

SUPPLY CHAIN FIT

Constituents and Performance Outcomes

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Written by:

Pan Theo Grosse-Ruyken

Schürbungert 9, 8057 Zurich, Switzerland

Submitted to:

WHU – Otto Beisheim School of Management

Referee:

Prof. Dr. Stephan M. Wagner

Chair of Logistics Management

Department of Management, Technology, and Economics

Swiss Federal Institute of Technology Zurich

Co-Referee:

Prof. Dr. Dr. h. c. Jürgen Weber

Institute of Management Accounting and Control (IMC)

WHU – Otto Beisheim School of Management

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List of Abbreviations

A	Austria
ANOVA	Analysis of variance
AVE	Average variance extracted
CCC	Cash conversion cycle
CFA	Confirmatory factor analysis
CFI	Comparative fit index
CFO	Chief financial officer
CH	Switzerland
DEA	Data envelopment analysis
df	Degrees of freedom
DMU	Decision making unit
EBIT	Earnings before interest and tax
ERP	Enterprise resource planning
F	France
G	Germany
GFI	Goodness of fit index
IR	Indicator reliability
IT	Information technology
KPI	Key performance indicators
M	Mean (\bar{x})
MANOVA	Multivariate analysis of variance
ML	Maximum likelihood
NNFI	Non-normed fit index (also TLI)
OEM	Original equipment manufacturer
OLS	Ordinary least squares
RMSEA	Root mean square error of approximation
ROA	Return on assets
ROCE	Return on capital employed
SCDE	Supply chain design efficiency
SCF	Supply chain fit
SCM	Supply chain management
SD	Standard deviation (s_x)
SE	Standard error
SEM	Structural equation modeling
SG	Sales growth
TLI	Tucker-Lewis Index (also NNFI)
UK	United Kingdom
US	United States (of America)
USA	United States of America
VIF	Variance inflation factor

Cues to abbreviations of items and constructs are provided in the Appendix.

Chapter I Introduction and Research Overview

1. Introduction

Increasing recognition is being placed, both in academia and in industry, on effective supply chain management. A famous quote from the work of Charles Darwin notes that “it is not the strongest species that survive, nor the most intelligent, but the ones most responsive to change”. Viewing effective supply chain management in light of this perspective, what does “most responsive” mean? Academics and practitioners agree that functional products are best delivered via physically-efficient supply chains, while innovative products are best delivered via market responsive supply chains. However, to date, only a few firms have systematically adjusted their supply chain strategies according to this argument. Instead of carrying only one product line, firms deliver a number of both functional and innovative products in parallel complicating the alignment of supply chain portfolios with product portfolios. Furthermore, as firms adopt new product lines, enter new markets, build new warehouses and production plants, and lose the protection of traditional industry barriers, formulating the right supply chain strategy is the utmost challenge. First, more competition means price and margin pressure due to the increased commoditization of products and services. Second, there is more variation in customer needs. The competitive mandate is to serve customers faster, better, and at lower cost. Hence, one of the major leverage factors to effective supply chain management is the “fit” between supply chain strategy and supply chain design variables

(Grosse-Ruyken and Wagner, 2009a; 2009b; Chopra and Meindl, 2009; Wagner and Grosse-Ruyken, 2008; Lee 2002; Fisher, 1997).

Cash is the lifeblood of every business (Pike and Neale, 1999) and successful supply chain management comes down to the ability to create shareholder value (Wagner and Locker, 2009; Pohlen and Coleman, 2005; Lambert and Pohlen, 2001). Several recent studies have found a direct link between excellent supply chain management and profitability (e.g., Dehning *et al.*, 2007; Hendricks and Singhal, 2005; Droge *et al.*, 2004; D'Avanzo *et al.*, 2003; Vickery *et al.*, 2003; Timme and Williams-Timme, 2000). Nonetheless, supply chain metrics are not explicitly linked to shareholder value (Hartley-Urquhart, 2006; Ketchen and Giunipero, 2004; Ellram and Liu, 2002; Stemmler, 2002). Whereas numerous concepts and technologies have been applied to optimize and to improve the supply chain (e.g., Ellram and Cousins, 2007; Hausmann, 2003; Cooper *et al.*, 1997; Ellram, 1991), analysis of the match between product types and the employed supply chain strategies has so far not been sufficient to assist decision-making in supply chain management (Grosse-Ruyken and Wagner, 2009b; Selldin and Olhager, 2007; Ketchen and Giunipero, 2004). Until today, researchers in the field of supply chain management, procurement, and finance have focused on the efficient configuration of operational processes and allocation of scarce resources by relying on the assumptions of neoclassical or new institutional economic theory. However, insights from all three disciplines have not been systematically integrated. Few firms structure their supply chain drivers effectively and achieve a fit between product types and supply chain strategies (Li and Brien, 2001; Stock *et al.*, 2000; Doty *et al.*, 1993). Furthermore, failure to categorize products in relation to supply chain management strategies is still not unusual in various industries. Even more important, the financial impact of theoretically ideal supply chain

management frameworks (Chopra and Meindl, 2009; Lee, 2002; Fisher, 1997), or in other words, the bottom line impact of supply chain management, has not been sufficiently investigated. This presents an open field for research. In order to fill this research gap, this dissertation is built on three research questions:

First, from a strategic perspective, we look at the bottom line impact of supply chain management, i.e., the impact of a fit in the supply chain on a firm's financial success. The impact of a supply chain fit, so far, has neither been quantified by firms nor documented in the literature. Configurational theory suggests that higher performance can be realized if a firm achieves a perfect "fit." As such, supply chain fit, i.e., strategic consistencies between demand aspects of the underlying product and supply chain design, is a major leverage factor in a firm's financial success. However, many firms struggle to achieve the ideal supply chain fit. Increased uncertainty of implied demand is often not served by sufficient supply chain responsiveness.

Second, from a tactical perspective, we investigate how supply chain designs perform in terms of Return on Capital Employed (ROCE). When designing supply chains, firms face the competing demands of increased physically-efficiency and improved market responsiveness. As a result, an optimal supply chain design will serve as a lever in making or breaking firms. Benchmarking supply chain designs enables firms to evaluate the potential of their supply chain and become best-in-class. Despite many studies on supply chain improvement and optimization, there is little research on integrated finance-supply chain management. We fill this gap by using Data Envelopment Analysis (DEA) to benchmark supply chain designs in terms of ROCE.

Third, from an operational perspective, we explore the required level of sourcing flexibility, i.e., the capability of a firm's procurement processes to respond or react rapidly to changing supply requirements, which is one of the building blocks of supply chain responsiveness. In today's decentralized supply chains, firms depend on their suppliers to create a large share of the value of their products. For this reason, understanding the causes and consequences of sourcing flexibility is critical. We show that supplier selection and information systems at the buyer-supplier interface positively influence sourcing flexibility. Sourcing flexibility, in turn, is curvilinearly (U-shaped) related to supply chain performance. Firms with either low or high levels of sourcing flexibility exhibit high supply chain performance, whereas medium levels of sourcing flexibility hinder that performance. In other words, the "stuck in the middle" phenomenon, which is frequently observed in areas of strategy and organization, is also evident in procurement decisions. Finally, sourcing flexibility positively influences the business performance of a product ("product performance"), such as its sales growth rate, market share, and profitability. The strong and positive relationship between sourcing flexibility and supply chain and product performances underscores that sourcing flexibility merits procurement managers' attention in supplier selection and procurement decisions. However, a mismatch between sourcing flexibility and product and supply chain characteristics can be detrimental to performance. A clear understanding of these factors is therefore crucial.

In summary, an effective supply chain management supports a business in both good times and bad. Increasing implied uncertainty from customers and supply sources is best served by increasing responsiveness from the supply chain. Hereby, firms should align their competitive strategy (and resulting implied uncertainty) and supply chain strategy (and

resulting responsiveness) as closely as possible (Chopra and Meindl, 2009). Lee and Billington (1993) identify three sources of uncertainty: demand (volume and mix), process (yield, machine downtimes, transportation reliabilities), and supply (part quality, delivery reliability). Clearly, cost, time and uncertainty are important in different degrees to all supply chains. However, if one aspect dominates, this helps to simplify the complex challenge of developing appropriate strategies for supply chain design. This dissertation focuses on the design of supply chains in which demand uncertainty is key challenge.

It is important to understand that the desired level of responsiveness required across the supply chain may be attained by assigning different levels of responsiveness and efficiency to each stage of the supply chain. High-performing supply chains have four distinguishing characteristics (Chopra and Meindl, 2009; Stock *et al.*, 2000; Lee and Billington, 1993):

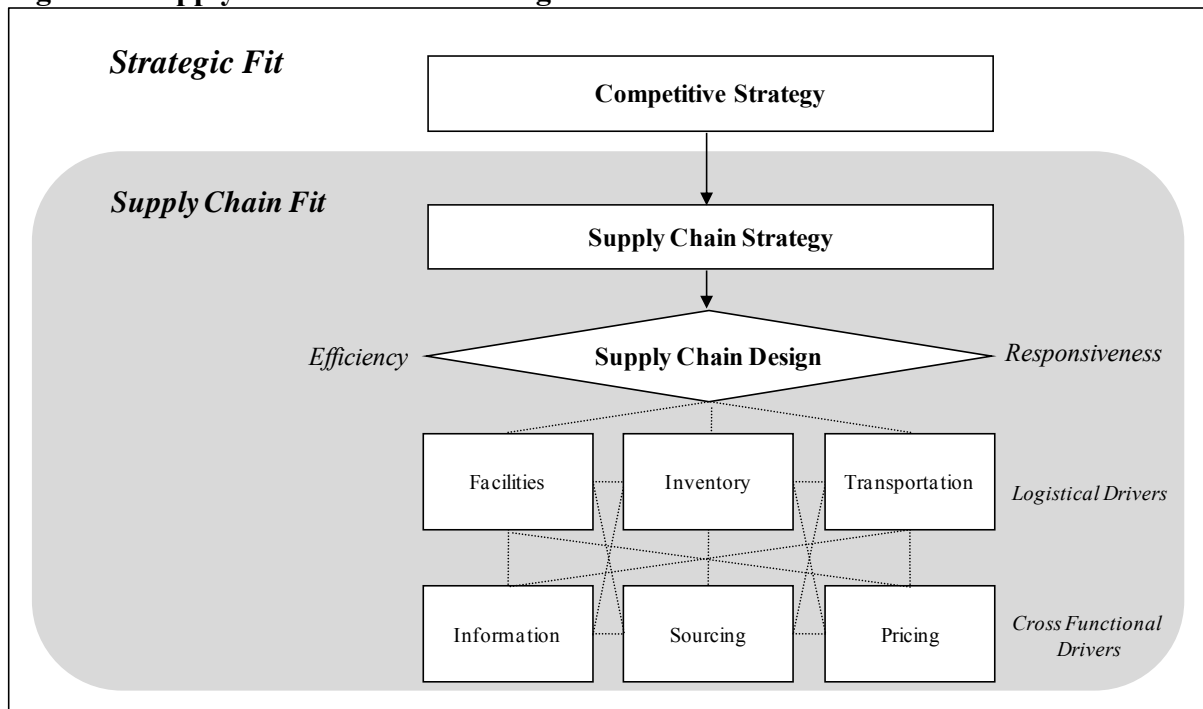
- They support, enhance, and are an integral part of a firm's competitive business strategy.
- They leverage a distinctive supply chain operating model/strategy to sustain competitiveness.
- They execute well against a balanced set of operational performance objectives and metrics to attain the optimal responsiveness.
- They focus on logistics (facilities, inventory, and transportation) and cross-functional (information, sourcing, and pricing) drivers that reinforce one another to support the operating model and best achieve operational objectives.

This dissertation takes these issues into consideration and addresses the constituents and performance outcomes of effective supply chain management. The purpose of this dissertation is to further the impact of the phenomenon of supply chain fit.

The remainder of this dissertation is structured as follows. The subsequent sections of this chapter offer an overview of the understanding of supply chain management, its current challenges and fit constituents. Then, the three core research questions of this dissertation are outlined. The research design and methodology used to investigate the delineated research questions are then presented. Chapter II focuses on the impact of a fit in the supply chain on a firm's financial success (research question I). Chapter III sheds light on supply chain design efficiency (research question II). Chapter IV investigates the relationship among sourcing flexibility, supply chain performance and product performance (research question III). Finally, Chapter V brings together the results of the previous chapters, summarizes the research results, and puts special emphasis on key academic and practically relevant findings.

2. Supply chain management, challenges and fit constituents

The past decades have seen an increasing recognition of the importance of supply chain management. Nevertheless, there is still no commonly agreed-upon terminology. As a consistent use of terms is essential, this section presents a short overview of supply chain management and its constituents as well as defines the terms which constitute the basis of this dissertation. Figure 1 illustrates the nomenclature and how these terms are connected.

Figure 1: Supply chain decision-making framework

Note. Framework adapted from Chopra and Meindl (2009).

Supply chain strategy attempts to achieve an optimal balance between efficiency and responsiveness that fits the competitive strategy of the manufacturing firm and meets customer needs. To reach that goal, the right combination of logistical and cross-functional drivers is required. For each driver, supply chain executives have to make a trade-off between efficiency and responsiveness based on interaction with the other drivers of the supply chain. The combined impact of these drivers, i.e., the supply chain design, determines the responsiveness and the profits of the entire supply chain. The responsiveness trade-offs must be solved depending on the characteristics of the underlying product, so that the right supply chain is designed for the product (Fisher, 1997). If firms strike the right balance between efficiency and responsiveness that match the demand aspects of the product, supply chain fit is achieved. Furthermore, is the supply chain strategy aligned to the competitive strategy, a

firm executes strategic fit. In the following, these terms will be derived from the pertinent literature, discussed, and defined.

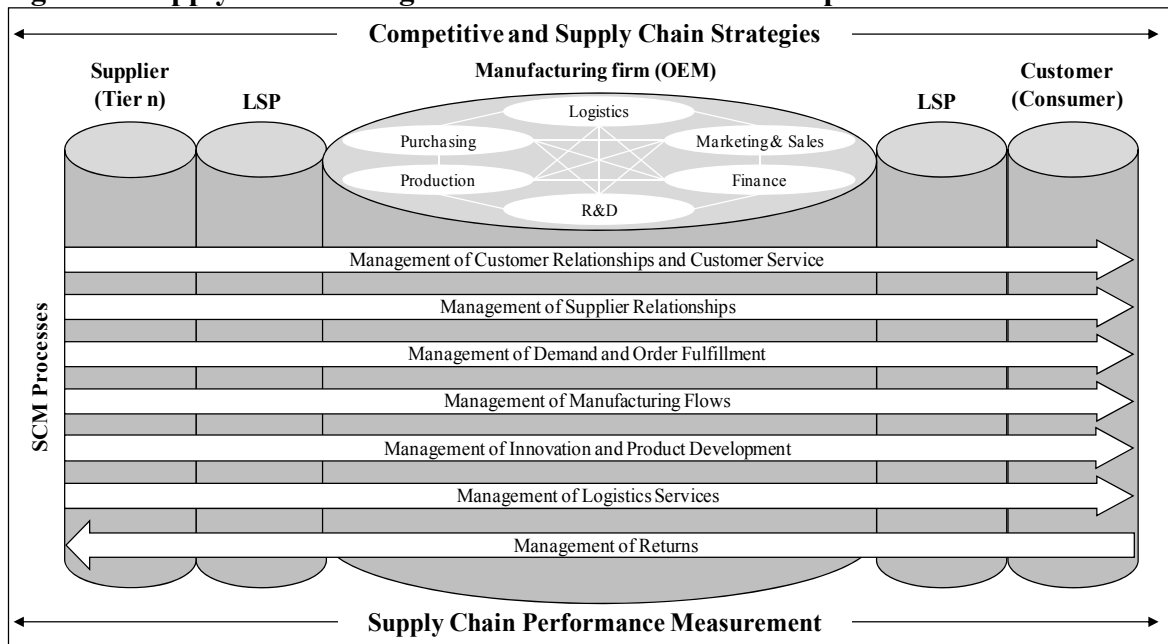
2.1. Supply chain management

Supply chain management, with its emphasis on linkages among value-adding activities in the chain, is perhaps the most significant development in business management since the early 1980s when U.S. firms began adopting the just-in-time concept. The understanding of supply chain management has developed over time and evolved differently across countries. The idea of supply chain management is anchored in the USA with the transfer of logistic principles from military to business operations. Secretary of War Elihu Root observed that for Americans the difficulties of making war lay not in the raising of soldiers, but in equipping, supplying, and transporting them. The evolution of modern warfare since 1898 amply demonstrates the truth of Root's observation. The scale and scope of modern wars, rapidly changing technology, and new military doctrines involving the rapid movement of large forces over great distances have made logistics the key to modern warfare. The development of modern technology and the necessity of worldwide operations after 1898 thrust logisticians into a new era of specialization, which lasted roughly until the end of World War II. The relatively simple logistical tasks and organizations that had met the needs of earlier times became much more complex, requiring more and better trained personnel, larger and more diverse logistical organizations, and greater management and control. The era of specialization overlapped with the last phase, the era of integration, which began before World War II and continues today. In this phase, the quantity of equipment is not the key success factor; getting the right equipment in the right quantity to the right place at the right time is indeed. But in order to manage these processes efficiently, it is necessary to take a

holistic perspective along the supply chain, by integrating both internal functions (e.g., procurement, production, and marketing) and external actors (e.g., suppliers and customers) through collaboration and relationship management (Weber, 2002).

Weber (2002) notes that the development of logistics towards supply chain management is based on a four-phase approach whereby the logistics know-how and the path-dependency increase from phase to phase. Hereby the first two phases are mainly determined by efficiency optimizations of logistics processes in terms of specialization and coordination of material flows; in the next two upcoming phases, logistics breaks out of its operational borders and focuses additionally (Weber, 1999) on holistic leadership functions by managing the whole supply chain flows – our modern understanding of supply chain management (Weber, 2002; Weber and Kummer, 1998).

Numerous definitions of a supply chain exist, and while they may differ in terminology, they are reasonably consistent in meaning. Following Mentzer (2001), supply chain management is defined as “the systemic, strategic coordination of the traditional business functions within a particular firm and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual firms and the supply chain as a whole” (Mentzer, 2001, p. 18). The supply chain consists of all parties involved, directly or indirectly, in fulfilling a customer (consumer) request through the manufacturer’s (OEM’s) goods and services that are created in the SCM processes (Figure 2). It is important to note that supply chains are dynamic and require the constant flow of information, product, and funds.

Figure 2: Supply chain management framework and its components

Note. Framework adapted from Cooper, Lambert, and Pagh (1997).

Because of its primary focus on key process integration throughout the supply chain (Weber, 2002), supply chain management leads to a balance between customer requirements and supply chain capabilities that best meets demand and supply. Furthermore, the optimized use of internal and external supplier capabilities and technologies is enhanced by supply chain management which improves the firm's performance by bringing trading partners along the supply chain in the interests of efficiency, responsiveness, and customer satisfaction. Benefits of supply chain management occur therefore across the extended firm that is engaged in improving shareholder value in at least one of four areas: revenue enhancement, operating expense reduction, working capital and fixed capital efficiency.

2.1.1. The objective of supply chain management

The objective of supply chain management is to maximize the value generated. The value a supply chain generates is the difference between what the final product is worth to the customer and the effort the supply chain expends in filling the customer's request. The value

for most commercial supply chains will be strongly correlated with supply chain profitability, the difference between revenue generated from the customer and the overall costs across the supply chain. Supply chain profitability is the total profit to be shared across all supply chain stages. It is clear, but noteworthy that for any supply chain, there is only one source of revenue: the customer. All flows of information, product, or funds generate costs within the supply chain. Therefore the appropriate management of these flows is a key to supply chain success, reducing system-wide costs while maintaining required service levels (e.g., Mentzer *et al.*, 2001; Simchi-Levi *et al.*, 2000; Lee and Billington, 1993).

Successful supply chain management requires many decisions which fall into three categories or phases, depending on the frequency of each decision and on the time frame over which a decision phase has an impact:

- **Supply chain strategy and design.** In this phase, a firm decides how to design the supply chain over the next several years, what the chain's configurations will be, how resources will be allocated, and what processes will be performed in each stage
- **Supply chain planning.** In this phase, the supply chain's configurations, determined in the strategy phase, establish constraints within which planning must be done. The planning phase starts with a forecast for the upcoming year
- **Supply chain operations.** During this phase, firms make daily decisions regarding how best to handle incoming customer orders.

All three phases have a strong impact on the profitability and success of a manufacturing firm. As supply chain decisions play a significant role in the success or failure of a firm, the best supply chains are not just fast and cost-effective, they are also agile, adaptable, and they ensure that all their firms' interests remain in alignment (Lee, 2004).

2.1.2. Supply chain drivers

In reaching the balance between efficiency and responsiveness that best meets the needs of the firm's competitive strategy, logistical and cross-functional drivers of supply chain management (facilities, inventory, transportation, information, sourcing, and pricing) must be aligned and adapted, as they interact with each other (see Figure 1). As a result, the structure of these drivers, which constitutes the underlying supply chain design of a manufacturing firm, determines if and how effective supply chain management is achieved across the supply chain. It is important to emphasize that the logistical and cross-functional drivers interact with each other determining the performance of the supply chain (Chopra and Meindl, 2009):

- **Facilities.** Facilities are the actual physical locations, production and/or storage sites, in the supply chain network where decisions regarding role, location, capacity, and flexibility of facilities have a significant impact on the performance of the supply chain.
- **Inventory.** Inventory includes all raw materials, work in process, and finished goods within a supply chain. Decisions about inventory levels can dramatically alter the supply chain's efficiency and responsiveness.
- **Transportation.** Transportation entails moving inventory from point to point in the supply chain. This can be done in many combinations of modes and routes, each with its own performance characteristics and hence affecting the supply chain's efficiency and responsiveness.
- **Information.** Information sharing and coordination is one of the biggest performance drivers within the supply chain because it directly affects each of the other drivers. Information consists of data and analysis regarding the logistic driver's facilities,

inventory, and transportation as well as of prices, costs, and customers throughout the supply chain.

- **Sourcing.** At the strategic level, sourcing decisions determine what function a firm performs in-house and what functions it outsources. Sourcing entails deciding who will perform a particular supply chain activity such as production, storage, transportation, or information management.
- **Pricing.** Pricing fixes the price levels of the goods and services that a firm makes available in the supply chain. Pricing has a strong impact on consumer behavior, thus affecting the supply chain performance.

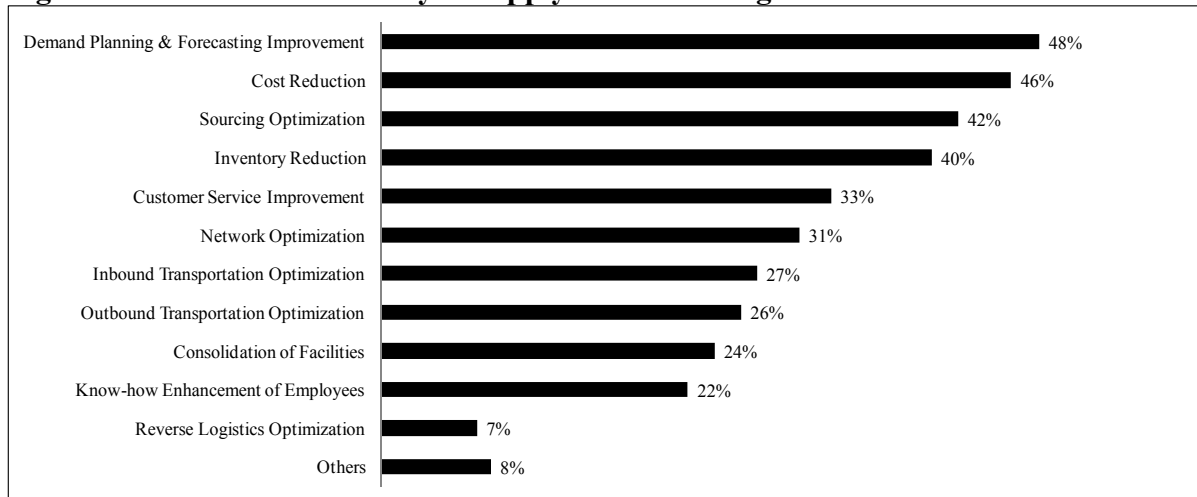
Excellent supply chain design and operation takes advantage of the interaction of the supply chain drivers and makes the appropriate trade-offs to deliver the desired level of responsiveness. The supply chain drivers are key leverage factors for supply chain management to master demand and supply uncertainty.

2.2. Supply chain challenges

An effective way to handle uncertainty is to develop effective demand and supply chain management capabilities. More firms are recognizing that a well-designed supply chain is a key component of commercial success. As a result, there is strong interest in identifying the trends that are shaping the future of supply chains. Wagner, Erhun, and Grosse-Ruyken (2009) identified, based on the empirical data set of sample I (see subchapter 4.1), demand planning and forecasting improvements, cost reductions, sourcing optimization and inventory reductions as the four major supply chain challenges in the next two years. The picture has slightly changed since 2006. Whereas cost reduction had been the top item in the agenda back then, followed by sourcing optimization and demand planning and forecasting improvement,

the latter one is now regarded as a top priority for manufacturing firms. Figure 3 gives an overview of current challenges in supply chain management.

Figure 3: Pictorial of hierarchy of supply chain challenges



Note. Multiple nominations were possible. N = 259.

2.2.1. Core challenges

Supply chain executives identified four core supply chain challenges which are described in the following.

Demand planning and forecasting improvement. Aligning demand and supply in today's complex and dynamic manufacturing environment remains challenging at best. As sources and capacities for manufacturing have increased, many firms have moved away from focusing solely on plant-level production planning. They adopt demand-driven approaches so that they can cope with changing customer demand more efficiently. Still, many manufacturing firms spend an inordinate amount of time and resources for better demand prediction. Yet, in spite of the significant investment, static forecasts are often out of date within hours of creation, questioning the real value of traditional planning tools as it relates to near-term demand volatility. Not surprisingly, 48% of the 259 respondents identified demand planning and forecasting improvement as the top priority in 2009 and 2010 for manufacturing

firms. The most common method of dealing with uncertainty is building up inventory in the supply chain. Departments buffer against their lack of confidence in the forecast with safety stocks. As each link in the chain creates its own buffers, inventories skyrocket. More accurate demand planning and forecasting improvements are needed for managers to predict shortened market visibility in uncertain environments. A key capability for manufacturers is to be able to respond rapidly to what is happening at the moment. As such, manufacturers need to transition from a supply chain driven strictly by forecasts to a demand-driven one. Rationalizing and optimizing what firms are best at selling, making and delivering – and aligning the sales force with that mindset – helps a manufacturing firm to create a more customer-focused mindset without sacrificing operational efficiency. Ultimately a demand-focused approach to planning can significantly improve demand planning and management efforts and help overall costs and customer service efforts.

Cost reduction. More than 46% of the respondents identified cost reduction as the most powerful way to increase profit margins. Many firms like Rolls-Royce, L’Oreal, Lego or Chrysler currently improve their supply chain operations by cutting costs. Chrysler, for example, vows to cut its costs by 25% in the next three years. Other cost reduction efforts in the field of supply chain management would add value and bring new business benefits. First, process efficiencies drive costs down as teams find best practices and streamline the end-to-end system of supply and delivery, taking cost out wherever possible. Second, shorter cycle times and visibility across the supply chain increase responsiveness and customer satisfaction, reduce customer turnover and help to retain valuable customers. Third, lean techniques reduce waste and non-value-adding steps, assuring best processing across the enterprise. Fourth, asset utilization and elimination of unnecessary assets reduces the need for

working capital. Finally, lower inventory levels that more closely meet the actual demand will reduce working capital needs and minimize carrying costs.

Sourcing optimization. As many firms step back and examine their core competencies, they realize that outsourcing non-core products and activities to suppliers creates synergies that can reduce costs, shorten lead-time or improve service. Although significant economic benefits can be realized from outsourcing all or parts of the supply chain processes, without the right systems, processes and supplier management competencies, such efforts bear very high risk (Wagner and Bode, 2008). In a heavily outsourced environment, manufacturing firms need to put more systems in place to compensate for the fact that they can no longer control the entire operations inside the firm boundaries. In an outsourced supply chain environment, the need for excellent inter-firm and intra-firm information flows (e.g., between the firm and its suppliers) becomes a high priority. Over 100,000 new product introductions per year which the German sportswear giant Adidas delivers worldwide, is a good example of how complex and challenging purchasing decisions are to handle such volumes through the supply chains.

Inventory reduction. As demand and supply in the value chain do not match perfectly per se, inventories are needed as buffers between supply chain stages. Inventory can be essential for maintaining a steady flow of production and high capacity utilization. The amount of time required to convert purchased materials and parts into finished products depends on the magnitude of these inventories. But with the widespread use of just-in-time or just-in-sequence deliveries and vendor-managed inventories as well as just-in-time or just-in-sequence production, firms can operate with minimal levels of inventory. This made supply chain and operations managers aware that inventories prevent the discovery of problems in

the supply chain and on the shop floor and can be detrimental to productivity. As a consequence, these managers commonly take inventory levels as indicators for process capability and efficiency. Inventory reductions can significantly reduce costs, however they also expose defects in the manufacturing process, forcing managers and workers to eliminate (rather than accommodate) sources of process variability. Inventory reductions can also result in productivity gains, and might serve as an indicator that process variability has been reduced and that less buffer stock is required. A 10% reduction in inventory leads for example with a lag of about one year to an average labor productivity gain of about 1% (Lieberman and Demeester, 1999). In combination, inventory reduction will remain a challenging task in the upcoming years, as 40% of the respondents approve.

2.2.2. Additional stresses

Challenges in supply chain management are manifold. Besides the four top challenges described above, manufacturing firms pay close attention to a number of other issues.

Customer service improvement. Customer service efforts were approved by 33% of the respondents. Logistics is concerned with the timely and accurate flow of finished goods from the production line to the customers. Customer service levels directly depend on the performance of the logistics system of the firm. Customer service may also represent the best opportunity for a firm to increase its market penetration and profitability. Therefore, excellent customer service helps to achieve a close interaction with customers to fulfill specific requirements and in reverse to be able to penetrate higher margins and achieve higher customer loyalty.

Network optimization. More than ever, value creation occurs in networks consisting of suppliers, manufacturing sites and logistic service facilities. As a consequence, a precise

management of the global supply chain network is a prerequisite for a timely market introduction of new products, smooth product ramp-ups, high delivery capability and quick response to customer demand. However, as firms grow over time and expand their supply chain network, it might happen one day that the network is not optimal anymore. To avoid bottlenecks, redundancies and other suboptimal structures that decrease the overall performance, 31% of the respondents will further focus on network optimization.

Consolidation of facilities as well as inbound and outbound optimization. Closely related to network optimization is the consolidation of facilities as well as the inbound and the outbound transportation optimization. Typical business drivers for facility consolidation are changes in volumes required by the customers in regional markets, product line extensions, mergers, acquisitions or divestiture of product lines. In order to ameliorate suboptimal network systems, consolidation of facilities helps. In that context, new network nodes emerge, for example, through the implementation of lead production facilities or regional distribution centers that optimize inbound and outbound transportation. Inbound transportation optimization is designed to create optimal inbound material shipments and loads to assembly and component facilities. Optimal plans must be created considering potential supply chain constraints. Outbound transportation and logistics is at the other side of the process of managing and optimizing the outbound shipment of vehicles from assembly plants through consolidation hubs to distributors or customers.

Know-how enhancement of employees. The right employee training, development and education provides significant payoffs for the employer. Hence the hiring, training and retention of qualified employee is high on the agenda of many firms. In the coming years, 22% of the firms plan to enhance the “supply chain knowledge” of their employees. Better

and well-trained employees – blue- and white-collar alike – are the basis for supply chain innovations, increasing process efficiencies, the ability to adapt to new technologies, and last but not least, higher job satisfaction, employee motivation and reduced employee turnover. Qualified people who understand the business of running supply chains are scarce.

Reverse logistics optimization. In many countries, new laws require firms to implement reverse logistics systems, for example, for electronic equipment. Since the reverse supply chain consists of three separate entities – the assembly plant, the disassembly plant and the recycling plant – operations have to be planned from a larger perspective that comprises those three entities. From the supply of products to collection, dismantling and reuse, the inventory of products and components must be properly maintained and inventory policies in reverse supply chains must be altered in terms of the level and location of buffer stocks. Since reverse logistics optimization is seen by a relatively small number of the respondents as a key supply chain driver, firms still seem to react to fulfill the required reverse logistics activities, but to a lesser degree see reverse logistics as a means for differentiation or cost reduction.

Others. Finally, value creation through “other” improvement initiatives, such as consolidation of outbound distribution networks or ERP system implementations, were also considered as a challenge supply chain and operations managers will tackle in the next two years.

Developing, selling, manufacturing and delivering customized products can be a challenge for the best organizations. Customers will only be satisfied and buy again if service and price are aligned with their expectations. Supply chain management plays a crucial role in meeting these expectations. An inefficient and poorly functioning supply chain can negatively impact every aspect of an organization, jeopardizing the long-term performance

and success of a business. Manufacturing firms that re-evaluate how the current supply chain strategies and structures – including infrastructure, technologies, processes and organizational structures – support their business must continuously adapt to changing customer preferences and competitive environments. In the end, business strategy and supply chain strategy must match and support each other to achieve a high supply chain performance.

2.3. Strategic fit

For any firm to be successful, its supply chain strategy must be aligned with its competitive strategy. Strategic fit refers to consistency between the customer priorities which the competitive strategy hopes to satisfy and the supply chain capabilities which the supply chain strategy aims to build. Few tasks are more difficult for the top management of a firm than achieving supply chain fit, i.e., the job of aligning the supply chain design to the specific demand aspects of the underlying product which implies achieving supply chain fit and to make sure that all core functionalities are in line with the overall competitive strategy (“strategic fit”). If an alignment between supply chain strategy and its supply chain design is not achieved, supply chain misfit occurs. It results in different functions within the firm and stages across the supply chain targeting different customer priorities. The question is how the supply chain drivers should be designed to achieve supply chain fit. In other words, what does a firm need to do to achieve that all-important supply chain fit?

A competitive strategy will implicitly or explicitly specify one or more customer segments that a firm hopes to satisfy with its product. To achieve supply chain fit, a firm must ensure that its supply chain capabilities (supply chain design) support its ability to satisfy with its product(s) the targeted customer segments. To achieve a fit, the following three steps are crucial.

2.3.1. Demand and supply uncertainty spectrum

Firms must understand the customer needs for each targeted segment and the uncertainty that the supply chain faces in satisfying these needs. A powerful but simple way to characterize a product, when seeking to devise the right supply chain strategy, is to look into its underlying uncertainty spectrum. It specifies the two key uncertainties: demand and supply. Demand uncertainty is linked to the predictability of the demand for the product. Fisher (1997) categorizes products as functional (standardized), with predictable demand, or innovative (individualized, customized, or fashionable), with unpredictable demand. Product characteristics vary in terms of demand predictability, life-cycle length, product variety, service, lead-times and specific market requirements. Fashion apparel, high-end laptops, the latest integrated circuits, and mass customized goods are examples of innovative products; consumable household items, food, oil and gas, and everyday clothing are examples of functional products. Functional products have less variety than innovative products, where variety is implicit in the fashion-oriented nature of the product or the rapid introduction of new product launches due to advancements in technology. Demand for functional products is much easier to forecast than the demand for innovative products. Due to the differences in product life-cycle and the nature of the product, functional products tend to have lower product profit margins, but the cost of obsolescence is low; innovative products tend to have higher product profit margins, but the cost of obsolescence is high. The demand aspects of a product listed by Fisher (1997) as shown in Table 1 point out that implied demand uncertainty is often correlated with other aspects of demand.

Table 1: Generic product profiles

Aspects of demand (product characteristics)	Functional products (predictable demand)	Innovative products (unpredictable demand)
Product life-cycle	more than 2 years	3 months to 1 year
Contribution margin	5%-20%	20%-60%
Product variety	Low (10-20 variants per category)	High (often millions of variables per category)
Average margin of error in the forecast at the time production is committed	10%	40%-100%
Average stock-out rate	1%-2%	10%-40%
Average forced end-of-season mark down as percentage of full price	0%	10%-25%
Lead-time required for made-to-order products	6 months to 1 year	1 day to 2 weeks

Note. Demand aspects adapted from Fisher (1997). The contribution margin equals price minus variable cost divided by price and is described as a percentage.

First, products with uncertain demand are often less mature and have less direct competition; this allows higher margins. Second, increased implied uncertainty leads to increased complexity in matching demand and supply. This leads either to higher inventory levels (oversupply) and to markdowns (if it is a failure) or to higher stock-out rates (if it is a success). Finally, forecasting is much tougher and less accurate when demand uncertainty is high. As a result, different supply chain strategies are required for functional than for innovative products.

Lee (2002) points out that along with demand uncertainty, it is important to consider supply uncertainty, resulting from the capability of the supply chain. Several characteristics of supply sources, like frequent breakdowns (Wagner and Bode, 2008), inflexible or limited supply capacity, low, unpredictable yields or evolving product processes affect supply uncertainty. Furthermore, supply uncertainty is triggered by the life-cycle position. Innovative products, introduced to the market, have higher supply uncertainty in contrast to mature (functional) products because designs and production processes are still evolving.

Demand and supply uncertainties can be used as a framework to devise the right supply chain strategy (Lee, 2002; Fisher, 1997). For this reason, firms should combine the uncertainty from the customers and the supply chain and map them on the implied

uncertainty spectrum of the underlying product. This helps the firm to identify the extent of the unpredictability of demand, disruption, and delay that for which the supply chain must be prepared. Based on that result, the firm can design its supply chain drivers accordingly to provide the optimal supply chain capabilities to best meet demand in that uncertain environment.

2.3.2. Supply chain capabilities

Supply chains have many characteristics that affect their physically-efficiency and market responsiveness. The supply chain drivers, which build supply chain capability, are the design tools for the supply chain structure to deliver the product through the chain in an optimal manner. The responsiveness spectrum of a supply chain includes the ability of a supply chain to fill a wide range of quantities, to meet requested, often very tight lead-times and/or high service levels, handle large varieties of products to create innovative products. As responsiveness is unfortunately not free (e.g., a wider range of varieties and/or quantities demanded increases capacity and complexity increases costs), firms have to focus on supply chain efficiency. For every strategic choice to increase responsiveness, additional costs which lower efficiency are incurred. As a consequence, with respect to the product which is supplied through the chain, an effective supply chain has to be designed. Depending on the underlying product or main product line of a manufacturing firm which is transformed through the value chain, either a physically-efficient supply chain or a market responsive supply chain is required with respect to its resource and inventory strategy as well as overall objectives. Both generic supply chain designs listed by Fisher (1997) are shown in Table 2.

Table 2: Generic supply chain design profiles

	Physically-efficiency	Market responsiveness
Primary purpose	Supply predictable demand efficiently at the lowest possible cost	Respond quickly to unpredictable demand in order to minimize stock-outs, forced markdown, and obsolete inventory
Manufacturing focus	Maintain high average utilization rate	Deploy excess buffer capacity
Inventory strategy	Generate high turns and minimize inventory throughout the chain	Deploy significant stocks of parts or finished goods
Lead-time focus	Shorten lead-time for cost and quality	Invest aggressively in ways to reduce lead-time
Approach to choosing suppliers	Select primary for cost and quality	Select primary for speed, flexibility and quality
Product-design strategy	Maximize performance and minimize cost	Use modular design in order to postpone product differentiation for as long as possible

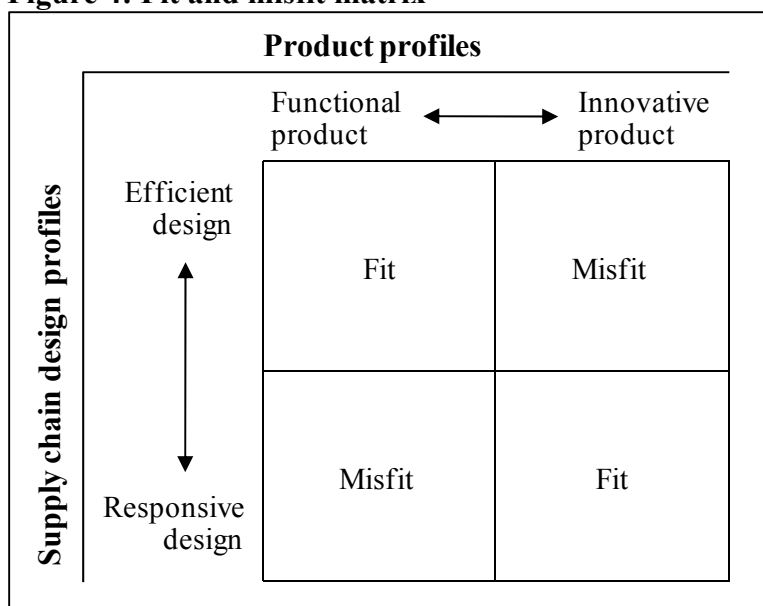
Note. Generic supply chain designs profiles adapted from Fisher (1997).

Chopra and Meindl (2009) note that the lowest possible cost for a given level of responsiveness can be shown by the cost-responsiveness efficient frontier. The efficient frontier line represents the cost-responsiveness performance of the best supply chains. We address this issue in detail in Chapter III. A firm which is not on that efficient frontier line can improve both its costs and its responsiveness by moving towards the efficient frontier. However if a firm is already on the efficient frontier line, it can improve its responsiveness only by increasing costs and becoming less efficient. Such a firm will have to make a trade-off between efficiency and responsiveness. Clearly, firms on the efficient frontier line are continuously improving their operations and changing technology to shift the efficient frontier itself. Given the trade-off between cost and responsiveness, a key strategic choice for any supply chain is to design a supply chain that provides the level of responsiveness it needs to provide to match the product characteristics.

Having determined the nature of the products and their supply chain priorities, a matrix for the ideal supply chain strategy can be formulated. Fisher (1997) identifies two ideal types of organization: 1) those in which functional products are embedded in physically-efficient

supply chains with a strong focus on cost minimization, high inventory turnovers and high average utilization rates; and 2) organizations where innovative (customized) products (which sell often for a single season) are supplied through market responsive supply chains with extra buffer inventory capacity, high flexibility requirements and a capability for market processing information. The two other types are “mismatch” or “misfit.” The four types are depicted in Figure 4.

Figure 4: Fit and misfit matrix



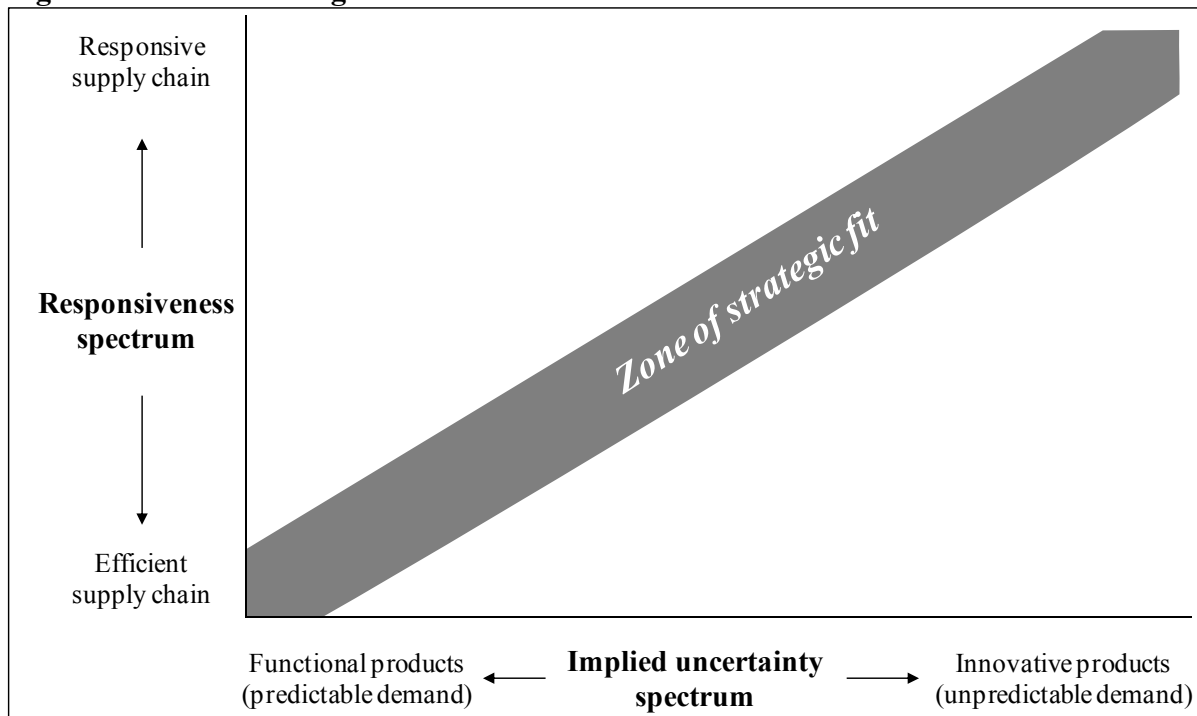
Note. Framework adapted from Fisher (1997).

2.3.3. Zone of strategic fit

As customer preferences and product demand aspects are always in flux, creating a supply chain fit can only be temporary. Managers must be aware that supply chain fit is a dynamic concept, not a static optimization project. In many firms, different departments devise competitive and functional strategies. Without proper communication, i.e. information sharing and coordination, between the departments and coordination by C-level executives, these strategies are not likely to achieve supply chain fit. For many firms, the failure to

achieve supply chain fit is a key reason for their inability to succeed as they lack strategic fit (Chopra and Meindl, 2009).

To achieve strategic fit, firms must take three steps. First, they need to understand the demand and supply uncertainty of their underlying product(s); second, they need to build a supply chain with the right capabilities, and third they need to ensure that the degree of supply chain responsiveness is consistent with the implied uncertainty and aligned with the overall competitive strategy. The goal is to “target high responsiveness for a supply chain facing high implied uncertainty, and efficiency for a supply chain facing low implied uncertainty” (Chopra and Meindl, 2009, p. 32). This relationship is represented by the zone of strategic fit illustrated in Figure 5.

Figure 5: Zone of strategic fit

Note. Framework adopted from Chopra and Meindl (2009).

Strategic fit is achieved if the ideal consistency among the multiple dimensions of the demand aspects of a firm's product and its embedded supply chain design, i.e., supply chain fit, is reached, and aligned with the overall competitive strategy. Our definition of supply chain fit extends the generic framework of Fisher (1997) in two dimensions. First, there is not always an either-or-strategy, but rather a mixed strategy which reflects the major stake of supply chains (Selldin and Olhager, 2007). Second, most products are neither clearly functional (standardized) nor innovative (customized), for example, automotive or apparel products, mastering cost effectiveness on one hand and on the other hand dealing with high product variety. As a result, there are multiple ideal supply chain fit constellations along the efficient frontier line, depending on the business model and the competitive strategy.

2.3.4. Obstacles

A firm's ability to find the balance between physically-efficiency and market responsiveness that best matches the customer needs is key to achieve supply chain fit. In deciding where this balance should be located on the responsiveness spectrum, firms face tremendous supply chain challenges (Wagner *et al.*, 2010a; Wagner *et al.*, 2009) and numerous obstacles (Chopra and Meindl, 2009):

- **Strategy execution.** Creating a successful supply chain strategy is not easy; executing it difficulties even less so. Toyota's production system, which is a supply chain strategy, has been known and understood, but it has been a competitive advantage for more than two decades (Lee *et al.*, 2005). Its brilliant strategy has been figured out by its competitors; however those firms had difficulty in replicating this strategy. Many high-potentials at all levels of the organization are needed to build and carry out a successful supply chain strategy.
- **Global supply chain management.** The benefits of global supply chains are evident, such as the ability to source suppliers worldwide and to obtain better or less expensive goods. The drawbacks, however, are longer distances as facilities within the supply chain are father apart, making coordination much harder and increased competition, as once-protected firms have to compete worldwide, thus forcing firms to put more strain on supply chains and thus more precisely balancing out their trade-offs.
- **Customer demand.** Customers today demand faster fulfillment, better quality and sophisticated design, and better performing products for the same price than they did years ago. The remarkable growth in customer demands urges supply chains to provide more and to perform better to maintain their business.

- **Product life-cycles.** Shorter product life-cycles makes the job of achieving supply chain fit much harder as the supply chain must constantly adapt to produce and deliver new customized products while coping with these products' demand uncertainty. Shorter life-cycles and increased uncertainty, combined with a smaller window of opportunity within the supply chain to achieve supply chain fit has put additional pressure on supply chains to coordinate and match supply to demand.
- **Variety of products.** The increase in product variety complicates the accuracy of demand and forecast planning, which often tends to raise uncertainty; uncertainty frequently results in increased costs and decreased responsiveness within the supply chain.
- **Supply chain ownership.** Most firms are less vertically integrated than they were decades ago, taking advantage of supplier and customer competencies. However, this has made managing the supply chain more difficult as different interests and policies of supply chain partners increase the complexity of coordination, thus reducing the profitability of the overall supply chain and the chance to achieve strategic fit..

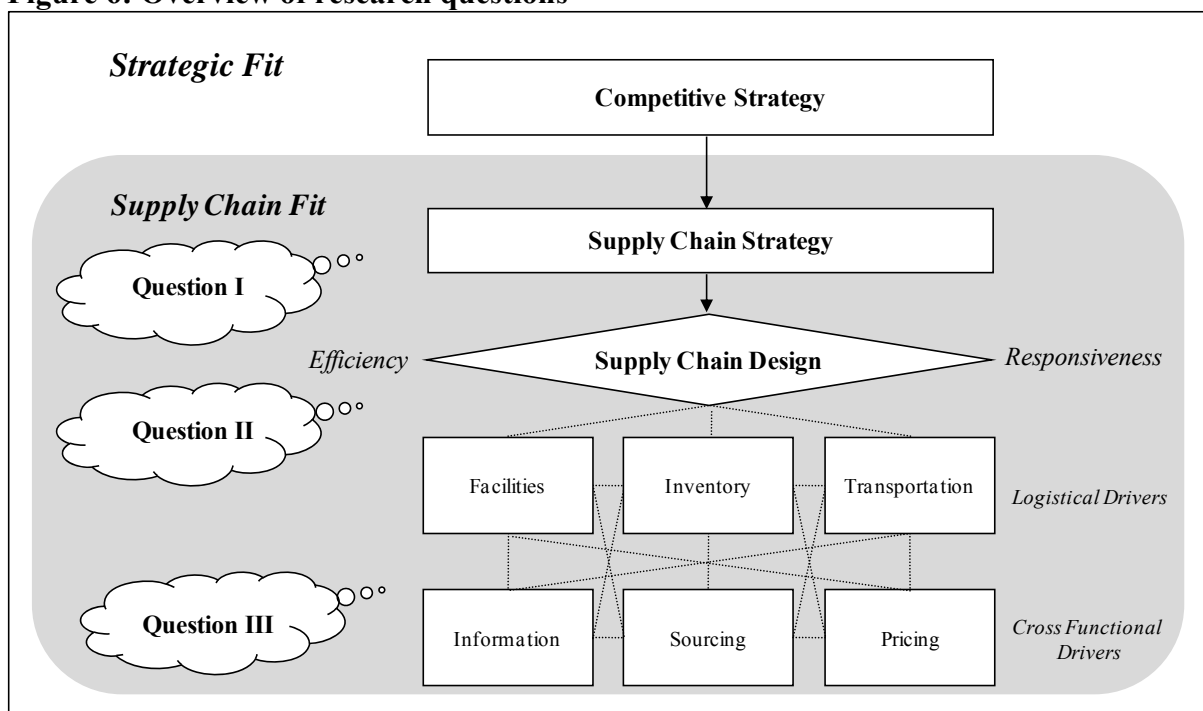
Those obstacles described above make it clear that achieving strategic fit is a major challenge. Supply chain management plays hereby a major factor in the success or failure of firms (e.g., Wagner *et al.*, 2010a; Wagner *et al.*, 2009; Chopra and Meindl, 2009; Mentzer, 2001; Lee, 2002; Simchi-Levi *et al.*, 2000).

3. Research questions

This dissertation consists of three chapters (Chapter II, Chapter III, and Chapter IV) each of which answers a particular research question. Top management must commit to

understanding the effects of supply chain management on financial performance. The three conceptual frameworks developed and tested in each of these chapters take unique perspectives on the theme of this dissertation: the phenomenon of supply chain fit, its constituents and performance outcomes and their relevance to the research on supply chain management. Figure 6 illustrates the three core research questions under investigation and their relationship with each other.

Figure 6: Overview of research questions



Note. The supply chain strategy must be aligned to the competitive strategy to achieve strategic fit. Supply chain fit is defined as the ideal strategic consistency among the multiple dimensions of the demand aspects of a firm's product and its embedded supply chain design and is a prerequisite for obtaining strategic fit.

3.1. Research question I

Supply chain fit, i.e., strategic consistencies between demand aspects of the underlying product and the underlying supply chain design, is a major leverage factor in a firm's success and is receiving increased attention from both academia and business. However, managing dynamic supply chains either with functional products or with innovative products is difficult

(Slone *et al.*, 2007), i.e., increased implied demand uncertainty is often not served by sufficient supply chain responsiveness (Chopra and Meindl, 2009; Thonemann *et al.*, 2007). For instance, a lack of supply chain fit among carmakers and parts suppliers in the U.S. automotive industry costs more than USD 10 billion each year. If the entire industry reached a supply chain fit, it could save USD 8 billion (Hensley and Knopf, 2005). Indicators of a lack of supply chain fit are manifold, and include degraded customer service, excessive inventory, escalating costs, and declining profitability. For instance, despite heavy investments in supply chain technology, Cisco Systems had to write off over USD 2 billion in excess inventory in 2001 (Bailen, 2001) due to a clear lack of supply chain fit, estimated costs of markdowns in US department stores are oftentimes up to 40%, and stock-outs account for 30% of retail sales (Hausman and Thorbeck, 2007). In other words, getting the right (new) product to the right (new) place at the right time at the right price, the traditional touchstones of supply chain success, remains a challenging, cost-intensive, and frequently multi-faceted goal (Fisher *et al.*, 2000).

Operational measures such as speed, cost, quality, innovativeness and flexibility are often the dependent variables of choice in supply chain studies (e.g., McKone *et al.*, 2001). “Scholars often argue that supply chain management has “bottom line” impact via such metrics, but the case for such relationships is based largely on assertion rather than demonstration. Thus, there is a great need for research establishing how and to what extent supply chain activities directly and indirectly shape firm profits and stock price.” (Ketchen and Giunipero, 2004, p. 54).

Although it is intuitive that a supply chain fit is likely to have a positive impact on profitability, there is little systematic analysis and documentation of the magnitude of this

impact in the literature. Most of the evidence that we have seen in literature is either anecdotal or based on case studies. Only some initial research has emerged, among others Vickery, Jayaram, Droge, and Calantone (2003) who investigate the link between supply chain integration and financial performance due to an improved customer service, Droge, Jayaram, and Vickery (2004) who indicate that an overall firm performance can be increased by integrating practices leading to a better time-based performance, or Dehning, Richardson, and Zmud (2007) who argue that excellent IT-based supply chain management systems increase process efficiency and hence the financial performance effects. In response to this call, we investigate in Chapter II the link between supply chain fit and firm's financial success. This leads to research question I:

Question I: *Does supply chain fit have a significant impact on a firm's financial success and if so, which supply chain fit constituents are of relevance?*

3.2. Research question II

Designing supply chain is one of the most strategic and challenging tasks of supply chain management (Delfmann and Klaas-Wissing, 2007). Excellent supply chain designs, among others at Zara, Procter & Gamble, Wal-Mart or Toyota, serve as competitive weapons. However, many firms still struggle with the design of efficient supply chains. For instance, supply chain design problems have contributed to a two-year delay at Boeing, the largest U.S. manufacturer of commercial jetliners and military aircraft. However, it is still not clear whether the breakdown of the "Dreamliner design" and its manufacturing was a matter of communication, execution or something else (Smock, 2009). Many other recent publications have highlighted the importance of supply chain design. For example, Danone was able to boost its sales growth by 8% to 12% by improving its quality, service, availability and

freshness (“market responsiveness”) (Loderhose, 2008). Chrysler aims to improve its supply chain operations to cut supply chain costs (“physically-efficiency”) by 25% in the next three years (Gupta and Orlofsky, 2008). Typically, firms producing and selling standardized (functional) products operate in mature industry segments in which pressure on profit margins is strong and competitive intensity is high. In contrast, customized (innovative) products are made in an environment of lower competitive intensity, on the basis of innovation and product variety (Lee, 2002; Christopher and Towill, 2000; Fisher, 1997). As supply chain inefficiencies harm the competitiveness of firms through effects on both cost (physical-efficiency) and time (market responsiveness), the design of the supply chain is of utmost importance. Although many studies have captured the importance of supply chain decisions about design and capabilities (Lee, 2004; Lee, 2002; Christopher and Towill, 2000; Fisher, 1997), far less attention has been given to its impact on profitability (Hausman and Thorbeck, 2007; Thonemann *et al.*, 2007; Hendricks and Singhal, 2005).

So far, supply chain design efficiency has not been benchmarked either in the literature or in practice. As a result, it is unknown how firms succeed in striking the right balance between physically-efficiency and market responsiveness of their supply chains in terms of profitability. Chapter III fills this gap by using Data Envelopment Analysis (DEA) to integrate supply chain design into an overall benchmark of financial profitability in terms of ROCE. This leads to research question II:

Question II: *How do supply chain designs perform in terms of Return on Capital Employed, and which supply chain design types are of relevance?*

3.3. Research question III

As explained in the previous section, logistics and cross-functional drivers should be designed so that a requested flexibility within the supply chain can meet customer demands. Flexibility is often seen as a firm's ability to match production to stochastic market demand and uncertainty. It is also closely linked to the firm's ability to provide customized (niche or innovative) products to the consumer. There is no formal definition of the specific dimensions which are needed to measure flexibility (D'Souza and Williams, 2000; Koste and Malhotra, 1999; Upton, 1994; Gupta and Somers, 1992; Sethi and Sethi, 1990; Slack, 1987; 1983). Flexibility can be exhibited in different ways. A firm that has a higher output than another firm, given limited time and resources, exhibits a higher (manufacturing) flexibility. A firm that delivers its products more quickly to its downstream partners, for example by aircraft, might exhibit higher (logistics) flexibility. A firm which can rely on a supplier portfolio allowing changing delivery frequencies, order sizes or frequent changes of volume allocation among them might exhibit a higher (sourcing) flexibility. In other words, flexibility consists of a supply chain's agility, adaptability, and responsiveness to the needs of its users (Youndt *et al.*, 1996). Slack (1983) defines flexibility as "the range of states a system can adopt, the cost of moving from one state to another, and the time which is necessary to move from one state to another" and extends it later (1987) to "the ease (in terms of cost, time, or both) with which changes can be made within the capability envelope". Products which are delivered more quickly will be more expensive and vice versa. Hence flexibility can be composed of two dimensions: range and adaptability in which firms can change or react with little penalty in time, cost or both providing the requested performance to its partners (Koste and Malhotra, 1999; Upton, 1994). The first dimension of flexibility is the number of

different states (range) which a firm can exercise (Upton, 1994; Slack, 1983) based on existing resources which exclude the option that “range can be increased by simply investing additional resources, in which case it would be a transient attribute” (Swafford *et al.*, 2006, pp. 173-174). The second dimension of flexibility is adaptability (Koste and Malhotra, 1999; Bordoloi *et al.*, 1999), which is the ability of a firm to shift from one state to another state in a timely and cost effective manner in order to modify supply network to strategies, technologies, and products as well as to adjust the supply chain’s design (Lee, 2004).

Manufacturing firms increasingly outsource many of their production activities to their suppliers. As a result, the average cost of purchased materials, components, and services across all manufacturing firms frequently exceeds 60% to 70% of the total cost of operations (Leenders *et al.*, 2006; Wagner, 2006). In such an environment, sourcing flexibility, i.e., “the availability of a range of options and the ability of the purchasing process to effectively exploit them so as to respond to changing requirements related to the supply of purchased components” (Swafford *et al.*, 2006, p. 174), is central to the success of firms that face environmental or market uncertainties. Firms can save millions of dollars by adapting the responsiveness of their supply chains through sourcing flexibility to reduce stock-outs and inventory in their supply chains, shorten lead-times, and improve the quality of their products. For example, by practicing sourcing flexibility, Zara, the Spanish fashion retailer, is able to limit its sales at markdown prices to 15%–20% of the total sales, compared to 30%–40% for its European peers (Cachon and Swinney, 2009; Ghemawat and Nueno, 2003). As such, sourcing flexibility is one of the fundamental characteristics of an agile supply chain. However, as important as it is, the link between sourcing flexibility and a firm’s product and supply chain success has not yet been established. More and Babu (2008, p. 40) state that, in

the literature, “the empirical justification of the benefits of implementing flexible supply chains is rare and in-depth empirical studies are lacking.” Consequently, such knowledge would support better supply chain design decision making.

In response to this call, in Chapter IV we investigate the impact of sourcing flexibility on supply chain and product performance. In this context, the composition of a firm’s supplier portfolio is essential to achieving the sourcing flexibility that is desirable in terms of efficiency (cost) and responsiveness (agility). A high degree of sourcing flexibility in the supply chain enables greater supply chain agility. However, sourcing flexibility comes at a cost and therefore does not automatically result in higher profitability due to increased responsiveness. This trade-off needs to be explored to reach definitive conclusions on the relationship between sourcing flexibility and performance. In summary, the research question III is:

Question III: *Does sourcing flexibility have a significant impact on supply chain and product performance and if so, which degree of sourcing flexibility sources is required for high supply chain performance and product performance?*

4. Empirical basis

In order to investigate these research questions, theory-driven models were hypothesized which were subsequently tested on a broad empirical basis. Hence, for Studies I, II and III, large-scale data collection was conducted. Considerable attention was paid to the design of the survey instrument, the ease of use, the burden on the respondents, and the maintenance of the respondents’ interest until the survey was completed (Dillman, 2007). Therefore, a

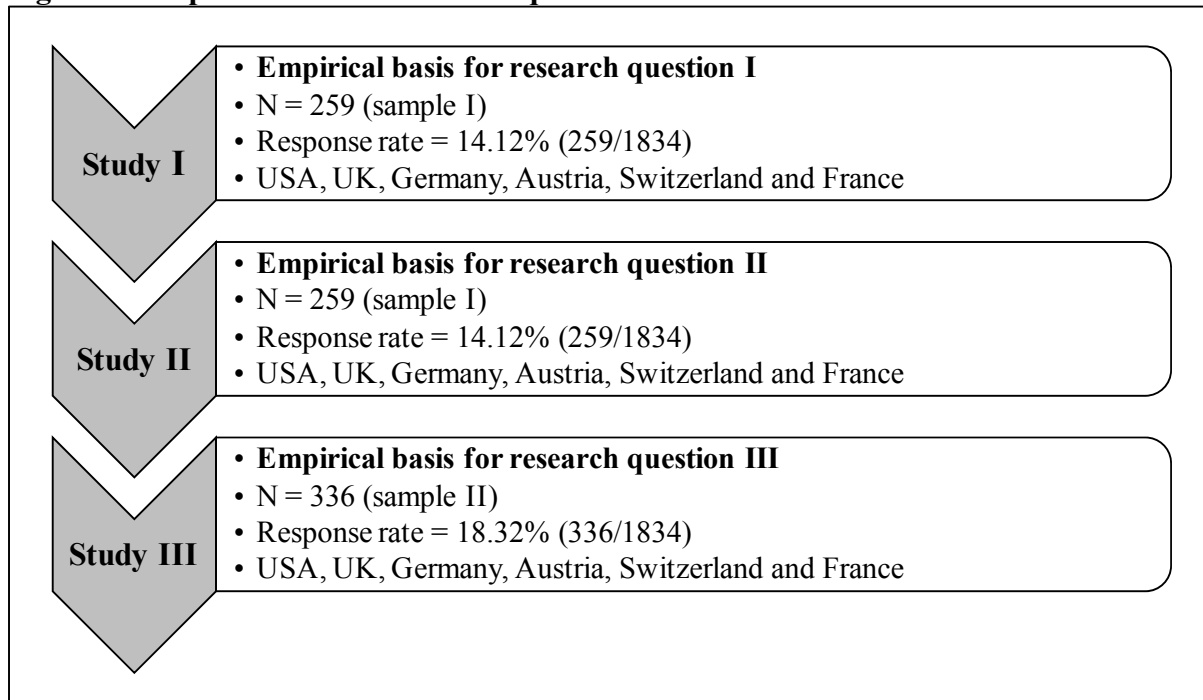
preliminary questionnaire was drafted with measurement scales and indexes which were based on existing research. Furthermore, we ensured general ease of understanding for respondents and construct validity. Therefore, the survey instrument was pre-tested with executives and managers who were asked to review the questionnaire for readability, ambiguity and completeness (Dillman, 2007). Several academics were asked to review the survey items for ambiguity and clarity, and to evaluate whether individual items appeared to be appropriate measures of their respective constructs (DeVellis, 2003). Several minor changes were made to the survey instrument based on the pretest. Moreover, the survey instrument incorporated the recommendations of Podsakoff, MacKenzie, Lee, and Podsakoff (2003) for reducing common method bias. Accordingly, the respondents were offered anonymity and confidentiality to reduce the chances of responses that are socially desirable, lenient, or consistent with how respondents believe researchers want them to respond. In addition, the respondents were informed that there are no correct or incorrect answers and to respond as honestly as possible to reduce evaluation apprehension.

All three studies were conducted by means of an internet-based survey. The internet-based survey was sent out three times, first to the USA and the UK, second to the German-speaking countries Germany, Austria and Switzerland, and third to France. Therefore, the English questionnaire was translated into German and French by two native speakers and then was back translated into English by two other people. Any differences that emerged were reconciled by these translators.

After these changes were completed, the survey was finalized and mailed. We mailed the survey only to targeted key professionals in the area of logistics and supply chain management. We focused on the largest firms in the USA and Europe. With the support of

Stanford alumni and a service provider, 1,834 contact details were obtained. Figure 7 depicts the data collection efforts which reflect our empirical basis.

Figure 7: Empirical basis of research questions



All three studies are out of the same cross-sectional sample, however while Studies I and II were examined on the basis of sample I (259 manufacturing firms), Study III was investigated on the basis of sample II (336 manufacturing firms). The reason is that out of the cross-sectional sample we could only obtain secondary data from Bloomberg and Thomson Reuters for 259 manufacturing firms listed on the stock exchanges in the USA and/or Europe.

4.1. Studies I and II

4.1.1. Data collection procedure

Research questions I and II and hence Studies I and II are based on sample I: on the cross-sectional sample of 1,834 firms which was conducted in the USA, the UK, Germany, Austria, Switzerland and France during September 2007 and April 2008. The sample, with 336 usable

responses, was used and could be split into 77 private and 259 public manufacturing firms. All contact addresses from public firms which were obtained from Stanford alumni, Department of Management Science and Engineering and with the help of a service provider who contacted the biggest manufacturing firms in the USA and Europe to get in contact with business, supply chain, logistics and procurement executives were screened for key performance indicators. The unit of analysis in Studies I and II is the main product line, defined as the current sales (revenue) driver of the firm and its underlying supply chain.

Studies I and II targeted single well-informed respondents (Kumar *et al.*, 1993; Phillips, 1981), i.e., senior managers in the purchasing or supply chain department, who are likely to have an overarching, boundary-spanning view of their firms' supply networks and supplier activities (Hallenbeck *et al.*, 1999).

The invitations to participate in the survey were sent by personalized emails containing a link to the internet-based survey. On average, the questionnaire in Studies I and II took 20.7 minutes to complete. Considerable efforts were made to achieve a good response rate. A composite summary of the results was offered in addition to participation in a lottery. Following Dillman's Total Design Method (Dillman, 2007), initial mailings were followed by reminders, with follow-up phone calls or second mailings, as necessary. Survey respondents were asked to answer each question using a 5-point Likert scale (1—low, 5—high) based on the characteristics of their business unit relative to their major competitors. The mailing and two follow-ups generated 400 responses (21.81%) in September 2007 and April 2008, which is above the recommended rule-of-thumb baseline minimum of 20% for empirical studies (Malhotra and Grover, 1998) even though several other studies subscribe to the philosophy that there is no generally accepted minimum response rate (Fowler, 1993).

However out of our sample, we could only obtain secondary data for 259 firms, i.e., all key performance indicators (KPIs) which we requested to calculate among others ROCE, sales or margin averages, yielding an effective response rate of 14.12% (259/1834). Hence, sample I covers 259 manufacturing firms from a wide range of industries listed on the stock exchange in the USA and/or Europe.

4.1.2. Sample characteristics

Approximately 61% of respondents were C-level executives, vice presidents, directors or department heads, mainly in supply chain management (41%), logistics (19%), production and procurement (17%), general management (10%) and closely related logistics fields (13%). These respondents are likely to possess an overarching, boundary-spanning view of their firms' upstream and downstream activities pertaining to their firms' main product lines.

A detailed breakdown is provided in Table 3.

Table 3: Breakdown of sample I composition

Industry Sector	N	%	Number of Employees	N	%
Aerospace & Defense	24	9.27	< 100	3	1.16
Automotive & Parts	29	11.20	100-499	20	7.72
Chemicals	16	6.18	500-999	17	6.56
Construction & Materials	14	5.41	1,000-4,999	52	20.08
Electricity	4	1.54	5,000-9,999	40	15.44
Electronic & Electrical Equipment	28	10.81	> 10,000	127	49.04
Food & Beverages	19	7.34	Respondent Job Title	N	%
Forestry & Paper	5	1.93	CxO/Vice President	37	14.29
Household Goods & Personal Goods	26	10.04	Director/Department Head	122	47.10
Industrial Metals	10	3.86	Manager	64	24.71
Machinery & Plant Engineering	24	9.27	Team Leader	18	6.95
Medical Equipment	10	3.86	Others	18	6.95
Mining	4	1.54	Respondent Function	N	%
Oil & Gas	6	2.32	Supply Chain Management	106	40.93
Pharmaceuticals & Biotechnology	12	4.63	General Management	27	10.42
Technology Hardware & Equipment	17	6.56	Logistics	48	18.53
Textiles	11	4.25	Purchasing	24	9.27
			Production/Manufacturing	20	7.72
TOTAL	259		Others	34	13.13

On average, the respondents have worked in the fields of procurement, logistics, supply chain, production, or related fields for 13.2 years, have been in their position for 3.9 years, and have been with the firm for 9.9 years (see Table 4), yielding a very good knowledge of the underlying main product line, its structure and supplier base.

Table 4: Respondent work experience of sample I

Work Experience	Seniority		Position		Function	
	N	%	N	%	N	%
0 years - 4 years	90	34.75	191	73.75	44	16.99
5 years - 9 years	72	27.80	43	16.60	55	21.24
10 years - 14 years	32	12.36	14	5.41	44	16.99
15 years - 19 years	25	9.65	6	2.32	47	18.15
> 20 years	40	15.44	5	1.93	69	26.64

The firms' annual sales range from EUR 14.1 million to EUR 170.5 billion; 65.3% of the firms' annual sales are above EUR 1 billion (mean = EUR 15.32 billion); the number of employees ranges from less than 100 to 398,200 (mean = 52,031), thus yielding a heterogeneous sample of mainly American and European firms. Given the range and size of the firms studied and the diversity of industries, any systematic bias in the results can be excluded.

4.1.3. Data examination

The data were thoroughly screened and examined for possible problems and inconsistencies. The univariate distributions of the manifest variables were examined for both skewness and kurtosis and found to be within acceptable ranges (skewness below $|2.0|$ and kurtosis below $|7.0|$). No obvious univariate or multivariate outliers were detected by means of visual inspection and the examination of the Mahalanobis distances ($p < 0.001$) (Cohen *et al.*, 2003).

Two approaches were used to check whether non-response bias is a potential threat to the representativeness of the sample and thus the validity of the findings. First, a wave analysis

was conducted, based on the assumption that late respondents are similar to non-respondents (Armstrong and Overton, 1977). *t*-tests at the 5% level yielded no statistically significant differences among the responses from early (initial invitation email wave) versus late (second and third reminder email wave) respondents on all 38 items as well as on a few key demographic variables. Second, the sample of respondents was compared to a sample of 100 randomly selected non-responding firms drawn from the initial sample ($N = 1,834$) in terms of annual sales and employees in 2006 (Wagner and Kemmerling, 2010). The data were gathered from Bloomberg and Thomson Reuters. For both variables, no mean differences between respondents and non-respondents were found to be significant according to the performed *t*-tests ($p < 0.05$). In sum, although these results do not rule out the possibility of non-response bias, they suggest that non-response bias may not be a problem. Thus, we conclude that non-response bias is not present and preceded the data analysis as described in subsequent sections.

4.2. Study III

4.2.1. Data collection procedure

The data collection procedure of Study III is the same as for Studies I and II. The mailing and two follow-ups generated in total 336 usable responses, yielding an effective response rate of 18.32% (336/1834).

4.2.2. Sample characteristics

Approximately 64% of respondents are C-level executives, vice presidents, directors, or department heads, primarily in supply chain management (38%), general management (26%), logistics (18%), purchasing (10%), and production (8%). These respondents are likely to

possess an overarching, boundary-spanning view of their respective firms' upstream and downstream activities pertaining to their firms' main product lines. A detailed breakdown of the sample II can be found in Table 5.

Table 5: Breakdown of sample II composition

Industry Sector	N	%	Number of Employees	N	%
Aerospace & Defense	25	7.4	< 100	29	8.6
Automotive & Parts	33	9.8	100-499	42	12.5
Chemicals	24	7.1	500-999	27	8.0
Construction & Materials	20	6.0	1,000-4,999	60	17.9
Electricity	5	1.5	5,000-9,999	43	12.8
Electronic & Electrical Equipment	29	8.6	> 10,000	133	39.6
Food & Beverages	25	7.4	N/A	2	0.6
Forestry & Paper	7	2.1	Respondent Job Title	N	%
Household Goods & Personal Goods	31	9.2	CxO/Vice President	62	18.4
Industrial Metals	13	3.9	Director/Department Head	154	45.8
Machinery & Plant Engineering	28	8.3	Manager	96	28.6
Medical Equipment	11	3.3	Team Leader	19	5.7
Mining	4	1.2	Others	5	1.5
Oil & Gas	8	2.4	Respondent Function	N	%
Pharmaceuticals & Biotechnology	12	3.6	Supply Chain Management	124	36.9
Technology Hardware & Equipment	21	6.2	General Management	89	26.5
Textiles	14	4.2	Logistics	59	17.6
Others	8	2.4	Purchasing	32	9.5
N/A	18	5.4	Production/Manufacturing	27	8.0
TOTAL	336		Others	5	1.5

On average, the respondents have worked in the field of purchasing, logistics, supply chain, production, or related fields for 13.4 years, have been in their current positions for 4.4 years and have been with their firms for 10 years (see Table 6). They demonstrate superior knowledge of the underlying main product lines, including the structure and supplier base of those product lines.

Table 6: Respondent work experience of sample II

Work Experience	Seniority		Position		Function	
	N	%	N	%	N	%
0 years - 4 years	121	36.01	239	71.13	59	17.56
5 years - 9 years	84	25.00	57	16.96	68	20.24
10 years - 14 years	48	14.29	24	7.14	62	18.45
15 years - 19 years	30	8.93	7	2.08	60	17.86
> 20 years	53	15.77	9	2.68	87	25.89

The firms' annual sales range from 14.06 million EUR to 170.49 billion EUR, with 51% of the firms' annual sales in excess of 1 billion EUR (mean 15.59 billion EUR). The number of employees ranges from less than 100 to 398,200 (mean 41,438). In terms of annual sales and retained employees, the sample is thus heterogeneous. The range and size of the included firms and the diversity of industries represented suggest that any systematic bias can be excluded. Given the range and size of the firms studied and the diversity of industries, as well as the informant competence and experience with regard to the topic of this study, the sample characteristics provide an optimal basis for analysis.

4.2.3. Data examination

Again, the data were thoroughly screened and analyzed for possible problems and inconsistencies. The univariate distributions of the manifest variables were examined for both skewness and kurtosis and found to be within acceptable ranges (skewness below |2.0| and kurtosis below |7.0|). No obvious univariate or multivariate outliers were detected by means of visual inspection and the examination of the Mahalanobis distances ($p < 0.001$) (Cohen *et al.*, 2003).

To address non-response bias in Study III, we first applied the procedure suggested by Armstrong and Overton (1977). We organized the data set into two groups of equal size, one group consisting of earlier respondents and one group consisting of later respondents. To

identify potential statistically significant differences between the two groups, we performed t-tests on the groups' responses. The t-tests ($p < 0.05$) yielded no statistically significant mean differences among all items used in our models. In addition, we tested for significant differences between firm size and industry clusters. Again, no statistically significant differences were identified. Second, we sampled from the population that did not respond to the original survey (non-respondents), contacted that sample by phone, and asked them to complete the survey (Wagner and Kemmerling, 2010; Mentzer and Flint, 1997). The responses from 52 non-respondents were compared to the data of respondents; t-test results did not reveal statistically significant differences. These tests suggest that non-response bias is not a problem in our study.

Chapter II The Bottom Line Impact of Supply Chain Management

This chapter investigates the bottom line impact of supply chain management, in particular the link between supply chain fit and a firm's financial success. In this chapter, the bottom line impact of supply chain management is restricted to the phenomenon of supply chain fit, a fit between demand aspects of a product and its supply chain design profile as described in Chapter I. The ideas posited in this research have support from the configurational literature (in a supply chain context), from the generic product and supply chain design profiles of Fisher (1997) as well as from the strategic fit concept of Chopra and Meindl (2009).

It is organized as follows: In Section 1, we begin by introducing the theoretical development of the conceptual framework and develop the constructs and core hypotheses within this framework. We then present in Sections 2 the psychometric development of the constructs, followed by regression analyses in Section 3. We discuss in Section 4 ensuing results as well as managerial and research implications.

1. Theoretical background and hypotheses

Based on the nomenclature outlined in the previous chapter, the relevant literature, selected theories, a conceptual framework, and hypotheses are developed in the following. Three basic premises underlie the proposed conceptual framework. The first is that certain supply chain design configurations are drivers of supply chain responsiveness. Second, products can be

classified mainly into two groups: functional products with predictable demand and hence a low implied demand uncertainty and innovative products with unpredictable demand and hence a high implied demand uncertainty. And the third is that there is a relationship between these drivers which impact in the financial performance of a firm.

1.1. Configurational approach

A basic element of supply chain management is the holistic or system view. Following this perspective, especially on a strategic level, supply chain management has to analyze the supply chain as a whole. The configurational approach is one method for realizing this (Neher, 2005). Configuration theory considers holistic configurations, or *gestalts*, of design elements (Miles and Snow, 1978). Hence it extends the traditional approach in strategic management research which strictly divides the concept of strategy between “how strategy is formed” (*process*) and “which decisions are taken” (*content*). In particular for supply chain management, in addition to content and process, the internal and external *environmental context* of the organization plays an important role for decision-making and should therefore be incorporated (Ketchen *et al.*, 1996).

The increased effectiveness is attributed to the internal consistency, or *fit*, among strategic, structural, and contextual patterns. Two well-known examples of configurational theories are Mintzberg’s (1983; 1979) theory of organizational structure and Miles and Snow’s theory (1978) of strategy, structure, and process. Both examples posit that a firm that approximates one of its *ideal types* is hypothesized to be more effective; an “ideal type” (McKinney, 1966) is a theoretical construct to represent a holistic configuration of organizational factors. Miles and Snow (1978) identify four ideal types of firm: the defender, the prospector, the analyzer, and the reactor. Each of these types is a unique configuration of

contextual, structural, and strategic factors. Miles and Snow's typology, which was transferred to the supply chain context (Hult *et al.*, 2006) posits that at least three of these ideal types – prospector, defender and analyzer – represent effective forms of firms.

For the purpose of this research, configuration theory is used as theoretical support for the underlying assumption that a firm with supply chain fit will achieve higher firm performance, i.e., supply chain management has a bottom line impact on firm's financial success. As configurations are constellations of design elements that occur together because their interdependence makes them fall into patterns (Meyer *et al.*, 1993a), strategic consistencies between demand aspects of the underlying product and its supply chain design posits that high organizational efficiency and performance result when firms consider the context in which strategy is crafted and implemented. Hence, the better a supply chain matches an ideal configuration, the better the financial performance.

1.2. Supply chain fit

Following the reasoning of Chopra and Meindl (2009), we define, as indicated earlier, supply chain fit as the ideal strategic consistency between the multiple dimensions of the innovativeness of a firm's product (product demand aspect) and its embedded supply chain responsiveness (supply chain design aspect), which, in turn, must be aligned with the overall competitive strategy. Appropriateness of a firm's strategy can be defined in terms of its fit, match, or congruence with the environmental contingencies facing the firm (Andrews, 1971). A competitive strategy will implicitly or explicitly specify one or more customer segments that a firm hopes to satisfy with its product(s). To avoid supply chain misfits, a firm must ensure that its competitive strategy is aligned to its supply chain strategy (Chopra and Meindl, 2009; Presutti and Mawhinney, 2007; Lee, 2004) and that its supply chain

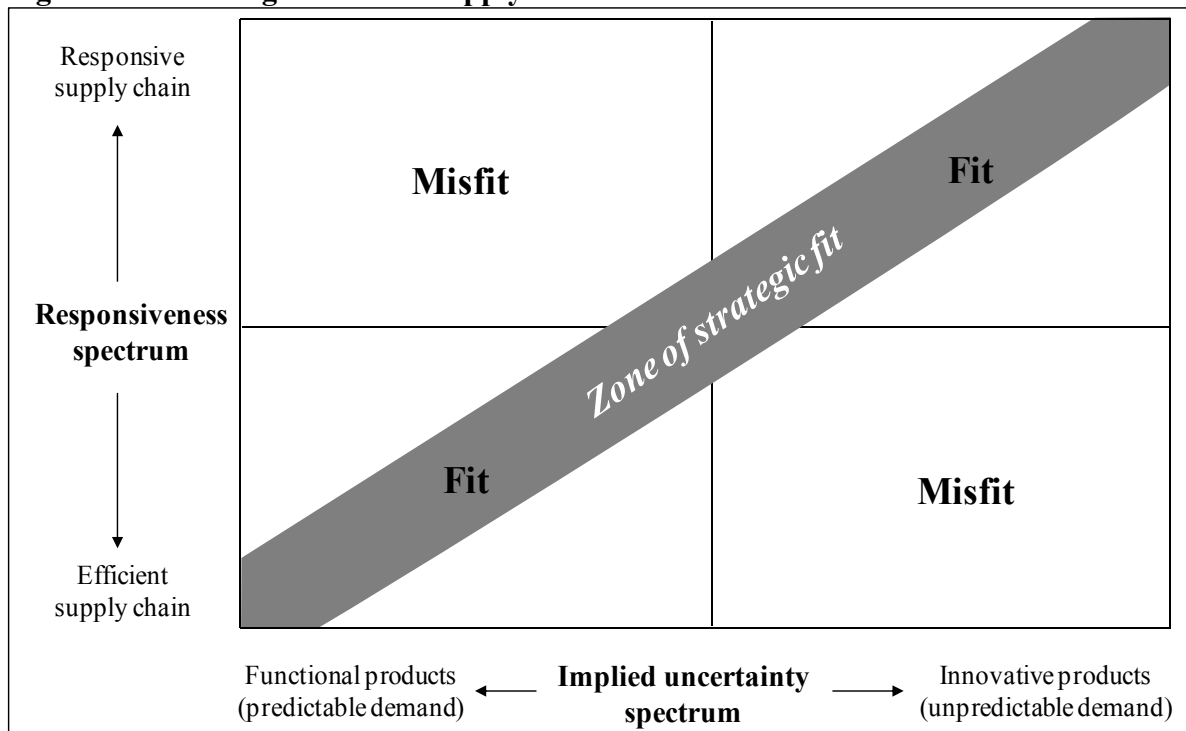
capabilities support its ability to satisfy the targeted customer segments. As customer preferences and consequently demand aspects of products are always in flux, any supply chain fit can only be temporary, i.e., supply chain fit is a dynamic concept. If inconsistencies between demand aspects of the product and the supply chain design occur, and if necessary adaptations do not take place or are not executed on time, a firm will likely exhibit a lack of supply chain fit and lose its competitive edge over time. Failure to achieve supply chain fit is a key reason for the failure of many firms (Chopra and Meindl, 2009). In contrast, Toyota's production system (TPS) for example has been a competitive advantage for more than two decades (Lee *et al.*, 2005). Its brilliant supply chain strategy has been figured out by all competitors, but they failed to emulate such a fit. The core of this strategic approach is mainly based on a fit between their product and supply chain configurations as much as (and this might be different from competitors) to which extend those configurations are managed and aligned to the overall competitive strategy, i.e., supply chain management at Toyota and their unorthodox manufacturing system TPS works continuously in tandem (Shook, 2009; Takeuchi *et al.*, 2008).

When organizational configurations fit or are similar to the ideal type, effectiveness is at its highest because of the greatest possible fit among contextual, structural, and strategic factors (Meyer *et al.*, 1993b). Fisher (1997) describes optimal configurations in terms of demand aspects of a product (determining the implied uncertainty spectrum) and differentiates between functional products, with predictable demand, and innovative products, with unpredictable demand. Demand aspects of a product vary in terms of demand predictability, life-cycle length, product variety, service, lead-times and specific market requirements. With a predictable demand environment (low implied uncertainty), a supply

chain configuration focusing on a physically-efficient supply chain is considered as most appropriate, whereas in case of an unpredictable demand environment (high implied uncertainty), a market responsive supply chain with extra buffer inventory capacity, high flexibility requirements and a capability for market processing information fits better. The generic product and supply chain design portfolios listed by Fisher (1997) are included in Tables 1 and 2.

In acknowledging that there is more than one way to succeed in each type of setting, the configurational approach accommodates the important concept of equifinality. A supply chain fit can hence also be achieved by following a mixed strategy in the underlying supply chain design. This extends Fisher's (1997) framework, because the diametrical request of a match or fit is given up. Since not all products are clearly functional or innovative, mastering cost effectiveness and dealing with high product variety are both required. A mixed strategy reflects also the majority of supply chains (Selldin and Olhager, 2007). Pursuing either a technological innovation or a niche strategy with an innovative product and a responsive strategy could enable a firm to succeed in an environment with high implied demand uncertainty. However, neither strategic approach will work unless it is embedded in a pattern of coherent organizational processes and structures (Meyer *et al.*, 1993a; Meyer *et al.*, 1993b). Key is to ensure that the degree of supply chain responsiveness is consistent with the implied uncertainty and aligned to the overall competitive strategy.

Figure 8: Achieving a fit in the supply chain

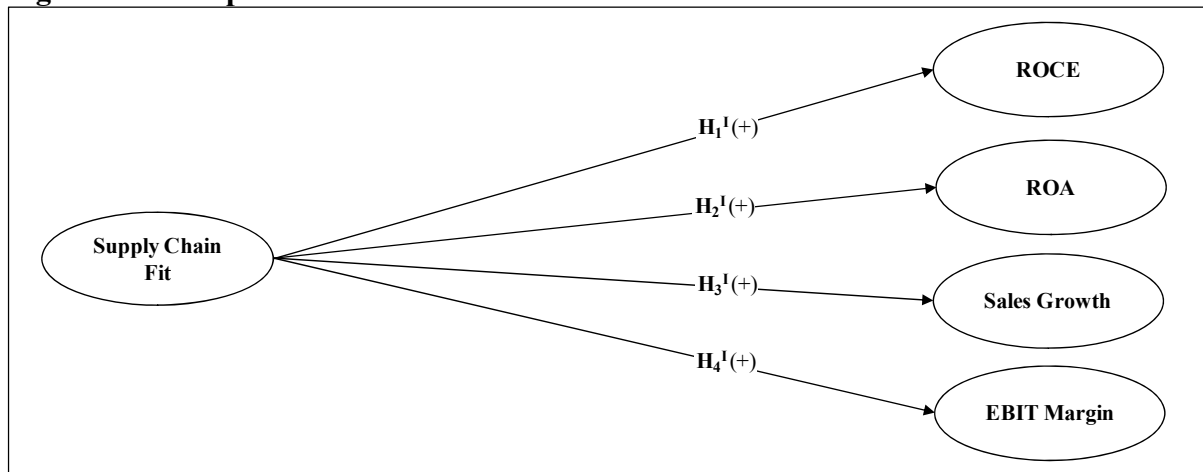


Note. Framework adapted from Chopra and Meindl (2009) and Fisher (1997).

1.3. Consequences of a supply chain fit

To explore the consequences of a supply chain fit on a firm's financial success, we develop a conceptual framework, displayed in Figure 9.

Figure 9: Conceptual framework I



Note. (+) indicates a positive relationship. H₁¹ represents the hypothesized positive relationship between supply chain fit and ROCE, H₂¹ between supply chain fit and ROA, H₃¹ between supply chain fit and Sales Growth, and H₄¹ represents the hypothesized positive relationship between supply chain fit and EBIT Margin.

The concept of fit, a core concept in normative models of strategy formulation, has traditionally been viewed as having desirable performance implications (Ginsberg and Venkatraman, 1985). In this context, supply chain fits are likely to positively affect the firm's short- and long-term revenue, cost and asset streams, i.e., its ROCE, ROA, Sales Growth as well as EBIT Margin (Chopra and Meindl, 2009; Selldin and Olhager, 2007; Thonemann *et al.*, 2007; Simchi-Levi *et al.*, 2000; Fisher, 1997; Van de Ven and Darzin, 1985).

On the revenue side, supply chain fit helps firms capitalizing on strong market demand due to low stock-outs avoiding loss in net sales and market share, influencing directly Sales Growth. Furthermore, the availability of products and higher logistics service-levels due to fits will generate as a consequence higher EBIT Margins, higher customer satisfaction and customer loyalty, and higher reputation of the manufacturing firm.

On the *cost* side, the decreased costs associated with supply chain fit derive from higher inventory turnovers, higher utilization rates, and shorter lead-times impacting ROCE and ROA. Costs associated with expediting, premium freight, obsolete inventory, additional marketing expenses, and penalties paid to the customer to recover loyalty can be avoided, increasing the firm's profitability.

On the *asset* side, the degree of centralization of the manufacturing footprint and logistics network has an impact on the asset base of a firm, which directly influences ROA. The inventory management, allocation and turnover affect its working capital. It is impossible to assess profits or profit growth accurately without relating them to the amount of funds (capital) that were employed in making profits. If a firm manages to achieve a ROA with fewer assets, the productivity of the supply chain increases since less capital is required to achieve the same output. With strategic decisions on the supply chain, firms have a direct influence on the productivity of a firm's asset base (asset turn) and the EBIT Margin.

As supply chain fit affects revenues, costs, and asset utilization of manufacturing firms, i.e., the key drivers of short- and long-term profitability in terms of ROCE, ROA, Sales Growth and EBIT Margin, we hypothesize that:

Hypothesis H₁^I: *Supply Chain Fit will be positively associated with ROCE*

Hypothesis H₂^I: *Supply Chain Fit will be positively associated with ROA*

Hypothesis H₃^I: *Supply Chain Fit will be positively associated with Sales Growth*

Hypothesis H₄^I: *Supply Chain Fit will be positively associated with EBIT Margin*

2. Methodology

2.1. Data sample and procedure

The proposed hypotheses were tested on a broad-empirical basis using the data from sample I. The data collection procedure, the sample characteristics, as well as the statistical data examination are described in detail in Chapter I.

2.2. Measures

Respondents were asked to indicate (1) the underlying product or product line; when it was introduced to the market and when a new version/update will be implemented; (2) the characteristics of the underlying product; and (3) how their supply chains were structured. These aspects represent a proxy for the (in)consistency between product innovativeness and supply chain responsiveness. Survey respondents were also asked to answer each question using a 5-point scale (1—low, 5—high) based on the characteristics of their business unit relative to their major competitors (Rensis, 1932). All items were scored so that higher numbers reflect increases in the underlying constructs. Translations of the individual scale items, response cues for each measure, and descriptive statistics are listed in Table 7.

Table 7: Measures of constructs I

Constructs and Items (scale 1-5)	Mean	SD
Product Innovativeness (PI)	2.45	0.83
<i>Please evaluate the following characteristics for the main product line...</i>		
PI1* How long is the average life-cycle of the products in the main product line? □ < 6 months ago □ 6 - 12 months ago □ 1 - 2 years ago □ 2 - 5 years ago □ > 5 years ago	1.95	1.27
PI2 How many different variants are available for the main product line? □ < 20 □ 20 - 49 □ 50 - 99 □ 100 - 999 □ > 1000 or more	2.79	1.32
PI3 What is the average margin of error in the forecast based on units at the time production is committed? □ 0% - 9% □ 10% - 19% □ 20% - 39% □ 40% - 59% □ 60% - 100%	2.59	1.01
PI4 What is the number of sales locations for the main product line? □ < 100 □ 100 - 499 □ 500 - 999 □ 1000 - 1499 □ 1500 or more	2.39	1.43
PI5 What is the frequency of change in order content for the main product line? □ extremely low □ low □ medium □ high □ extremely high	2.56	0.94
Supply Chain Responsiveness (SCR)	3.40	0.61
<i>Please indicate the strategic supply chain priorities for the main product line... (1: not important at all – 5: extremely important)</i>		
SCR1 Improve delivery reliability	3.91	0.84
SCR2 Maintain buffer inventory of parts or finished goods	3.34	0.87
SCR3 Retain buffer capacity in manufacturing	3.17	0.92
SCR4 Respond quickly to unpredictable demand	3.56	0.88
SCR5 Increase frequency of new product introductions	3.05	0.86
Competition Intensity (CI)	3.48	0.75
<i>Please indicate the competitive intensity of your main product line... (1: strongly disagree – 5: strongly agree)</i>		
CI1 Cutthroat competition	3.73	1.00
CI2 Anything that one competitor can offer, others can match readily	3.03	1.11
CI3 Price competition is a hallmark of your industry	3.28	1.12
CI4* Relatively weak competitors	3.90	0.96

Note. All items were measured on five-point rating scales (Likert-type). Construct mean is calculated as (arithmetic) mean of all scale scores. SD refers to standard deviation. Unit of analysis is the main product (line) defined as the current sales (revenue) driver of the firm. Control variables are competition intensity as indicated as well as firm size and country effects.

* Item scale was reverse-scored.

Doty, Glick, and Huber (1993) point out that the conceptualization of fit, which is most consistent with logical arguments of configurational theories, is the systems approach to fit, which Van de Ven and Darzin (1985) identified as the most complex and promising for future research. The systems approach defines fit in terms of consistency across multiple dimensions of organizational design and context. Accordingly, supply chain fit is high to the extent that a supply chain of a firm is similar to an ideal type along multiple dimensions of

the underlying product. Assessing lack of supply chain fit as conceptualized in the systems approach requires measuring the deviations of the supply chain of a real firm from the supply chain of one or more ideal-type firms. The ideal types are represented by multivariate ideal profiles that provide the correspondence between the verbal descriptions of the ideal types and the measures used to assess real firms. Real firms' deviations from ideal types of supply chains can be assessed with analysis of the underlying product innovativeness and of the corresponding supply chain responsiveness (Lee, 2002; Fisher, 1997). The numerical examples for our product innovativeness and supply chain responsiveness measures listed by Fisher (1997) were transformed into five-step Likert scales where the specific numerical targets appeared at the respective endpoints of the five-step scale (Selldin and Olhager, 2007).

Supply chain fit (SCF) is calculated as the difference between the standardized *product innovativeness* (PI) and the standardized *supply chain responsiveness* (SCR). Similar procedures were already applied, for example by Siguaw, Brown, and Widing (1994) who measured the influence of the market orientation of a firm on sales force behavior and attitudes. Certainly, this proxy for supply chain fit does not measure the exact current amount of supply chain fit a firm achieves due to consistencies between its supply chain design and the underlying product (which is arguably almost impossible to obtain), but it may serve as an acceptable approximation. *The product innovativeness* (PI) measure consists of five items (Fisher, 1997) that capture the demand aspects of the product. The product life-cycle (PI1) is the length of time between the introduction of the product to the market and its removal from the market. For firms it is often necessary to stretch the product line into a "product family" of a significant number of variants (PI2) with respect to changing customer requirements and

market segmentation. The average forecast error (PI3) of the main product line is defined as the deviation of the forecasted quantity (units) from the actual quantity needed at the time production is committed: Forecast Error = absolute value of (Actual – Forecast). Next, sales locations (PI4) are trading platforms in which goods and/or services reach customers and potential customers. It is assumed that the higher the number of sales locations, the better the firm's ability to provide widespread and/or intensive sales (and distribution) coverage. Changes in order content (PI5) take place if the order is changed in terms of content, size, delivery time or other patterns. *The supply chain responsiveness* (SCR) measure also consists of five items that capture the supply chain design (Fisher, 1997): delivery reliability (SCR1), buffer inventory of parts or finished goods (SCR2), buffer capacity in manufacturing (SCR3), quick response to unpredictable demand (SCR4) and frequency of new product introductions (SCR5). Respondents were hereby asked to indicate the strategic supply chain priority of their supply chain design. We defined the strategic supply chain priority as the primary purpose of the firm in designing the supply chain with regard to the needs of the main product (line).

Profitability was measured by four key performance indicators (KPIs): ROCE, ROA, Sales Growth, and EBIT Margin. *ROCE* is an excellent measure for the returns that a firm is realizing from its capital employed. The ratio can be seen as representing the efficiency with which capital is being utilized to generate revenue. It is commonly used as a measure for comparing the performance between businesses and for assessing whether a business is generating enough returns to pay for its cost of capital. We define ROCE as follows: $ROCE = \text{EBIT} / \text{Capital employed}$. Capital employed is herein defined as: Net fixed assets + Current assets – Current liabilities. Goodwill and intangible assets are excluded. *ROA* shows how

effectively a firm utilized its assets in generating profits. ROA is defined as: $ROA = \text{Net income} / \text{Total assets}$. ROA gives an idea as to how efficient management is at using its assets to generate earnings. In other words, the ROA percentage shows how profitable a firm's assets are in generating revenue. *Sales Growth* indicates how fast and how strong a manufacturing firm increases in sales over a specific period. It was calculated as follows: $\text{Sales Growth} = [(\text{sales in 2006} - \text{sales in 2004}) / \text{sales in 2004}]$. *EBIT Margin* helps evaluating how a firm has grown over time. It is defined as: $\text{EBIT Margin} = \text{EBIT} / \text{net revenue}$. Secondary data for all KPIs were obtained from Bloomberg and Thomson Reuters.

To eliminate undesirable sources of variance, we included control variables which may influence and confound the relationships of the key variables in our model. First, *firm size* is an important structural variable. Larger firms might have more market penetration power than smaller ones and thus be more profitable. Smaller firms, in contrast, might be more innovative, and therefore more profitable. Firm size was measured by a single item asking respondents for the number of employees at their firm; this was double-checked against secondary data. Second, *competitive intensity*, the extent to which a firm perceives its competition to be intense and the extent to which it competes to retain its market share, is another important structural variable with potential impact on profitability. It was captured by four items asking respondents for the intensity of rivalry among firms in the industry. We employed the scale used by Jaworski and Kohli (1993). Third, we eliminated *country effects*. Economic, political, and cultural differences influence the strategic and operational possibilities of firms and therefore might influence profitability. Following the procedure suggested by Cohen, Cohen, West, and Aiken (2003, pp. 303-307), the responses from the UK were coded as the variable "Country UK", responses from France were coded as the

variable “Country France”, and responses from the German-speaking countries were coded as the variable “Country Germany”. Finally, responses from the U.S. were used as the baseline.

3. Statistical analysis and results

3.1. Reliability and validity

Before testing our core hypotheses, we first assessed the reliability and validity of the reflective constructs and the underlying items, followed by the assessment of the structural relationships, i.e., the relationships among the constructs. This ensures reliable and valid measures of constructs before attempting to draw conclusions about the nature of the construct relationships (Anderson and Gerbing, 1988). The independent variable supply chain fit is building on two reflective constructs (product innovativeness and supply chain responsiveness). We assessed the reliability and validity of the reflective constructs using confirmatory factor analysis (CFA) (Bagozzi *et al.*, 1991). Hereby product innovativeness, supply chain responsiveness and the control variable (competitive intensity) were included into one three-factor CFA model. As there were no indications of the presence of multivariate non-normality (normalized Mardia coefficient estimate of 1.32), the model was estimated with Amos 16.0 using the maximum likelihood estimation method.

Table 8: Factor analysis results and measurement statistics I

Constructs and items (scale 1-5)	Cronbach alpha	Total variance explained	Communalities	Item-to-total correlation	Composite reliability	AVE	Factor loading	t-value	SE	IR
Product Innovativeness (PI)										
	0.718	0.482			0.860	0.566				
PI1			0.385	0.424			0.621	^a	^b	0.457
PI2			0.364	0.398			0.603	5.373	0.178	0.395
PI3			0.511	0.524			0.715	6.357	0.147	0.667
PI4			0.630	0.573			0.794	6.186	0.278	0.628
PI5			0.523	0.518			0.723	5.805	0.171	0.748
Supply Chain Responsiveness (SCR)										
	0.744	0.499			0.874	0.597				
SCR1			0.253	0.329			0.503	^a	^b	0.269
SCR2			0.521	0.516			0.722	4.862	0.382	0.624
SCR3			0.654	0.622			0.809	5.035	0.475	0.726
SCR4			0.580	0.575			0.762	5.075	0.377	0.647
SCR5			0.487	0.500			0.698	4.841	0.344	0.553
Competition Intensity (CI)										
	0.686	0.518			0.810	0.536				
CI1			0.553	0.497			0.847	^a	^b	0.52
CI2			0.613	0.533			0.931	7.024	0.200	0.598
CI3			0.616	0.541			0.404	6.887	0.219	0.576
CI4			0.289	0.312			0.904	4.709	0.134	0.298

Note. All items were measured on five-point rating scales (Likert-type). SE refers to standard error from the unstandardized solution, AVE refers to average variance extracted, and IR refers to indicator reliability (Fornell and Larcker, 1981).

^a *t*-values are from the unstandardized solution; all are significant at the 0.001 level (two-tailed).

^b Factor loading was fixed at 1.0 for identification purposes.

The CFA results depicted in Table 8 indicate acceptable psychometric properties for all constructs. Composite reliabilities and average variances extracted for all constructs reach the common cut-off values of 0.70 (Nunnally and Bernstein, 1994) and 0.50 (Bagozzi and Yi, 1988; Fornell and Larcker, 1981), indicating construct validity. Without exception, each item loaded on its hypothesized construct with large loadings, significant at the 99% confidence interval, which represents a high level of item validity. This high level of item reliability implies that the items are strongly influenced by the construct they are measuring and indicates that sets of items used to capture the construct are unidimensional.

Overall, the results demonstrate acceptable levels of fit for all reflective constructs (Hair *et al.*, 2006): Chi-square $\chi^2/df = 1.998$ ($\chi^2_{(74)} = 147.860$, $p < 0.001$), CFI (Comparative Fit Index) = 0.907, NNFI (TLI) (Non-Normed Fit Index also known as Tucker-Lewis Index) = 0.886, GFI (Goodness of Fit Index) = 0.922, and RMSEA (Root Mean Square Error of Approximation) = 0.062 (90% confidence interval = [0.047, 0.077]). For CFI, values above 0.95 indicate a good fit; acceptable values for NNFI and GFI are above 0.9 and for RMSEA below 0.07 (Steiger, 2007; Hair *et al.*, 2006).

The estimates of the CFA model also allow us to assess convergent and discriminant validity. Inter-construct correlations and squared correlations are provided in Table 9. All the results are within acceptable ranges, indicating convergent and discriminant validity of our reflective constructs as measured by their items (Fornell and Larcker, 1981). As the dependent variable is based on objective secondary data, the concern regarding common method bias can be discarded.

Table 9: Inter-construct correlations and AVE I

	Mean	SD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) ROCE	0.20	0.21	1.000	0.490	0.030	0.430	0.020	0.010	0.000	0.000	0.010	0.010
(2) ROA	0.08	0.07	0.70**	1.000	0.100	0.600	0.030	0.000	0.000	0.000	0.020	0.010
(3) SG	0.09	0.11	0.17**	0.31**	1.000	0.070	0.020	0.010	0.000	0.000	0.010	0.010
(4) EBIT-M	0.08	0.07	0.66**	0.78**	0.26**	1.000	0.020	0.050	0.010	0.010	0.020	0.020
(5) SCF	0.00	1.00	0.14*	0.18**	0.14*	0.14*	1.000	0.010	0.000	0.000	0.000	0.010
(6) FS	52,031	88,308	0.090	0.050	-0.080	0.22**	0.110	1.000	0.040	0.110	0.000	0.040
(7) C-F	N/A	N/A	0.070	0.020	0.030	0.120	-0.040	0.19**	1.000	0.020	0.170	0.000
(8) C-UK	N/A	N/A	-0.070	-0.050	-0.030	-0.100	0.000	-0.33**	-0.12*	1.000	0.050	0.010
(9) C-G	N/A	N/A	-0.100	-0.13*	-0.100	-0.15*	-0.070	-0.060	-0.42**	-0.22**	1.000	0.010
(10) CI	3.49	0.76	-0.100	-0.100	-0.110	-0.13*	0.120	0.19**	0.030	-0.100	-0.070	1.000

Note. Pearson correlation coefficients are below the diagonal, and squared correlations (shared variance) are above the diagonal; N/A = not applicable; SD refers to standard deviation. AVE of single items is 1. For discriminant validity above-diagonal elements should be smaller than on-diagonal elements.

** Significant at the 0.01 level (two-tailed).

* Significant at the 0.05 level (two-tailed).

Abbreviations: ROCE: Return on Capital Employed, ROA: Return on Assets, SG: Sales Growth, EBIT-M: EBIT Margin, SCF: Supply Chain Fit, FS: Firm Size, C-F: Country France, C-UK: Country UK, C-G: German speaking countries, CI: Competition Intensity.

3.2. Regression model estimation and hypotheses testing

In order to test our developed hypotheses, four linear models were estimated by means of ordinary least square (OLS) regression models as follows:

$$\mathbf{H}_1^I: ROCE = \alpha + \beta_1FS + \beta_2F + \beta_3UK + \beta_4G + \beta_5CI + \beta_6SCF + e$$

$$\mathbf{H}_2^I: ROA = \alpha + \beta_1FS + \beta_2F + \beta_3UK + \beta_4G + \beta_5CI + \beta_6SCF + e$$

$$\mathbf{H}_3^I: EBIT\ Margin = \alpha + \beta_1FS + \beta_2F + \beta_3UK + \beta_4G + \beta_5CI + \beta_6SCF + e$$

$$\mathbf{H}_4^I: Sales\ Growth = \alpha + \beta_1FS + \beta_2F + \beta_3UK + \beta_4G + \beta_5CI + \beta_6SCF + e$$

Performance variables were first regressed on control variables and then the independent variable SCF was entered. The critical assumptions underlying OLS regression analysis were checked, i.e., (1) the residuals are normally distributed; (2) the residuals are of constant variance (homoscedasticity) over sets of values of the independent construct; and (3) multicollinearity of the independent construct is within an acceptable range (Cohen *et al.*, 2003). To this end, the regression model was subjected to a visual residual analysis using normal Q-Q plots: No obvious outliers were detected and residuals appeared to be approximately normally distributed. Homoscedasticity was checked using the Breusch-Pagan test (sum of explained squares = 47.91, LM = 17.95, $p = 0.00053$) which did not indicate a serious problem with heteroscedasticity. The bivariate correlations between the independent variables as well as variance inflation factors (VIF) were within acceptable ranges (i.e., bivariate correlation < 0.70 and VIF < 10). The largest VIF was 1.35, thus indicating that multicollinearity did not pose a serious problem to the regression analysis. In summary, the conducted tests provided no grounds to assume the inappropriateness of the chosen method.

All hypotheses (H_1^1 , H_2^1 , H_3^1 , and H_4^1) are supported. Our results indicate that supply chain fit has a significant positive impact on a firm's financial success, i.e., on ROCE ($\beta = 0.143$; R^2 change = 0.020**), on ROA ($\beta = 0.175$; R^2 change = 0.030***), on Sales Growth ($\beta = 0.157$; R^2 change = 0.024**) and on EBIT Margin ($\beta = 0.132$; R^2 change = 0.017**). Table 10 reports the results of the regression analysis with standardized parameter estimates.

Table 10: Results of model estimation I (OLS regression)

Independent variables	Dependent variables							
	ROCE		ROA		Sales Growth		EBIT Margin	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Control variables								
Firm Size	0.087	0.069	0.042	0.022	-0.105	-0.120*	0.213***	0.201***
Country France	-0.008	0.009	-0.076	-0.057	-0.02	-0.004	0.002	0.017
Country UK	-0.079	-0.081	-0.102	-0.103	-0.115	-0.115	-0.079	-0.079
Country Germany	-0.123*	-0.109	-0.188***	-0.171**	-0.143*	-0.125*	-0.163**	-0.149**
Competition Intensity	-0.136**	-0.149**	-0.126**	-0.142**	-0.112*	-0.127**	-0.191***	-0.204***
Predictor variable								
Supply Chain Fit		0.143**		0.175***		0.157**		0.132**
R^2	0.038	0.058	0.043	0.073	0.038	0.062	0.103	0.120
R^2 change		0.020**		0.030***		0.024**		0.017**
F	1.963*	2.519**	2.218*	3.225***	1.929*	2.670**	5.713***	5.613***

Note. Beta refers to standardized OLS regression estimates.

*** Significant at the 0.01 level (one-tailed).

** Significant at the 0.05 level (one-tailed).

* Significant at the 0.1 level (one-tailed).

3.3. Post-hoc analysis

In order to derive additional insight, we conducted a post-hoc analysis to be able to differentiate between firms with a supply chain fit and firms without a supply chain fit and to investigate the performance outcomes of both groups. First, the data sample was split into two groups with respect to supply chain responsiveness. The first group ("fit firms") comprised all cases with +/- one standard deviation (0.61) around the arithmetic mean (N = 163). The second group ("misfit firms") constitutes of the remaining data points (N = 96). In

a second step, we categorized both groups (fit firms and misfit firms) into functional (N = 200) and innovative product lines (N = 59) by following the classification provided by Fisher (1997), see Tables 1 and Table 2. Furthermore we double-checked issuing results with the descriptions of the main product line (“what is the main product line of your firm”), with the indicated product life-cycle length and “when an updated version or new product (line) will be implemented”. Finally, an external expert team validated the sample of supply chain fit firms and their counterparts. An overview is shown in Figure 10.

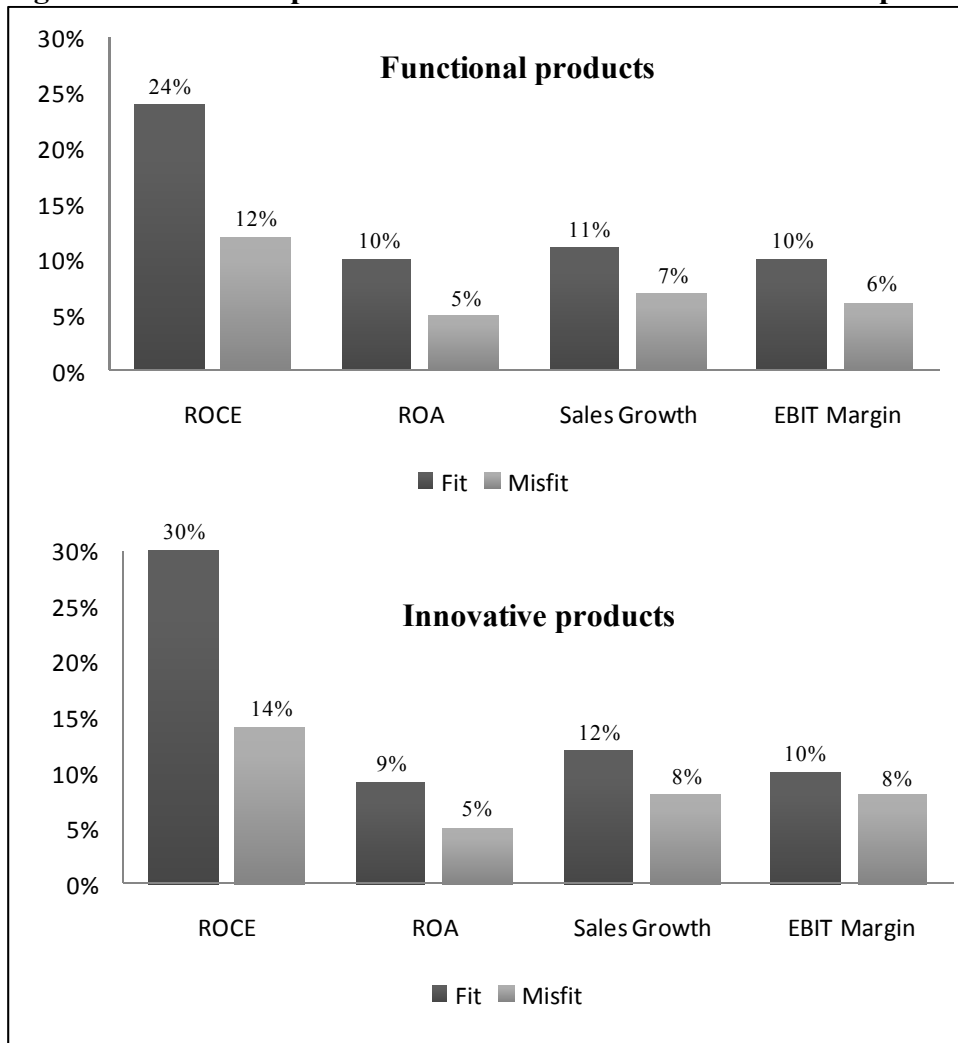
Figure 10: Overview of fit and misfit firms

		Product profiles		
		Functional product	Innovative product	
Supply chain design profiles	Efficient design	127 (Fit)	23 (Misfit)	$\Sigma = 150$
	Responsive design	73 (Misfit)	36 (Fit)	$\Sigma = 109$
		$\Sigma = 200$	$\Sigma = 59$	$\Sigma \Sigma = 259$

The results are evident: Firms adapting their supply chain to the demand aspects of the product achieve superior profitability, i.e., up to 100% higher profits. Our results indicate that their Return on Assets (ROA) is 5 percentage points higher for firms with functional products and 4 percentage points higher for firms with innovative products compared to those firms without supply chain fit. Fit firms achieve also with functional products 12 percentage points higher Return on Capital Employed (ROCE) results, 16 percentage points higher with innovative products compared to their misfit counterparts. Moreover fit firms outperform

misfit firms with 4 percentage points higher Sales Growth rates for both product types and with 4 percentage points higher EBIT Margins for fit firms with functional products and 2 percentage points higher EBIT Margins for fit firms with innovative products. A summary is presented in Figure 11.

Figure 11: Financial performance of fit firms and misfit counterparts



Note. Average KPIs (2004-2006) of functional products (N = 200) and innovative products (N = 59).

Nevertheless, the benefits of supply chain fit have still not yet reached about 37% of firms with functional products and 39% of firms with innovative products. A cross-country comparison among major industrial countries shows that firms in the U.S. are well ahead of

their European counterparts by a 15% higher share of firms with a better understanding of supply chain fit. Firms headquartered in the U.S. show with 73% the highest share of fit firms, probably as the development of supply chain management had its origin here and in contrast to the U.S., Europe is culturally much more fragmented. Hence European firms have to catch up with only 58% of fit firms on average, among which firms based in the UK are closest to their U.S. counterparts with 71%.

4. Discussion and implications

Results indicate that *supply chain management has a significant bottom line impact on a firm's financial success*. Firms that achieve a supply chain fit outperform in terms of profitability in all industries their counterparts, indicating that supply chain fit is a huge financial leverage factor. True, supply chain fit explains a rather small portion of the variance in the dependent variable but this is not surprisingly a clear indication that beyond the scope of the estimated regression model (which represents partial models) there are more factors that drive financial success. From the perspective of operational management, the benefits of a fit in the supply chain can hardly be quantified and are oftentimes indispensable: A fit prevents firms from reputation and credibility damages including further negative downstream impacts in terms of lead-times, service levels, innovativeness, and quality patterns.

Firms have to realize that the impact of supply chain management is much bigger than its impact beyond the “classical” logistics performance indicators, like delivery performance. Several managerial implications can be deducted from mastering supply chain challenges and managing the supply chain towards profitability:

Supply chain management must be anchored in the top management. The financial potential of supply chain fit makes a strong case for the identification and investigation of the underlying factors in achieving supply chain fit. Maintaining a supply chain fit affects revenues, costs and assets. A supply chain fitting the respective demand aspects of the product will result in perfect order fulfillment, providing goods on time and in full. Customers can be adequately satisfied at any time and revenues can be increased. A supply chain fit also affects a firm's cost base. An optimum production and warehouse footprint in combination with lean distribution processes keep logistics and supply chain administration costs at a minimum level assure the required service levels. Therefore, supply chain managers should make sure that the top management realizes the impact of operational decisions on a firm's financial success. As a consequence, supply chain management merits to be anchored in the top-management of manufacturing firms.

Firms need to understand the demand and the supply chain design aspects of the business model they are operating. As the degree of supply chain fit determines financial performance, firms need to assess their products (and competitive strategy) and devise the supply chain strategy accordingly. The best supply chains are not only fast and cost-effective, but also agile and adaptable enough to ensure that all of a firms' interests stay aligned. A common source of error: in many industries the degree of the diversity of product portfolios has considerably increased. Firms that used to manufacture few product variants in large-scale productions, nowadays manufacture numerous variants in increasingly smaller batches. In many cases however, the supply chain has not been adapted to the changed requirements and is still tailored towards mass production. The necessary responsiveness is often generated by a too high level of inventories. Firms with innovative products that do not achieve supply

chain fit, focus more on physically-efficient supply chain design characteristics. They are too cost-oriented in their supply chain design with a low focus on responsiveness. Firms need to realize that a lack of supply chain fit will not only significantly decrease profitability, but it also gives away the “value of alignment” which might further affect the reliability and robustness of a supply chain. Therefore, firms need to understand clearly the demand and the supply chain design aspects of the business model (cost-oriented versus differentiation-oriented) they are operating.

Supply chain fit is a dynamic concept. Customer preferences are always in a state of flux and continuously bring up new requirements for delivery lead-times, service and product demand. Their expectations must be on the watch list of supply chain managers. Firms will master these challenges successfully when their supply chains can keep up with the alternated market conditions. Thus a major guiding principle is responsiveness in the supply chain design tracking and fitting to dynamically alternating demand aspects of the product and supporting the business model along the product life-cycle. As a consequence, *firms need to continuously adapt their dynamic supply chains.* Radical and regular transformations occur which change the current setting of the firm and as a hence the current supply chain fit. As the interdependence makes them fall into patterns, new configurations arise. Supply chain managers need to consider continuously occurring transformations, even the smallest ones, and adapt the design elements of the supply chain to the new constellations. By doing so, the consistency between supply chain and product aspects stay aligned and inconsistencies can be avoided safeguarding supply chain fit. Unfortunately, as indicated, up to 39% of firms do simply not master transformations in supply chains to an optimal level in terms of physical efficiency and market responsiveness and stuck as a result oftentimes in supply chain misfits.

Chapter III Supply Chain Design Efficiency: Benchmarking Supply Chains in Manufacturing Firms

Based on the data gathered in sample I, this chapter investigates using the benchmarking tool Data Envelopment Analysis (DEA) *supply chain design efficiency*, an optimal combination of physically-efficient and market responsive supply chain designs profiles aiming to achieve high ROCE results.

In Section 1, we present the theoretical background, followed by the methodology including the psychometric development of the constructs in Section 2. In Section 3, the statistics analysis as well as the DEA results is provided. A discussion of the ensuing results as well as managerial implications is presented in Section 4.

1. Theoretical background

In line with the reasoning of configuration theory, we introduce the concept of *supply chain design efficiency* of a manufacturing firm. We define supply chain design efficiency as the optimal configuration in a supply chain between physically-efficient and market responsive design patterns to increase profitability in terms of ROCE. Following Fine (1998), we evaluated supply chain designs for their effectiveness in improving ROCE.

1.1. Configurational approach

As we already described in Chapter II, the configurational approach considers holistic configurations, or *gestalts*, of design elements (Miles and Snow, 1978). Hence it extends, as mentioned above, the traditional approach in strategic management research which strictly divides the concept of strategy between “how strategy is formed” (*process*) and “which decisions are taken” (*content*). In particular for supply chain management, in addition to content and process, the internal and external *environmental context* of the organization plays an important role for decision-making and should therefore be incorporated (Ketchen *et al.*, 1996). The increased effectiveness is attributed to the internal consistency, or *fit*, among strategic, structural, and contextual patterns.

For the purpose of this research, the configurational approach is used as theoretical support for the underlying assumption that different supply chain design types emerge which display a common profile, i.e., configuration. Hence, the closer a supply chain design matches an ideal constellation, the better the financial performance.

1.2. Supply chain design spectrum

Our supply chain design spectrum is rooted in the understanding that supply chains ought to not only be fast and cost-effective; but they must also be “triple-A” supply chains, i.e., they must be agile, adaptable, and aligned (Lee, 2004). To build triple-A supply chains and to generate competitive advantages, the design of supply chains in today’s competitive environment are one of the most important and difficult challenges faced by managers (Reeve and Srinivasan, 2005; Tagras and Lee, 1992). A competitive strategy will implicitly, or explicitly, specify one or more customer segments that a firm hopes to satisfy with its

product(s) and its supply chain design(s). Therefore, there is no “one size fits all” model; rather, each supply chain is unique in its supply chain design needs.

In stressing the need to distinguish between conflicting supply chain designs, Fisher (1997) categorized products into functional products, with predictable demand, and innovative products, with unpredictable demand. Product characteristics vary in terms of demand predictability, life-cycle length, product variety, service, lead-times and specific market requirements. With respect to the product supplied through the chain, an effective supply chain has to be designed. Depending on the underlying product, either a physically-efficient supply chain, or a market responsive supply chain, is required with respect to its resource and inventory strategy, as well as the overall objectives.

Having determined the nature of the products and their supply chain priorities, a matrix for the ideal supply chain strategy can be formulated. Two ideal types (“fit”) can be identified. The first type is organizations in which functional (standardized) products are embedded in physically-efficient supply chains with a strong focus on cost minimization, high inventory turnovers and high average utilization rates. The second type is firms where innovative (customized) products (which sell often for a single season) are supplied through market responsive supply chains with extra buffer inventory capacity, high flexibility requirements and a capability for market processing information. All other types are less effective (Fisher, 1997) whereas those with functional products and a responsive supply chain and vice versa, innovative products with a physically-efficient supply chain are regarded as mismatches (“misfit”). Other supply chain classifications which differentiate for example between built-to-stock, configure-to-order, build-to-order, and engineered-to-order supply chains (Reeve and Srinivasan, 2005) can be respectively adapted into Figure 4 which

provides a breakdown of fit and misfit constellations between supply chain design and demand aspects of a product (product characteristics).

Nowadays however, a mixed (leagile, hybrid) strategy reflects the major stake of supply chains (Selldin and Olhager, 2007; Goldsby et al., 2006), rather than an “either-or-strategy” and hence, as described in Chapter I, there are a multiple of ideal supply chain design constellations along the efficient frontier line, depending on the business model and the overall competitive strategy.

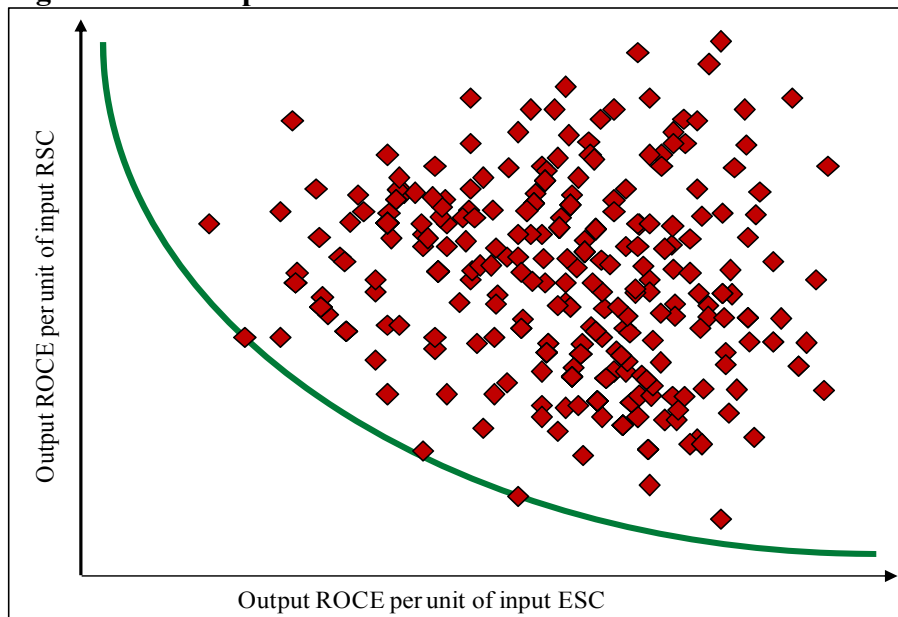
1.3. Data Envelopment Analysis as a benchmarking tool

Supply chain strategy strikes to achieve an optimal balance between physically-efficiency (cost effectiveness) and market responsiveness that fits with the competitive strategy of the manufacturing firm. Balancing physical-efficiency and market responsiveness in supply chains represents a strategic decision. While some supply chain executives place more emphasis on physically-efficiency, others focus on market responsiveness. As a consequence, we need to take this trade-off into account when assessing supply chain designs.

We employ Data Envelopment Analysis (DEA), also referred to as the CCR model, after Charnes, Cooper, and Rhodes (1978), for benchmarking supply chain designs. DEA has been frequently used in the supply chain management and marketing literature (e.g., Eggert *et al.*, 2009; Yu and Lin, 2008; Humphreys *et al.*, 2005; Metters *et al.*, 1999; Schefczyk, 1993). DEA lends itself particularly to contexts where researchers assess efficiency by way of benchmarking managerial actions against a best-in-class standard. In our research, we compared supply chain designs against a best-in-class benchmark. The enveloped data all differ with respect to the degree of physically-efficiency and the degree of market responsiveness in the given supply chain design of a manufacturing firm.

The benchmarking methodology DEA, which measures the relative efficiency of Decision Making Units (DMU), is based on linear programming. It is a non-parametric programming approach to frontier estimation which cannot provide absolute efficiencies, only efficiencies relative to the data considered. The DEA does not require the existence of a particular function to specify the relationships, or trade-offs, among the performance measures in the computation of efficiency (Eggert *et al.*, 2009; Wong and Wong, 2007; Steward, 1996).

DEA identifies peer groups of firms that follow a similar supply chain design constellation. Data points in the efficient frontier are not dominated by relationships following the same strategy. These data points form an efficiency frontier together, extended to both axes. Consequently, those points are considered 100% efficient with regard to the respective supply chain design. Although they follow different supply chain design strategies, they are each considered to be best-in-class. All other constellations not situated on the efficient frontier are not Pareto-optimal. A firm which is not on that efficient frontier line can improve both its physical efficiency and its market responsiveness by moving towards the efficient frontier achieving highest ROCE results (see Figure 12). However, a firm on the efficient frontier line can improve its responsiveness by increasing costs and becoming less efficient, unless it succeeds to improve its operations and change technology to shift the efficient frontier itself. Due to the linear program formulation, the efficiency scores range from 0% to 100%.

Figure 12: Conceptual framework II

Note. The DEA supply chain design efficiency frontier line is based on firms with the highest ROCE, and an optimal combination of physically-efficiency (ESC) and market responsiveness (RSC).

In summary, the DEA integrates physically-efficiency and market responsiveness into a common efficiency measure (SCDE), while accounting for different supply chain design constellations. Relying on the constructed DEA-measure prevents us from comparing “oranges with lemons”. Instead, we benchmark specific supply chain designs against an efficient frontier. This allows us to empirically investigate the efficiency of the implemented supply chain designs of manufacturing firms.

2. Methodology

2.1. Data sample and procedure

The proposed hypotheses were tested on a broad-empirical basis using the data from sample I. The data collection procedure, the sample characteristics, as well as the statistical data examination are described in detail in Chapter I.

2.2. Measures

To generate our constructs and facilitate our analysis, survey respondents were asked to answer each question using a 5-point Likert scale (1—low, 5—high), based on the characteristics of their business unit relative to their major competitors and indicate the strategic supply chain priorities for the main product line illustrating the implemented degree of supply chain responsiveness. All items were scored (1—not important at all, 5—extremely important), such that higher scale points reflected increases in the underlying constructs (see Table 11).

Table 11: Measures of constructs II

Constructs and Items (scale 1-5)	Mean	SD
Efficient Supply Chain (ESC)	3.84	0.82
<i>Please indicate the strategic supply chain priorities for the main product line...</i>		
ESC1 Minimize total supply chain costs	4.07	0.96
ESC2 Generate high turns and minimize inventory throughout the supply chain	3.88	0.97
ESC3 Maintain high average utilization rate in the supply chain	3.60	0.96
Responsive Supply Chain (RSC)	3.28	0.67
<i>Please indicate the strategic supply chain priorities for the main product line...</i>		
RSC1 Maintain buffer inventory of parts or finished goods	3.34	0.88
RSC2 Retain buffer capacity in manufacturing	3.17	0.92
RSC3 Respond quickly to unpredictable demand	3.56	0.88
RSC4 Increase frequency of new product introductions	3.06	0.87

Note. SD refers to standard deviation.

We relied on existing supply chain management constructs to measure both supply chain design types, proposed by Selldin and Olhager (2007). Both measures permit us to see, to what extent firms view both specific supply chain design types as alternatives (mutually exclusive) or if they regard these as complementary.

The *efficient supply chain* measure consists of three indicators that capture the degree of physically-efficiency of the supply chain design: minimal supply chain costs (ESC1), a high inventory turnover and low inventory stocks (ESC2) as well as a high average utilization rate

(ESC3). Respondents were asked to indicate the strategic supply chain priority of their supply chain structure which we defined as the primary purpose of the firm in structuring the supply chain with regards to the needs of the main product line.

The *responsive supply chain* measure consists of four indicators that capture the degree of market responsiveness of the supply chain structure: maintain the buffer inventory of parts or finished goods (RSC1), retain the buffer capacity in manufacturing (RSC2), response quickly to unpredictable demand (RSC3), and increase frequency of new product introductions (RSC4). In contexts where demand is volatile and the customer requirement for variety is high, a much higher level of responsiveness, or agility, is required (Christopher and Towill, 2000).

The *ROCE* measure is an excellent measure for the returns that a firm is realizing from its capital employed. The ratio can be seen as representing the efficiency with which capital is being utilized to generate revenue. It is commonly used as a measure for comparing the performance between businesses and for assessing whether a business generates enough returns to pay for its cost of capital. We define ROCE as follows: $ROCE = EBIT / \text{Capital employed}$. Capital employed is hereby defined as: Net fixed assets + Current assets – Current liabilities. Assets are not considering goodwill and intangible assets. Note that ROCE should always be higher than the rate at which the firm borrows; otherwise, any increase in borrowing will reduce shareholders' earnings. Objective secondary data for our ROCE calculation were obtained from Bloomberg and Thomson Reuters.

3. Statistical analysis and results

3.1. Reliability and validity

We assessed the reliability and validity of both reflective constructs using a covariance-based confirmatory factor analysis (CFA) (Bagozzi *et al.*, 1991). As there were no indications of the presence of multivariate non-normality, the model was estimated with Amos 16.0 using the maximum likelihood estimation method.

The CFA results, depicted in Table 12, indicate adequate psychometric properties for both constructs. The Cronbach alpha and average variances extracted (AVE) for all constructs reach the common cut-off values of 0.70 (Nunnally and Bernstein, 1994) and 0.50 (Bagozzi and Yi, 1988; Fornell and Larcker, 1981), indicating construct validity. Without exception, each item loaded on its hypothesized construct with large loadings, significant at the 99% confidence interval, representing a high level of item validity. This high level of item validity implies that the items are strongly influenced by the construct they are measuring and indicates that sets of items used to capture the construct are uni-dimensional.

Overall, the results demonstrate adequate levels of fit for both constructs (Hair *et al.*, 2006). Chi-square $\chi^2/df = 1.290$ ($\chi^2(13) = 16.76$; p insignificant at 0.210), CFI (Comparative Fit Index) = 0.993, NNFI (TLI) (Non-Normed Fit Index, also known as Tucker-Lewis Index) = 0.988, GFI (Goodness of Fit Index) = 0.982, and the RMSEA (Root Mean Square Error of Approximation) = 0.034. For the CFI, values above 0.95 indicate a good fit; acceptable values for NNFI and GFI are above 0.9 and for RMSEA below 0.05 (Hair *et al.*, 2006).

Table 12: Factor analysis results and measurement statistics II

Constructs and items (scale 1-5)	Cronbach alpha	Total variance explained	Communalities	Item-to-total correlation	Composite reliability	AVE	Factor loading	t-value	SE	IR
Efficient Supply Chain (ESC)	0.814	0.728			0.810	0.587				
ESC1			0.735	0.670			0.813	^a	^b	0.481
ESC2			0.751	0.685			0.839	10.693	0.980	0.523
ESC3			0.701	0.639			0.808	10.435	0.890	1.000
Responsive Supply Chain (RSC)	0.760	0.581			0.834	0.563				
RSC1			0.565	0.542			0.667	^a	^b	0.452
RSC2			0.691	0.647			0.780	9.056	0.144	0.619
RSC3			0.571	0.548			0.654	7.817	0.128	0.460
RSC4			0.499	0.495			0.589	7.171	0.119	1.000

Note. All items were measured on five-point rating scales (Likert-type). SE refers to standard error from the unstandardized solution, AVE refers to average variance extracted, and IR refers to indicator reliability (Fornell and Larcker, 1981).

^a *t*-values are from the unstandardized solution; all are significant at the 0.001 level (two-tailed).

^b Factor loading was fixed at 1.0 for identification purposes.

The estimates of the CFA model allow us to assess convergent and discriminant validity. Results of inter-construct correlations, average variances extracted (AVE), and squared correlations, were within the appropriate ranges. Each construct extracted a variance that is larger than the highest variance it shares with the other construct, indicating support for the convergent and discriminant validity of both constructs, as measured by their items (Fornell and Larcker, 1981). Multicollinearity for our constructs was not a serious hindrance to the study's validity, because none of the relevant checks (eigenvalues, variance inflation factor, or the condition index) suggested multicollinearity (Hair *et al.*, 2006). Nor was there any evidence of heteroscedasticity detected. Finally, the outlier analysis did not indicate extreme values. As the dependent variable is based on objective secondary data, the concern regarding common method bias can be discarded. Inter-construct correlations and AVE are presented in Table 13.

Table 13: Inter-construct correlations and AVE II

	Mean	SD	(1)	(2)	(3)
(1) ESC	3.84	0.82	0.587	0.024	0.007
(2) RSC	3.28	0.67	-0.156*	0.563	0.002
(3) ROCE	0.20	0.21	0.081	0.045	1.000

Note. Pearson correlation coefficients are below the diagonal, and squared correlations (shared variance) are above the diagonal. SD refers to standard deviation; ESC refers to a physically-efficient supply chain and RSC to a market responsive supply chain design. Average variance extracted (AVE) is on-diagonal. AVE of single items is 1. For discriminant validity above-diagonal elements should be smaller than on-diagonal elements.

* Significant at the 0.05 level (two-tailed).

3.2. Data Envelopment Analysis results

The average supply chain design efficiency obtained in our sample was 46.83%, with a standard deviation of 15.28%. Supply chain design efficiency scores displayed high levels of variations. Firms on the efficient frontier line achieved the highest ROCE for their given level of inputs, i.e., largest ROCE/RSC, largest ROCE/EFC or largest convex combinations of ROCE/RSC and ROCE/EFC. Only four manufacturing firms, i.e., less than 2% of our sample, were evaluated as fully efficient (see Table 14). The 25 percentile is 37.18, the 50 percentile is 43.87 and 75 percentile is 53.

Table 14: Results of model estimation II (DEA)

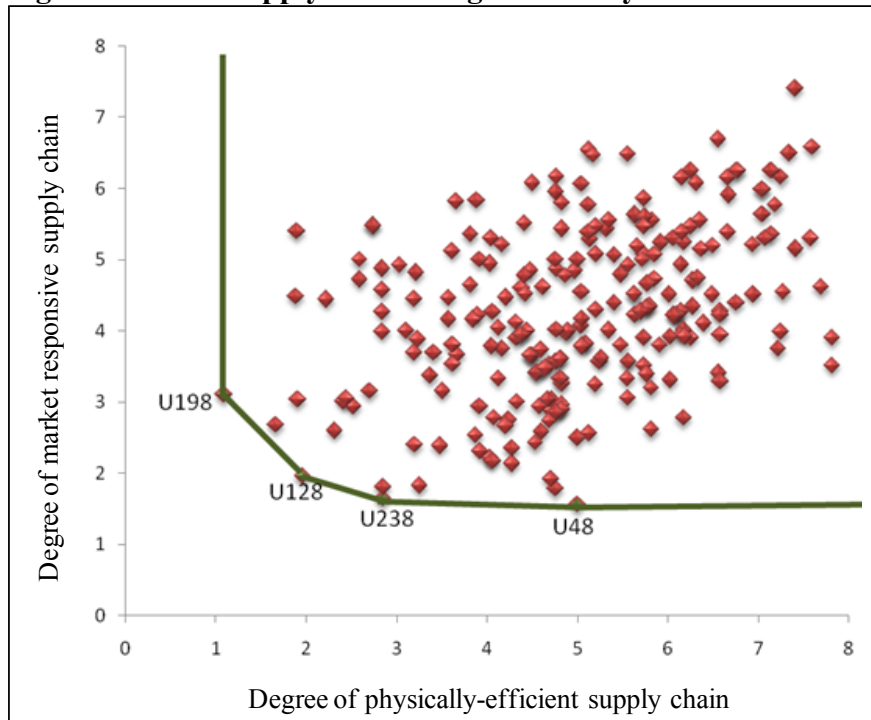
DMU	Inputs		Output	Efficiency
#	ESC	RSC	ROCE	SCDE
1	4.000	1.250	0.800	1.000
2	3.000	3.000	1.530	1.000
3	1.670	4.750	1.530	1.000
4	4.330	2.500	1.520	1.000
5	4.330	2.750	1.520	0.942
6	2.330	3.750	1.400	0.933
7	4.000	2.250	1.230	0.898
8	3.330	1.250	0.700	0.891
9	3.670	1.500	0.780	0.834
⋮	⋮	⋮	⋮	⋮
251	4.330	3.750	0.460	0.231
252	4.000	4.000	0.470	0.230
253	3.670	3.750	0.420	0.222
254	4.330	2.250	0.300	0.218
255	4.000	3.000	0.360	0.216
256	4.330	2.750	0.290	0.180
257	3.670	3.500	0.300	0.166
258	3.670	3.750	0.300	0.159
259	2.670	2.750	0.000	0.000

Note. Input variables represent the physically-efficiency and market responsiveness of the underlying supply chain design of the Decision Making Unit (DMU). Output variable is ROCE. *Efficiency* (DEA results) is shown by the supply chain design efficiency score (SCDE). N = 259.

Results indicate that the majority of the underlying manufacturing firms did not attain an optimal supply chain design combination of the characteristics from both supply chain design types while maintaining an excellent ROCE; they reach either higher physically-efficiency (ESC) elements or higher market responsiveness (RSC), or both, in their supply chain design, however, at the expense of lower ROCE results. In contrast, firms on the efficient frontier line achieve an extreme well fit in their supply chain design: Either they have very low attributes of physically-efficient supply chain design elements (ESC) and high attributes of market responsive supply chain design elements (RSC), for example data point U198 (ESC is in average 1.6 and RSC is in average 4.7), or vice versa, i.e., data point U48 (ESC is in average 4.0 and RSC is in average 1.25) or U238 (ESC is in average 4.3 and RSC is in

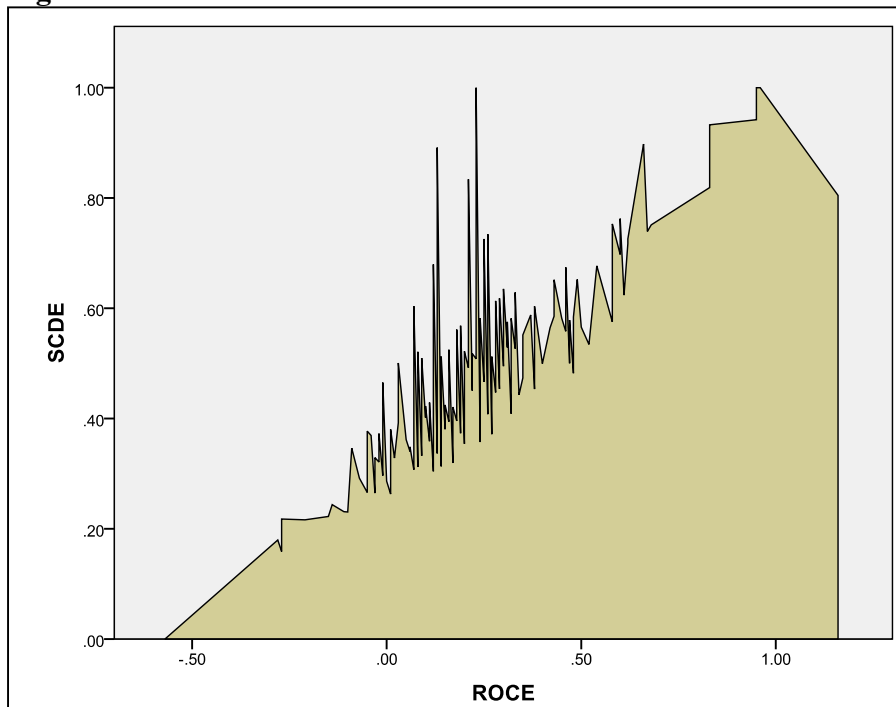
average 2.5); or physically-efficient supply chain design elements and market responsive supply chain design elements are balanced out, for example data point U128 (both ESC and RSC are in average 3.0). The efficient frontier line SCDE is displayed in Figure 13.

Figure 13: DEA supply chain design efficiency frontier line



Note. The DEA supply chain design efficiency frontier line is based on firms with the highest ROCE, and an optimal combination of physically-efficient and market responsiveness. The X-axis and Y-axis represent CCR results based on quotients of output to inputs (ROCE/ESC and ROCE/RSC or combinations of both). N = 259.

Our results indicate that the ROCE of a manufacturing firm increases significantly with higher supply chain design efficiency (SCDE). This is indicated in Figure 14. The top 25% SCDE firms achieve on average a ROCE of 44.81% compared to the worst 25% SCDE firms with a ROCE of 2.67%, i.e., a ROCE increase of 15.78.

Figure 14: SCDE and ROCE

Note. SCDE refers to supply chain design efficiency. N = 259.

4. Discussion and implications

Achieving supply chain excellence requires firms to concentrate their resources on what they do best and on what provides them with the highest ROCE. As mentioned previously, firms are struggling to improve their supply chain operations, recognizing the increasing importance of finding the best process and supply chain for their products (Chopra and Meindl, 2009; Selldin and Olhager, 2007). While the merits of an excellent supply chain design are straightforward, it was still unknown how well the evidence correlates with actual performance. Against this background, our research offers several interesting contributions.

First, by adopting the firm's perspective and drawing upon configuration theory, we introduced the concept of *supply chain design efficiency* as a combination of two supply chain design types: physically-efficiency and market responsiveness. We demonstrated how supply chain design efficiency may not only be conceptually described, but also empirically

measured. To this end, we introduced DEA as an appropriate methodology to operationalize the construct (Charnes *et al.*, 1978). Second, our study revealed that supply chain design efficiency provides an interesting metric for assisting managers in their decision-making process. Instead of comparing the supply chains of manufacturing across the board, our approach provides a basis for comparing supply chain designs against their best-in-class benchmark, i.e., to investigate supply chains within their specific design context. By calculating an efficiency score between 0% and 100%, our measure allows managers to evaluate the potential for improvement of any given supply chain design. Finally, results suggest that many supply chains display a potential for increasing efficiency. The mean score of supply chain design efficiency was 46.83%, however, less than 2% of the supply chain designs we investigated were fully efficient. Hence, from a managerial perspective, the findings suggest that a vast majority of supply chains still offer avenues for further improving existing supply chain designs, from which several managerial implications can be deduced:

Supply chain design is a strategic weapon. In contrast to products, design and processes are tough to imitate. Toyota's production system, which is a supply chain design strategy, has been known and understood, but it has been a competitive advantage for over two decades for Toyota (Lee *et al.*, 2005). Competitors have learned about its brilliant strategy, but they have failed to achieve it. As a result, Toyota's supply chain design strategy served as an excellent strategic weapon. Today, the best supply chains are not only physically-efficient (cost-effective) and market responsive (fast), but also agile and adaptable to ensure that all firms' interests stay aligned (Lee, 2004). Therefore, firms need to understand which supply chain designs are required regarding the environment in which they are operating to best meet supply and demand. A manufacturing firm has multiple strategic choices; it can emphasize

physically-efficiency in the supply chain design, market responsiveness, or seek improvements in both. The latter improvement is not subject to a trade-off; rather, the attributes are simultaneously attainable (Selldin and Olhager, 2007). Similar approaches on how to optimize perceived trade-offs between product ranges and costs, or between productivity and flexibility, are described by Schmenner and Swink (1998), Grubbström and Olhager (1997) or Hayes and Pisano (1996). The product range, or flexibility dimension, corresponds to the market responsive supply chain, whereas costs or productivity dimensions correspond to the physically-efficient supply chain. Excellent supply chains are likely to have attributes that support both strong physically-efficient functions in delivering goods and a strong market mediation function for conveying information.

Supply chain design is a financial leverage factor. It is impossible to assess profits or profit growth properly without relating them to the amount of funds (capital) that were employed in making profits. With strategic decisions on the supply chain design, firms directly influence the two main drivers for ROCE improvement: the productivity of a firm's asset base (asset turn) and the EBIT Margin. On the one hand, as indicated, the degree of centralization of the manufacturing footprint and logistics network has an impact on the asset base of a firm, which directly influences ROCE. The inventory management and inventory allocation of the manufacturing impacts its working capital. On the other hand, an optimized cost structure for supply chain processes and an optimum logistics service-level will increase the EBIT Margin. Therefore, supply chain design efficiency is a financial leveraging factor. The four top supply chains on the efficient frontier line outperform their counterparts by 3.87 higher ROCE results.

Supply chain design is a holistic challenge. Our results indicate that the supply chain design efficiency is 46.83%. This leaves a vast room for improvement. Benchmarking supply chain designs enables firms to evaluate the potential of their supply chain. Nevertheless, supply chain management must incorporate a holistic stance. Manufacturing firms may not always experience the opportunity or the resources to create an optimal supply chain design for their products. Oftentimes, firms have to manage within existing supply chain designs or other upstream/downstream parties that dominate the supply chain. As a result, not all firms may be capable of designing supply chains of their choice. However, only if supply chains are designed in an optimally efficient mode, a supply chain design will deliver high financial performance. Hence, all supply chain parties must optimize their operations from a holistic stance and design the supply chain using unique patterns fitting the overall competitive strategy to become leaders in their industries by shedding millions of dollars of inefficiencies from their supply chains.

Chapter IV Exploring Sourcing Flexibility, Supply Chain Performance and Product Performance

This chapter presents research that examines the relationship among sourcing flexibility, supply chain performance and product performance. In Section 1, we develop the conceptual framework and the hypotheses. In Section 2, we discuss shortly the process of data collection and detail the measures and control variables used in the survey. In Section 3, reliability and validity of constructs are examined, followed by a multivariate statistical analysis and a discussion of the ensuing results in Section 4.

1. Theoretical background and hypotheses

1.1. Sourcing flexibility

As described in research question III, manufacturing firms increasingly outsource many of their production activities to their suppliers. As a result, the average cost of purchased materials, components, and services across all manufacturing firms frequently exceeds 60% to 70% of the total cost of operations (Leenders *et al.*, 2006; Wagner, 2006). In such an environment, sourcing flexibility, i.e., “the availability of a range of options and the ability of the purchasing process to effectively exploit them so as to respond to changing requirements related to the supply of purchased components” (Swafford *et al.*, 2006, p. 174), is central to the success of firms that face environmental or market uncertainties. Firms can save millions

of dollars by adapting the responsiveness of their supply chains through sourcing flexibility to reduce stock-outs and inventory in their supply chains, shorten lead-times, increase quality of their products, etc. For example, by practicing sourcing flexibility, Zara, the Spanish fashion retailer, is able to limit its sales at markdown prices to 15%–20% of the total sales, compared to 30%–40% for its European peers (Cachon and Swinney, 2009; Ghemawat and Nueno, 2003). As such, sourcing flexibility is one of the fundamental characteristics of an agile supply chain. However, as important as it is, the link between sourcing flexibility and a firm's product and supply chain success has not yet been established.

Research question III is the first attempt to empirically investigate the impact of sourcing flexibility on supply chain performance and the business performance of the product (which we call “product performance” in the rest of the paper). Although many studies have captured the importance of flexibility, in particular manufacturing flexibility (Vokurka and O’Leary-Kelly, 2000; Koste and Malhotra, 1999; Burgess, 1994; Upton, 1994; Youssef, 1994; Gerwin, 1993; 1987; Slack, 1987; 1983), far less attention has been given to sourcing flexibility (Swafford *et al.*, 2006; Sharifi and Zhang, 1999; Goldman *et al.*, 1994). In the literature on flexibility and uncertainty, the notion “the greater the flexibility, the better the performance” (Swamidass and Newell, 1987, p. 512) often stems from intuitive expectations. Nevertheless, prior studies have been unable to find conclusive results on the link between various building blocks of supply chain flexibility and performance (Fantazy *et al.*, 2009; Pagell and Krause, 2004). As such, More and Babu (2008, p. 40) state that, in the literature, “the empirical justification of the benefits of implementing flexible supply chains is rare and in-depth empirical studies are lacking.”

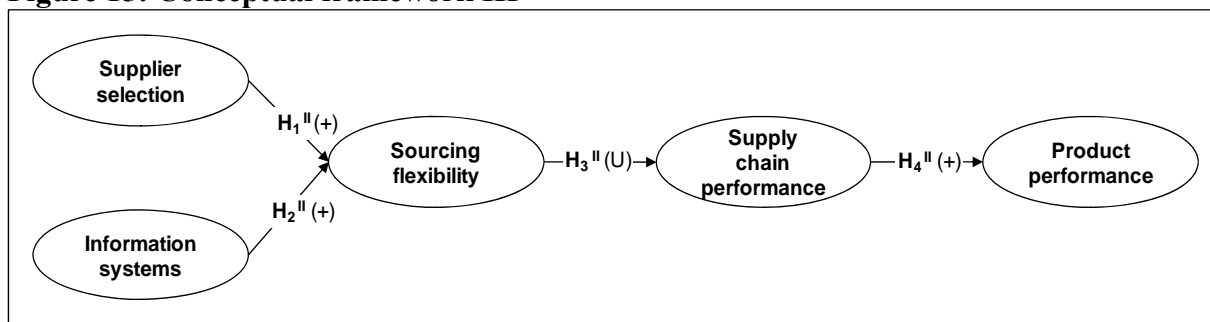
In response to this call, we perform a survey-based empirical study of the impact of sourcing flexibility on supply chain and product performance. Sourcing flexibility must match a buyer's requirements with respect to product quantities, product mix, delivery schedules, etc., and must ultimately support a firm's supply chain strategy (Yazlali and Erhun, 2007; Childerhouse *et al.*, 2002; Christopher and Towill, 2001; Li and O'Brien, 2001; Fisher, 1997). A commonly accepted principle for product–supply chain match states that standardized (functional) products with stable demands should be supplied by a physically-efficient supply chain, while customized (innovative) products with stochastic demands in uncertain environments and markets should be supplied by a market responsive or agile supply chain (Lee, 2002; Christopher and Towill, 2000; Fisher, 1997). While supply chain agility has many diverse components, we focus on sourcing flexibility. In this context, the composition of a firm's supplier portfolio is essential to achieving the sourcing flexibility that is desirable in terms of physically-efficiency (cost) and market responsiveness (agility). A high degree of sourcing flexibility in the supply chain enables greater supply chain agility. However, sourcing flexibility comes at a cost and therefore does not automatically result in higher profitability due to increased responsiveness. This trade-off needs to be investigated in order to reach definitive conclusions concerning the relationship between sourcing flexibility and performance.

1.2. Conceptual framework

To explore this relationship, we develop a conceptual framework, displayed in Figure 15. For the effective management of buyer-supplier relationships, firms need to choose the appropriate level of cooperation (from arm's length to coordinated relationships) and adapt suitable management practices (Bensaou, 1999; Lambert *et al.*, 1996; Anderson and Narus,

1990). Furthermore, technologies such as information systems are needed to support boundary-spanning activities associated with the effective management of buyer-supplier relationships. We explain how the criteria for the evaluation and selection of suppliers as well as the strategic supply chain priorities of manufacturing firms related to their information systems determine a firm's sourcing flexibility. We subsequently consider the relationship between sourcing flexibility and supply chain performance, probing the trade-offs we highlighted above. Finally, we look into the relationship between a firm's sourcing flexibility and its product performance, such as its sales growth rate, market share, and profitability.

Figure 15: Conceptual framework III



Note. (+) indicates a positive relationship and (U) refers to a curvilinear (U-shaped) relationship.

H_1^{II} represents the hypothesized positive structural relationship between supplier selection and sourcing flexibility, H_2^{II} between information systems and sourcing flexibility, and H_4^{II} between supply chain performance and product performance. H_3^{II} represents the hypothesized curvilinear relationship between sourcing flexibility and supply chain performance.

Supplier Selection and Sourcing Flexibility. Our conceptual framework is rooted in the understanding that supply chains should not only be fast and cost-effective; but they must also be “triple-A” supply chains, i.e., they must be agile, adaptable, and aligned (Lee, 2004). To build triple-A supply chains and to generate competitive advantages, “one of the most important aspects that firms must incorporate into their strategic management processes” is supplier selection decisions (González *et al.*, 2004, p. 492), which constitute a multi-criteria decision-making problem along several price and non-price attributes (Chen-Ritzo *et al.*,

2005; Ghodsypour and O'Brien, 1998). Our first hypothesis posits that supplier selection positively impacts agility:

Hypothesis H₁^{II}: *Supplier selection is positively associated with sourcing flexibility.*

Information Systems and Sourcing Flexibility. The integration of information systems across organizational boundaries at multiple process and functional levels can allow firms to increase flexibility and reduce costs (Hill and Scudder, 2002; Frohlich and Westbrook, 2001; Holland and Lockett, 1997). For example, increased visibility through point-of-sales data can help suppliers to predict demand. As such, the availability of precise and timely information can help firms align production schedules with actual usage rather than sales or shipments. On one hand, this alignment of information provides comparative efficiency through lower inventory and coordination costs, and shorter, more reliable response times (Dai and Kauffman, 2002; Clemons *et al.*, 1993). On the other hand, information systems can enable firms to establish one-to-many linkages and to enhance sourcing leverage by altering search-related costs (Choudhury, 1997; Bakos and Brynjolfsson, 1993). Both are key in enabling a firm to act and react quickly and more efficiently, and thus decrease demand distortion, reduce lead-times, and increase sourcing flexibility (Lee *et al.*, 1997). A suitable information system is therefore not only necessary to ensure smooth flows of materials along the value chain, but the corresponding strong information links with suppliers in the firm's portfolio improve sourcing flexibility. Therefore, we hypothesize:

Hypothesis H₂^{II}: *Information systems are positively associated with sourcing flexibility.*

Sourcing Flexibility and Supply Chain Performance. Supply chain performance is a result of the supply chain's ability to respond quickly and effectively to a changing marketplace (Chopra and Meindl, 2009). The effects of demand variability can be mitigated either by increasing capacity or increasing the (sourcing) flexibility of available capacity (Iravani *et al.*, 2005). We investigate how sourcing flexibility affects supply chain performance. Sourcing flexibility improves an organization's responsiveness and customer satisfaction by enabling the procurement managers to adapt the product mix, product quantities, delivery schedules, etc. to short-term requirements for the manufacturing operations or from outside customers (Narasimhan *et al.*, 2001). However, extant research posits that the relationship between supply chain flexibility and performance is not linear (Tang and Tomlin, 2008). Firms tend to emphasize sourcing flexibility to best meet customer requirements in environments with high uncertainty. In contrast, firms operating in predictable environments might exercise less sourcing flexibility to minimize total costs. Firms in both situations can achieve high supply performance. Therefore, we hypothesize:

Hypothesis H₃^{II}: *Sourcing flexibility has a curvilinear (U-shaped) relationship with supply chain performance*

Supply Chain Performance and Product Performance. The better the supply chain performance, the better the involved products will penetrate the market. We therefore posit that supply chain performance positively affects product performance in terms of sales growth, market share, and profitability. Thus, we hypothesize that:

Hypothesis H₄^{II}: *Supply chain performance is positively associated with product performance.*

To test these hypotheses, which form the backbone of our conceptual framework, we contacted executives in manufacturing firms in the U.S. and Europe via a survey.

2. Methodology

2.1. Data sample and procedure

The proposed hypotheses were tested on a broad-empirical basis using the data from sample II. The data collection procedure, the sample characteristics, as well as the statistical data examination including non-response bias concerns are described in detail in Chapter I.

2.2. Measures

To generate our constructs and facilitate our analysis, we employ six measures: supplier selection, information systems, sourcing flexibility, supply chain performance, product performance as well as the control variable competition intensity (see Table 15).

Table 15: Measures of constructs III

Constructs and Items (scale 1-5)	Mean	SD
Supplier Selection (SS)	3.97	0.58
<i>Please indicate the importance of the following criteria for the evaluation and selection of suppliers for the main product line...</i>		
SS1 Cost	4.08	0.82
SS2 Quality	4.52	0.70
SS3 Service	3.93	0.88
SS4 Innovativeness	3.34	1.02
Information Systems (IS)	3.69	0.75
<i>Please indicate the information system-related strategic supply chain priorities for the main product line...</i>		
IS1 Share intra-firm information and data access	3.95	0.90
IS2 Integrate operating and planning databases across applications	3.81	0.95
IS3 Share inter-firm information and data access	3.39	0.91
IS4 Maintain integrated database and access method to facilitate information sharing	3.59	0.97
Sourcing Flexibility (SF)	2.97	0.60
<i>Please indicate the sourcing-related strategic supply chain priorities for the main product line...</i>		
SF1 Broad range of supplier delivery frequencies (weekly, daily, etc.)...	3.11	0.98
SF2 High flexibility within supplier contracts	3.07	0.89
SF3 Broad range of possible order sizes from suppliers	3.06	0.91
SF4 Frequent change of volume allocation among existing suppliers	2.69	0.89
SF5 Frequent change of suppliers' order quantities	3.30	0.92
SF6 Change of delivery times for orders placed with suppliers on a short notice	2.90	0.92
Supply Chain Performance (SCP)	3.52	0.59
<i>Relative to the comparable products of your main competitor, please indicate the supply chain performance of the main product line...</i>		
SCP1 Customer order lead-time	3.35	0.73
SCP2 Customer order fill rate	3.44	0.75
SCP3 Customer delivery reliability	3.51	0.80
SCP4 Customer satisfaction	3.63	0.74
Product Performance (PP)	3.47	0.69
<i>Relative to the comparable products of your main competitor, please indicate the performance of your main product line...</i>		
PP1 Sales growth rate	3.48	0.80
PP2 Market share	3.56	0.97
PP3 Profitability	3.37	0.85
Competition Intensity (CI)	3.32	0.89
<i>Please indicate the competitive intensity of your main product line...</i>		
CI1 Cutthroat competition	3.73	1.00
CI2 Anything that one competitor can offer, others can match readily	3.04	1.11
CI3 Price competition is a hallmark of your industry	3.28	1.13

Note. All items were measured on five-point rating scales (Likert-type). Construct mean is calculated as (arithmetic) mean of all scale scores. SD refers to standard deviation. Unit of analysis is the main product (line) defined as the current sales (revenue) driver of the firm.

The selection of suppliers is a multi-criteria decision-making problem along several price and non-price attributes (Wagner and Friedl, 2007; Chen-Ritzo *et al.*, 2005; Ghodsypour and O'Brien, 1998). It is impossible to list all the criteria that are applicable during the selection process; many of these criteria cannot even easily be quantified. However, some key indicators, such as cost, quality, service, and innovativeness, help buyers configure their supplier base to achieve the desired sourcing flexibility.

The *supplier selection* measure consists of these four items. The primary purpose of efficient firms is to supply at the lowest possible *cost* (Fisher, 1997). Thus, the supplier's price (i.e., the *cost* for the buyer) is a critical criterion for supplier selection. The *quality* of the products is of utmost importance in building strategic buyer-supplier partnerships (Hsu *et al.*, 2006; Kannan and Tan, 2002; Ellram, 1990) and in satisfying buyer requirements. The *service* the supplier provides in terms of delivery reliability, quantity, lead-times, flexibility, and speed to cover the firm's total requirements is yet another factor in supplier selection. Finally, *innovativeness* increasingly becomes a key capability of suppliers. No firm can develop all important new technologies in-house, and firms need to manage their suppliers so as to ensure vital technology transfers (Ulrich and Ellison, 2005).

The *information systems* measure captures the extent to which the information systems of an organization are integrated, enabling a firm to enhance efficiencies of boundary-spanning activities. Communication frequency, intensity, and coordination through information systems build stronger buyer-supplier partnerships, increase channel effectiveness and efficiency, and ensure that there are no information delays (Anand and Goyal, 2009; Croson and Donohue, 2003; Mohr and Nevin, 1990). Information systems enable each channel entity to be informed immediately by providing accurate, thorough, and timely information about

current and expected conditions. In our survey, we applied the scale used by Rodrigues, Stank, and Lynch (2004) and considered four items to create the information systems construct (i.e., whether the firms share intra-firm information and data access; integrate operating and planning databases across applications; share inter-firm information and data access; and maintain integrated database and access method to facilitate information sharing).

The *sourcing flexibility* measure represents the available options for ensuring material availability to support changing manufacturing needs (range) and reflects the ease with which the firm can exercise these options (adaptability) (Koste and Malhotra, 1999; Upton, 1994). First, the options can be described as the extent to which a firm can influence or benefit from the supplier's available capacity as well as short and/or variable supplier lead-times. Second, sourcing flexibility covers the extent to which a firm can tap into suppliers' ability to deal with volume requirements, changes in part specifications, and the quantity and timing of orders in response to the uncertainty in material requirements. We incorporated these factors into our survey with six questions (on delivery frequency, contract, order size, and volume allocation flexibility, and flexibility in changing order quantities and delivery times); we adapted Swafford, Gosh, and Murthy (2006) as well as Narasimhan and Das (1999) to create the sourcing flexibility construct.

The *supply chain performance* measure, which we adapted from Beamon (1999) and Rodrigues, Stank, and Lynch (2004), concerns the extended supply chain's activities in meeting end-customer requirements, expressed in customer satisfaction, product availability, on-time delivery, and inventory and capacity in the supply chain needed to deliver that performance. Finally, the *product performance* measure captures the product's performance

relative to the main competitor in terms of growth, market share, and profitability (Joshi and Sharna, 2004).

To eliminate undesirable sources of variance, we included control variables that may influence and confound the relationships of the key variables in our model. First, *firm size* is an important structural variable. Larger firms might have more market penetration power than smaller ones and thus might be more profitable. Smaller firms, in contrast, might be more innovative, and therefore more profitable. Firm size was measured by a single item asking respondents for the number of employees at their firm; this was double-checked against secondary data. Second, *competitive intensity*, the extent to which a firm perceives its competition to be intense and the extent to which it competes to retain its market share, is another important structural variable with potential impact on profitability. It was captured by four items asking respondents for the intensity of rivalry among firms in the industry. We employed the scale used by Jaworski and Kohli (1993). Third, we eliminated *country effects*. Economic, political, and cultural differences influence the strategic and operational possibilities of firms and therefore might influence profitability. Following the procedure suggested by Cohen, Cohen, West, and Aiken (2003, pp. 303-307), the responses from the UK were coded as the variable “Country UK”, responses from France were coded as the variable “Country France”, and responses from the German-speaking countries were coded as the variable “Country Germany”. Finally, responses from the U.S. were used as the baseline.

3. Statistical analysis and results

3.1. Reliability and validity

Before testing our core hypotheses, we first assessed the reliability and validity of the reflective constructs and the underlying items, followed by the assessment of the structural relationships, i.e., the relationships among the constructs. This ensures reliable and valid measures of constructs before attempting to draw conclusions about the nature of the construct relationships (Anderson and Gerbing, 1988). Our model consists of five reflective constructs (information systems, sourcing flexibility, supply chain performance, product performance, and competitive intensity) and one formative construct (supplier selection). The formative construct for supplier selection is appropriate because the performance and capabilities of a supplier in terms of cost, quality, service, and innovativeness result in an index that supports the buyer's supplier selection decision based on various dimensions that do not necessarily show strong mutual correlations.

Reflective and formative constructs must be validated separately (Diamantopoulos and Siguaw, 2006; Diamantopoulos and Winklhofer, 2001; Hulland, 1999; Chin, 1998; Fornell and Cha, 1994). We assessed the reliability and validity of the reflective constructs using confirmatory factor analysis (CFA) (Bagozzi *et al.*, 1991). All constructs, including the control variable (competitive intensity), were included in one five-factor CFA model. As there were no indications of the presence of multivariate non-normality, the model was estimated with Amos 16.0 using the maximum likelihood estimation method (see Table 16).

Table 16: Factor analysis results and measurement statistics III a

Constructs and items (scale 1-5)	Cronbach alpha	Total variance explained	Communalities	Item-to-total correlation	Composite reliability	AVE	Factor loading	t-value	SE	IR
Information Systems (IS)	0.850	0.645			0.899	0.791				
IS1			0.658	0.696			0.775	- ^a	- ^b	0.474
IS2			0.695	0.716			0.805	14.519	0.076	0.475
IS3			0.568	0.651			0.715	12.616	0.750	0.422
IS4			0.660	0.695			0.769	13.242	0.790	1.000
Sourcing Flexibility (SF)	0.776	0.476			0.843	0.741				
SF1			0.359	0.429			0.584	- ^a	- ^b	0.608
SF2			0.402	0.487			0.533	6.78	0.148	0.619
SF3			0.513	0.545			0.620	7.237	0.168	0.732
SF4			0.530	0.552			0.678	7.344	0.180	0.770
SF5			0.587	0.601			0.721	7.522	0.187	0.747
SF6			0.466	0.516			0.594	7.095	0.165	1.000
Supply Chain Performance (SCP)	0.778	0.600			0.856	0.680				
SCP1			0.511	0.516			0.583	- ^a	- ^b	0.531
SCP2			0.643	0.619			0.706	9.332	0.131	0.584
SCP3			0.654	0.630			0.737	9.062	0.151	0.694
SCP4			0.593	0.571			0.711	8.453	0.146	1.000
Product Performance (PP)	0.711	0.624			0.838	0.532				
CI1			0.605	0.524			0.663	- ^a	- ^b	0.335
CI2			0.627	0.522			0.643	8.332	0.139	0.551
CI3			0.643	0.537			0.705	8.243	0.130	1.000
Competition Intensity (CI)	0.728	0.632			0.846	0.585				
CI1			0.559	0.515			0.635	- ^a	- ^b	0.392
CI2			0.683	0.599			0.776	8.371	0.158	0.579
CI3			0.655	0.538			0.656	8.461	0.132	1.000

Note. All items were measured on five-point rating scales (Likert-type). SE refers to standard error, AVE refers to average variance extracted, and IR refers to indicator reliability (Fornell and Larcker, 1981).

^a *t*-values are from the unstandardized solution; all are significant at the 0.001 level (2-tailed).

^b Factor loading was fixed at 1.0 for identification purposes.

The CFA results depicted in Table 16 indicate acceptable psychometric properties for all constructs. Composite reliabilities and average variances (AVE) extracted for all constructs reach the common cut-off values of 0.70 (Nunnally and Bernstein, 1994) and 0.50 (Bagozzi and Yi, 1988; Fornell and Larcker, 1981), respectively, indicating construct validity. Without exception, each item loaded on its hypothesized construct with large loadings, significant at the 99% confidence interval, which represents a high level of item validity. This high level of

item validity implies that the items are strongly influenced by the construct they are measuring and indicates that sets of items used to capture the construct are unidimensional.

Overall, the results demonstrate acceptable levels of fit for all reflective constructs (Hair *et al.*, 2006): Chi-square $\chi^2/df = 1.409$ ($\chi^2_{(160)} = 225.376$, $p < 0.001$), CFI (Comparative Fit Index) = 0.965, NNFI (TLI) (Non-Normed Fit Index also known as Tucker-Lewis Index) = 0.959, GFI (Goodness of Fit Index) = 0.937, and RMSEA (Root Mean Square Error of Approximation) = 0.035 (90% confidence interval = [0.024, 0.045]). For CFI, values above 0.95 indicate a good fit; acceptable values for NNFI and GFI are above 0.9 and for RMSEA below 0.05 (Hair *et al.*, 2006).

The estimates of the five-factor CFA model also allow us to assess convergent and discriminant validity. Inter-construct correlations, average variances extracted (AVE), and squared correlations are provided in Table 17. All the results are within acceptable ranges, indicating convergent and discriminant validity of our reflective constructs as measured by their items (Fornell and Larcker, 1981).

Table 17: Inter-construct correlations and AVE III

	Mean	SD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) IS	3.62	0.81	0.791	0.119	0.115	0.000	0.006	0.010	0.014	0.013	0.000	0.019
(2) SS	3.97	0.57	0.345**	N/A	0.208	0.002	0.002	0.021	0.000	0.003	0.016	0.008
(3) SF	2.93	0.60	0.340**	0.456**	0.741	0.040	0.001	0.017	0.000	0.001	0.016	0.010
(4) SCP	3.52	0.59	-0.018	-0.046	-0.200**	0.680	0.114	0.044	0.000	0.003	0.042	0.002
(5) PP	3.47	0.71	0.077	0.050	-0.024	0.337**	0.532	0.052	0.003	0.000	0.006	0.000
(6) CI	3.32	0.89	0.099**	0.144	0.132*	-0.209*	-0.229*	0.585	0.005	0.005	0.002	0.002
(7) FS	41,438	81,196	0.119*	-0.002	0.014	0.004	0.057	0.072	1.000	0.006	0.012	0.001
(8) C-UK	N/A	N/A	-0.113*	0.058	-0.023	-0.052	0.003	-0.072	-0.080	1.000	0.010	0.044
(9) C-F	N/A	N/A	0.008	-0.128*	-0.013	-0.205**	-0.074	0.047	0.110	-0.102**	1.000	0.141
(10) C-G	N/A	N/A	0.140**	0.090	0.098	0.049	0.005	-0.042	0.032	-0.209	-0.375**	1.000

Note. Pearson correlation coefficients are below the diagonal, and squared correlations (shared variance) are above the diagonal; Average variance extracted (AVE) is shown on-diagonal. AVE of single items is 1. N/A = not applicable; SD refers to standard deviation. For discriminant validity above-diagonal elements should be smaller than on-diagonal elements.

** Significant at the 0.01 level (two-tailed).

* Significant at the 0.05 level (two-tailed).

Abbreviations: IS: Information Systems, SS: Supplier Selection, SF: Sourcing Flexibility, SCP: Supply Chain Performance, PP: Product Performance, CI: Competitive Intensity, FS: Firm Size, C-UK: Country UK, C-F: Country France, C-G: German speaking countries.

As opposed to items measuring reflective constructs that should be highly correlated, there are no expectations on items in formative constructs; they can have positive, negative, or zero correlations (Bollen and Lennox, 1991). Therefore, the traditional measures of item and factor reliability assumption of unidimensionality does not apply (Chin, 1998). A statistical way to circumvent this problem is to use the latent variable partial least square (PLS) estimation method to derive “optimal factor weights” for the formative measurement model (see Table 18). Except for the t-statistics for service indicator (SS3), all test results are within acceptable limits. In order not to compromise on the generality of our modeling (including measurement approach), we retain the SS3 even though it does not contribute substantially to the measurement of supplier selection.

Table 18: Factor analysis results and measurement statistics III b

Construct and items (scale 1-5)	Number of items	Factor weights	t-values	VIF	Condition index
Supplier Selection (SS)	4				
SS1 Cost		0.762	9.653	1.070	8.477
SS2 Quality		0.272	2.305	1.379	12.030
SS3 Service		-0.012	0.142	1.407	16.053
SS4 Innovativeness		0.405	3.463	1.166	21.670

Note. All items were measured on five-point rating scales (Likert-type). Absolute t-values are shown. VIF refers to variance inflation factor.

Multicollinearity for our constructs was not a serious hindrance to the study’s validity because none of the relevant checks (eigenvalues, variance inflation factor, condition index) suggested multicollinearity (Hair *et al.*, 2006). Nor was any evidence of heteroscedasticity detected. Finally, outlier analysis did not indicate extreme values.

To examine the potential for common method bias, Harman’s one-factor test was applied (Podsakoff *et al.*, 2003). All 20 items in reflective constructs used in the measurement models were subjected to a principal component factor analysis using the Kaiser-criterion which yielded, as hypothesized, five factors with the first factor accounting for a proportion of

20.4% of the cumulative variance explained by the five factors (60%). This is substantially below the threshold of 50% proposed by Podsakoff and Organ (1986), thus suggesting the absence of a significant common method bias effect.

3.2. Structural model estimation and hypotheses testing

We analyzed the hypothesized positive structural relationships between supplier selection and sourcing flexibility H_1^{II} , information systems and sourcing flexibility H_2^{II} , and supply chain performance and product performance H_4^{II} ; and the hypothesized curvilinear relationship H_3^{II} between sourcing flexibility and supply chain performance. In this section, we provide the details of our analysis; Table 19 summarizes the results of the hypotheses tests that we performed.

Table 19: Results of model estimation III a (SEM)

Hypothesized relationship		Beta	t-value	f ²	R ²	Support of hypothesis
Independent variables	Dependent variables					
Supplier Selection	Sourcing Flexibility	0.378***	7.425	0.141	0.227	H_1^{II} : yes
Information Systems	Sourcing Flexibility	0.188***	3.641	0.180	0.138	H_2^{II} : yes
(Sourcing Flexibility) ²	Supply Chain Performance	0.433***	8.667	0.060	0.268	H_3^{II} : yes
Supply Chain Performance	Product Performance	0.325***	6.485	0.022	0.127	H_4^{II} : yes

Note. Beta refers to standardized OLS regression estimates. Absolute t-values are shown. f² refers to effect size.

*** Significant at the 0.01 level (one-tailed).

To test H_1^{II} , H_2^{II} , and H_4^{II} , we used variance-based PLS structural equation modeling because it allows for the inclusion of reflective and formative constructs (Lohmöller, 1989; Wold, 1980). Furthermore, in contrast to commonly employed covariance-based structural equation modeling, in the variance-based structural equation modeling, the independent variables are approximated as exact linear combinations of dependent variables, which provides an exact definition of the component scores, avoids the indeterminacy problem, and

precludes parameter identification problems (Bollen and Lennox, 1991; Fornell and Bookstein, 1982). However, with the variance-based structural equation modeling (whose objective is prediction), no overall fit indices can be reported; a price should be paid for the inclusion of reflective and formative constructs.

The primary objective of PLS analysis is the minimization of error which is equivalent to the maximization of variance explained in all endogenous constructs. The degree to which any particular PLS model accomplishes this objective can be determined by examining the variance explained (R^2) values for the dependent (endogenous) constructs. With the effect size f^2 and the change in R^2 , we evaluated whether the impact of a particular independent latent variable on a dependent latent variable has substantive impact (Cohen, 1988). We calculated the statistical significance level of the parameter estimates and the standard errors using 500 bootstrapping runs. The results in Table 19 show that each of the endogenous constructs has a significant impact ($p < 0.001$) on its associated exogenous constructs, providing support for hypotheses H_1^{II} ($\beta = 0.378$), H_2^{II} ($\beta = 0.188$), and H_4^{II} ($\beta = 0.325$). Thus, we find empirical support that supplier selection and information exchange among buyers and suppliers can result in significant sourcing flexibility improvements, and that supply chain performance positively affects a product's performance in the market. Furthermore, R^2 values range from 0.127 to 0.227, indicating a high variance explained for all dependent constructs.

To test H_3^{II} , i.e., the quadratic effects of sourcing flexibility on supply chain performance, we performed hierarchical regression analyses (see Table 20). By adding the squared term of sourcing flexibility to the hierarchical multiple regression analysis, a significantly higher variance can be explained ($R^2 = 0.268$). The curvilinear effect demonstrates a U-shaped

relationship between sourcing flexibility and supply chain performance, supporting H_3^{II} ($\beta = 0.433$). This relation suggests that firms realize superior performance either with rigid sourcing structures or with flexible ones. Intermediate sourcing flexibility levels hinder supply chain performance.

Table 20: Results of model estimation III b (SEM)

Independent variables	Dependent variable: Supply Chain Performance		
	Model 1	Model 2	Model 3
Control variables			
Country UK	-0.100* (-1.803)	-0.096* (-1.745)	-0.074 (-1.491)
Country France	-0.240*** (-4.119)	-0.226*** (-3.933)	-0.168** (-3.203)
Country Germany	-0.062 (-1.043)	-0.035 (-0.590)	-0.046 (-0.850)
Competitive Intensity	-0.118** (-2.204)	-0.084 (-1.574)	-0.119** (-2.446)
Firm Size	-0.027 (0.501)	0.028 (0.530)	0.055 (1.143)
Predictor variables			
Sourcing Flexibility	-0.184**(-3.436)	-0.028 (-0.537)	
(Sourcing Flexibility) ²			0.433*** (8.667)
R^2	0.068	0.100	0.268
R^2 change	0.068***	0.032***	0.168***
F	4.831***	6.125***	17.163***

Note. Beta refers to standardized OLS regression estimates. t-values are shown in bracket.

*** Significant at the 0.01 level (one-tailed).

** Significant at the 0.05 level (one-tailed).

* Significant at the 0.1 level (one-tailed).

4. Discussion and implications

Chapter IV presents empirical validation that sourcing flexibility for a given product is a key determinant of supply chain performance and product performance. To the best of our knowledge, this study is the first in the literature that (1) provides evidence that sourcing flexibility is curvilinearly related to supply chain performance and (2) establishes the link between sourcing flexibility and product performance. We also extend previous research on the causes and consequences of sourcing flexibility, which is an important component of responsive supply chains.

The curvilinear relation between sourcing flexibility and supply chain performance suggests that firms can realize high supply chain performance if their sourcing arrangements (i.e., contracts) with suppliers are either rigid or allow for flexible sourcing of products in terms of product quantities, product mix, delivery schedules, etc. One reason for this phenomenon may stem from Fisher's (1997) distinction between efficient and responsive supply chains. On one hand, firms in heterogeneous or unpredictable environments that offer customized products are better positioned for achieving high supply chain and product performance with more modular or flexible supply chain structures. This is in line with the results of Schilling and Steensma (2001) and Hitt, Keats, and DeMarie (1998) who suggest that firms will require strategic flexibility to survive in a global environment. On the other hand, firms that operate in homogeneous markets and offer standardized products can achieve a high supply chain performance only if costs are controlled tightly and sourcing flexibility is limited to a minimum. For firms in between, more flexibility may hinder the supply chain performance by creating a mismatch between product and supply chain characteristics. This "stuck in the middle" phenomenon is frequently observed in other areas of strategy and organization (e.g., Bouquet *et al.*, 2009; Dess and Davis, 1984; Hambrick, 1983), and we have present in Chapter IV empirical evidence that it is also evident in procurement decisions.

Chapter V Summary, Limitations, and Outlook

This chapter summarizes the previous chapters and presents the theoretical and managerial implications of the results and the models, as tested in Chapters II, III, and IV. It begins with a summary of the main results with regard to the three research questions stated in the introductory chapter. Next, a delineation of the main academic contributions and the most relevant managerial implications is provided. Finally, major limitations are listed and directions for future research are identified.

1. Summary and review of the research questions

As described in Chapter I, scholars and practitioners have put the topic of effective supply chain strategy and management on their agendas. In recent years, the interest in this issue has gained momentum, driven by three factors: (1) higher implied demand uncertainty due to tougher competition, product plurality and globalization of supply chains and markets, amongst others; (2) prevalence of increasingly complex, tightly coupled and responsive supply chain design requirements; and (3) inter-, intra-organizational and external challenges, obstacles and trade-offs within supply chains. Anecdotes, theoretical frameworks and case studies convey how a fit in the supply chain can have positive consequences for global operating manufacturing firms. The bulk of supply chain strategy research has relied heavily on these examples and on case study methodologies, yet often with rhetorical or vague suggestions that lack quantitative substantiation. Given these circumstances, the purpose of

this dissertation was to study the phenomenon of supply chain fit, its constituents and performance outcomes in more detail in order to enhance the current understanding.

First, the literature was reviewed in Chapter I. Particular emphasis was placed on the clarification of the terms relevant in the domain of supply chain management, encompassing the generic *product and supply chain design profiles* of Fisher (1997) as well as the concepts of *strategic fit*, *supply chain fit* and *supply chain design efficiency*, all of which were discussed and defined in the context of the literature. In addition, the traditional classification of a fit or match in the supply chain (Fisher, 1997) was extended in the way that the proclaimed diametrical setting was amplified with a multiple portfolio approach of ideal supply chain fit constellations along the efficient frontier line, depending on the business model and the overall competitive strategy. The clarification of this nomenclature served as starting point for the subsequent chapters.

The research presented in this dissertation follows a theory-driven, large-scale empirical approach and is based on samples I and II. Data were gathered by means of an internet-based survey of executives in the German-speaking countries of Germany, Switzerland, and Austria, in addition to the USA, the UK, and France. In Chapter I, research questions I, II and III were described, with the applied data collection procedures and the characteristics of the drawn samples. The obtained data sets (sample I: N = 259; sample II: N = 336) constitute a rich empirical basis for the investigation of the three research questions outlined in Section 3 of Chapter I.

These research questions were investigated in Chapters II, III, and IV. Relying on three model-based approaches and by applying several major theoretical concepts, this dissertation

makes an original contribution to the research. In the following, the major results are summarized.

1.1. Research question I

Research question I highlights the strategic role of supply chain management and the bottom line impact of supply chain management practices on the firm's performance. In Chapter II, research question I investigated the following relationship:

Question I: *Does supply chain fit have a significant impact on a firm's financial success and if so, which supply chain fit constituents are of relevance?*

Holistically framed fit-performance relationships involving strategy, firm, and environment, a conceptualization consistent with many organizational theories, in particular those that identify a typology of effective organizational configurations (e.g., Mintzberg, 1983; Porter, 1980; Burns and Stalker, 1961) are central to strategic supply chain management. To answer research question I and to understand the relationship between product and supply chain profiles as well as among supply chain design, supply chain strategy, and the competitive strategy of a firm, the research presented in Chapter II draws from configurational theory: when organizational configurations fit or are similar to the ideal type, effectiveness is at its highest because of the greatest possible fit among contextual, structural, and strategic factors (Meyer *et al.*, 1993b). Based on this theory, the central idea behind the conceptual framework was that a fit in the supply chain leads to higher financial performance.

Following the concept of strategic fit (Chopra and Meindl, 2009), the generic product and supply chain profiles (Fisher, 1997) were proposed as relevant for achieving fit in the supply

chain. Subsequently, hypotheses were formulated that relate supply chain fit to a firm's financial success in terms of ROCE, ROA as well as EBIT Margin and Sales Growth. Supply chain fit was measured by asking the respondents to indicate the demand aspects of the product as well as accordingly the supply chain design aspects.

With regard to research question I, the findings from the four linear models estimated by OLS regression support the assumption that a fit in the supply chain affects the financial success of a firm. Hence, supply chain fit can be conceived as financial driver of a firm. The results reveal that supply chain fit, building upon the constituents of the demand aspects of a product and its supply chain design, directly affect ROCE, ROA, EBIT Margin, and Sales Growth. The conducted post-hoc analysis supports the financial leverage impact of supply chain fit. Nonetheless, supply chain fit only marginally explained the variance in firm performance, i.e., ROCE, ROA, EBIT Margin and Sales Growth. This calls for a further investigation of supply chain fit in the light of a firm's financial success.

1.2. Research question II

By adopting the firm's perspective and drawing upon configuration theory, research question II explored the relationship between supply chain design and a firm's financial success in terms of ROCE. Achieving supply chain design efficiency requires firms to concentrate their resources on what they do best and on what provides them with the highest ROCE. While the merits of an excellent supply chain design are straightforward, it was still not clear how well the evidence correlate with actual performance. Hence, research question II was formulated as:

Question II: *How do supply chain designs perform in terms of Return on Capital Employed, and which supply chain design types are of relevance?*

To answer this question, we introduced the concept of *supply chain design efficiency* as a combination of two supply chain design types: physically-efficiency and market responsiveness. We demonstrated how supply chain design efficiency may not only be conceptually described, but also empirically measured. To this end, we used DEA as an appropriate methodology to operationalize the constructs (Charnes *et al.*, 1978). Instead of comparing the supply chains of manufacturing across the board, the DEA approach provides a basis for comparing supply chain designs against their best-in-class benchmark, i.e., to investigate supply chains within their specific design context. By calculating an efficiency score between 0% and 100%, our measure allows to evaluate the potential for improvement of any given supply chain design. Results indicate that many supply chains display a potential for increasing efficiency. The mean score of supply chain design efficiency was 46.83%, however, less than 2% of the supply chain designs we investigated were fully efficient. The task of supply chain management is to design supply chains that fit best to the unique requirements of the manufacturing firm to best meet demand and supply. As we noted previously, top management needs to develop an appreciation of how an effectively managed supply chain design contributes to overall financial performance.

Instead of focusing on how Zara, Wal-Mart, Procter & Gamble, Toyota, or other best-in-class firms are using their own supply chains to dominate the competition, firms should look at what all top-performing supply chains have in common on a broader basic level. By developing an understanding of the traits that underlie high-functioning supply chains, firms will be well on their way to building their own models for supply chain design efficiency. At

the very least, this pattern of results should stimulate some revisions and future research for the investigated link.

1.3. Research question III

As indicated in Chapter IV, far less attention has been given to sourcing flexibility (Swafford *et al.*, 2006; Sharifi and Zhang, 1999; Goldman *et al.*, 1994), a key cross-functional driver (see Chapter I). Prior studies have been unable to find conclusive results on the link between the building blocks of supply chain responsiveness and performance (Fantazy *et al.*, 2009; Pagell and Krause, 2004). As such, More and Babu (2008, p. 40) state that, in the literature, “the empirical justification of the benefits of implementing flexible supply chains is rare and in-depth empirical studies are lacking.” In response, research question III was formulated as follows:

Question III: *Does sourcing flexibility have a significant impact on supply chain and product performance and if so, which degree of sourcing flexibility sources is required for superior supply chain and product performance?*

A major building block of supply chain responsiveness is sourcing flexibility (Swafford *et al.*, 2006). This research suggested that sourcing flexibility is stimulated by information sharing as well as by supplier selection and that sourcing flexibility has an impact on supply chain performance which in turn affects product performance. Building upon these central hypotheses, a covariance-based structural equation modeling technique was used to analyze the model with data from sample II. The results offer several original insights and make several scholarly and managerial contributions. In detail, the results show that supplier

selection has a significant impact on sourcing flexibility. This is critical when a firm facing with uncertain market conditions relies on its suppliers to adjust material supply in response to unexpected changes in customer orders for manufactured products. Consequently, firms requiring higher levels of responsiveness put more emphasis on rigorous supplier selection along various criteria. Similarly, Swafford, Ghosh, and Murthy (2006) note that within sourcing flexibility, key determinants of range of flexibility are the extent to which supplier lead-time can be changed and the extent to which supplier capacity can be influenced when a firm faces sudden changes in customer demand. Furthermore, results indicate that an increased information exchange through implemented information systems between buyers and suppliers on multiple levels can result in significant improvements in sourcing flexibility. Thus, a greater level of external integration can support better management of collaborative relationships and enable firms to achieve higher efficiency. This also supports the findings of Cachon and Fisher (2000) and Krajewski and Wei (2000). Finally, empirical evidence provides a U-shaped relationship between sourcing flexibility and supply chain performance.

The average cost of purchased materials, components, and services across all manufacturing firms frequently exceeds 60% or even 70% of the total cost of operations (Leenders *et al.*, 2006; Wagner, 2006). In light of this enormous amount of business which is outsourced to suppliers, the results of research question III should urge managers to take sourcing flexibility into account more frequently when making supplier selection and sourcing decisions. Sourcing flexibility is a key factor for supply chain and product performance and merits researchers' and managers' attention.

2. Major academic contributions

The research presented in this dissertation contributes to the academic discussion in multiple ways. As the specific findings and research implications have already been extensively discussed in Chapters II, III and IV, this section focuses on more general aspects. By using survey data with a large number of respondents, and by developing and testing theory-driven conceptual models, this dissertation moves beyond the case-based and normative research that dominates the literature on supply chain fit.

First, we fill a gap in the operations management literature on the bottom line impact of supply chain management on firm performance. Supply chain management literature has so far focused more on efficiency improvement and cost reduction in supply chain operations (e.g., Kopczak and Johnson, 2003; Aviv, 2001), and less on the phenomenon of supply chain fit. This could be because, in contrast to efficiency, it is much harder to place a value on supply chain fit. By associating supply chain fit with firm performance, we provide an estimate of the value of a supply chain fit.

Second, although numerous classifications like the strategic fit concept of Chopra and Meindl (2009) as well as the generic product and supply chain profiles of Fisher (1997) which are in line with the reasoning of strategic management literature (Porter, 1980) or Mintzberg's (1983; 1979) theory of organizational structure and Miles and Snow's (1978) theory of strategy, structure, and process have been proposed, empirical studies have so far neglected to take the phenomenon of supply chain fit sufficiently into consideration. This dissertation moves beyond these conceptual classifications and provides evidence that supply chain management research can benefit from configurational approaches (instead of

relationships between single constructs). Chapters II and III provide important contributions to the academic discussion which may serve as a starting point for further studies.

Finally, the evidence presented in this paper contributes to recent research to quantify the impact of supply chain management strategies. One core research stream focuses on mathematical models aiming to understand how alternate ways of managing supply chains impact capital and operating costs, service, and inventory levels (e.g., Erhun *et al.*, 2008; Taylor, 2002; Aviv, 2001; Cachon and Fisher, 2000). The second core research stream empirically examines the relationship between supply chain practice and performance (e.g., Frohlich and Westbrook, 2001; Shin *et al.*, 2000; Swamidass and Newell, 1987). Despite significant research in this field, most of the evidence is based on self-reported data. Therefore, it is still not clear how well the evidence correlates to actual performance. Here we extended recent research which has begun to use secondary data (e.g., Hendricks and Singhal, 2005) and link effective supply chain management, i.e., supply chain fit, to a firm's financial success. Furthermore, our multi-method approach, i.e., primary subjective data from the survey and secondary objective financial data helps to overcome methodological problems (e.g., common method bias) and to establish relevance of supply chain management research by demonstrating how the research outputs apply to practice which hint numerous directions for future research.

3. Major implications for practice

The insights from the presented conceptual frameworks provide significant implications for practitioners. As most of them have already been discussed, only a summary of major and comprehensive implications is given.

Supply chain management. Effective supply chain management comes in line with achieving supply chain fit, a prerequisite for strategic fit as described in Chapter II. Our results can be taken as indications that supply chain fit is a relevant contextual variable for strategic supply chain decision-making. Borrowing from strategic management literature and configurational theory, this leads to the need to reevaluate the fit between supply chain design and the demand aspects of the product. A certain supply chain design may perform well at one stage of the product life-cycle, but probably not (necessarily) during the whole product life-cycle, as Chapter III indicates. Therefore, supply chain designs should be (re-)assessed in the light of supply chain fit.

At the heart of this dissertation we claim that firms have to realize the bottom line impact of supply chain management because the impact of supply chain management is significant and too substantial in terms of ROCE, ROA, Sales Growth and EBIT Margin than its impact beyond the “classical” logistics performance indicators, like delivery performance. This makes a strong support that supply chain management must be anchored in the top management. Only then, the obstacles, challenges and trade-offs in the supply chains can be managed in an optimal manner. Therefore, a promising approach might be the creation of a *Chief Supply Chain Officer* who not only steers the supply chain management operations and monitors the firm’s supply chain fit, but who also engages in forming a “fit management culture”.

Supply chain fit constituents. As the degree of supply chain fit impacts the financial performance, firms need to assess their products (and competitive strategy) and devise the supply chain strategy accordingly. Lee (2002) mentions that the best supply chains are not only cost-effective (physically-efficient) and fast (market responsive), but also agile and

adaptable enough to ensure that all of a firm's interests stay aligned. The message for managers is: achieve consistency between demand aspects of your product and your supply chain design and align it to the competitive strategy. Although this message may appear rather abstract in research terminology, Chapter II and Chapter III explained how supply chain fit can be achieved (see also Chapter I) and how supply chain designs can be benchmarked, a first original approach to get transparency of the own supply chain design efficiency. While most of the popular supply chain management literature devotes a significant space to supply chain strategy issues, it provides poor analysis of alternative supply chain designs in the light of their relative advantages with regard to supply chain fit.

Prioritization of supply chain drivers. Logistics as well as cross-functional drivers are the engines for designing supply chains. As such, prioritization of supply chain drivers is key to achieve supply chain fit. As all supply chain drivers work simultaneously and depend on each other, each driver has to be analyzed in order to balance out and optimize all logistics and cross-functional drivers from a holistic perspective. Algere, Lapiedra, and Chiva (2006) note that firms might speed up their execution of options, given limited time and resources, instead of increasing the range of options at the expense of adaptability. The findings of Chapter IV should further encourage managers conceive supply chain drivers, for example sourcing flexibility, as opportunities for improvement and to leverage this potential towards achieving supply chain fit.

4. Limitations

As with any empirical research, the results of this dissertation have to be assessed in light of the constraints under which the data was gathered and analyzed.

4.1. Data gathering and statistical analysis

First, this dissertation concentrated on a complex area in supply chain management research. Thus, the constructs developed and validated in this dissertation need to be more rigorously defined, and their measures tested further for reliability and validity. Solid statistical results obtained from the estimated confirmatory factor analysis models provide good indications for the factorial structure. However, the validation of scales is an inexact and iterative process. Thus, the construct validity can only be accomplished through a series of studies that further refine and test the measures across populations and settings. A more profound investigation of the nomological network of the constructs developed in this dissertation, mainly for *supply chain fit* (SCF), might yield a more parsimonious set of constructs, i.e., a more sophisticated proxy for supply chain fit might capture the fit in the supply chain more precisely.

Second, the models should be validated on other samples, if the findings are to be generalized to the population of firms. For example, the models investigated in Chapters II, III and IV were tested with data gathered from manufacturing firms in the USA, the UK, France, Germany, Austria and Switzerland. However, besides these efforts, this raises still the question whether the model would be validated with samples from other countries and/or regions, like Asia or South America. Likewise, all three studies focused on manufacturing firms. Replications with other industries than the herein reported ones, like logistics service providers or retailers, would be a consequential next step.

Third, we followed the compromise adopted by many researchers (e.g., Swafford *et al.*, 2006; Pagell and Krause, 2004) and used the same data to purify and validate our measures and then to test the hypotheses. While this was an important design step keeping the samples manageable, this includes the threat of a potential single informant bias which cannot

completely be ruled out. Hence, the opportunity to survey multiple key informants (Wagner *et al.*, 2010b) per firm, i.e., to establish inter-rater reliability, was abandoned.

Fourth, another limitation arises from the fact that for the estimated model of research question III (Chapter IV) both explanatory and outcome variables are based on self-reports. This raises the problem of common method variance in which the independent and dependent variables are hardly distinguishable (Bollen and Paxton, 1998; Podsakoff and Organ, 1986; Phillips, 1981). Despite the encouraging tests reported herein, the problem of common method variance cannot be completely ruled out. Hence, a bias arising from common method variance may be a greater problem for the results in Chapter IV were the outcome variable *supply chain performance* and *product performance* may be vulnerable to a subjective perceptual measurement. In contrast, the results of Chapters II and III are stable against this issue, since the usage of objective secondary data for the outcome variables eliminates the concern of common method bias.

Fifth, the response rates of the survey (sample I: 14.12%; sample II: 18.32%) might be a potential weakness even though many recent studies in the field of supply chain management have also struggled receiving good response rates (e.g., Bode, 2008; Gibson *et al.*, 2005; Sinkovics and Roath, 2004) and several other studies subscribe to the philosophy that there is no generally accepted minimum response rate (Fowler, 1993). Despite encouraging results of non response bias tests reported herein, the possibility cannot be completely dismissed.

Finally, as this research is cross-sectional, it cannot establish causality among variables. Although the performed tests did not provide an indication of recall issues, regency bias might still exist. Only a longitudinal research design could confirm causality or evolutions of key variables over time.

4.2. Conceptual frameworks

Apart from these limitations associated with the empirical approach, the three conceptual frameworks and their testing exhibit limitations.

In Chapters II and IV, the rather low coefficients of determination (R^2) in all the estimated models indicate that partial models were investigated. Obviously, various factors hold predictive power for the investigated dependent variables that were omitted in the conceptual frameworks. This has to be taken under consideration when interpreting the results.

Furthermore, in Chapter IV, the downstream-oriented *supply chain performance* measure from Beamon (1999) and Rodrigues, Stank, and Lynch (2004) was used. For this reason, this scale cannot perform a more detailed examination of how sourcing flexibility affect other elements of supply chain performance. The limitation regarding performance measurement might be eliminated if a broader performance measurement approach, i.e., “adaptability of a firm, market and financial success,” would have been taken under consideration (Weber and Schäffer, 2006, p. 420).

Chapter II discussed only a selection of product demand aspects which were based on the generic product and supply chain design profiles of Fisher (1997). The low coefficients of determination make a strong case for the further exploration of supply chain fit and its constituents. A more precise operationalization of supply chain design variables which are relevant to capture the degree of responsiveness together with an investigation of their relationship to product demand aspects would be of high managerial relevance. A deeper knowledge of how supply chain design variables increase or decrease *supply chain design*

efficiency and consequently affect supply chain fit would give managers important information for their decisions about supply chain design.

With regard to the conceptualization of Chapter III, it is noteworthy that the results are correlated to the limits of DEA, which measures the relative efficiency of Decision Making Units. This non-parametric programming approach to frontier estimation cannot provide absolute efficiencies, only efficiencies relative to the data considered.

5. Directions for future research

Apart from tying in with the limitations cited above, several further avenues for future research seem promising. The following aspects should stimulate research interest and encourage further research in the field of supply chain management.

5.1. Model extensions and alternative underpinnings

First, the phenomenon of supply chain fit should be applied to other supply chain management areas. This dissertation focused on the design of a supply chain in which demand uncertainty is the key challenge. It would be interesting to apply the phenomenon of supply chain fit to the two other sources of uncertainty: process and supply (Lee and Billington, 1993). Furthermore, the supply chain fit concept could also be applied in particular to supply chain finance. An important supply chain management goal is to achieve an optimized working capital management in order to activate tied capital which is frozen in account receivables and payables as well as in inventories. The ability to deliver at anytime is often a top priority for firms and leads to high inventories and stocks, i.e., the tied capital is not optimized (Grosse-Ruyken *et al.*, 2008) which increases the potential of bankruptcy of

supply chains in economic recessions. This domino effect is intensified if a holistic approach taking the whole supply chain into consideration is missing to release tied-up capital, i.e., capital which is for example frozen in inventory. Thus, each working-capital management decision should consider all upstream and downstream partners within the supply chain, especially regarding the management of the Cash Conversion Cycle (CCC), which measures the number of days a firm takes to convert resource inputs into actual cash, a key measurement of a firm's performance in this regard. In contrast to current mainstream, the optimal level of CCC for responsive supply chains could be seen from a holistic "fit stance" concluding that a strong working-capital system depends on the business model, its specific supply chain design configurations and risk aspects within the supply chain. Hence, further investigations of optimal working capital management strategies from a "holistic fit stance" considering the financial and operational trade-offs in addition to the risk aspects would be of high relevance.

Second, it is difficult to determine the cause of an observed transformation change, and whether the response to it is based on learning, such as understanding the relationship of that response (Fiol and Lyles, 1985) to the experienced (in)consistency of demand aspects of the product and supply chain design variables. As a lack of supply chain fit does not appear overnight but evolves over time, there is a constant threat that misfits do not receive sufficient management attention. Managers generally do not get credit for preventing potential misfits, especially since the potential consequences are not known in advance. Therefore, it can be estimated that over the course of time firms simply neglect the supply chain design aspects and underestimate both the tangible and intangible benefits of achieving supply chain fit.

Further investigations are necessary to deepen the knowledge and to monitor better the supply chain fit along the product life-cycle.

Third, selecting an ideal configuration is a complex balancing act. It would be interesting to figure out if managers avoid the blandness or chaos of too little configuration while skirting the obsession of too much. Basically, the appropriate level of configuration depends on the implied uncertainty spectrum. The more changing and uncertain the environment, the more loosely coupled the elements of the supply chain of a firm may have to be (Miller, 1993). “Excellent wines have complexity and nuance, blending together different tastes into a harmonious balance. They avoid clashing cacophonies of flavors as well as the strident dominance of a single sharp note” (Miller, 1996, p. 511).

Fourth, Fine (1998) and Randall (2001) point out that supply chain decisions are often more capitally intensive and longer lived than product line decisions, suggesting limitations for an optimal supply chain design fitting each product iteration. Hence, it would be interesting to investigate patterns of how supply chain design can dynamically be adapted and aligned, fitting, to a high degree, to every product iteration, extending the results of Randall, Morgan, and Morton (2003) to safeguard supply chain fit in each product iteration.

Fifth, collecting data from both sides of the relationship dyad, or even investigating triad-relationships, would be an interesting and promising task for future research with respect to supply chain fit. Various factors such as the comparative level of each firm’s dependence can only be examined by using such dyadic or triadic data.

Sixth, in Chapter IV we restricted ourselves to production-related sourcing flexibility; other activities may be outsourced for different reasons. In addition, we focused on sourcing flexibility. However, logistics flexibility and/or manufacturing flexibility might have

significant explanatory power in terms of profitability. Further investigations would be promising.

Finally, in all chapters the configuration view was used to underpin the phenomenon of supply chain fit and its constituents. The configurational theory is based on contingency theory and strategic choice theory. The contingency approach contends that there is an association between environmental factors and organizational structure. If the environment changes, then the organizational structure changes as well (deterministic view of contingency theory) or should be adapted by decision-makers (strategic choice theory). In any case, a strategic fit between environmental factors and organizational structure leads to superior performance. Configuration theory is based on the former theories but addresses successful organizational patterns as indicated in Chapters II and III. The idea is that, given certain environmental factors, groups of firms and supply chains emerge that display a common profile, i.e., configuration, of conceptually independent characteristics. Hence, the closer a supply chain matches an ideal constellation, the better the performance. However, these environment-structure-performance configurations have not been investigated before against a background of supply chain fit. This dissertation provides a first step into that research direction by adding the fit dimension to supply chain configurations. It would be a promising research field to elaborate a set of dimensions and variables for the description of constellations which take all aspects of supply chain management into account, i.e., better supply chain fit predictors and scales to identify determinants based on specified industry requirements have to be developed and continuously updated in order to maintain a high level of supply chain fit. For this reason, a complete set of factors should be included in the descriptions of ideal types for the respective industry. At minimum, ideal types should be

described in terms of the imperatives which drive firms in supply chain management toward certain configurations (Miller, 1986).

5.2. Cross-country effects

Given globalization and the increasing importance of international business, the transferability of models, theories, and practices across national borders and national cultures has become an important issue in the academic and business world. Comparing two or more data sets is an essential means of discovering peculiarity or universality of methods, attributes, theories or practices.

Hence, we put tremendous efforts to obtain data from different European countries (France, UK, Germany, Austria and Switzerland) and the USA. Nevertheless, it is important to note that the results may not generalize to all countries. Differences in buyer-supplier relationships or different supply chain management perceptions may vary among countries. Therefore, for the investigation of supply chain fit, three of Hofstede's (2003) five dimensions of cultural difference (power distance, uncertainty avoidance, individualism versus collectivism, masculinity versus femininity, long-term versus short-term orientation) can be expected to be of particular importance in the context of supply chain fit: uncertainty avoidance, masculinity versus femininity and long-term versus short-term orientation. For instance, supply chain managers in the USA could be expected to focus differently on supply chain design because of their short term-orientation, in contrast to more long-term oriented Japanese counterparts.

5.3. Longitudinal research design

All three studies investigating research questions I, II and III are longitudinal and hence preclude establishing a strong claim of causality in the estimated models. Many of the investigated aspects and theories are highly dynamic, such as the configurational perspective on supply chain fit. Such aspects cannot be fully examined in a cross-sectional study, but should be addressed with a longitudinal approach. Certainly, a longitudinal research design would enhance the knowledge of how firms adjust over time to maintain a high level of supply chain fit and how their supply chain designs are adjusted to changes in demand. Further insights into the trade-offs between physically-efficiency and market responsiveness could be gathered and assist in understanding the bottom line impact of supply chain management on firm performance. Similarly, it would be useful to conduct in-depth case studies of firms over time within a specific industry so as to understand the industry specific demand aspects and supply chain design processes that lead to supply chain fit.

6. Outlook

This dissertation makes an important contribution to the understanding of the bottom line impact of effective supply chain management in terms of supply chain fit, its constituents and performance outcomes. It offers several unique insights into supply chain management and deepens the knowledge of supply chain fit, and, hence contributes to the academic discussion in the operational field and offers strong and relevant implications for practitioners from a strategic, tactical and operational perspective.

Although this dissertation investigated important questions and produced valuable answers, there is ample room for further research. This dissertation has laid the groundwork

for the investigation of appealing and motivating research questions. Further investigating those questions and to find original answers will be an intriguing and rewarding task for researchers and managers alike, following a statement of Johann Wolfgang von Goethe that being “pleased with one’s limits is a wretched state”, in particular in the dynamic field of supply chain management.

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Appendix

Appendix: Overview of constructs and their abbreviations

Construct abbreviation	Construct	Origin	Measurement items	Item cues
SS	Supplier Selection	Ellram (1990) and Hsu, Kannan, and Leong (2006)	SS1, SS2, SS3, SS4	See Table 15
IS	Information Systems	Rodrigues, Stank, and Lynch (2004)	IS1, IS2, IS3, IS4	See Table 15
SF	Sourcing Flexibility	Swafford, Gosch, and Murthy (2006) and Narasimhan and Das (1999)	SF1, SF2, SF3, SF4, SF5, SF6	See Table 15
SCP	Supply Chain Performance	Beamon (1999) and Rodrigues, Stank, and Lynch (2004)	SCP1, SCP2, SCP3, SCP4	See Table 15
PP	Product Performance	Joshi and Sharma (2004)	PP1, PP2, PP3	See Table 15
CI	Competition Intensity	Jaworski and Kohli (1993)	CI1, CI2, CI3, (CI4)	See Table 15, (7)
PI	Product Innovativeness	Seldin and Olhager (2007) and Fisher (1997)	PI1, PI2, PI3, PI4, PI5	See Table 7
SCR	Supply Chain Responsiveness	Seldin and Olhager (2007) and Fisher (1997)	SCR1, SCR2, SCR3, SCR4, SCR5	See Table 7
ESC	Efficient Supply Chain	Fisher (1997)	ESC1, ESC2, ESC3,	See Table 7
RSC	Responsive Supply Chain	Fisher (1997)	RSC1, RSC2, RSC3, RSC4	See Table 11