ein aktuelles Bild über die Entwicklung industrieller Dienstleistungen im letzten Jahrzehnt. Forscher*innen können diese Erkenntnisse nutzen, um einen schnellen Überblick über die Entwicklung industrieller Dienstleistungen zu erhalten. Für die Marketingpraxis kann die deskriptive Untersuchung eine Grundlage für Benchmark-Analysen bieten. Manager können die Entwicklung der Dienstleistungen im eigenen Unternehmen mit dem der Industrie vergleichen und feststellen, ob sie unter oder über dem Industriedurchschnitt liegen. Der zweite Teil der Dissertation stellt eine neue quantitative Studie der Profitabilitätseffekte von Servitization vor. In der Marketingforschung trägt dies dazu bei die komplexen Zusammenhänge zwischen Dienstleistungen und finanziellen Auswirkungen besser zu verstehen. Marketing-Manager können die Ergebnisse nutzen, um ihre Dienstleistungsstrategie zu optimieren. Insbesondere die Einflussfaktoren der Portfoliobreite und Wachstumsstrategie bieten die Möglichkeit die Profitabilitätseffekte von Dienstleistungen zu beeinflussen. Zusammenfassend stellt die Dissertation einen Beitrag zum besseren Verständnis von Servitization dar.

Eidesstattliche Erklärung

Erklärung gem. §4 Abs. 2 Promotionsordnung zum Dr. rer. pol. des Fachbereichs Wirtschaftswissenschaft der Freien Universität Berlin vom 13. Februar 2013

Hiermit erkläre ich, dass ich mich noch keinem Promotionsverfahren unterzogen oder um Zulassung zu einem solchen beworben habe, und die Dissertation in der gleichen oder einer anderen Fassung bzw. Überarbeitung einer anderen Fakultät, einem Prüfungsausschuss oder einem Fachvertreter an einer anderen Hochschule nicht bereits zur Überprüfung vorgelegen hat.

Berlin, den 26. November 2021

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Unterschrift Rodi Akalan

Erklärung nach §10 Abs. 3 Promotionsordnung zum Dr. rer. pol. des Fachbereichs Wirtschaftswissenschaft der Freien Universität Berlin vom 13. Februar 2013

Hiermit erkläre ich, dass ich für die Dissertation folgende Hilfsmittel und Hilfen verwendet habe:

- Daten der SEC Edgar Datenbank und WRDS Compustat Datenbank
- Programmiersoftware: Python
- Statistik Software: Stata SE 17.0
- Im Literaturverzeichnis angegebene Literatur
- Referenzmanagement Software: Elsevier Mendeley
- Office Software: Microsoft Word, Microsoft Excel

Auf dieser Grundlage habe ich die Arbeit selbstständig verfasst.

Berlin, den 26. November 2021

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