Governance in global value chains: Exploring multiple layers of lead-firm orchestration

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Declaration

This dissertation is the result of my own work and includes nothing which is the outcome of work done in collaboration except as declared in the Preface and specified in the text.

It is not substantially the same as any that I have submitted, or, is being concurrently submitted for a degree or diploma or other qualification at the University of Cambridge or any other University or similar institution except as declared in the Preface and specified in the text. I further state that no substantial part of my dissertation has already been submitted, or, is being concurrently submitted for any such degree, diploma or other qualification at the University of Cambridge or any other University or similar institution except as declared in the Preface and specified in the text

It does not exceed the prescribed word limit for the relevant Degree Committee.

Peter Hertenstein
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Abstract

This thesis explores the mechanics of governance within several layers of participating firms in the global value chain of the automotive industry, and how new forms of governance shape the development of the Brazilian and Chinese automotive industry. In particular, it examines how the local supply firms from Brazil and China can integrate and upgrade in the globalized automotive industry. By using the global value chain (GVC) framework, the changing inter-firm dynamics between buyer and supplier are analyzed, and their impact on the indigenous supply firms from Brazil and China examined.

The results highlight the role of product architecture in defining the value chain governance approach. Through the evolution of product architecture, the lead-firms can globalize their approaches to procurement and supply chain management. Moreover, the globally harmonized products allow the lead-firm to effectively restructure the global supply base to establish a globally harmonized components supply industry by internationalizing the most capable supply firms. Oligopolies along the entire GVC are consciously created by the lead firm. The dynamics of competition between supply firms are changing, as the market for integral components with high asset-specificity are merging into one global market with oligopolistic and oligopsonistic features. While some supply firms from the emerging markets have been able to utilize their business ties with western assembly firms to upgrade within the GVC, most are under pressure to be squeezed out of the GVC through increased global competition.

The thesis contributes to the field of development studies by analyzing the prospects for emerging market firms to participate and upgrade in the GVC of western lead-firms. Furthermore, it contributes to the economic theory of governance by presenting evidence of forms of influence outside the realm of supplier-buyer contracts.

The thesis further extends the global value chain framework by introduction a fine-tuned approach to ‘power’ as a determinant of governance.

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Abbreviations

ANFAVEA	National Association of Automotive Vehicle Producers of Brazil
BMW	Bayerische Motoren Werke / Bavarian Motor Works
EM	Emerging Markets
EU	European Union
EUR	“Euro”, the European currency
FAW	First Automobile Works
FDI	Foreign Direct Investments
GDP	Gross Domestic Product
GM	General Motors
GVC	Global Value Chain
ICT	Information and Communication Technologies
JV	Joint Venture
MLB	Name for modular platform by Volkswagen
MNB	Name for modular platform by Volkswagen
MNC	Multinational Corporations
MQB	Name for modular platform by Volkswagen
MSB	Name for modular platform by Volkswagen
M&A	Merger and Acquisition
NAFTA	North American Free Trade Agreement
OEM	Original Equipment Manufacturer
OICA	International Organization of Motor Vehicle Manufacturers
PQ	Name for modular platform by Volkswagen
R&D	Research and Development
SAIC	SAIC Motor (formerly Shanghai Automotive Industry Corporation)
USD	US Dollars, the US currency
VW	Volkswagen
WTO	World Trade Organization

Part I: Globalization and structural changes in the world economy

The world economy has changed. The past three decades saw an unprecedented industrial restructuring worldwide, ushering into a new phase of globalization. The new phase of globalization through accelerated internationalization of firms, vertical disintegration and dominance of large multinational corporations (MNCs) has changed the competitive landscape in the world economy (Chandler, 1994; Cassis, 1999; Nolan, 2001a; Dembrinski, 2009). Enabled by technology advances in transportation and more importantly telecommunication, the firms' refocused on their 'core business'. Through the subsequent outsourcing of manufacturing processes, the leading firms have triggered an unprecedented restructuring of global manufacturing (Womack, Jones and Roos, 1990; Ruigrok and van Tulder, 1995; Nolan, Zhang and Chunhang, 2007; Sturgeon, Van Biesebroeck and Gereffi, 2008; Dicken, 2011; Milberg and Winkler, 2013). The large and focused firms that emerged as lead firms in their respective industries take on an orchestrating role for the extended value chain through new forms of governance. These new mechanics of governance pose new challenges for the integration of developing markets into the world economy. In particular, firms from the emerging markets face a new set of challenges through increased globalization of markets, concentration of power and new requirements for participation set by the lead firms in the value chain.

At center stage is the modern lead firm, a powerful and large multinational corporation, spanning across national borders and multiple continents, which governs and orchestrates trade and capital flows of entire industries in structured global value chains (GVC) (Dembrinski, 2008; OECD, 2012). Less powerful firms participating in such global value chains are increasingly becoming dependent on the leading MNCs,

and have to follow the strategic direction set by the lead firm. Thus, the boundaries of the firm become increasingly blurred (Coase, 1937; Cantwell, 2013). The globalization of entire industries is steered by the firm at the top. Globalization accelerates as the lead firms restructure their production network and value chains globally. This creates a new and unprecedented economic context for the emerging economies. Comparison to the economic context during the industrialization of previous countries, such as developed economies or emerging economies such as the Asian Tigers, has become impossible (Amsden, 1989; Nolan, 2001a). This asks for a reevaluation of the prospects for development and industrialization for latecomers in the context of the world economy that is structured in and dominated by orchestrated global value chains.

Several tendencies have converged to lead to the global business revolution and the emergence of global value chains as a dominant form of governance structure for transnational trade and capital flows today. First, the fine-slicing of activities, second the rise of big business and the multinational corporation, and third the restructuring and reconfiguration of production. The factors that led to the deep structural changes in the global value chains that transform the world economy are summarized in Figure 1. First, the activities needed for production have been fine-sliced, enabling business to focus on their core activities and outsource much of the non-core activities previously performed in-house (Chandler, 1977; Ruigrok and van Tulder, 1995; Milberg and Winkler, 2013). Value chains have been split up, and span across a much larger number of firms involved in production. Second, the rise of big business and the multinational corporation in its search for new markets, resources or other localization advantages has changed the dynamics of competition and international trade (Buckley and Casson, 1976; Hennart, 1982; Dunning and Lundan, 2008). The multinational corporation has become the dominant form of business, and has effectively consolidated entire

industries at both, national and global levels, merging several markets into a single global market. The role of big business was spurred by a wave of privatization in the 1990s that increased the pressure from institutional investors to seek for additional profits by seeking for new markets or offshoring activities to cheaper locations.

The rapid internationalization of firms and emergence of multinational corporations, was enabled by the liberalization of trade and capital flows as well as key enabling innovations, especially in the information and communications technology and transportation technologies (Ramasamy, 2011; Nolan, 2012). Furthermore, the evolution of production systems, introduction of lean manufacturing principles, such as zero stock, just-in-time and just-in-sequence delivery, enabled the lead firms to restructure the supply base and changed the way business-to-business relationships are formed over time (Womack, Jones and Roos, 1990). This enabled powerful corporations to effectively manage and govern increasingly complex and international supply chains. Historic catalysts accelerated the process of globalization, such as the dissolution of the USSR and previous East Bloc countries (Nolan, 2001b), the rise of the East Asian Tiger economies (Amsden, 1989), and the economic opening of China and India, two of the largest economies in the world (Nolan, 2001a). These catalysts have led to immense efforts to integrate the emerging markets into the world economy. Furthermore, it has led to a global shift in production to cheaper locations, "unbundling" production and consumption from one another (Dicken, 2011; Baldwin, 2014), and rapidly increasing international trade at a rate outpacing the growth of the world economy (OECD, 2012; UNCTAD, 2013).

During the time of this research project, technologies have emerged at a rapid pace through digitalization, again revolutionizing the automotive industry through disruptive innovations (Christensen, 2006). These include the electrification of the

powertrain, new production firms of additive manufacturing and industry 4.0, and advances in automated driving and connected vehicles through the use of Internet of the Things applications and algorithms that enable self-learning systems through artificial intelligence (Oliver, Holweg and Luo, 2009; Wang and Kimble, 2011). This has lead to a convergence of industries, as new technologies like semi-conductors and enhanced software engineering become increasingly important (Li, 2010). New firms from other industries enter the automotive industry, to capture dominant positions in the value chain for key technologies of the future (Christensen, Verlinden and Westerman, 2002). The new entrants to the industry include powerful firms such as Tesla that developed vehicles based on a different technology, or Apple, Google or Uber that want to play a key role for in the technology for automated driving. Other established supply firms, such as Qualcomm, play an increased role as their products (semi-conductors) become more relevant for the industry. Incumbent firms need to rapidly adapt their business models and technologies, in order to maintain their position in the automotive industry (Christensen, 1997; Christensen and Raynor, 2003). This requires them to develop dynamic capabilities, to adapt to the fast paced changes in the industry (Teece and Pisano, 1994; Teece, Pisano and Shuen, 1997; Eisenhardt and Martin, 2000; Zollo and Winter, 2002; Teece, 2014a)

The rapid introduction of these technologies was unforeseen at the beginning of this project, and the trajectory and changes they will bring are unclear and still open. Therefore, even though these changes dominate current discussions on the automotive industry, they are not at the core of this research. While the framework used and developed in this research project may help to understand how the advances in technology shape the structure of the industry, it has not been developed for this purpose, and might require adaptation through future research. Further research on

disruptive innovations are required on an industry level, to fully capture the dynamics at work (Markides, 2006).

In the new era of globalization, the power difference in global value chains has shifted towards the lead firm, altering the dynamics of inter-firm relations. Milberg and Winkler show how the global value chain has become the dominant form of global trade, and capture flows in the 2010s (Milberg and Winkler, 2013; OECD, 2013). GVCs have become the defining structure for participation, distribution of activities, and opportunities for expansion and upgrading at both, the national and firm level (Hertenstein, Sutherland and Anderson, 2017).

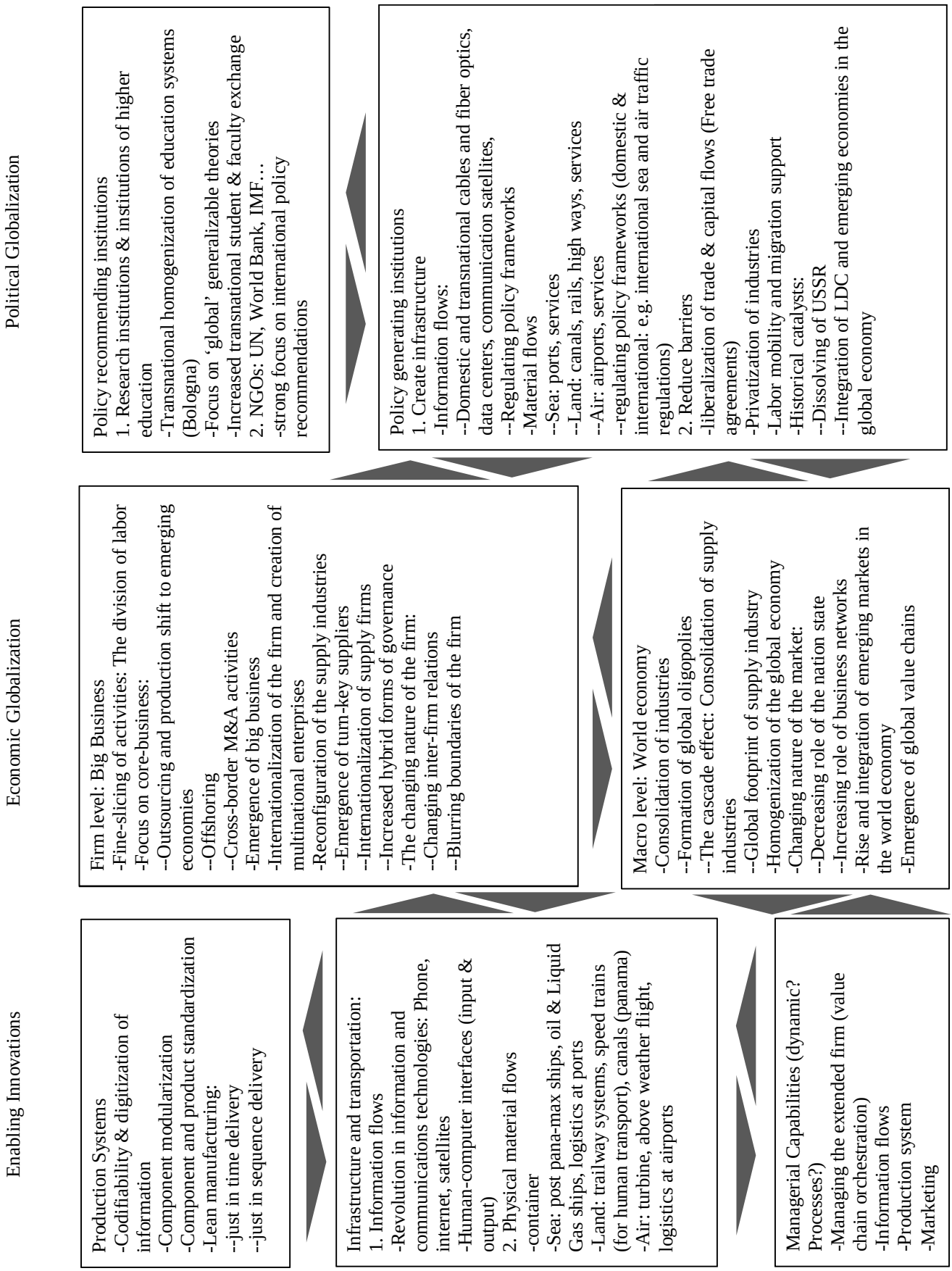
This study investigates the new dynamics of inter-firm relations in the global value chains of the automotive industry, with a particular focus on the prospects for participation and upgrading of indigenous firms from the emerging markets of Brazil and China in the global value chains of a leading western assembly firm. The unit of analysis is one discrete value chain of a leading automotive assembler. Volkswagen has been selected as the assembler, because it is one of the largest assemblers in the world, and somewhat under-research in comparison to its two main rivals: Toyota and General Motors. This research began before the disclosure of the diesel scandal of Volkswagen. All data collection was finished before the news broke out, so that the data and results presented in this research are unaffected. The leading research questions are:

(1) How and why has Volkswagen restructured its global value chain over time?

(2) How has the restructuring of the global value chain changed the governance mechanics between firms?

(3) How does the structure of the GVC and its governance impact the prospects for participating and upgrading for supply firms from the emerging markets?

Figure 1: The Dynamics of globalization



Source: Author's own figure, based on literature review

This dissertation is structured as follows: First, the literature on globalization is reviewed, followed by a theory section on the global value chain framework. Then, the method of this research is explained. This is followed by a study of the globalization of the automotive industry and the case studies, which offer multiple vantage points into the value chain, from assembly to tier-3 supply firms. Finally, the findings are discussed in light of the theory and implications for developing countries.

Drivers of the economic globalization

The rise of big business

The emergence of large, private, multinational corporations plays a central role in globalization and the development of global value chains (Dembrinski, 2009). Early research on business as an organization proposed that the maximum size of business is constrained by the growing complexity of conscious organization (Cassis, 1999). The maximum size of the firm has continuously been enlarged, as technological advanced enabled more effective ways of management and effective organization of economic activities (Chandler, 1977). One of the key propositions brought forward by Chandler, is that the emergence of large firms altered the basic structure of entire industries (Chandler, 1977). Furthermore, through advanced management capabilities, firms have been able to expand and build local monopolistic power – seen as a prerequisite for internationalization of the firm (Hymer, 1960; Buckley and Casson, 1976; Hennart, 1982). In a study on the largest listed companies, Dembinski finds that big businesses contribute to the economic growth in disproportionately more than SMEs. He further shows that these big businesses are more productive, showing "extraordinary performance" (Dembinski 2009: 114).

The rise of the multinational enterprise

While some international corporations, like the Dutch East India Company, existed as early as 1602, most firms started internationalizing after the Second World War, starting a phase of economic globalization. In the 1960s, scholars started to analyze the trend and Hymer developed the ground work towards a theory of the MNC (Hymer, 1960). In the early period, mostly large corporations started to internationalize. It was assumed that monopolistic advantages at home are a prerequisite to expand to new markets, so that only big companies were able to do so (Hymer, 1960). However, even smaller firms, such as supply firms of niche products started to follow, and the theory was further adapted. Dunning formulated the eclectic paradigm, or OLI framework (ownership, localization and internalization), in which he described the prerequisites and objectives for internationalization (Dunning, 1993). The key prerequisites for firms to internationalize are ownership advantages at home, which the firm can exploit abroad. Such ownership advantages can be in the sense of the resource based view of the firm , i.e. intellectual property, superior technology, superior capabilities like R&D, and superior marketing expertise (Penrose, 1959; Barney, 1991; Teece, Pisano and Shuen, 1997). Localization advantages refer to advantages generated by entering the target market, such as access to market, access to location bound advantages like cheap labor, or access to location bound resources (Dunning, 2001; Meyer, 2015). Finally, the firm needs to have advantages from internalizing the overseas subsidiary as opposed to an externalized approach through licensing, or exports through hands-off market-type mechanism (Buckley and Casson, 1976; Hennart, 2001; Buckley, 2014).

In Dunning's framework, a firm is required to have ownership advantages it can exploit abroad – which differs from the monopolistic advantage. The distinction to monopolistic advantage is insofar important, as more and more smaller firms started to

internationalize since the 1990s, some if which did not necessarily have monopolistic advantage. This shift lead to an accelerated globalization across all industries and firms, from consumer goods, over production, logistics, and retail to entertainment. Since the early 2000s, even young firms and start-ups have been shown to develop an international footprint almost from inception. Such 'born global' firms showcase the accelerated internationalization of the firms which leads to a rapid and deep economic globalization (Hennart, 2014).

Production shift to the east

Driven by the economic growth in the emerging markets and catalyzed by the state policies to localize economic activities and attract inward FDI for job creation and economic development, a tremendous geographic shift of production to the east took place since the 1990s (Dicken, 2011). Production of goods moved from the old triad region of USA, Europe and Japan towards East Asia (most notably China) and to some extend towards South America (most notably Brazil) (Dicken, 2011: 334). Both, Brazil and China benefited greatly from this shift (Shapiro, 1994; Thun, 2006; Van Biesenbroeck and Sturgeon, 2010). This shift has been very visible in the automotive industry. While the traditional two regions of Europe and North America accounted for a combined 62% of global production in 1997, their share decreased over just 15 years to a mere 41% in 2012 (OICA, 1998, 2014). The main benefiter has been the Asian region, which increased its share of production from 33% to 53% over the same time span, but also Latin America, which sustained its share at 5%. At a country level, the two highest increases in production volume have been achieved by China, followed by Brazil.

Yet, this shift in production has not been accompanied by an emergence of new strong entrants to the industry from the two countries. After decades of reforms in the

countries, China developed state policies to build up a local industry comprised of indigenous as "national champions". Yet, very few firms play a role in the global market (Nolan, 2001b; Sutherland, 2003; Thun, 2006). In both emerging economies, the vast majority of the production is achieved by incumbent firms from the advanced economies, which entered these markets. This applies to both, assemblers as well as supply firms in the automotive industry.

Unbundling of activities

The fine-slicing of activities and emergence of the MNC reaping benefits from cheap location advantages in foreign countries has separated production from consumption (Baldwin, 2014). The geographic separation was driven by the MNC's ability to separate production from marketing, as managerial competencies increased and barriers for transportation decreased. In its search for markets, resources, and localization advantages such as cheap labor, the MNC divided its activities and localized each activity to an adventurous location across the globe (OECD, 2012; Menz, Kunisch and Collis, 2013). The question for countries participating in the global economy has shifted from what to *what you sell* to what to *what you do*. "In most economies, around a third of intermediate imports end up in exports." (OECD, 2013: 9). The aim is to attract to localize high value-added activities, rather than a bundle of low value-added activities. This is especially important for emerging economies, which have a comparative disadvantage for most high-value-added activities, and often depend on foreign direct investments from foreign MNCs. The rules for competition have changed, as a deep level of localization for a wide array of activities has become unlikely, the localization of high-value-added activities has become the prime aim (OECD, 2012). Furthermore, as firms learned to offshore and relocate many of their

activities and increasingly started to sequentially shift activities after relatively short periods to new locations so that the 'stickiness' of FDI and activities has become more important (Dunning, 2000; Buckley and Ghauri, 2004; OECD, 2013). Countries are aiming to attract activities that are difficult and unlikely to be relocated, once they have been localized, i.e. "sticky" activities that are unlikely to cross national border to be done elsewhere. Such sticky FDI entail large investment requirements and buildup of localized special knowledge. The automotive industry is a prime example of "stick" investments, as relocating production is very costly and production requires local knowledge and supply base capabilities.

The consolidation of industries

On the industry level, the emergence of big business and the MNC shaped whole industries. Large corporations merged and expanded their market share via mergers and acquisitions (M&A), and entire industries were consolidated and transformed into oligopolies. The trend has been observed in a wide variety of different industries, from the commercial aircraft over most segments in the information technology industry to pharmaceuticals or beverages, just to name a few (for a list of industrial sectors, see Nolan, 2012: 18-20). In this "trend towards increased concentration" (Dicken, 2011: 315), large firms are able to capture significant market share that enable them to dominate the entire industry. Participating firms in the industry, such as supply firms, can become fully dependent on few such large firms. Moreover, this trend converged with the simultaneous internationalization of firms and the rise of the MNC. As a consequence, many industries are consolidated not on a national level, but on a global scale, with few large MNCs dominating the industry (Gibbon, Bair and Ponte, 2008).

The quick emergence of large MNCs was accelerated by aggressive M&A growth-strategies. M&A allow firms rapid growth and internationalization, albeit more drastic and associated with higher risks (Haspelslagh and Jemison, 1991). Several waves of M&A have accelerated the consolidation of industries. The first wave of large M&A occurred during the late 1960s. From 1965 to 1969, the numbers of mergers and acquisitions tripled from 2,000 to over 6,000, leading to what Chandler called a 'mania' for growth through M&A (1994: 315). Most of the M&A activities, however, were aiming for diversification, rather than horizontal or vertical integration. Often, target firms were not in the same industry as the host company, a trend that has dramatically changed since then (Chandler, 1994: 622).

During the transition to post-Fordism since the 1990s, a second wave of M&A took place, in what can be called a 'decade of mergers and acquisitions'. This time, a large proportion of M&A activities were transnational, with cross-border M&A surging from a mere $156 billion in 1992 to $1100 billion in 1997, almost doubling in the next year to over $2 trillion in 1998 and rose to over $3.3 trillion before the turn of the century (Nolan, 2001a: 38). Since then, international M&A activities have been steadily grown in value, volume, and deal-size, with the two financial crises in 2000 and 2008 only making dents to the trend.

The explosion of M&A since 1990s lead to a shift in power in the global economy and prepared the path for the dominance of a few MNCs. With the resulting large firms, many industries have developed oligopolistic features (Nolan, 2012). Thus, the decade of M&A had a deep impact on the global economy and transformed whole industries. With the parallel vertical disintegration as described above, and the globally liberalized trade flows, the diversion of value adding processes in industrial value chains spread spatially across the world, leading to value chains that are truly global in

scope, and which are governed by a handful of lead firms with immense power (Gereffi, Humphrey and Sturgeon, 2005; Sturgeon, Van Biesebroeck and Gereffi, 2008).

The cascade effect: Deep value chain restructuring and consolidation

The industrial consolidation not only happened at the level of the lead firms. Instead, the newly formed large corporations exerted pressure for growth and consolidation onto their suppliers (Nolan, 2001b; Nolan, Zhang and Liu, 2007). As the number of possible clients for the supplier industries decreased, through the consolidation of the clients, the pressure to meet the clients' demands increased. The bilateral dependencies increase, as large firms in the supply base mirror the behavior of the assembler, focusing on its respective core business, and restructure its supply chain accordingly (Morris and Barnes, 2008; Sturgeon, Van Biesebroeck and Gereffi, 2008; Sturgeon *et al.*, 2009; Ramasamy, 2011). Especially large MNCs seek for suppliers that can provide their products or services on a global scale, to decrease complexity in the supply chain and to be able to produce standardized products at different production locations across the world (McCann and Kim, 2008; Isaksen and Kalsaas, 2009). Thus, the "process of concentration through the simultaneous de-merger of non-core businesses and merger of core businesses is cascading across the value chain" (Nolan, Zhang, & Liu, 2007: 43), inevitably leading to large first tier suppliers to position themselves as globally leafing firms. These tier-1 suppliers in turn exert pressure for consolidation on their suppliers, setting in motion a cascade effect to pass the pressure on along the entire value chain.

Key innovations enabling globalization

The global business revolution has been enabled by key innovations and technologies that enable the large multinational corporation to effectively operate globally. The important innovations that transformed the world economy include the transportation of goods and (digitalized) information to economize transnational products and information flows, new innovative production systems like lean manufacturing and modularization that enable firms to effectively manage the extended firm, and key managerial capabilities to expand the limits of the organizational size of the firm.

Reorganization of work and the fine-slicing of activities

As early as 1776, Adam Smith observed and described the process of how the separation of activities and focusing on core processes can increase productivity. In his story of a pin factory, Adam Smith observed how innovations and changing patterns of production processes with the division of tasks and specialization of the workforce led to an increased output (Smith, 1776: 7). This specialization and division of tasks kicked off a process of standardization and coding, to decrease complexity and enable simple, repetitive tasks to be performed in a shorter time period (Pavitt, 2003). What became known as 'Fordism', was the strictly organized division of tasks into a value chain. The division of tasks was first implemented within a factory, or within a company. The transformation from craftsmanship to a system of mass production started during the early industrial revolution. It resulted in such narrowly divided processes, that each single task became easily manageable by unskilled labor, whose work often did not require more than to serve the machine that did the real work (Ruigrok and van Tulder, 1995). While this meant he loss of the 'craft workman' (Womack, Jones and Roos,

1990), it also enabled low skilled labor to be integrated into the production, without the necessity of high up-front investments in education. Furthermore, the repetitive tasks and elimination of little inefficient breaks when switching from one task to another lead to an increase in productivity (Smith, 1776; Womack, Jones and Roos, 1990; Ruigrok and van Tulder, 1995).

Since then, another underlying transformation took place in the global economy, the transformation from Fordism to what some call 'Toyotism'. While the core change in Fordism was the change towards a strictly divided tasks, 'Toyotism' is the move from strictly divided tasks towards a more flexible specialization (Ruigrok and van Tulder, 1995). This allows the work force to take on multiple activities over time, so that work fatigue or overly repetitive tasks can be minimized. The Worker can become more engaged in this tasks, and is encouraged to seek ways to improve the process. As such, the pendulum moves back from a too narrowly strict division of tasks in order to "restore the worker's position as master over his machine" (Piore and Sabel, 1984), without losing the benefits of mechanization and technological advances through Fordism.

Refocusing on core business activities

In the post-Fordism era, the theatre of the division of tasks changed. In the Fordism-era, it was contained in the factory. In the past decades, the process of dividing tasks has been taken a step further. Instead of dividing tasks performed by individuals, the division moved to a different level: the firm level. Vertically integrated firms started disintegration in order to focus on their 'core business'. The separation of tasks allowed the firms to identify the high value added activities and separate them from low value added activities - outsourcing low value added activities to service and supply firms

(Womack, Jones and Roos, 1990; Ruigrok and van Tulder, 1995). That means that entire firms started to specialize in what they are best at, or in which they were able to achieve the highest profit margin, and outsourced other tasks to service or goods providers. Through the separation of activities and increase focus on their main business, firms decreased their complexities and were able to increase their efficiencies and become more competitive by performing simple, repetitive tasks to be performed in a shorter time (Pavitt, 2003). The process of standardization and fine slicing of activities in the value chain is no longer contained within a firm, but is done across firms, as firms outsource non-core activities. This initiated a global business revolution, in which firms outsourced large junks of their previously in house activities in order to focus on their core business to become more competitive (Gereffi and Korzeniewicz, 1994; Nolan, 2001a; Milberg and Winkler, 2013; UNCTAD, 2013). Increasingly, the restructuring of the value chain happens at a global level (Nolan, 2001a; Nolan, Zhang and Chunhang, 2007). In the ongoing restructuring of activities, firms globalized their value chains (Kaplinsky, 2004; OECD, 2013; WTO, 2013), and outsourced many of their activities to new countries (Chandler, 1977; Milberg and Winkler, 2013). The global economy thus witnessed a "widespread narrowing of the range of business activity undertaken by the individual large firm" after the 1970s (Nolan, 2001: 33f), as large firms sold their assets in 'non-core' business segments. This allowed narrowing down the focus on research and development (R&D) expenses and brand marketing in segments in which the firm could become an expert to take a leading position in the world market. In essence, it allowed firms to set free resources needed for the fast growth on a global stage, as the economies merged into one global economy. As a result, there are the same recognizable brands present in a globalized mass media culture. Not only have firms outsourced some of their overhead and production

capacities, but to an increasing extend the R&D capabilities (Contractor *et al.*, 2010; Bertrand and Mol, 2013).

The lead firms of the known brands focus on R&D, marketing and the assembly of different parts and components for the terminal vehicle (Dicken, 2011). In conclusion, "capitalism today […] entails the detailed disaggregation of stages of production and consumption across national boundaries, under the organizational structure of densely networked firms or enterprises" (Gereffi & Korzeniewicz, 1994: 1). The automotive industry has been no exemption of this process, and has essentially become an assembly industry. The lead firms of the known brands focus on R&D, marketing and the assembly of different parts and components for the terminal vehicle (Dicken, 2011).

The restructuring of industries

The narrowing down on the core focus has an important effect on the structure of manufacturing industries. By outsourcing activities to the supply base, the formerly integrated firms have separated from upstream or downstream activities, and thereby created new opportunities for specialized supply firms to integrate these activities. Large amounts of the value-added activities are embedded in the supply base, as large supply industries are born. The result is a complex and large network of firms that work together towards the production of the final product.

Furthermore, the global industry has become increasingly consolidated. Large supply firms with strong R&D capabilities emerged in the past two decades (Abreu *et al.*, 1999; Sturgeon, Van Biesebroeck and Gereffi, 2008). Simultaneous to the restructuring of the production network, the firms operating in these networks have internationalized (Hertenstein, Sutherland and Anderson, 2017), establishing a global

production footprint. The new structure of production has, therefore, become global, giving birth to the global value chains we know today (Milberg and Winkler, 2013; OECD, 2013; UNCTAD, 2013).

Innovations in transportation of goods and information

The most profound changes in the world economy were made possible through key innovations that help bridge distances. The concept of 'distance' is not limited to geographic distance, but refers to cultural, administrative, geographic and economic distance (Ghemawat, 2001). Distances are increased through obstacles or barriers, and can be reduced by overcoming such barriers. The key innovation that made the globalization possible involve reducing barriers to bridge distance. In particular, barriers in transportation of physical, tangible goods, and the transportation of intangible information were reduced.

Key innovations to decrease the cost of transportation for physical goods include trains that drastically decreased the cost and time for transportation on land, the invention of automobiles to reduce cost for infrastructure and increase flexibility of transportation in respect to the train system, the continuous invention on large transport ships, including the standardization of containers in 1961. Key innovations were made in aircraft industry, most notably the invention of the jet engine to allow flying long distances and at high altitude to be independent from climate conditions. Other inventions include building infrastructure to decrease barriers. For instance, while the beeline between the two villages Zermatt and Saas Fee in Switzerland is a mere 20 km, they are separated by more than twice the distance by road, thanks to the mountain range that separates the two valleys. It is the road that makes it possible to travel relatively quickly from one to the other. Hence, infrastructure, such as the newly opened

Gotthardt tunnel decrease distances and enable firms to rapidly and cost efficiently transport physical goods from one location to another. The building of key canals like the Panama Canal in 1914 drastically reduce time and cost of transportation. These inventions have bridged the distance between countries and continents, and are crucial to enabling globalization.

Equally, if not even more important is the transportation of non-physical goods, in the form of digitized information. Possibly the most profound change in the business landscape, and enabler of the big business revolution, came with the invention of transmitters in 1947 and the integrated circuit in 1958, that gave rise to the semiconductor industry out of which the information and communications technology (ICT) industry emerged. Subsequent innovations, such as the personal computer, the internet and mobile devices like laptops, tablets and smart phones, further helped building a solid infrastructure for information flows. With the development of the telegraph, telephone and later the internet, communication and information exchange has vastly improved and become faster and more cost efficient. The revolution in the ICT sector has facilitated a revolution in the globalized financial system and capital markets, in the marketing strategies and development of globally recognized brands and in the organization of research and development (R&D) and product design, with products simultaneously increasing in complexity (Nolan, 2001a).

The ICT sector helps to establish a centralized communication system, much like the 'central nerve system' of the human body, in the large multinational enterprises. This is of utmost importance for companies that are spread all across the world and yet, in the era of lean production, have to become a 'community', with fluid and quick exchanges of knowledge (Womack et al., 1990: 53). Moreover, the ICT revolution is of most important to the supply chain, in order to effectively manage a chain that has

increased in size and in complexity. Without these technological changes, the revolution towards production networks would not have been possible (Vernon, 1971; Gereffi, 2001).

Equally important were key innovations to codify information, so that is can be digitized and become detached from physical objects. In the past, much of the information was bound to physical objects such as paper books. Through the ability to digitize such information, the nature of transportation changes for such information. While digitized information can be transported at the very low cost and essentially travel at the speed of light, physical goods require energy intensive and time consuming means for transportation, and a different kind of infrastructure The boundaries between the two are constantly changing, as new technologies enable the digitalization of information that was formerly bound to a physical object (Steinmueller, 2000). For instance, it took the invention of writing to de-couple a message from the sending person. Several stages of inventions followed, that made the transport of such messages easier, like letters and postal service, telegraph cables, and the phone that enabled people to have a live conversation across essentially the entire world. The key innovation was the internet and the cell phone technology, which enables the transport of digitized information at fast speeds and with a wide bandwidth, covering a wide and flexible geographic area. More recent inventions, like live stream video calls over the internet enable us to transport even more information, such as gestures or facial expressions, or quickly draw diagrams to clarify a statement, as people might have done in a conversation sitting next to one another. Through further inventions, such as precise capturing and digitizing of movements and the re-production of these, a deeper spectrum of information can be transported.

Innovation in production systems and management capabilities

Equally important, yet less discussed in the context of globalization, are key innovations in production systems (Hill, 1989; Womack, Jones and Roos, 1990; Sturgeon, 2002; Fujimoto, 2012) and managerial capabilities that enabled the globalization. While the abovementioned innovations in transportation of goods and information have directly lead to the globalization in the sense of closing distances, further innovations in production systems and managerial capabilities were required to enable firms to effectively manage across national borders (Rugman and D'Cruz, 2000; Birkinshaw *et al.*, 2006; Bouquet and Birkinshaw, 2008; Ambos, Andersson and Birkinshaw, 2010; Buckley, 2010, 2011). These innovations have an indirect impact on globalization, as they enable firms to internationalize and become multinationals – and develop into the most important driver for globalization.

Additionally, international experience and IT enabled the large corporation to manage its own operations, spanning across multiple countries. Production processes and supply chain management innovations came along with 'Toyotism', such as just-in-time delivery (Womack, Jones and Roos, 1990). The adaptation of supply chain management enables the firms to effectively manage complex supply chains across national borders.(Sturgeon, Van Biesebroeck and Gereffi, 2008; Contractor *et al.*, 2010; Bertrand and Mol, 2013; Milberg and Winkler, 2013).

This requires effective coordination between firms, for which the core firms have developed strong relationships with their suppliers: "In order to minimize their system costs across the value chain, they "actively select the most capable among their numerous suppliers, in a form of 'industrial planning", and adopt 'aligned suppliers' who can work with them across the world" (Womack, Jones and Roos, 1990; Li, 2010). At the core of the lean production by Womack et al., is the inter-firm linkages and relationships within value chains. Toyotism could not work without such relationships,

as the firms only have a basic contract rather than a fine-tuned contract types for western relations. (Womack et al., 1990: 48).

The role of systems integrators

An important role in the lean manufacturing system is that of the systems integrator. 'Systems integrators' integrate different components into a sub-system or into the final product. The systems integrator has to coordinate and orchestrate different component supply firms. As Dembinski writes: "Contractors demand more of their partners not only to manufacture a product or service, but also to contribute to its development, to organise and monitor a network of sub-suppliers,…" (Dembinski 2008: 57). This is a particular difficult process for products with complex systems, comprised of highly interdependent components (Dembrinski, 2008). As an engineering concept, 'systems integration' refers to the testing and verifying of components' performance, and the integration of these into the system (Johnson, 2003: 36). In the context of large firms and their leading role in global value chains, it goes beyond just that. As Li found in his comparison of the relationship of a British Telekom provider (the systems integrator) with its domestic suppliers, and that of a Chinese company in a similar position in the value chain, to be effective and efficiently make full use of their value chain, should develop a much deeper relationship to their key suppliers, that go well beyond a mere arms-length managing and 'testing' of the products (Li, 2010). The role of the system integrator in a modern business network is not just the mere assembly and testing of components, but that of a conductor of an orchestra, who is holding all strings together and creates a holistic 'product' by orchestrating and shaping all parts of the value chain in accordance of its needs for the end product, thus having a leading and possibly dominant role in the entire value chain.

In order to achieve efficient systems integration, the systems integrator has to exert power over the involved supply firms. It begins with the development of the end product, in which the suppliers of important and complex sub-systems have to be involved. Exerting power over the value chain has become essential to maintain quality standards and the pace of production after vital production have been outsourced.

Historically, the concept of systems integration was developed during the Cold War and originates from the US defense system (Sapolsky, 2003). It was developed with the intention to "coordinate and control the development of complex aerospace and computing systems (Johnson, 2003: 36). This became necessary, as systems grew in complexity, so that knowledge was distributed among the increasing number of people and firms involved in the research and development process and as responsibilities were spread among departments or different firms.

In large, transnational operating firms, systems integration has become an important management system to control the value chain and to ensure smooth production processes of products with increased complexity. According to Tell, a "systematic shift in innovation patterns took place, from an emphasis on individual human creativity, ingenuity, entrepreneurship, and vision in an initial system building phase to more collective and organized patterns of corporate led innovation in components, subsystems, architectures, and their integration in maturing systems" (Tell, 2003: 56). With the increased complexity of passenger cars of today, which include more than 15,000 different components, a development timeframe of several years, and coordinated R&D efforts with large, transnational suppliers, system integration at several levels is key to success.

As Nolan et al. point out, the resources and technological advance required for the development of new products has increased exponentially, and does not sit

completely within the core firm (Nolan, Zhang and Liu, 2007). An increasing and highly important part of the knowledge and of the product development happens outside the core firm, making the integration of knowledge to one of the most important tasks (Principe, 2003; Nolan, Zhang and Chunhang, 2007). One of the most important capabilities of a firm is, therefore, its ability to design components and sub-systems in collaboration with its suppliers in such a way, that they are not only compatible with one another, but complementing each other and are 'optimized for overall systems performance (Sapolsky, 2003: 24).

The systems integrator firms acts as a 'brain' in its value chain, focusing on the tasks like R&D and product design, final assembly and distribution, but also financing, brand design and marketing, while their 'turnkey suppliers' focus on the tasks outside the core firm (Dicken, 2011: 154). Additionally, the 'core firms' act as 'system integrators' and increasingly take the function of organizing, planning and coordinating the entire value chain, as it expands in the times of outsourcing (Nolan, 2001a). As such, these globalized core firms have the 'commanding heights' of the global business system (Nolan, 2001a) and immense power over their industry and hence the development of a local indigenous industry and the development of a foreign economy.

In summary, the tasks of system integrator firms include: selection and cultivation of top tier suppliers, setting out roadmaps, future visions and long term plans with their suppliers, effecting operation procedures, penetrating further into the value chain, beyond their first-tier suppliers, knowledge integration, and the integration of the different modules and sub-systems on the assembly line.

Political trends enabling globalization

Liberalization of trade and capital flows

Central to the globalization is the liberalization of trade flows. The triumph of neoclassic economics channeled into international trade treaties and the liberalization of transnational investment flows and led to the globalization of the capitalist economy (Nolan, 2012). Several historical events catalyzed the drivers for globalization and accelerated globalization. Since the 1990s, firms have internationalized at unprecedented pace and the market share of transnational enterprises has grown rapidly, as has their importance in the global economy. This trend has continuously accelerated until the financial crisis of 2008. Exports have more than tripled in value since 1990, together with the share of business that is done internationally in comparison to domestic: "In 1990 the sales of foreign affiliates were equivalent to 27 per cent of world GDP. By 2009 this had risen to 53 per cent and the sales of foreign affiliates were almost double world exports." (Nolan, 2012: 38) The rise of a globalized economy is further reflected in the growing importance of foreign markets for multinational enterprises, measured in the proportion of foreign assets to domestic assets and foreign sales to domestic sales: From the l00 largest enterprises, the foreign assets have risen to 57% of their total assets, their foreign sales even to a staggering 61% of total sales (UNCTAD, 2010; Nolan, 2012). The search for profits of business that drives the globalization has become global, as the barriers for trade and capital flows were reduces.

Privatization of businesses

The liberalization of trade and capital flows coincided with s wave of privatization around the world. Following neoclassic economic models, entire industry

sectors that were previously state owned in most countries were privatized. This includes infrastructure like rail networks and highways, airports and shipping ports, energy producers, electric network companies, telecommunication providers, as well as large service providers like railway companies. Through ownership in large investment firms, the focus of such firms shifted towards profit maximization. This, at times, facilitated the internationalization and globalization of the businesses.

Historic events catalyzing globalization

After the collapse of the USSR, great endeavors took place to integrate the former east bloc countries into transnational treaties, which further accelerated the process of economic globalization. In addition, the opening of the 'rest of the world', comprised of former 'inward-looking' developing countries of the non-communist block, forged a truly *global* economy that reaches into every corner of the world. Nations became interdependent on one another, and moreover become dependent on large transnational firms with a global footprint and a strong presence in almost every economy.

Part II: Global value chains framework

The firm in an era of business networks

The fine-slicing, outsourcing and internationalization of activities and processes during the "global business revolution" in the past decades has led to the creation of global value chains (Chandler, 1994; Ruigrok and van Tulder, 1995; Kaplinsky, 2004). Not only have firms outsourced some of their overhead and production capabilities, but to an increasing extend the R&D capabilities (Contractor *et al.*, 2010; Bertrand and Mol, 2013). Especially for sub-components and modules, responsibility for future innovations has been handed over to the supply base (Womack, Jones and Roos, 1990; Nolan, Zhang and Liu, 2007). This has fundamentally changed the approach to R&D in the global automotive industry (*Locating Global Advantage: Industry Dynamics in the International Economy*, 2004; Hatani, 2005; McCann and Kim, 2008; Mei, 2008; Pavlinek and Zenka, 2010) and created value chains with close and very intense assembly-supplier relationships through extensive knowledge sharing and two-way interaction (Humphrey and Memedovic, 2003; Birkinshaw and Fey, 2005; Gereffi, Humphrey and Sturgeon, 2005; Frederick and Gereffi, 2009). By outsourcing some of the firm's capabilities to their suppliers, the firm has become more dependent on its supply based. Through the increased focus on network capabilities, inter-firm linkages have intensified, in particular for complex components (Dembrinski, 2009). This in turn makes firms more interdependent on one another and decreases the likelihood of them shuffling the supplier base. The firm establishes close business relationships in the form of 'complementary cooperation networks', in order to keep the control over the outsourced activities (Ruigrok and van Tulder, 1995). As Womack, Jones and Roos describe, inter-firm linkages are vital to the firm and at the core of the 'lean production

system' (Womack, Jones and Roos, 1990). Ensuring just-in-time delivery, establishing total quality management and continuous improvement have become an essential competitive advantage, but require the lead firm to embed these management systems within its entire value chain (Kaplinsky and Morris, 2000).

Consequently, in the GVC literature the firm is viewed as part of a collective network on which it depends (Pyke & Sengenberger, 1992: 1). The GVC framework, commonly used in economic geography, emphasizes that firms increasingly focus on their networking capabilities, particularly their ability to manage the resources and capabilities that lie within the network and outside the legal boundaries of the firm.

The ability to manage the capabilities embedded in the value chain has become increasingly important. Fine goes so far as to describe the management of the value chains as the core competitive advantage: "there is no competency more critical than that of superior design of one's capability chain-from the final consumer all the way upstream to the sources of raw materials and new technological concepts" (Fine, 1998: 71). Fine argues that the focal point of a firm's advantage is embedded in the external value chain, rather than within the individual corporation. Similarly, Porter argues that much of the competitiveness of a firm can be determined through its external environment, including its the value chain, as this is "the arena in which competitive advantage is won or lost" (Porter, 1987: 29). According to Fine, it is the ability to spot lucrative opportunities within ones' value chain and to invest in these that differentiates top performing firms from ordinary firms. Hence, the 'superior competency portfolio management' is the most critical capability of top-performing firms and its competitive advantage (Fine, 1998: 76).

Utilizing, maintaining and coordinating the capabilities of the outsourced activities within the firm's value chain requires conscious steering and controlling of

the extended business network (Gereffi and Fernandez-Stark, 2011; OECD, 2013). Nurturing the parties that are involved and controlling resource allocation and capability building in one's value chains has become one of the most important tasks for the lead firms in the value chain. This factor becomes even more important as firms expand to become multinational and their value chains become spread across multiple nations.

Global value chains, focal firms and inter-firm relations

The ability to effectively steer and control the activities in the value chain that lie outside the boundaries of the firm is based on asymmetrical distribution of power. MNCs have three advantages that enable them to "master-mind" their economic environment: the capacity to spread the economic activity globally, a price mark-up based on superior branding capabilities, and bargaining power towards the suppliers that allows the lead-firm to reap the benefits of productivity advanced in the entire value chain (Dembrinski, 2009). In particular the bargaining power of one firm towards its supplier or buyer contribute to the firm's dominant position in the value chain (Porter, 1979). A firm that controls a bottleneck in the value chain has control over supply or demand, which increases its bargaining power within the value chain. Dembinski argues that the focal firm is the nexus of the GVC (Dembrinski, 2009). The focal firm is such a firm that "consistently operates value adding processes on both sides of the focal point within a chain, i.e. both in production and in marketing/distribution" (Dembinski 2009: 121). This is the case in the automotive industry, in which the assembler is involved in production and assembly of the vehicles, as well as in distribution through global wholesale networks, own retail and distribution networks, and financial and leasing services for the final customer.

In the GVC literature, the most powerful firms have been coined ‘lead firms’ (Gereffi and Korzeniewicz, 1994; Fold, 2002). Such lead firms have considerable power over their business network and are typically large firms that control significant areas of the value chain. Controlling and orchestrating the activities in one’s supply chain is possible through the revolution in communication technologies, is especially important in the post-Fordism concept of ‘lean production’, where stock-control is handled by ‘just in time’ and ‘just in sequence’ delivery, as a sources of eliminating waste and to increase profitability and performance (Womack, Jones and Roos, 1990).

The role of the lead firm has increased over time, as inter-firm interdependencies have intensified (Schmitz and Navadi, 1999; Bair and Gereffi, 2001; Coe, Dicken and Hess, 2008). This is especially true for the automotive industry, which embraced Toyota’s lean production model with strong vertical inter-firm relationships along the value chain (Humphrey, 1995; Humphrey and Memedovic, 2003; Sturgeon, Van Biesebroeck and Gereffi, 2008). In such value chains, the lead firms excerpt considerable control over legally independent firms in its value chain.

The influence of lead-firms has increased to an extent that it can take the form of partial control over separate firms without ownership. As a result from the vertical disintegration, exerting control beyond the firm’s boundaries is a way to ensure and secure supplies of raw material and produced goods that meet all the requirements of the terminal firm. In behaving so, the nature of what can be seen as an individual ‘firm’ has greatly changed (Coase, 1937).

Coase suggested, that the boundaries of the firm have shifted as corporations reach beyond their legal entity (Coase, 1937). By strongly influencing or even partly controlling their suppliers’ communication systems, operations, planning and even strategies, the boundaries of the firms have become blurred. Fine called the realm of

influence outside of the core firm the ‘extended enterprise’ (1998: 89). In such intertwined operations, the relationships between individual entities have little to do with the neoclassic assumed arms-length, price-driven free market one (Williamson, 1981; Casson, 1987). As Li describes it:

“The relationship between the core firm and the rest of the value chain is neither Adam Smith’s ‘invisible hand’ relationship, which is characterized by specialization, marketplace exchange and competition between single-unit, independent business enterprises, nor Alfred Chandler’s ‘visible hand’ relationship, which represents the internal planning and coordination mechanism within the large modern firm since the late nineteenth century” (Li, 2010: 17).

Nolan has coined the concept of the ‘external firm’, in which the firm exerts influence outside its legal boundaries by planning and coordinating the activities within its value chain. What can be defined as a ‘firm, thus, is not its legal entity, but its sphere of influence in which it consciously coordinates the allocation of resources and tasks (Nolan, Zhang and Liu, 2007). Essentially, it requires studying the ‘firm’ in its extended form: As a network or group of cooperating firms, rather than as its legal entity. The GVC framework has been developed to study such networks of interdependent firms. Therefore, this research will lend the concepts of the GVC framework to study the inter-firm relations in the global automotive value chain, and its impact on development.

In its role as a coordinator, the leading firm in a value chain can be seen as a ‘spider’ in a web of businesses (Ruigrok and van Tulder, 1995), controlling and establishing a network of connecting activities and production procedures.

Definition and analysis of GVCs

Global value chains (GVC) are descriptive chains of all the value-added activities required for the creation, sale and distribution of a final product. In the early research the analysis focused on production networks that were defined as "a network of labor and production processes whose end result is a finished commodity" (Hopkins & Wallerstein, 1986: 159). This concept was extended to include all process steps required for the final product, including conceptual product inception, research and development, multiple stages of material processing, production, manufacturing, assembly processes, logistics, to marketing, distribution sales and aftersales services (Kaplinsky and Morris, 2000). As an analytical framework, it thus entails the analysis of all the different value adding stages of such a chain, hence the newer term "value chains" (Coe, Dicken and Hess, 2008). Through fine-slicing of activities and restructuring of firms to focus on the 'core activities', value chains today span over a multitude of firms that are involved in the activities towards the final product (Chandler, 1994; Ruigrok and van Tulder, 1995; Kaplinsky, 2004). Furthermore, after decades of outsourcing and offshoring, value chains, by their very nature, have become global, and form complex networks of individual activities performed by different firms and across multiple participants to create the final product (Gereffi and Korzeniewicz, 1994; Gereffi, 1999). Despite such complexities and assumingly individual activities performed by legally or geographically isolated and independent participants, the activities within a GVC are explicitly governed by lead firms in the value chain (Humphrey, 1995; Humphrey and Schmitz, 2001; Ponte *et al.*, 2014). Lead firms are powerful, large and mostly multinational corporations that can orchestrate the activities within a global value chain (Fold, 2002; Sturgeon, Van Biesebroeck and Gereffi, 2008).

The literature on GVC developed from three different strands: research on global commodity chains (GCC), global value chains (GVC) and global production

chains (Coe, Dicken and Hess, 2008). The concept of global value chains emerged in the 1990s (most notably, Gereffi & Korzeniewicz 1994), and has increasingly caught attention as an alternative framework for understanding globalized industries (OECD, 2013; UNCTAD, 2013). However, value chains as such are not a new phenomenon. Indeed, one of the fathers of modern economy, Adam Smiths, when describing the division of labor in his 1776 book 'An Inquiry into the Nature and Causes of The Wealth of Nations', describes in great detail the value chain of the apparel industry, more specifically of the production of a woolen coat (Smith 1776: 13f):

> "This great increase in the quantity of work, which, in consequence of the division of labour, the same number of people are capable of performing, is owing to three different circumstances; first, to the increase of dexterity in every particular workman; secondly, to the saving of the time which is commonly lost in passing from one species of work to another; and, lastly, to the invention of a great number of machines which facilitate and abridge labour, and enable one man to do the work of many.
>
> The different operations into which the making of a pin, or of a metal button, is subdivided, are all of them much more simple, and the dexterity of the person, of whose life it has been the sole business to perform them, is usually much greater."

More than two centuries later, value chain analysis has become more and more important, as the vertical disintegration and separation of tasks performed for the creation of a product has become global and spanning multiple firms (Ruigrok and van Tulder, 1995; Nolan, 2012). This process has been further accelerated through revolutionary new production systems like lean manufacturing that enable the lead firms to effectively orchestrate outsourced value chains (Womack, Jones and Roos, 1990). Consequently, the separation of activities has been divided not only within the factory, as in the times of Adam Smith, nor just between firms, as described by Chandler (1977), but between countries in an ever more globalizing world.

Linkages, spatial spread, and governance structures

The GVC framework offers three dimensions of analysis: First, an 'input-output' structure that links together all the production and service activities in the value chain in a sequential manner of value-adding tasks. Much as in Porter's understanding of value chains: "a firm's value chain is an interdependent system of network of activities, connected by linkages. Linkages occur when the way in which one activity is performed affects the cost or effectiveness of other activities" (Porter 1990: 41). Second, the 'territoriality' of the activities in the value chain and their special spread. And third, the 'governance structure' of the value chain, in particular the inter-firm relations and linkages (Gereffi & Korzeniewicz, 1994: 7). Since the early conceptual development of commodity chains, two key elements have changed in the economic environment that is studied: First, economies have become more global and increasingly complex. Hence, the framework used is explicitly international in dimension (Gereffi, 1999). And second, inter-firm linkages have intensified, changing the governance structure of many value chains.

Analyzing governance structures allows to explain how resources (e.g. financial, material, and human resources) are allocated to the different participating firms along the value chain (Gereffi, 1994: 97). The relationships between firms in a given value chain appear to be asymmetrical (Kaplinsky and Morris, 2000; Schmitz and Humphrey, 2000; Li, 2010). Only few lead firms "reside at the top of the world production networks" (Li, 2010: 14) and are able to determine the distribution of resources in the value chain, thereby excerpting power over the other firms involved in the value creating process. By analyzing the governance structures it is possible to understand how value chains are coordinated and controlled when power asymmetries occur, how resources are allocated along the value chain and how individual firms and

geographic locations (i.e. production hubs and ultimately the position of nations in the global value chain) develop and evolve over time (Gereffi & Fernandez-stark, 2011: 8).

The vantage point for analyzing governance structures has been top-down, with the focus being on the lead firms (Gereffi & Fernandez-stark, 2011: 12). However, as power asymmetries can only occur when two or more firms are involved, a more holistic approach to analyze such asymmetries and its relational dynamics seems necessary. For this reason, this study conducts a multiple vantage point approach, to include and analyze firms at multiple levels in the value chain (see methods section).

Governance in the GVC framework

Governance in the GVC framework is based on power asymmetries between firms involved in the value chain. The understanding of governance has developed over time, adapting the framework of analysis. Initially, Gereffi developed a dichotomous framework and distinguished between two different government structures; the 'producer-driven' and the 'buyer-driven' value chains (Gereffi & Korzeniewicz, 1994:7). Although this concept was later further developed into a typology of five different structures, it still offers a solid starting point to understand the underlying principles of power asymmetries in the relationships in value chains.

Producer-driven value chains are mainly dominated and directed by large manufacturing firms at the core of the value chain, like IBM in the ICT industry or car assemblers in the automotive industry. Ruigrock and Van Tulder frame such value chains as "informal control hierarchies, where one core assembler is positioned as a monopolist at the apex of a hierarchical, closed network" (Ruigrok & van Tulder, 1995: 78). In producer-driven value chains, the lead firm, which plays the central role at the core of the network, focuses on producing goods. It coordinates and controls backward

and forward linkages in the network and excerpts power over vast parts of the value chain, like sourcing of parts and raw materials as well as distribution of the final product. The lead firms are often large, transnational corporations. They are mostly the terminal firm in the value chain, with well-developed brand names. The segments of the value chain in which the lead firms are positioned are often the most profitable, highly concentrated and with high entry barriers for new entrants. Typical lead firms in such value chains are manufacturers of advanced products such as aircrafts, computers or automobiles, which require high investments and technological standards (Gereffi, 1999).

Buyer-driven value chains, on the other hand, are controlled and coordinated by trading companies, brand-named merchandisers or large retailers. The production process in these value chains is decentralized and distributed over several firms in exporting countries, often in peripheral countries with great distance to the final customer (Gereffi and Korzeniewicz, 1994; Gereffi, 1999). In buyer-driven value chains, it is large retailers, close to the consumer, which dominate and direct the value chain through their purchasing power. An example of such a value chain is the apparel industry with large retailers such as Wal-Mart, Kmart or Sears.

The three underlying principles for the determination of buyer- and producer-driven value chains are (1) the 'complexity of transactions', that is the complexity of the information flow and knowledge transfer between the different actors in the value chain, (2) the 'codifiablity of information', which is the ability to codify and efficiently transmit information, and (3) the 'capability of suppliers' or level of competence (Gereffi, Humphrey and Sturgeon, 2005; Frederick and Gereffi, 2009). While complexity increases through new demands set by the lead firm, such as just-in-time

supply or product differentiation, lead firms can also reduce complexity through product standardization or codification of the information (Gereffi et al., 2005).

Typology of GVC governance structures

According to most transaction cost based scholars, control over processes requires equity stake in the company. Most scholars oversimplify and distinguish only between market and hierarchy structure (Williamson, 1996). Internalization theory, for instance, differentiates mainly between hands-off market relationships and control through equity stakes (Buckley and Casson, 1976; Rugman, 1981; Buckley, 2014). Hybrid forms of governance are often ignored. Through elastic contractual agreements, however, it is possible to maintain some control over outsourced activities, without the necessity of ownership (Williamson, 1979, 1996, 2002).

The underlying principles of the early product network research eventually lead to the development of five governance structures types, extending the dichotomy by adding three more elaborate intermediary concepts (Gereffi et al. 2005; Table 1).

Table 1: Key determinants of global value chain governance

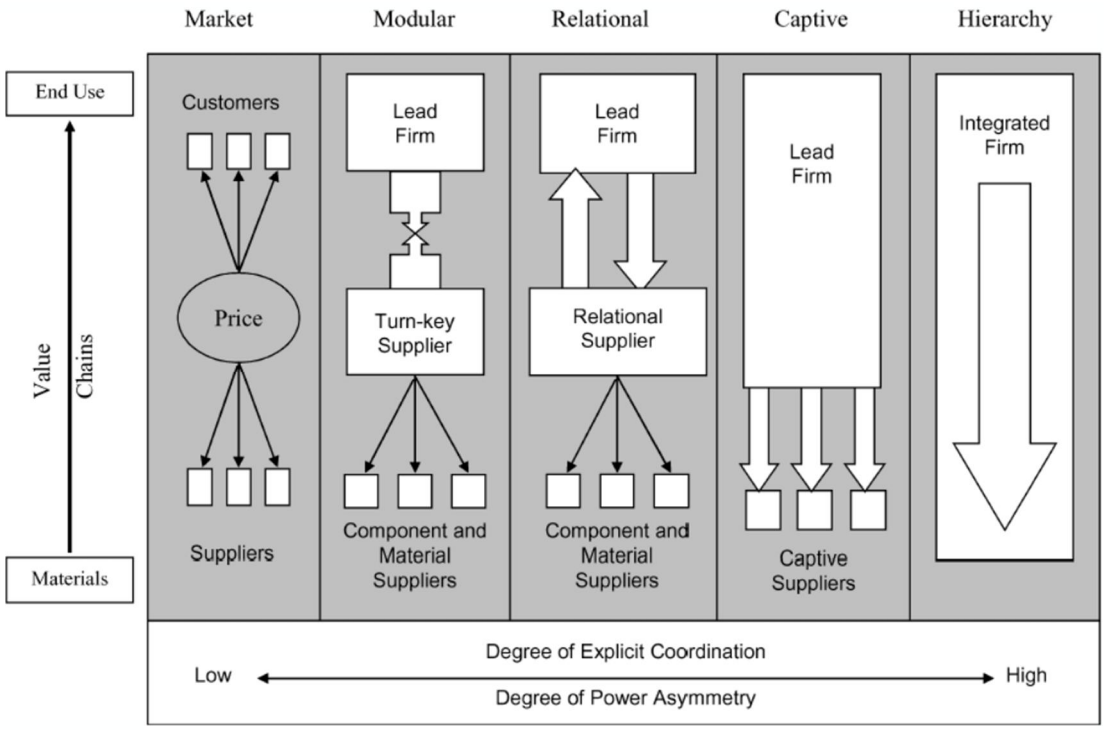
Governance type	Complexity of transactions	Ability to codify transactions	Capabilities in the supply-base	Degree of explicit coordination and power asymmetry
Market	Low	High	High	Low
Modular	High	High	High	↑
Relational	High	Low	High	↕
Captive	High	High	Low	↓
Hierarchy	High	Low	Low	High

There are eight possible combinations of the three variables. Five of them generate global value chain types. The combination of low complexity of transactions and low ability to codify is unlikely to occur. This excludes two combinations. Further, if the complexity of the transaction is low and the ability to codify is high, then low supplier capability would lead to exclusion from the value chain. While this is an important outcome, it does not generate a governance type *per se*.

Source: Gereffi et al., 2005

The structures go from 'market' structures determined by market forces (i.e. price), to hierarchy with fully vertically integrated firms (Figure 2). Between the two extremes is a mixtures of semi-control governance forms. The structures are coined *modular*, *relational* and *captive* structures, in which the lead firm takes increasing orchestrating and controlling role over its non-equity business network (Figure 2). These hybrid forms of governance do not require ownership of the firm. For instance, Japanese firms like Toyota have legally independent firms that in fact are dependent on Toyota, closely orchestrated by Toyota, led by former Toyota employees with loyalty to the Toyota group and that are in fact considered as part of Toyota's 'inner circle' (Cusumano, 1985; Hill, 1989; Womack, Jones and Roos, 1990).

Figure 2: Types of global value chain governance structures



Source: Gereffi et al., 2005

Market governance structures consist of lose linkages where the cost of switching partners is low, much like in an ideal neoclassic market under perfect competition. Relationships are hands off and price competition is the determining factor for choosing a partner.

In *modular* value chains, the lead firm controls the distribution channels and is the link between the finished product and the final customer. They know the customer and determine design requirements of the final product. However, many of the production competencies lie with the 'turn-key suppliers', which produce key modules that require extensive knowledge and capabilities in R&D and manufacturing. Such 'turn-key suppliers' control their supply chain and take responsibility for the production processes, ensure quality standards are met and make sure that suppliers have adequate technologies and competencies. The products are characterized as being differentiated and highly customized; yet suppliers use generic machinery to pool their capacities for their different customers and to limit transaction-specific investments. Hence, Sturgeon (2002) referred to modular governance structures which rely on turn-key suppliers as 'modular production networks' in which highly competent suppliers can be added to the global production system according to the demand (Sturgeon, 2002).

Relational value chains are defined through the bilateral dependencies between suppliers and buyer, which is a result from the complex interactions and information flows between the two firms. The relational supplier produces highly customized products that require high standards of technology and own product design capabilities, thereby being dependent on its buyer, while the buyer is dependent on the supply firm's capabilities at the same time. Product specifications are set by the buyer, which thereby exerts some degree of control over the supplier. Interactions between the two are frequent and the information exchange complex. The close linkages that are created can

be managed through trust and reputation that has built over time, or alternatively ethnic or family ties (e.g. Menkhoff 1992). Relational suppliers often show a close spatial proximity to the buyer.

Captive value chains are characterized by buyers with considerable power over smaller suppliers. The suppliers are highly dependent on the buyer and have little R&D capabilities or intellectual property. However, as the complexity of the transaction is high switching cost for suppliers are high. Therefore, the suppliers are closely monitored and controlled by the buyer.

Hierarchical value chains consist of highly vertically integrated firms. Parts production is owned by the lead firm, and the lead firm excerpts managerial control over its subsidiaries and affiliates (Gereffi et al. 2005; Gereffi & Fernandez-stark 2011: 9).

Power asymmetries in the GVC

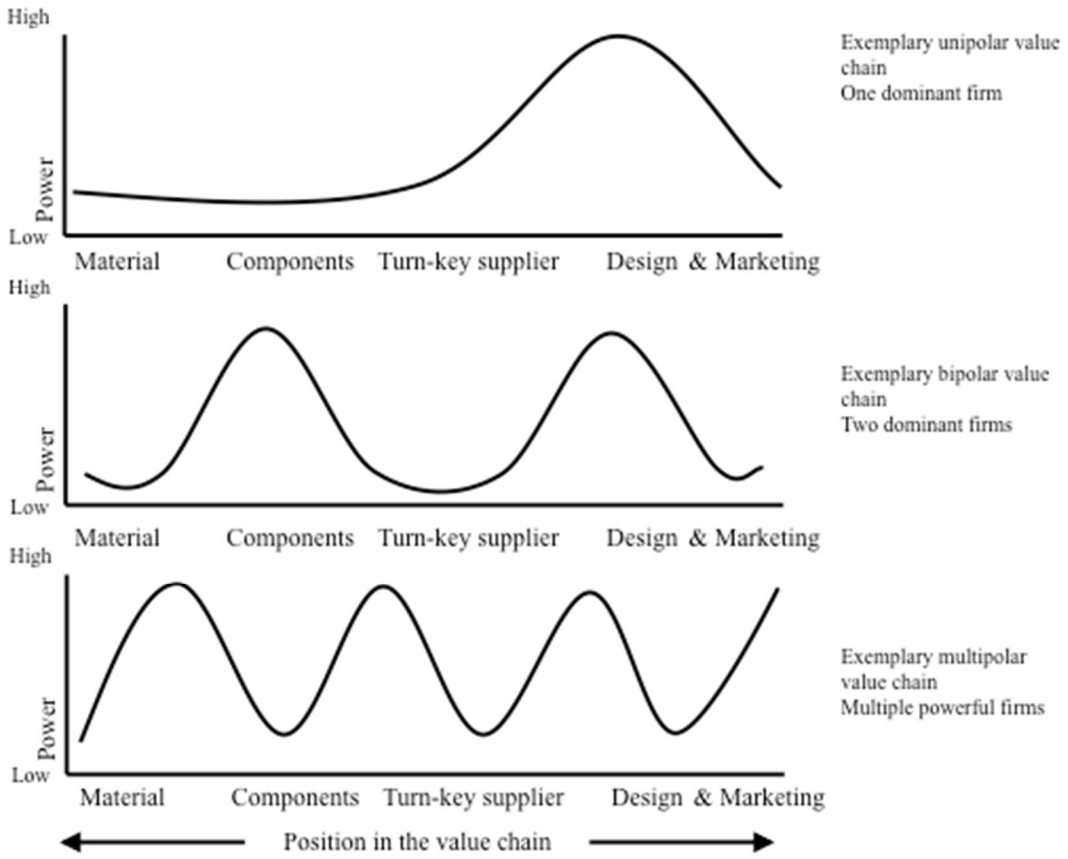
The ability of lead firms to exert control over parts of the value chain has been steadily increased through technology, contracting and management capabilities. Modern IT systems, for example, enable firms to transfer accurate information in real-time across the world, and to share such information with other vendors at the effect of more control (Nolan, 2001b). The degree to which GVCs are explicitly governed depends on two factors: First, the power asymmetries between the firms and second, the requirement of knowledge transfer at the interface between the two firms (Humphrey and Schmitz, 2001; Gereffi, Humphrey and Sturgeon, 2005; Frederick and Gereffi, 2009).

Power asymmetries between the firms involved in the value chain derive from the ability of a firm to gain control over crucial activities in the value chain, like control

over large proportions of the market, either as buyer or seller. Lead firms were assumed as large firms, and GVCs either buyer and producer driven (Gereffi and Korzeniewicz, 1994; Ponte, 2014). Consequently, power is distributed asymmetrical in many GVCs, with some firms dominating and dictating the activities along the entire value chain. The ongoing consolidation of lead firms led to oligopsony structures in which few buyers can consolidated considerable power (Nolan, Zhang and Liu, 2007).

Early conceptions of governance structures assumed unipolar GVC, in which one lead firm dominates the entire value chain (Fold, 2002). Although the 'lead' firm is often positioned close to the final customer, the powerful firms can sit at different positions along the value chain. For instance, large suppliers can orchestrate their upstream value chains without their customer being involved (Kaplinsky and Morris, 2000). This can lead to multilayered value chains and different governance structures within a given GVC. Governance structures are not static but change over time as the determinants (i.e. complexity of the interactions between the firms involved) change. Changes can occur in the way they are managed and when new technologies influence the design and production system of the product (Gereffi et al., 2005). This concept of 'unipolar' value chains was recently extended to allow for 'bipolar' and 'multipolar' value chains (Fold, 2002; Sturgeon, 2002; Riisgaard and Hammer, 2011; Ponte, 2014). In such GVCs, multiple powerful firms can co-exist, each controlling a key stake in the value chain, as well as excerpting some degree of control over external up- or downstream activities (Figure 3). Even though power appear to be more equally distributed along the value chain, multipolar value chains differ from hand-off market structures, "because they are shaped by explicit strategic actions of powerful actors (both inside and outside the chain), even if they exhibit multiple foci of power and various kinds of linkages" (Ponte 2014: 359).

Figure 3: Power asymmetries in global value chains



Source: Author's own figure

Figure 3 exemplifies different value chain structures, from unipolar to multipolar. The dominant firm can sit at different positions of the value chain, e.g. have the power over technologies, including for specially processed raw materials for high-tech applications, power over distribution channels, ownership over design and assembly, as automotive assembly groups, or access to the market via superior branding and marketing, as in the fashion goods industry.

Linking product architecture, knowledge-transfer and degree of control

The extent to which the lead firm exerts power over the participating firms for strategic decision making outside the spectrum of R&D and component development

depends on bargaining power of the firms based on owning a competitive advantage that enables the firm to dominate a crucial link or position in the value chain, like superior product knowledge, systems integration capabilities or access to the market.[1] While there may be powerful firms in all tiers along the value chain, most value chains involve a high number of far less powerful firms. How close the firms have to work together is defined by "the complexity of information and knowledge transfer required to sustain a particular transaction" and "the extent to which this information and knowledge can be codified" (Gereffi, Humphrey and Sturgeon, 2005).

The complexity of the knowledge transfer, in turn, depends on the product characteristics. Hence, an important determinant for the governance structure are the characteristics of the product. The first determinant that of product characteristics, can be linked to the literature on architecture for a deeper understanding. In his product architecture typology, Fujimoto differentiates between integral or modular nature of a product and open and closed product architecture (Figure 4). Modular architecture products are such that allow a high degree of codification for the interfaces between components. Individual components can be matched through clearly defined interfaces to build a final product. Integral architecture, on the other hand, exists when interfaces are difficult to codify and are therefore difficult to standardize. Interdependencies of components are high, so that changing one component has an impact on others. Detailed designs are only known to the firm, and may be subcontracted to an outside firm, but the basic design of the tool system is contained within one company (Fujimoto, 2007).

Open and closed differentiates between industry white standardization of interfaces and interface designs that are contained within the firm. Open architecture

[1] In the resource-based view of the firm, the competitive advantage must be VRINE (valuable, rare, inimitable, non-substitutable, and exploitable) for the firm to utilize its advantage and gain power over other firms and to allow the lead firm to capture and control a quasi oligopolistic position.

requires standardization at the industry level, while closed architecture occurs when it offers competitive advantage to the owner firm. Since integral components cannot be standardized, this requires the architecture to be closed-integral; open-integral architecture is impossible

Figure 4: Basic types of product architecture

	Integral	Modular
Closed	Small cars Motorcycle Game software Compact consumer electronics	Mainframe computer Machine tools LEGO
Open		Personal computer Bicycle PC Software Internet

Source: Fojimoto, 2007

The complexity of a transaction is to a large degree driven by the interfaces of components, i.e. the product architecture. Open-modular interfaces are standardized, so that full information is codified and available outside the transaction. In closed-modular architecture interfaces and designs required for the interfaces is part of the transaction, but is fully codifiable. The most complex transactions involve closed-integral architectures. In such instances, the interfaces cannot be fully codified, for instance because the different components are interdependent. This means that any changes to one component requires adaptation of the other. At the time of the transaction, the

components and interfaces re not fully developed and defined but need further R&D before finalization. This requires the involved firms to co-develop the components, which entail complex transfer of tacit knowledge. Transaction cost theory would suggest that for closed-integral architectures, the firm would opt for a high degree of vertical integration. Individual components correspond with one another, and their performance is influenced by the performance of structurally separate components or modules (Ulrich, 1995; Ulrich and Eppinger, 2004; Fujimoto, 2007). As Park and Ro write: “With integral product architecture, components are tightly coupled, creating the need for coordinated design and production processes to create optimal linkages between component to ensure optimum-product performance.” (Park and Ro, 2013). They go on to argue that because of the degree of coordination required, this would suggest an internalized approach for development and production. However, this is not always the case. Increasingly, several firms are involved in the product development process, such as supply firms for highly specialized components, which they later supply to the production and assembly locations of the final firm (Hertenstein and Williamson, 2018). Closed products require systems integration at the firm level. Moreover, close-integral products require extensive collaboration of the individual development centers of the involved companies, and require extensive transfer of tacit knowledge between firms to ensure successful integration of components with no standardized interfaces. This has led to increased mixtures of semi-control over the external firm, by some referred to as ‘extended firm’ (Fine, 1998). The necessity for close interaction and the knowledge advantage of the systems integrating firm in closed designs provides the lead firm with the potential to exert extensive power over the participating external firms both up- and down-stream in the value chain. The extent of control can be similar to in-house development.

Global value chains and development

The GVC linkages, spread of activities and governance structure have an impeccable impact on the development of emerging markets. In particular, the localization of activities to an emerging market (spread of activities) and the integration of indigenous firms from the emerging markets into the GVC of dominant western lead firms influence the prospects for development of emerging markets.

In todays globalized economy, the value-added activities have been separated from consumption in the "unbundling" of value chains (Baldwin, 2014). Due to affordable international transportation and the reduction of trade barriers, activities can be located anywhere, where local advantages exist. Hence, the 'level of localization' of activities is important to countries, and will be analyzed in the following chapters. In particular, the role of the lead firm in determining the level of depth for localization of the external value chain will be discussed later.

GVC governance and gateways of entry

In earlier research, the GVC view participation of firms was developed from a district cluster perspective (Bair and Gereffi, 2001), where the firm is regarded as "part of, and depending on, a collective network" that is spatially close (Pyke & Sengenberger, 1992: 1). While the role of spatial industry districts may have decreased or even ceased in most globally distributed supply chains, the underlying function of inter-firm relationships have only grown stronger and the principle of clusters remained, albeit independent of geographic spatiality (Schmitz and Navadi, 1999). This is especially true for the automotive industry and Toyota's lean production model, where the importance of strong vertical inter-firm relationships along the value chain was reorganized and relationships often intensified (Humphrey, 1995).

This means the inter-firm ties have become more important for the development

of firms. Johanson and Vahlne developed a framework for internationalization of the firm that is based on the idea of business networks (Johanson and Vahlne, 2009). They argue that for firms to internationalize (i.e. use the firm specific advantage at home to expand operations to other locations), ownership advantages no longer suffice. Instead, they highlight the role of "insidership" into business networks as a prerequisite for internationalization as the firm can learn from the network and adapt its operations based on the acquired knowledge (Johanson and Vahlne, 2009; Vahlne and Johanson, 2013). Independent from this stream of research, other scholars have found that lead firms in GVCs play a key role for upgrading of the firms involved in the value chain (McDermott and Corredoira, 2010). Both streams of research highlight how important participating in value chains is for the development of the firm.

GVC governance and firm-level upgrading

Upgrading refers to the process of achieving higher rents by outperforming the competition. In the value chain context, upgrading can be achieved through capability building that enables the firm to produce better products, increase its efficiency and productivity, or more into more skilled activities to create more value (Kaplinsky and Morris, 2000; Humphrey and Schmitz, 2001; Gereffi and Fernandez-Stark, 2011). In early literature on upgrading, the ability to upgrade was derived from attributes from within the firm (Hamel and Pralahad, 1994; Teece and Pisano, 1994). As Kaplinsky and Morris argue, these concepts fall short in capturing the systemic aspects of upgrading in value chains in which firms are linked together (Raphael Kaplinsky & Morris, 2000: 38). A commonly used typology of upgrading in the context of GVC differentiates between four ways of upgrading (Schmitz and Humphrey, 2000):

First, *process upgrading,* which refers to the increase of productivity through process efficiency. This can involve processes within individual firms as well as inter-firm processes at the link between two firms in a value chain. Process upgrading can be achieved by reorganizing the production system, or by introducing superior processing technologies (Schmitz, 1999). Second, *product upgrading,* which refers to the development of better or new products that achieve higher value added. This can be achieved through product innovation or innovative product development processes and fast product updates, enabling the form to move to more sophisticated and profitable segments (Gereffi, 1999). Third, *functional upgrading,* which refers to changing the firms' function in the value chain by performing new activities. Examples are upgrading from manufacturing components to assembling systems, or upgrading from manufacturing to designing products (Bair and Gereffi, 2001). Fourth, *chain or inter-sectorial upgrading,* which refers to upgrading across value chains, by entering new value chains and applying the capabilities in the new, potentially more profitable sectors (Humphrey and Schmitz, 2002; Giuliani, Pietrobelli and Rabellotti, 2005).

Multiple studies have documented the links between value chain governance and upgrading (Gereffi, 1999; Schmitz and Humphrey, 2000; Giuliani, Pietrobelli and Rabellotti, 2005). Lead firm orchestration and coordination of global value chains include the allocation of activities within the value chain (i.e. selecting and allocating activities to capable supply firms), developing and enabling supply firms for technological upgrades (Giuliani, Pietrobelli and Rabellotti, 2005), collaborative expansion to new (international) production hubs (i.e. location choice for FDI) (Hertenstein, Sutherland and Anderson, 2017), and restructuring and consolidating the supply chain (i.e. by encouraging mergers and acquisitions) (Nolan, Zhang and Chunhang, 2007). Consequently, the upgrading prospects of participating supply firms

depends to a large extend on the lead firms' orchestrating activities.

Supply firm development often occurs in the emerging markets, in which some of the supply firms otherwise lack in quality controls and production process standards to deliver the components to the requirements at a low price. Yet, the interactions and dynamics between the two firms involved are relatively unexplored. In oligopsony markets like the automotive industry, where few buyers dominate the industry, multiple supply firms can fully depend on the lead firm. Moreover, with powerful lead firms being involved in assisting and nurturing the supply firms to upgrade their products, processes or functions, supply firms from the emerging economies can be awkwardly dependent on the lead firm. Consequently, the challenge of upgrading has to be viewed within these wider perspectives of the business network or value chain in which a firm is embedded.

Part III: Research methods

Research approach

In seeking to answer the research question, a multiple case study method seemed most appropriate, because it offers the opportunity to deeply explore the inter-firm relations, governance approaches and competitive dynamics between firms. The case study approach is especially useful to answer the 'why' and 'how' questions (Yin, 2003) and is, according to Gereffi et al. (2005), a particular valuable approach for studies on the changing governance structures of global value chains. Through the case-study approach a longitudinal view of the topic can be taken, to document how certain decisions and changes in the strategy of the lead firm changes the economic environment of the supply firms and affects the indigenous firms' development over time. Furthermore, this approach is especially useful for early stages of the research (Gibbert, Ruigrok and Wicki, 2008), which is arguably the case for a comparative study on how the value chains of German firms have been established in Brazil and China. The research is inductive in nature and no hypothesis formulated, as the structural changes in the value chain are not known (Glesne, 1999).

For the analysis of the changing governance patters in a value chain, it is important to consider not only the "top" firms (i.e. assemblers in the automotive industry), but also other potential lead firms, like large suppliers in the automotive industry that are positioned further upstream. The case study was designed to include multiple vantage points of several firms from a single discreet value chain. This allows to develop a holistic view of the firm interactions and to triangulate the findings. The value chain was explored from three vantage points of firms at different positions in the value chain, to include the perspective of a lead firm, a turn-key supplier and

component supply firms from several different positions in the value chain. Selecting multiple cases of indigenous supply firms was important, as multiple cases are more likely to yield generalizable and robust findings (Eisenhardt, 1989; Yin, 2003). Furthermore, the multi-vantage-point approach includes multiple companies for different positions along the value chain to enhance external validity (Gibbert, Ruigrok and Wicki, 2008).

Case study design and sample selection

A single industry was chosen as the research object for this study, the automotive industry. Sometimes called 'the industry of industries' (Drucker 1946: 149; Womack et al. 1990: 1), the automotive industry has consistently been at the forefront of changes and innovation of manufacturing systems, supply chain organization, globalization and consolidation processes in the past decades. The automotive industry gave rise to the concepts of Fordism and lean production and is an influential trend setting industry (Womack, Jones and Roos, 1990). Both, Fordism as well as modern lean production or 'Toyotism', were first developed in the automotive industry, which underwent tremendous changes during the global business revolution. These two examples show how the automotive industry is often at the forefront of global trends, such as technology upgrades or manufacturing process innovations. Thus, the industry is the ideal research object to study the effects of individual large firms dominating a market on the development process of a late-industrializing economy.

Over the past two decades, the global automotive industry has undergone considerable global consolidation, developing oligopolistic features (Nolan, 2012). A few global players fiercely compete, leaving little room for new entrants (Sutherland, 2003; Datamonitor, 2011). The consolidation not only pertains to the assemblers but, as importantly, tier-1 and tier-2 component suppliers, as pressure for economies of scale

and lean production have been passed on down the value chain (Nolan, 2001a). The global tier-1 supplier base, for example, has rapidly consolidated and consists of a relatively small number of very large, highly competitive, globally active players. Assembly MNCs have intensified their business network relationships and have established long-term strategic partnerships with component makers to lower development costs for new platforms and vehicles. Such relationships include top tier suppliers, but also competing assemblers in the form of alliances and shared platform development (Womack, Jones and Roos, 1990). As a result, it has become increasingly difficult to shuffle the supplier base and to break up business relationships, which can create challenges for new players from the emerging markets looking to enter such networks. The global auto industry epitomizes modern networked GVCs as orchestrated by MNCs (Dicken, 2011). It may therefore provide insights into how firms from the emerging markets can enter production networks, create learning opportunities, and undergo upgrading processes based on their position and involvement in GVCs.

As Dicken notes, it is also one of the most 'transnationalized' industries (Dicken 2011: 351), making it an ideal object to understand global governance structures and the impact on local industrialization. GVC governance structures differ somewhat from industry to industry. In the automotive industry, exports of wholly assembled vehicles are rather limited owing to political considerations, which means production happens in regional production centers, whereas development and the organization remains more central than in other industries (Van Biesenbroeck and Sturgeon, 2010). Suppliers are forced to be able to supply globally, while having their R&D centers close to that of the assembler: "Increasingly, lead firms demand that their largest suppliers have a global presence and system design capabilities as a precondition to being considered as

a source for a complex part or subsystem" (Van Biesenbroeck & Sturgeon, 2010: 209). As such, new entrants to the networks may see themselves challenged to quickly internationalize, to meet the demands of their global customers.

Insights gleaned from it may be relevant to other industries, particularly manufacturing ones involving complex supply chains entailing numerous discrete inputs. Furthermore, the automotive industry is typically seen as an important manufacturing industry for economic growth and development (Dicken, 2011), and has been chosen as a pillar industry for development; so also in the case of Brazil and China (Shapiro, 1994; Thun, 2006; Wolfe, 2010). In addition to economic reasons, the automotive industry has strong signaling effects for modernization, making it an important industry for politicians to reach people for their cause (Wolfe, 2010). The automotive industry is thus an interesting industry to consider network relationships and their impact the prospects for firms from the emerging markets to participate and upgrade within the GVC of a western lead firm.

Why Brazil and China

Brazil and China were selected as the two emerging economies for this research, as both national industries have evolved to become major production hubs in the global automotive industry and have become central in the global strategies of the large leading MNCs in the industry. In both countries, the automotive sector was considered as a 'pillar' industry, and was specifically chosen by policy makers to play a strategic role in the development of the country and its economy (Shapiro, 1994; Thun, 2006).

China has risen to become the second largest economy for the first time in 2010 (World Bank, 2010). For over two decades it has attracted FDI from developed economies. It has become the second largest FDI recipient in the world, after the USA

(UNCTAD 2011: 4), indicating its deep involvement and integration into the global value chains of western firms. Furthermore, China's newly risen outward FDI make China an interesting subject to study the competitive dynamics between western and Chinese enterprises involved in the global value chains, and for an analysis of catch-up processes of firms from the emerging markets, much like the cases of Japanese and South Korean before (Cusumano, 1985; Amsden, 1989). In 2015, China's FDI outflows reached a total of 118.02 billion US$ according to the Chinese Ministry of Commerce, up 14.7% from the previous year and increasing for the 13th consecutive year (MOFCOM, 2016). The accumulated outward FDI stock volume increased to over 1 trillion US$ at the end of 2015 (MOFCOM, 2016). By the end of 2010, more than 13,000 Chinese companies had invested into 178 countries and have established about 16,000 subsidiaries (MOFCOM 2010: 79). With global FDI outflows standing at 1.75 trillion US$ in 2016, China ranks 2nd in the world in terms of outward FDI flows (UNCTAD, 2017). Yet, none of the Chinese assemblers has reached production volume numbers anywhere close to the globally leading firms, and only two Chinese suppliers made it on the top 100 suppliers list in 2016, ranking 18 and 77 out of 100 in terms of revenue (News, 2016).

Most importantly, however, for the purposes of our research, China has become a thriving hub for MNC global value chains. For efficiency reasons and owing to state industrial policy, relationships between global assembly firms and local firms have been encouraged, and some local firms have been able to develop strong relationships with the foreign assemblers, which design meticulously controlled global value chains (Anderson, Håkansson and Johanson, 1994; Nolan, 2001a; Johanson and Vahlne, 2011).

Brazil stands in stark contrast to the ambitions of the Chinese industry and its development path. As a much smaller economy, Brazil has attracted less inward FDI and attention lately, and has discarded plans to develop own large assemblers early on in the industrialization process. However, Brazil policy makers formulated plans to develop a strong indigenous supplier base in the automotive industry, as a basis for further industrialization, technological upgrading and as a training ground for a highly skilled workforce. But even as the fifth largest production hub in the world, Brazil only brought forth one supplier in the top 100 list of 2013, and most of the supplier base fell into foreign control before the turn of the century. With the consolidation of the global industry, the shaping of large multinational suppliers, and the formation of global value chains, Brazil followed a different trajectory as China, and it is interesting to study the transformation of the supplier base that took place in Brazil since the 1990s. Contrasting and comparing the Brazilian path with the Chinese development will allow to identify similarities as well as differences in the success of their chosen ways to become part of the global economy.

Why German automotive firms?

The German automotive industry is, together with the US and Japanese automotive industry, a leading automotive industry in the world. Germany has brought forth large, well-known companies in the automotive industry such was BMW, Daimler or Volkswagen (VW), as well as large multinational suppliers in the likes of BOSCH or Continental. Yet, the German automotive industry has been somewhat 'understudied' and remained in the shadow of General Motors (GM), which has for a long time been the largest auto producer in the world, and Toyota and Hyundai, which captured the attention of many studies for their unprecedented rise in the global industry

and innovative production system. Unlike the Japanese or South Korean industry, the German industry has a strong tradition in automotive, from the invention of the combustion engine, which is still used in almost every vehicle sold today, to producing iconic cars like the VW Beetle or VW 'Bulli' (Transporter), that stood as a symbol of a whole generation of people. Moreover, as of today, the automotive industry is arguably the most important industry in Germany, amounting for about 3% of the country's GDP, 2.5% of direct employment, and about 33% of all research and development (R&D) expenses in Germany (GTAI, 2013). Furthermore, German firms are among the leading firms in the world and with a particular strong position in the two national industries of Brazil and China.

Case study firm selection

The aim was to analyze a sufficient number of firms to be fairly confident that the results had some general applicability while limiting the sample to enable in-depth interviews within a tractable timescale. To study a discrete value chain, one lead firm was selected, as well as six German suppliers, two service providers, and ten supply firms from the emerging markets of Brazil and China. All the selected supply firms along the value chain are participants in the value chain of the lead firm, and were selected in a way that firms from all different positions in the value chain are represented, including firms with high tech and with relatively undifferentiated products.

The Volkswagen group was selected as the core lead firm, for three reasons: First, for its size and position in the global automotive industry as one of the three largest assembly groups together with Toyota and General Motors. In the past decade, Volkswagen was first able to catch up and overtake GM, and in 2016 became the largest

manufacturer in the world in terms of units produced. VW also pursued the most aggressive strategy of lean production and especially vehicle platform reduction, as it reduced its platforms among the different passenger car brands from 16 to just four (Dicken, 2011: 340). Such a drastic reduction of platforms indicates even more dramatic changes in the value chain set-up. Furthermore, VW followed a very distinctive growth strategy via mergers and acquisitions that sets VW apart from GM and Toyota. Thus, it makes for an interesting and so far understudied case to be documented, and an ideal case for the purpose of this study. Second, Volkswagen has a particular long standing history in Brazil and China, and a strong position as leading assembler in the two emerging markets. Third, Volkswagen is the least studied assembly group of the big three international assembly groups, thus worthy to be studied and documented in depth. It should be noted here that all data collection from Volkswagen and the supply firms stopped before to the "Dieselgate" scandal came out. The data used and presented in this study is not affected by the scandal and subsequent shifts in the market and assembly-supplier relations have not been documented.

Selecting a number of German suppliers seemed reasonable, as close ties and a quick response to the strategy changes of the Volkswagen group can be expected. For the selection of BOSCH as a turn-key supplier, the selection criteria were similar to Volkswagen: as the largest automotive supply firm in the world with a long history in Brazil and China, BOSCH was the ideal candidate. The other German case studies were selected to represent firms at different levels of the value chain, from large firms like Schaeffler, to well-known specialized firms like Brose, hidden champions like Marquardt and producers of relatively undifferentiated products like Witzenmann.

The selection criteria for the Brazilian firms were the following: The firms must be of Brazilian origin, make the majority of their revenues in the automotive industry,

and had already began to develop an international footprint necessary to maintain their position in the globalized automotive value chain. This last point was developed from initial round of interviews with the two powerful firms, Volkswagen and BOSCH. Based on these considerations, pre-selection from the Mercosur Automotive Supplier Report led to 23 Brazilian firms in different positions in the value chain. These firms were first grouped with the help of engineers from Volkswagen, according to their strategic importance, which is determined by the supplied components and products and correlated with R&D intensity and technological requirements of the product. Three groups of firms emerged from the sample: One group of firms of highly technical components, a second group of technology demanding components, and a third group of relatively simple products. Accordingly, the indigenous supply firms for in-depth analysis were selected to represent each of the identified groups.

The selection criteria for the Chinese firms where analog to the criteria of Brazilian firms: The firm must be of Chinese origin, focus primarily on the automotive industry and have started to internationalize. Using China's Automotive Industry Yearbook, 48 large-scale component suppliers were identified. The case studies were grouped in the same way the Brazilian firms were grouped, for a first understanding of each of the firms' position in the value chain. Of these, eleven had undertaken significant internationalization, and six firms agreed to participate in the research. The final sample of companies was heterogeneous in terms of position and role in the value chain, product type, and level of internationalization. It includes some of China's most successful business groups (Fuyao and Yanfeng), as well as smaller and less known cases (Lawrence and YAPP).

Data collection and analysis

Primary and secondary data was collected from several sources. Primary data was collected through observations and interviews in each case firm. Additional secondary archival data was collected to support the primary data collection and to triangulate the data and so improve the accuracy of the picture emerging (Jick, 1979; Eisenhardt and Graebner, 2007; Gibbert, Ruigrok and Wicki, 2008). Such documents came from internal documents, annual reports, company web pages, magazines and newspapers, published interviews by company officials, and books.

The interviews were conducted between July 2012 and June 2015 in Germany, Brazil, China, the UK and the US. Two rounds of interviews were conducted for each case study, where possible. The second round of interviews complemented the first by asking follow-up and clarification questions. Interviews were conducted with multiple individuals from the firms to gain perspectives from employees. Interviewees came from different levels in the corporate hierarchy, from engineers to board members, multiple business units, typically from purchasing, sales and R&D departments, and different geographic locations (Eisenhardt and Graebner, 2007). Additional interviews were conducted with industry experts not related to the case firms, such as management consultants, top management of additional automotive firms or policy makers, to supplement the primary case data (Gibbert, Ruigrok and Wicki, 2008). A total of 104 semi-structured interviews were conducted, that commonly lasted between 30 minutes and two hours. Whenever possible, the interviews were conducted in English. However, since some firms in the study are of German origin, some of the interviews were conducted in the German language. All interviewees were given personal anonymity. Whenever the interviewee agreed, interviews were recorded, and later transcribed. The interviews were analyzed using an open coding system for grounded theory (Saunders, Lewis and Thornhill, 2007; Kvale and Brinkmann, 2009).

At the beginning of each interview background questions were asked, such as the name of the informant, their role in their firm, and how many years have he/she worked with their firm. This was followed by questions regarding the R&D process, role of the firm in the automotive industry, purchasing and sales strategies, and competitive position of the firm and so on. Informants were encouraged to provide more details when their descriptions were brief or when novel strands of narrative emerged (Strauss and Corbin, 1990; Martin and Eisenhardt, 2010). Data collection stopped when theoretical saturation was reached (Strauss, 1987).

Data analysis

Within-case and cross-case analyses was used following recommendations for multiple case studies (Eisenhardt, 1989; Miles and Hubermann, 1994). First, individual cases that triangulated all of the data including observations, interviews, and documents were written up (Jick, 1979). This was followed by a cross-case analysis using replication logic across firms, treating each firm as a case. During the cross-case analysis, alternative theoretical relationships were searched for, in case the data fit better to alternative theories than the initial emergent theory (Eisenhardt, 1989; Gilbert, 2005). Some of novel conceptual constructs and new theoretical relationships were revised or deleted if they did not replicate across the cases. Using replication logic, data analysis was completed when a match between emergent theory and the empirical data was reached.

Limitations

The selected approach does not come without its limitations. First, as a case study approach, the findings are derived from a relatively small number of firms. Future

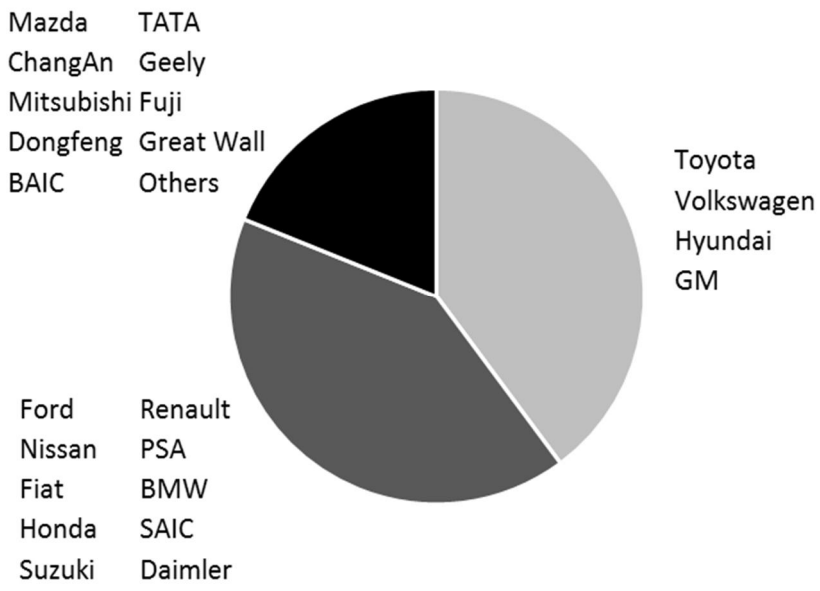
research is required to test the proposed implications of this study. Second, this study focuses on a single industry. While this provides deep insights to the dynamics of this industry, it limits the generalizability of the findings. Depending on size of industry, level of globalization, product characteristics, level of modularization and codifiability, the inter-firm relations and governance approaches may look very different in other industries, leading to different implications for development. Third, the study only includes Brazil and China. Both countries are relatively large, with strong industries and a high level of integration into the world economy. Yet, their development is very different. This limits the generalizability in regards to implications for development, as most emerging markets are smaller in size and face a different set of challenges.

Part IV: The globalization of the automotive industry

The consolidation of the automotive industry

The global automotive industry has undergone a tremendous consolidation since 1985 in an attempt to increase economies of scale and to reduce R&D costs and realize synergies. In 2016, the industry is highly consolidated and has developed oligopolistic features (Nolan, 2012). Competition is fierce, and few global players occupy large shares of the global industry (Sutherland, 2003; Datamonitor, 2011). In 2015, the top four largest assemblers accounted for 40% of the global passenger car production. The next 10 largest assemblers accounted for another 41%, leaving just 19% for all other assemblers (OICA 2016; see Figure 5).

Figure 5: Market share in the automotive industry



Source: Author's calculation based on OICA, 2016

Every traditional major automotive nation is represented in the group of the top four largest producers: Japan, Germany, USA and South Korea (with Toyota,

Volkswagen, General Motors and Hyundai respectively). The same four countries are also the nation of origin for all of the next 10 largest car producers, with the exception of SAIC, the largest Chinese assembler. Even without considering alliances among the leading producers, the industry appears highly consolidated and features oligopolistic traits.

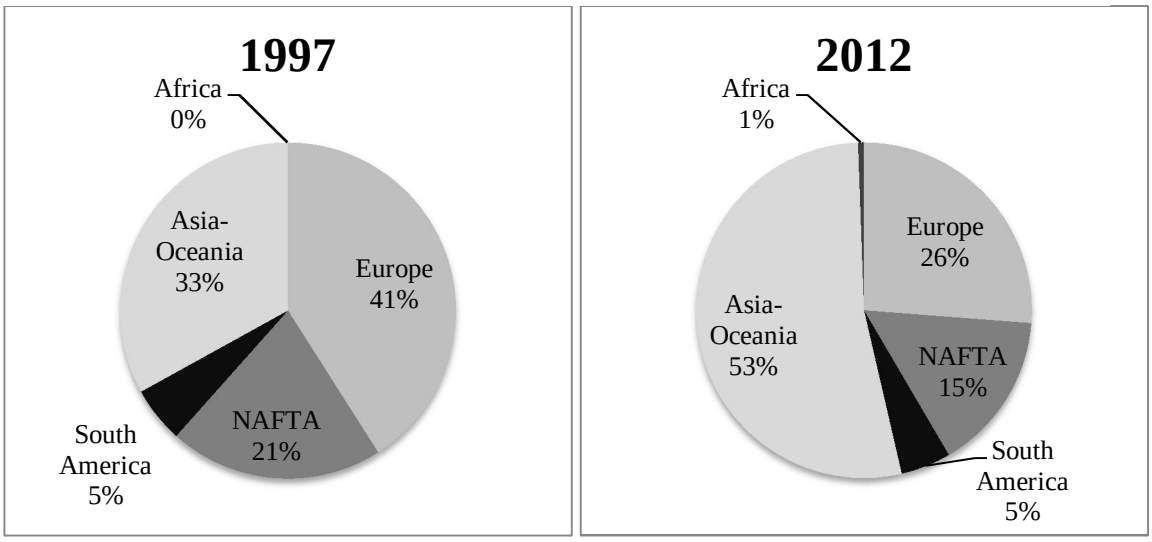
Shifts in global production

In the past 25 years, the geography of production underwent tremendous shifts from the old triad regions of USA, Europe and Japan towards emerging markets in East Asia and towards South America (Dicken 2011: 334). A key driver for the shift in production is the market growth in these regions. Unlike most consumer products, vehicles are typically produced or assembled in close proximity to the final consumer, which results in low numbers of exports for wholly assembled vehicles, due to political forces constraining and limiting imports. Policy makers try to attract inward FDI to localize vehicle production and establish production plants through import taxes and tax reductions (Van Biesenbroeck and Sturgeon, 2010). Because of the large scale of one production plant (a standardized plant of VW produces 150,000 vehicles annually), the high up-front investments required and the large upstream supply base needed for production, production typically clusters around the initial locations for investments. This is especially the case for relatively young production sites in the developing world.

While the traditional two regions of Europe and North America accounted for a combined 62% of global production in 1997, their share decreased over just 15 years to a mere 41% in 2012 (OICA, 1998, 2013). The main benefiter has been the Asian region, which increased its share of production from 33% to 53% over the same time span (ibid.; Figure 6), but also Latin America, which sustained its share at 5%.

While this shift may have been accelerated by the financial crisis of 2008 and the subsequent decline of the automotive industries in both, USA and Europe, the crisis cannot be made liable for this change. In fact, both the USA and the European regions experienced growth rates of 30% and 12% respectively over the 15 years. Thus, the numbers depict a much deeper shift that becomes more visible on a country level.

Figure 6: Geographic shift in production



Source: Author's calculations based on OICA 1998 and 2013

Succeeding its entry into the World Trade Organization (WTO), China has become the largest market for passenger cars in 2009 (Tian, 2010), and the largest producer in the same year (OICA, 2009, 2010). As a country, China experienced a growth in production of a staggering +3121% from 1997 to 2012. Thereby, China accounts for almost the entire production increase in the region. After opening its industry to foreign investments, all major automobile producers invested to open production plants with their joint-venture partners. Similarly, Brazil, which accounts for 82% of production in South America in 2012 (OICA, 2013), experienced a growth

of production of 56% from 1997 to 2012 (OICA, 1998, 2013), sustaining the global production share at 5%, while the European and North American relative shares shrank.

Germany in the global automotive industry

Germany sees itself as the birthplace of the automobile and to this present day, Germany is most famous for its automobiles. The automotive industry has played a central role in the German economy. With innovations like the combustion engine, Germany has a strong tradition in automobiles. The auto industry is one of Germans largest and certainly its most important industry. With a turnover of 351 billion Euro, the automotive industry accounted for about 20% of Germanys total industry revenue (GTAI, 2013). The industry makes more than 3% of the nation's GDP, and contributes more than 2.5% for direct employment. The automotive industry is also a driver for the successful export model of the economy, as some 77% of the vehicles produced in Germany are destined for foreign markets. The 19.6 billion EURO of investments into R&D in the auto industry make about one third of the nation's R&D expenditure (GTAI, 2013). Moreover, Germany is the home for global players like Daimler, BMW or Volkswagen that are widely renowned for the highest quality standards, innovation and enjoyable drivers experience. With the founding of the Volkswagen AG in 1938, Germany has brought forth an assembler that was able claim a spot at the table of the largest assemblers worldwide and that fights to become the number one in terms of vehicle production numbers (Lupa, 2008; OICA, 2013).

The Brazilian automotive industry

The automotive industry is arguably the most important industry for the Brazilian economy. Chosen for its close linkages with steel and oil, the automotive

industry received special attention from policy makers since its inception in the 1950s (Shapiro, 1994; Wolfe, 2010), and was to become the spearhead of Brazil's development. The auto industry should create a large domestic market for the domestic steel and oil industry to grow upon. Furthermore, the Brazilian government chose the automobile (trucks) as the primary means for transportation, to bring together the vast landmasses of the country and unite the fragmented economy.

The industrial development of Brazil's automotive industry took off in 1950s when president Juscelino Kubitschek (1056-1961) included the automotive industry in his Target Plan (Wolfe, 2010: 113). Establishing indigenous assemblers or 'national champions' was discarded early on by politicians, as the potential market was considered too small to allow such a path and financial and technological requirements too high (Shapiro, 1994). Instead of establishing indigenous assemblers, Brazil relied heavily on investments from international firms of the western developed world (Wolfe, 2010). By attracting foreign firms to invest into Brazil, the government hoped for a localization of their production that would provide jobs and create a highly skilled workforce. Localizing the production was incentivized through a combination of financial incentives for localizing production and penalties for imports.

Unlike on the assembly level, it was the plan to develop a strong supply base of indigenous Brazilian firms. The local content rate of components for passenger cars was set to increase to 80 percent by weight and 70 percent by value in 1960 (Abreu *et al.*, 1999; Ramalho and Francisco, 2008). However, even though the supply industry was not very consolidated at that time, foreign supply firms entered the Brazilian market and soon dominated the industry. In particular capital and technology-intensive sectors of the value chain were dominated by foreign firms, while local firms produced standardized components and replacement parts with low profit margins (Kim and Lee,

1994; Shapiro, 1994).

By 1972, the Brazilian government created a policy framework that would allow the local industry to become more integrated into the global industry. Brazilian government encouraged exports of whole vehicles as a means to fight international trade deficits, and exports increased dramatically "from under U.S. $100 million in 1973 to U.S. $1.57 billion by 1981 (ANFAVEA, 1989)" (Lee & Cason, 1994: 234). The policy framework was a success, and today Brazil plays an important role in the global automotive industry, as one of the major production hubs in the world, ranked in a respectable 7th place, with 3.5% share of global passenger vehicle production (following China, Japan, Germany, USA, South Korea and India) (OICA, 2013).

In the 1990s, the government introduced deregulation policies to open the market (Ramalho & Francisco, 2008). Prior to 1990, the Brazilian market was dominated by just four assembly firms: Volkswagen, Fiat, Ford and General Motors. When the market opened, new firms entered the market, such as Toyota, Hyundai, Nissan, Renault and Peugeot, introduction new technologies and vehicle models to the market. In the relatively close market, the foreign assembly groups had little interest introducing new technologies. With the opening of the market in 1990, the competitive environment changed. New foreign assembly groups entered the market, and intensified the competition. The extend assembly groups reacted by rapidly upgrading their technologies and introducing new vehicles. Local supply firms began to feel the intense competition of foreign rivals entering the domestic industry along the entire value chain and from the increased technological demands of both, the new assembly groups and the incumbent firms.

With steady growth rates since the opening of the market in 1990, Brazil has been the second fastest growing production location in the global economy, underlining

its importance in the global industry. Yet, Brazil is one of only two of the largest production economies with no own indigenous assembly firms with significant scale (the other being Mexico). Instead, it has depended on foreign multinationals to take the lead and develop Brazil into the strong hub it is today (Tewksbury, 1930; Shapiro, 1994; Ramalho and Francisco, 2008; Wolfe, 2010).

Additionally, compared to its relative importance as a production hub in the world, Brazil has brought forth very few notable international firms in the industry. In 2014, only one Brazilian supply firm barely made it into the top 100 largest auto supply firm ranked by revenue (Automotive News, 2013). This is surprising, considering Brazil's vast production output, and the time the indigenous firms had to develop the necessary firm specific advantages (mainly technologies) since the 1950s and international footprint since the opening of the market in the 1990s to become globally competitive.

The Chinese automotive industry

Over the past two decades the Chinese automotive industry grew at a staggering speed. The rapid growth in domestic production capacity was underpinned both by the investments of foreign multinationals from the advanced economies as well as the creation of indigenous Chinese car producers. China has risen to become the third largest economy in 2008 (World Bank, 2010). For years it has attracted foreign direct investments (FDI) from developed economies and has become the second largest FDI recipient in the world, after the USA (UNCTAD 2011: 4). Lately, China even evolved to become one of the major sources of outward FDI. The auto industry has been no exception. Since joining the World Trade Organization (WTO), sales have grown in

two digit percentage numbers, and domestic vehicle production has increased from a mere 481,970 vehicles produced in 1997 to a staggering 15,523,658 produced in 2012 (OICA, 1998, 2013).

The beginning of China's automotive industry goes back to the 1950s, when vehicles were produced l locally for the first time, by the indigenous manufacturer 'First Automobile Works' (FAW). FAW was founded with the aid of the Soviet Union, and the was incorporated in 1953 (Oliver, Holweg and Luo, 2009). In 1978, the automotive industry was chosen as one of the "pillar" industries for development (Thun, 2004, 2006). The aim of China was to build up its own strong industry to catch up with developed countries, to create jobs and to increase wealth and welfare for its citizens through own "national champion" firms (Sutherland, 2001).

In the 1980s, the market opened to foreign investors, which were allowed to invest into joint-ventures with Chinese partner firms. At this time, the global automotive industry had been highly consolidated, while the Chinese industry was immensely fragmented. While the number of global assemblers was reduced through a number of M&A, the number of Chinese assemblers even increased to over 100 during the same time (Liu and Zhao, 2006; Ramasamy, 2011). This left the majority of Chinese firms weak, as economies of scales through consolidation are crucial in the automotive industry.

In order to further integrate into the world economy, joining the WTO became necessary. Joining the WTO was supposed to bring a much needed competition into the Chinese market, to enforce a long necessary restructuring process of the state-owned sector to develop a new breed of internationally competitive firms (Thun, 2006). Investments from foreign firms rapidly increased, and approximately $12 billion were invested already by 2003 (Thun 2006: 7). The foreign partners had better technologies,

and the Chinese firms became dependent on their foreign partners. While it was hoped that the joint-ventures would lead to technology spillovers, some argue that the dominant foreign firms hinder the development of an indigenous automotive industry in China (Chang, 2004).

The Chinese market has become the most attractive and most important market for car sales in the world. In 2009, it overtook the US as the largest markets for passenger cars (Tian, 2010), and has been steadily growing ever since. Moreover, in contrast to the traditional large markets of US, Europe and Japan, China is expected to grow further in the next decades. While the traditional markets are saturated with 791 cars per 1000 citizens (for USA; 563 cars per 1000 for Europe), China has a huge potential for further growth, with only 79 vehicles per 1000 citizens (OICA, 2013). Thus, the undisputed potential of this market triggered a race of foreign firms into the market, what Dicken called “a scramble … to enter China” (Dicken 2011: 364), as multinational firms seek to cut out their share of the pie.

Part V: Case Studies

Volkswagen: The lead firm and GVC orchestrator

The Volkswagen AG is a German manufacturer of passenger cars and commercial vehicles, headquartered in Wolfsburg. With over 10.3 million vehicles sold in 2016, Volkswagen has become the largest automotive producer in the world, for the first time overtaking its Japanese rival Toyota. Even though Volkswagen was founded in 1937, it was not until December 1945 that Volkswagen began producing passenger cars in serious volumes, as the company was assigned to manufacture armaments and war machinery between 1939 and 1945. Volkswagen is a relative latecomer in the automotive industry, compared to the likes of Daimler or Ford, which built first vehicles in 1886 and 1896 respectively. Nevertheless, it is of little surprise that Volkswagen would one day become one of the largest automotive manufacturer of the world. Large volume production is at the very heart of Volkswagen, which translates into "people's car" and was founded under the German Nazi regime to produce an affordable car for the masses. The ambition and objective to become a serious volume producer began right after World War II, with the production of the 'Volkswagen Typ 1', more commonly known as the 'Volkswagen Beetle' or 'Bug' as it is called in the US. In 1971, annual production of the Volkswagen Beetle peaked at 1,3 million units. On February 17, 1972, a total of 15,007,034 Beetles had been produced, surpassing the first truly mass-produced vehicle and previous record holder, the Fold Model T, which was produced from 1908 to 1927. Until the end of production in 2003, a total of over 21 million Volkswagen Beetles were produced, still holding the record for the most produced passenger car in the world. Other successful models followed, like the iconic

Transporter series and later models like the Passat or Golf, which helped Volkswagen to grow organically.

Despite the success of some of Volkswagen's own vehicles, the firm did not base its strategy on organic growth alone. Over the years, VW has become one of the most aggressive acquirer in the automotive industry. Mergers and acquisitions have a long tradition in the Volkswagen group, with the first acquisition taking place on January 1st, 1965, when Volkswagen bought the "Auto-Union GmbH", which would later be known as AUDI. In the following years, Volkswagen acquired a number of European manufacturers: in 1985, Volkswagen first bought 51% and later in the same year 75% shares of the Spanish producer SEAT. In 1991, after the dissolvent of the USSR, Volkswagen acquired the traditional Czech manufacturer Skoda. In 1998, Volkswagen acquired Bugatti and Bentley, two luxurious super car manufacturers, to widen the segment and integrate superior technology into the company. Later the same year, the Volkswagen daughter AUDI acquires the Italian super sports car manufacturer Lamborghini. Through these acquisitions, Volkswagen is able to offer a wide spectrum of passenger cars in its portfolio, and the focus for acquisitions shifted to commercial vehicles.

In 2006, Volkswagen acquired MAN, a manufacturer of heavy commercial vehicles. The MAN acquisition supplemented the portfolio of light commercial vehicles produced under the Volkswagen brand. This is quickly followed up by the purchase of first 38% and then 67% of the voting rights of the Scandinavian Scania, a producer of heavy commercial vehicles and an increase of the stake in MAN to 55% and later 75%. Through the acquisitions of MAN and Scania, Volkswagen was able to add the full range of commercial vehicles to its product portfolio.

Somewhat out of line is the acquisition of Porsche. After a long takeover battle between the two companies and leading families behind them (Porsche and Piech), Volkswagen finally won in 2009, after accumulating a 49.9% stake in Porsche. After the takeover battle was won, Porsche was fully integrated into the Volkswagen group, and became one of the key developing brands besides Audi and Volkswagen.

In 2012, AUDI's subsidiary Lamborghini acquires the Italian based producer of motor bikes, Ducati. This marks the last grand acquisition of Volkswagen, and extends to product portfolio beyond automobiles. Through its acquisitions, Volkswagen owns 12 brands as of 2017 (Volkswagen, Volkswagen commercial vehicles, AUDI, Porsche, SEAT, Skoda, Bugatti, Bentley, Lamborghini, Ducati, MAN and Scania). Of its eight passenger cars brands, five are considered mass producers (VW, SEAT, Audi, Skoda, and Porsche) and three luxury or sports vehicle manufacturers (Bugatti, Bentley, and Lamborghini). Through its subsidiaries, Volkswagen offers a broad product portfolio from a wide range of passenger cars, including small vehicles like the Volkswagen Up!, to sports utility vehicles (SUV – like the Touareg), sports vehicles (Porsche), luxury vehicles (Bentley), and super cars (Bugatti and Lamborghini), the full range of commercial vehicles, from small (VW Transporter) to heave trucks (MAN) and busses (Scania), to motorbikes (Ducati).

The internationalization of Volkswagen

Volkswagen's internationalization began soon after production of passenger cars started in December 1945. In October 1947, just 22 months after start of production, Volkswagen exported its first vehicles to the Netherlands. Five years later, in September 1952, Volkswagen established its first foreign representation office and import company, the "Volkswagen Canada Ltd." in Toronto. This is the beginning of

an aggressive internationalization strategy, first via exports and later international production. In October 1953, just one year after its first international office, Volkswagen opened 82 international representative offices, and exports account for 44% of the vehicle production in Germany. A total of 68,754 vehicles are exported in that year. Additionally, Volkswagen laid the foundation of its first international production with “Volkswagen do Brasil Ltda.”. What started as a complete know-down plant (to assemble fully produced kits), soon became a full localized production plant for the Volkswagen transporter in 1957 and for VW Beetle in 1959.

What follows are investments to open production plants in South Africa in 1956, Mexico in 1964, Belgium in 1971, Brazil in 1976, Argentina in 1980 and finally China, to form a joint venture with SAIC in 1984 and a second joint venture with FAW in 1991 (Table 2).

Table 2: Early internationalization of Volkswagen's production

Year	*Target*	*Brand*
1953	Brazil	VW
1956	South Africa	VW
1964	Mexico	VW
1971	Belgium	VW
1976	Brazil	VW
1980	Argentina	VW
1984	China	VW
1991	China	VW
1999	India	Skoda

Source: Author’s summary from several corporate sources (annual reports, presentations, website)

In the next decade, Volkswagen focuses on growth in the European market through a number of M&A, with a special focus on the newly opened Eastern European countries. The market entry in China in 1984 marked the last transcontinental entry

until Skoda's entry to the Indian market in 1999, and was to become the single most important factor for the impressive growth that made Volkswagen one of the top three largest automotive producers in the world. Through the early investment in 1984, Volkswagen was one of the first international automotive manufacturers to enter the Chinese market, and enjoyed first mover advantages that set Volkswagen up to grab high market shares. After China's succession to the World Trade Organization in 2001, almost all international green field investments from Volkswagen focused on China. Since then, Volkswagen opened 16 production plants in China, and only four plants elsewhere (Russia, India, USA and Mexico).

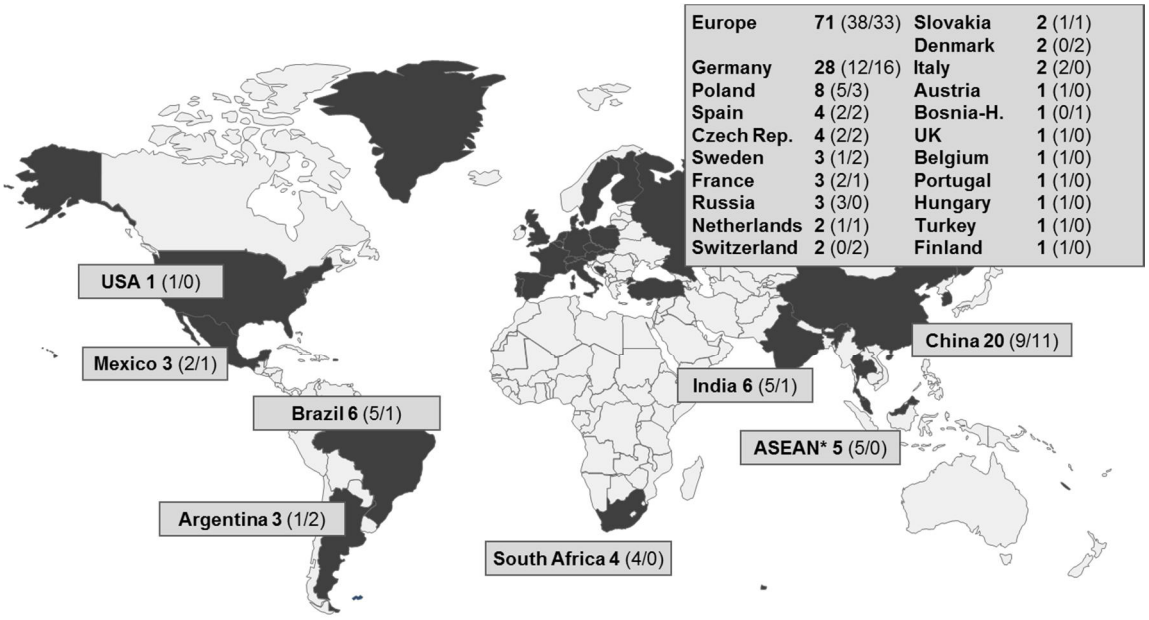
The role of the early expansion into Brazil and later China for the later success of the company cannot be underestimated, as it marks the turning point of the relative latecomer firm to become the global powerhouse and leading mass manufacturer of passenger cars it has become in 2016. Because of its early investments to China, Volkswagen has been able to establish itself as the leading automotive assembler in the growing market. In 2016, Volkswagen sold 3,873 million vehicles with its joint-ventures in China, which accounts for 37% of its global sales.

Volkswagen's global operations

In 2016, over 200 different vehicle models rolled off Volkswagen's production lines, totaling in over 10.3 million produced units in a year, averaging in over 28.000 vehicles per day. To achieve such impressive numbers, Volkswagen operates over 119 production plants around the world in 2016. Of the 119 plants, 70 are assembly plants for finished vehicles, and 49 component manufacturing sites (Figure 7). The component manufacturing sites produce engines, transmissions, turbo chargers, compressors, axles and seats. The production plants are located in 31 countries across four continents. With

very significant sales and production overseas, Volkswagen's global operations are a complex network of tightly controlled plants. As we shall see in the next chapter, economies of scale and the new product architecture require a close cooperation between the international plants and tight control from the headquarters in Wolfsburg, to run global operations smoothly. Volkswagen developed a standardized assembly line for vehicle plants. When fully build, each plant can have an annual capacity of approximately 300,000 vehicles.

Figure 7: Volkswagen's global production footprint



Source: Author's summary from company information (Volkswagen Navigator 2016 and website)

Supply firms play a key role for production to run smoothly. To ensure smooth upstream supply chain operations, Volkswagen collocates key suppliers to the majority of its production lines. Each assembly plant focuses on the production of a particular

vehicle. Most assembly lines can produce several vehicles that are based on the same platform. The tooling change for metal stamping takes less than 30 minutes, so that two different vehicles can roll off the assembly line in a single day. When a new vehicle starts production, the assembly lines are selected based on capacity and proximity to the final customer.

The evolution of Volkswagen's production architecture

At the center of the passenger car as a product is its platform, which norms and standardizes the mounting points for all the components and systems that are assembled for the final product. A key event in the evolution of vehicle platforms is Volkswagen's introduction of its new platform logic, the MQB, MLB, MSB and MNB,[2] which are used globally and replace the old PQ platforms[3], drastically reducing the number of platforms from over ten to just four across several brands within the Volkswagen group (including Audi, Porsche, SEAT and Skoda).

In the past decades, VW went through several platform updates that showcase the evolution of the product architecture. In the 1950s, the earliest vehicles did not share common parts or platforms, but were each developed from the ground up. As early as the 1970s, Volkswagen realized it could create synergies and achieve economies of scale by using common parts in several vehicles. The first shared platform was the PQ1/A01, introduced in 1974 for the Volkswagen Polo, Volkswagen Derby and Audi 50. This was followed by many different platforms, most of which were used by only two to three different vehicles of similar size. The first platforms that were shared by

[2] MQB stands for "Modularer Querbaukasten", where MB translates loosely to "Modular Kit", and Q, L, S and N stand for the engine mounting: Q for "quer" (transverse), L for "laengs" (longitudinal), S for "standard" (which is only used for sport vehicles like Porsche), and N for "Nutzfahrzeuge" (commercial vehicles – currently in development).
[3] The P in PL/PQ stands for 'passenger car', and Q or L for 'quer' (German for transverse) or 'longitudinal' engine mounting.

more than three vehicles were developed after the rise of the Japanese automotive industry, the success of the lean manufacturing principles, and the success of Japanese assemblers in reducing the number of platforms. The PQ34/A4 was Volkswagen's first platform following the Japanese example, and was used for nine vehicles. Shortly after, Volkswagen developed the PQ35/A5 platform, which was used for 19 vehicles. The two platforms were developed in 1997 and 2003 respectively, to match the success of the Japanese platform and lean manufacturing strategy. In 2012, VW introduced its latest platform logic, the MQB, MLB, MSB and MNB, which replaced the old PQ platforms, drastically reducing the number of platforms from above then to just four. The new platforms are rolled out globally, which means local platforms have been erased. While in the past, both Brazil and the joint ventures in China had own platforms to develop vehicles for the local markets, these vehicles will now be based on the new global platforms, which are developed at headquarter in Wolfsburg.

The objective of these new platforms was to further increase the use of common parts, enabling the firm to use the same standardized component in several vehicles, rather than developing or customizing the components for specific vehicles. A high rate of common parts allows the firms to utilize the economies of scale for such components. The target standardization rate for the new MQB platform is 70% of the vehicle value, decreasing the material costs by approximately 20% (Interview, Volkswagen case).

The main driver for cost reduction is procurement, which can reduce the costs by increasing economies of scale for standardized components. The increased use of common parts has important implication for the structure of the supply base and the integration of supply firms from the emerging markets. Therefore, the global vehicle platforms directly influence the prospects for supply firms from the emerging markets.

The largest impact is driven by the integration of supply firms during the vehicle development process.

Volkswagen's product development process

The development of passenger cars is separated into three distinct sections, each of which is developed independently from the other. The most important section is the vehicle platform, which is the basis chassis structure of the vehicle, outlining the mounting points for all other components and systems. To enable the use of a selection of alternative components, modularizing the vehicle components much like in a Lego system it standardizes the mounting points of the engine. The second most important section is the power train, which includes the engine, gearbox, exhaust system and control systems, and requires a high degree of coordination between components (including chassis components) for advanced performance. It is therefore developed as a whole system. The third section is the vehicle body, which is the most distinctive characteristic for the customer and includes the exterior design and body parts (e.g. stamped metal parts, windows, or lighting systems) and interior parts like seats, dashboard, door panels, entertainment systems, seating, safety equipment like belts and airbags or air conditioning systems.

The core development of the three distinct sections is separated, although each system influences the design and performance of the other. The three sections have different life cycles. The platform has the longest life cycle, and is rarely updated, as any update makes all the readily developed components for that system obsolete. Once developed, the platform is relatively static. For this reason, the new MQB platform was already developed in a way to allow large battery cells to be installed, years before VW launched its first hybrid vehicle to make use of this functionality. Because of its central

and structure giving nature, a platform launch must coincide with the launch of a new vehicle, and potentially requires a new engine design. Hence, it is the most complex system to be updated. Similarly, the power train has a relatively long life cycle, with an engine family often in use for 12 or more years with few version updates. The body has the shortest life span, with approximately seven years (at VW, other assembly firms reduced the life time to just 3-4 years) with just minor facelifts and updates between, until a new generation is launched. The reason for the frequent updates of the body is, that the body is the defining part of a vehicle to the customer, as it is what is ultimately recognized as the vehicle. Unlike the body, the vehicle platform and power-train can be used across multiple generations of distinctive vehicles (i.e. different body shapes).

Consequently, the vehicle platform is rarely updated, and not constantly being re-developed. The body and the power-train, on the other hand, are constantly being updated through new projects. Both are developed independent from one another, but use a similar, standardized product development process.

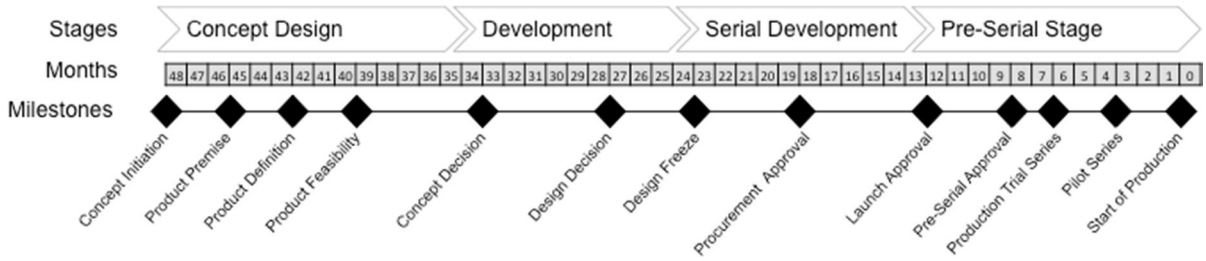
The standardized development process for new vehicles takes approximately 48 months and is divided into four separate segments: concept phase, development phase, serial development phase, and production phase or roll-out (Figure 8). The concept phase takes 12 months and consists of four milestones: concept initiation, product premise development, product definition and product feasibility. The concept initiation kicks off the development process for the predefined range of specifications for the vehicle that have been defined during a strategic decision phase to refine the product portfolio prior to development during which design studies, market research and technology scouting all contribute to detailing and validating the concept. The product premises refine the predefined range. The design concept follows the premises, defines the exterior and interior design of the vehicle, and finishes on month 43 with the

milestone product definition. At this point, full scale design studies have been produced and approved by the board of management, including external and internal design. What follows are feasibility checks, which include technological feasibility, manufacturing capabilities and capacities, business case and market response. With the milestone “concept decision”, the project enters the development phase and the lead is handed over from the design team to the developing engineers.

The development phase is the most critical, as all of the approximately 15,000 components are developed during this phase, including intensive functional testing for the components. Because of the integral nature of an automobile, the phase requires a high degree of communication between the engineers, to reconcile the different components. The special dimensions and boundaries for each component are defined in a vehicle cutting plan, to avoid overlapping (for instance, the open position of the ashtray once overlapped with a specific gear stick position). At milestone “design decision”, all components are defined and alternatives reduced to the final range of components that will be used in the vehicle. At this stage, Volkswagen has completely finished and fully working vehicles for test driving. What follows is extensive testing and refining of the components, to eradicate any errors, until the design freeze milestone. This is the most important milestone, as it finalizes the design and development stage. After this milestone, 24 months prior to production, CAD files should not be changed anymore. Up to now, all prototypes have been produced using tools and machines for prototyping. After the design freeze, the final tools for mass production are produced, at very high investment expenses. The project now enters the serial development phase, with extensive durability testing. The lead shifts from the developing engineers to production engineers, who define the production logistics, production line layout and facilities for the first production, and produce and prepare

all the required tools and machinery, including a transition phase for a quick transition of the product line, which is still producing previous models. This phase ends in the launch approved milestone, after which the roll-out is implemented, in a pre-serial approval production trial series, the pilot series and finally the start of production at full scale.

Figure 8: Volkswagen's vehicle development process



Source: Author’s own figure based on fieldwork

Volkswagen’s international R&D configuration

Volkswagen has three principal developing firms among its eight passenger car brands: Volkswagen, AUDI and Porsche. Each of the three developing brands is responsible for one of the different global vehicle platforms (MQB, MLB and MSB, respectively) and the platform specific engine groups.

Despite the international dispersed production network, core functions such as R&D remain relatively central at the headquarters in Wolfsburg (for VW branded R&D). For the MQB platform based vehicles, Volkswagen operates seven development centers in five different countries (Table 3; Figure 9). Four of its R&D centers are located in their biggest and most important markets, Germany (Europe), USA, Brazil, and China. The only country with more than one R&D center is China, where Volkswagen established three R&D centers, one in each joint venture and one wholly owned central center. Foreign assemblers can have up to two joint ventures in China

and Volkswagen has one with SAIC and one with FAW. Each joint venture has its own R&D center. Additionally, Volkswagen operates a central R&D center in China, which coordinates between the two joint ventures and headquarter in Germany. Overall, VW employs more than 20,000 engineers in their R&D centers around the world (Table 3).

Table 3: Number of engineers and roles of Volkswagen's R&D centers

	Germany	US	Brazil	VW China	FAW-VW	S-VW
	P, T, S, R, M	T	A	T, A, S	T, A, S	T, A, S
Number of employees	>10,000	>1000	>500	>400	1,220	>1,400

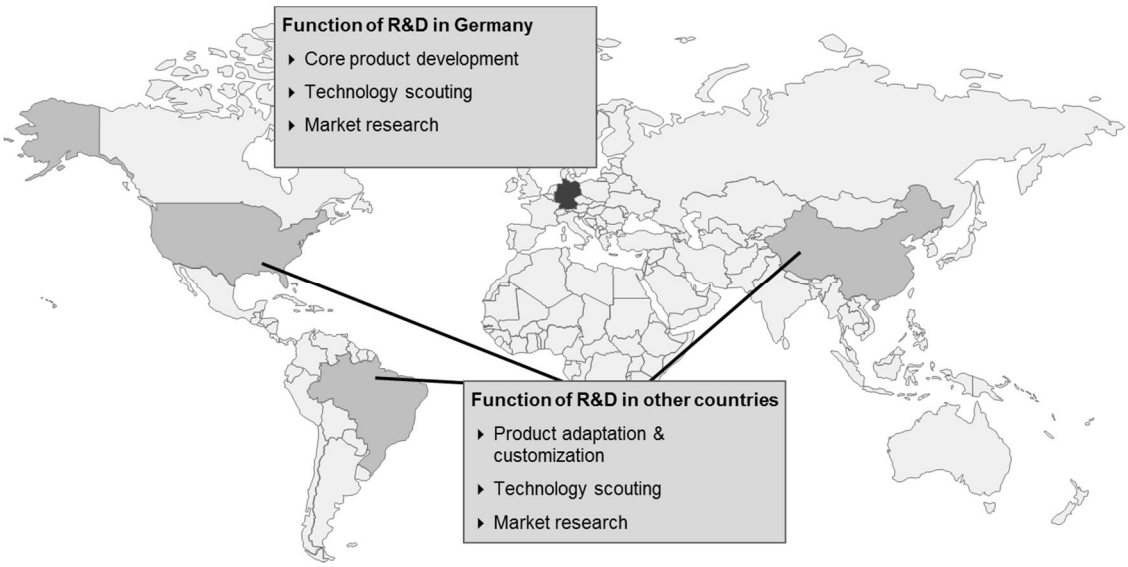
Functions:
Development:
P (product design, core development for products)
A (adaptation and application of products for a specific market)
Research:
T (technology scouting, competitor analysis through reverse engineering,)
S (specific market knowledge)
R (research: advanced engineering, material science, collaborations with universities)
M (processing and production methods)

Source: Author's own table, based on fieldwork and company information

The most important R&D center is located at the VW headquarters in Wolfsburg, Germany (Figure 9). Here, Volkswagen employs the most R&D engineers, and develops all platforms, components, and powertrains within the scope of Volkswagen's R&D. Furthermore, all Volkswagen branded vehicles are designed and developed in Wolfsburg. Prior to the new global vehicle platforms, selected vehicles were developed outside of Wolfsburg. The VW Gol was developed in Brazil, specifically for the Brazilian market but based on the old Golf platform, and the VW Bora and VW Lavida (based on the old Jetta platform) were developed in the two

Chinese joint ventures, FAW-VW and Shanghai-VW respectively. Even in the past, these vehicles were derivative of previous VW vehicles that were developed in Wolfsburg. Since the introduction of the new global platforms, the VW Gol has been discontinued, and newer versions of the China specific vehicles are being developed in Wolfsburg. While the core development of all new vehicles is based in Wolfsburg, adaptations are developed locally. These include such adaptations as exterior and interior design, to accommodate for specific consumer tastes of the Chinese market.

Figure 9: International R&D centers of Volkswagen



Source: Author's own figure, based on fieldwork

The domestic and overseas R&D centers have different functions and roles in VW's R&D process. The main role of the domestic R&D center is the platform development and core product development. The overseas R&D centers have two principal roles: First, to adapt centrally developed vehicles and apply them to each market. Such adaptations include technical specification adaptations to meet government regulations (e.g. emission standards or quality and safety regulations), as well as adaptations to meet the specific consumer tastes (e.g. entertainment systems,

adaptations to language and interface, interior design, chrome and color choice, gear shift preferences, engine size preferences, chassis suspension preferences, seating preferences etc.). The knowledge necessary for these specific adaptations is best created in the local environment through an embedded R&D center close to the customer and regulating body.

The second role of the local R&D centers is to scout for technologies that are specifically developed in these locations. Such scouting activities involved re-engineering of newly launched vehicles from competitors, collaborations with Universities or other institutions in knowledge clusters and market research to understand consumer tastes and trends in the market.

Until recently, Volkswagen had planned to expand its R&D activities in China, to delegate more responsibility and core development to one of its joint ventures for the development of a 'budget car' under a new brand that would allow Volkswagen to compete in low price segments in the emerging economies. In autumn 2014, however, all efforts to localize the project in China were rolled back, and the team was relocated to Wolfsburg in Germany. This shows a clear trend to recentralize core R&D to Germany.

The decision to recentralize R&D in Wolfsburg slowed down the development progress for the budget car. Development costs in Germany exceed its budgets. Even more critical is the German engineering approach or ethos, hindering the development of an affordable vehicle. German engineers are often very enthusiastic about the performance of the vehicles they develop, and concerned about quality and safety issues, leading to overdeveloped vehicles and performance overshoot. Whilst this mindset helped create the outstanding reputation for German cars in general, it stands in the way for budget vehicles that require compromises. For years, Volkswagen has

tried to develop a budget car for the emerging markets, but has continuously failed to do so, as engineers have proved unable to lower the specifications to develop a "good enough" vehicle with a combination of performance and price attractive to the mainstream Chinese or Brazilian market. Even though consumer demand and regulatory frameworks allow lower specified components (e.g. chassis parts, engine duration tests, etc), Volkswagen engineers based in Germany bristle against developing such a vehicle. As senior managers of R&D said, R&D was centralized for three reasons: First, to consolidate R&D efforts after the wave of M&A, second to gain more control at headquarters through the centralized approach to prevent knowledge flows to joint venture partners in China, and third because of the new product architecture of the new Volkswagen group platform design, the MQB, which allows for centralized R&D. The specific activities in each of the R&D centers, divided into product development, product adaptation, technology scouting, market knowledge generation, research activities and process methods, are summarized in Table 3.

The role of suppliers in innovation and development in Volkswagen

Volkswagen proudly presents itself as the world's most innovative and technologically advanced automotive assembler with the deepest knowledge and understanding on a breadth of technologies in the automotive industry, like powertrains, chassis development, powertrain integration, driver comfort, safety and driving experience. With over 20,000 engineers working in research and development worldwide, and more than 5 billion Euro annual budget for R&D, Volkswagen is one of the giants in the industry. None the less, suppliers play a key role in Volkswagen's vehicle development process and add know-how, technology and innovations along the entire value chain. For instance, VW's internally developed and manufactured engine

models require the technology and knowhow of the leading injection system suppliers BOSCH, Continental, Delphi or Denso. With increasingly strict regulation for emission standards worldwide, engines need to be continuous development to become more efficient, a process in which key suppliers play a key role and are deeply involved. The expertise of technology service providers such as Ricardo, a combustion engine and powertrain expert in the industry, are also sought after for ambitious niche products such as the Bugatti Veyron 16 cylinder engine with more than 1,000 horse power. Key suppliers are also deeply involved in non-powertrain technologies, such as control systems, entertainment systems, gear shift systems, steering systems with the aim of enabling VW to develop and build its vehicles to perfection through simultaneous engineering, of the most capable engineers along the value chain.

Hence, supply firms play in important role for the development of new vehicles. For some core systems and components, Volkswagen has to rely on the external knowledge and expertise of the supply firms. Most components are not readily available on the market, but have to be customized for the specific vehicle. Due to the integral nature of the vehicles, supply firms are deeply involved in the overall vehicle development process. This is because any adaptations to one component can influence the performance and functionality of another. The more performance oriented the vehicle, the higher are the interdependencies between components. Because of such interdependencies, engineers from Volkswagen and the supply firms of integral components and systems need to be in constant exchange throughout the vehicle development process. Due to the outsourcing of non-core activities and the increased R&D capabilities in the supply base, key suppliers are involved in the development process from very early stages on. Some firms are involved even before the vehicle development process, during the strategic decision process of what vehicles to develop.

Especially suppliers with own strong R&D competencies and innovative products are integrated at all stages.

The integration and involvement of supply firms in the vehicle development process happens at different stages, depending on the integral nature of the component. The nature of the component defines the role of the supply firm and its development capabilities. For highly integral components that are predominantly developed by the supplier, supply firms are involved into the vehicle development process from the first day. Components with fewer interdependencies require less knowledge exchange. Supply firms of such components are involved at later stages of the process.

Suppliers with specialized capabilities and knowledge underpinning important components are integrated early on in the product development process, or even in the strategic decision process prior to the vehicle development. Volkswagen differentiates between four types relationships with suppliers: innovating, developing, 'produce as per blueprint', and commodity suppliers. What is essentially driven by the technological requirements and manufacturing processes for the components, also correlates to the different capabilities of the supply firm, its strategic position in the value chain and the characteristics of the product.

Suppliers that independently develop own innovations, ideas and technologies and pitch them to Volkswagen, 'push' their innovative capabilities, and are involved in the vehicle development process before concept design phase (Figure 10). Examples of such innovations are anti brake locking systems (ABS), which was first developed by a supply firm before it eventually became industry standard. Such innovating suppliers are of strategic importance to Volkswagen, because they can add new innovative technologies to the vehicles that help differentiate from the competition. Such innovations can occur in a wide variety of components, from interior or exterior design

like lightning technologies for LED solutions important for the body, to important powertrain technologies like injection systems to increase the engine efficiency, reduce fuel consumption and lower CO2 exhaustion. Supply firms that 'push' their innovative ideas and technologies to the assemblers are ahead of the assembly firm in terms of innovation for their respective component. Maintaining a good relationship and offering opportunities to add superior new technology to premium vehicles (Porsche and Audi), combined with the potential to expand the use of the technology to volume brands of Volkswagen, Skoda and SEAT, are key factors for VW to be the most attractive first buyer for such technologies. However, it is the supply firm that can chose its first customer that introduces the new technology to the market.

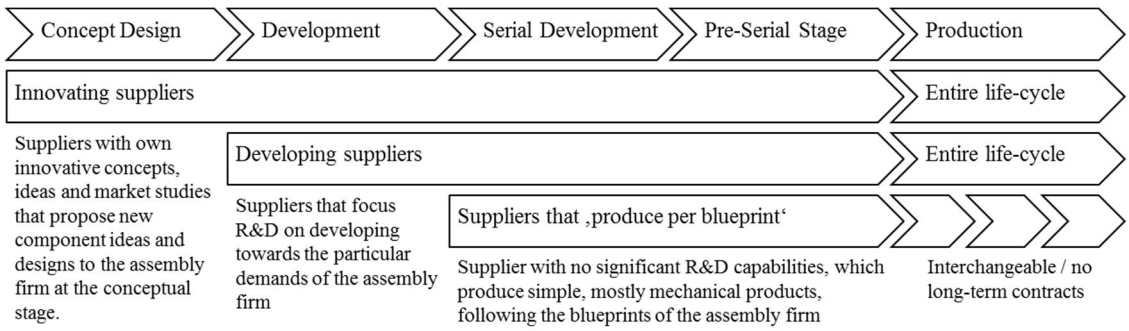
Developing suppliers are such that have superior component or system knowledge and develop their components or systems independently from the assembler. All technical drawings are made at the supply firm, and Volkswagen is dependent on their development capability. Volkswagen ‘pulls’ the product development capabilities from such supply firms, to use their expertise to co-engineer the newest components with the combined expertise of the assembly firm and the supply firm. In this case the assembler lays out the features and specific requirements and requests the supplier to develop components for the next generation of vehicles. The developing supply firms are involved in the development process after the concept decision milestone (Figure 10).

Produce per blueprint suppliers are such that have no development capabilities. Technical drawings and designs are made and provided by Volkswagen, and the supply firm only manufactures the components. Suppliers of relatively simple, mostly mechanical, products receive blueprints from Volkswagen as sub-contractors, to manufacture the components as per the blueprint that has been developed from internal

engineers. The components are developed and designed by Volkswagen. The supply firm has no to little own design and development capabilities, and focuses solely on the manufacturing of the component. These firms are only involved in the later stages of the vehicle development process when first prototypes are built, and when tooling is prepared for the mass production and first mass produced prototypes and attempts have to be performed, around 24 months prior to start of production (Figure 10).

Finally, supply firms of commodities such as chemicals or steel, which supply standardized materials, are involved only 12-24 months prior to start of production, to ensure availability of the material (Figure 10). However, as the properties for the materials are known, and no customization or adaptation has to be applied at the supply firm, such suppliers are not involved in the vehicle development process.

Figure 10: Involvement of supply firms in the vehicle development process



Source: Author’s own figure, based on fieldwork

The majority of R&D activities has been centralized within Volkswagen. All platform and core product development occurs at headquarter in Wolfsburg. Only adaptations are applied in the regional R&D centers. For supply firms involved in the R&D process, this means that regular meetings for knowledge exchange and regular testing of prototypes happens in Wolfsburg. For highly integral components or systems,

the engineers of the supplier meet with Volkswagen's engineers as often as once a week. This requires the suppliers' R&D center to be in close geographic proximity to Volkswagen, for an efficient simultaneous engineering process.

Both, innovating and development suppliers are considered strategic, as they have capabilities that are required for a successful vehicle development, and are not within the boundaries of Volkswagen.

With the distinction of supply firms, Volkswagen can select the most capable supply firms to take on new activities and extend their role in the value chain. For instance, the most capable supplier of the most complex door component is selected for the assembly of the door. In addition to developing and manufacturing its component, this supplier then orchestrates the upstream value chain including other door components, and takes on the role of a module supplier. Similarly, key supply firms are selected to expand their production and serve Volkswagen in additional countries or regions.

Volkswagen furthermore categorizes supply firms according to performance. If supply firms do not perform as well as their benchmark, but are critical to Volkswagen, supplier development programs are offered. Such programs include consultation for process optimization, upgrading manufacturing capabilities or reviewing development capabilities. Through regular audit visits of its supply firms, Volkswagen gains a good overview of what capabilities individual supply firms have.

As the vehicle platforms have been reduced to just four global platforms, all core activities happen centrally. Hence, a globally centralized governance and purchasing strategy was implemented, where all major decisions are made at the location of the R&D activities of the global platforms, at HQ in Wolfsburg, Germany. This is in stark contrast to the earlier development and purchasing strategy, which was

more localized, and in which both, Brazil and China had much larger responsibilities than what they have today.

Volkswagen's approach to value chain governance

With the introduction of the new platforms, regional vehicle platforms and adaptations like the BX-platform used for Brazilian vehicles are eliminated. The competitive advantage of the new platform is the utilization of economies of scale for components, as it enables Volkswagen to drastically increase the number of carry-over parts, (components that are standardized and can be used in several vehicles). Before the new platform, components had to be newly developed or adapted for specific vehicles. "The new platform works like a shelf, in which we can put all the developed components. If we develop a new vehicle, we can simply take the existing components and fit them together for the new car. A bit like LEGO" (Interview, Volkswagen case). According to VW, the target is to reach a standardization rate of approximately 70% (in value), thereby decreasing the R&D expenses by 30% (Interview, Volkswagen case). The implications for purchasing are massive. The purchasing strategy is closely linked to the product architecture because of the integrated nature of the product. The use of common parts, the rate of standardization and modularization of components and the global use of components are made possible by the product architecture and change the requirements for supply firms. As the number of platforms has been reduced to just four, and the use of standardized platforms has been globalized, so has the procurement strategy. Instead of purchasing different components for each vehicle and the different markets, the exact same component can be used globally. Consequently, the Volkswagen group has gradually centralized its procurement processes since the late 1990s in conjunction with its product architecture evolution and introduction of global

vehicle platforms. Volkswagen harmonized its global purchasing strategy to meet the requirements of the new platform strategy, avoid parallel development of the same component in the markets and further enjoy the benefits of economies of scale. What has been a gradually evolving strategy now peaks in a global unified purchasing strategy (Figure 11). With global platforms in place, common parts can be sourced world-wide. To achieve maximum economies of scale, few global supply firms are selected to supply the common parts to all of Volkswagen's production sites world-wide. In particular for highly customized components and systems, this approach enables the company to reduce development expenses. With increasingly global supply firms, the purchasing strategy has to be global as well, in order to achieve the efficiency outcomes for the platform strategy.

The purchasing strategy follows the vehicle development process, because of the different roles of supply firms. A close collaboration and joint development during the R&D phase is necessary to produce reliable and safe vehicles. Important procurement decisions are made during the R&D process, such as selection and nomination of strategic suppliers for the entirety of the seven-year product life-cycle. Hence, the purchasing strategy follows Volkswagen's R&D process.

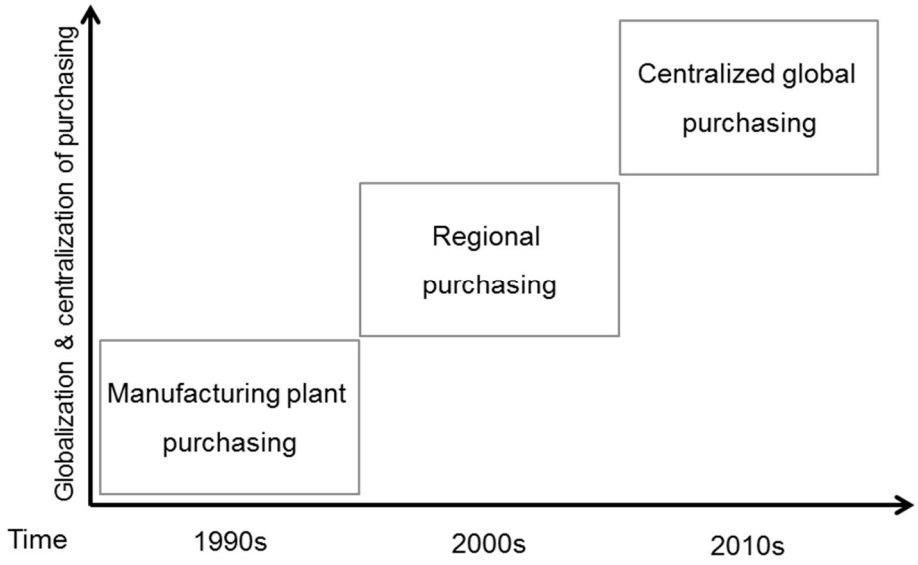
From regional to global purchasing

Before the introduction of lean manufacturing techniques in the 1990s, every manufacturing plant was responsible for its own sourcing of parts and components. Very few vehicles shared their platform with others, which meant the number of carry-over components was small and each production line could only produce one specific vehicle. Components were sourced from local supply firms, depending on the demand of the individual production plant. There was no central coordination or alignment of

the supply base across multiple production plants, unless they were in close geographic proximity to one another. With the introduction of the PQ platforms, several vehicles were based on the same shared platform and several production plants needed to purchase the same components for the first time. Consequently, sourcing changed from plant-based to regional responsibilities. Wolfsburg purchased the components for all of Volkswagen's production plants in Europe, Ingolstadt the components for AUDI branded vehicles in Europe, Sao Bernardo do Campo the components for Latin America, ChangChun the components for the joint venture with the Chinese assembler First Automotive Works (FAW) and so on. This was already a major step to increase the benefits of economies of scale in the supply base, and to start building a common supply base for the large production regions.

With the introduction of the global platforms MQB, MLB and MSB, the purchasing strategy was further centralized globally in 2012 (Figure 11). All the important decisions for the markets are made at headquarter, and all suppliers are nominated by the central committee at Wolfsburg, undergoing a standardized system of requirement checks, firm visits, quality improvement processes and alignment of supply chain systems before approval. All the important negotiations with the supply firms for any location in the world now occur at the headquarters of the Volkswagen Group in Wolfsburg, Germany. Through the centralized approach, Volkswagen further increased its bargaining power over supply firms, as they now negotiate for larger batch purchases that often span across multiple continents. This is made possible through the increased number of common parts across different vehicles and across all countries.

Figure 11: Evolving purchasing strategies of Volkswagen



Source: Author's own figure, based on fieldwork

Cornerstones of Volkswagen's global purchasing strategy

The new supplier strategy includes a set of targets, e.g. to reduce to total number of suppliers in order to decrease complexity of supplier relationships and to increase the economy of scale effects for its suppliers, while simultaneously following a strict multiple supplier strategy, which means that VW aims to have at least two, better three capable suppliers for each component, as to reduce the dependency on one supplier and to increase the competition among the suppliers.

Four principles were introduced with the global purchasing strategy. First, the introduction of a new central sourcing committee, across the twelve brands of the Volkswagen group and involving representatives from several departments. Second, the reduction of supply firms for any particular component by developing global suppliers that are present at all production hubs. Third, and somewhat in contrast to the first, a multiple supplier strategy in order to remain independent from the suppliers and to maintain the competition between suppliers. And fourth, a local-to-local strategy to increase the localization of parts. In order to reduce risks from supply chain delays and

to hedge against currency fluctuations, parts should be produced in close geographic proximity to Volkswagen's assembly lines. In the following, the objectives and enforcement mechanics of each of the principles are explained.

In the current global purchasing strategy, VW installed a central sourcing committee at headquarters in Wolfsburg, through which all supplier nominations and supply contracts go, allowing the firms to compare and contrast the quality, price, capabilities and long standing relationships of all the firms that supply components to the VW group. Through the new strategy, VW centralized all important decisions regarding its supply chain, and moved the decision power to its HQ in Wolfsburg. The new strategy extends beyond the Volkswagen brand, and includes all currently active 12 brands. The central sourcing committee enables Volkswagen to truly globalize purchasing. It includes senior managers from several departments, such as purchasing, research and development, production, quality, finance, and representatives from the brands, to synthesize supplier databases, cost comparison across brands and regions, and previous experiences with supply firms to create a single point of purchasing. "We want one face to the supplier, so that all negotiation are done with the same people who have all information and full transparence before the purchasing decisions. Through the committee, we can finally compare prices and negotiation practices across all brands" (Interview, Volkswagen case). "Everyone important sits in those meetings. It is torture for our suppliers, if someone is not happy." (Interview, Volkswagen case). The committee is responsible for all the important decisions for all the brands and all markets.

Through the centralized approach, Volkswagen can bundle its power at headquarter in Wolfsburg, where the committee meets. Supply firms can only be nominated after going through a standardized process of requirement checks that

include firm visits, quality improvement processes and alignment of supply chain systems. Key negotiations with the supply firms take place at the headquarters of the Volkswagen Group in Wolfsburg, Germany. This enables the Volkswagen group to standardize and compare all supply firms practices, and prices globally.

The second principle of the new purchasing strategy is the reduction of supply firms. The purpose of the reduction of supply firms is first, to further increase the economies of scale and increase Volkswagens bargaining position, second, to decrease complexities in the supply chain, third, to harmonize sourcing globally (i.e. selecting one supply firm to supply to all production hubs world-wide), and fourth to restructure production of key components so that the most capable and qualitative supply firms are responsible for strategically important components. This has been enabled through the new product architecture and global purchasing strategy. Through the introduction of globally standardized components, Volkswagen can source components for all its over 100 production plants from a single supplier. This has several advantages for Volkswagen. First, it reduces the complexity of knowledge transfers necessary during the simultaneous engineering process of new vehicles. Furthermore, Volkswagen can ensure quality standards and functionality are met for all components. A single source for one component increases the benefits of economies of scale. The complexities involved in orchestrating and controlling its global supply chain and supply firms are also reduced. Finally, Volkswagen increases its bargaining power with the increased volumes per purchase for individual suppliers. “We can now negotiate prices for orders to all our plants worldwide, which increases the magnitude of a single order and puts us in a strong position” (Interview, Volkswagen case).

Reducing the number of supply firms is achieved in two ways: First, by reducing the number of individual components to be used for the assembly of vehicles. This is

achieved through the higher number of carry-over components, and by combining individual components to modules. Volkswagen allocates additional activities such as sub-assembly to the most competent supply firms, to move from components supply to modules that are then shipped to the assembly plant. Second, rather than nominating different supply firms to supply the same component in the different regions, Volkswagen can nominate one firm to supply to all of its over 100 production plants worldwide. Internal documents at Volkswagen showed that Volkswagen was able to reduce the average number of suppliers for any particular component from above ten in the early 2000s to as few as two to three worldwide in 2014.

In contrast to the reduction of direct suppliers, Volkswagen also introduced a multiple-supplier-strategy, which means that they want to have at least two, better three supply firms for every component. The multiple-supplier strategy reduces risks in the supply chain, as it makes Volkswagen less dependent on a single supply firm in case production is disrupted because of natural disasters or bankruptcies of supply firms. For a lean production system with close to zero stock and just-in-time delivery, such failures in the supply chain can quickly have critical consequences. Mitigating such risks has become a major concern for large manufacturing firms. Having two to three supply firms enables Volkswagen the flexibility of maintaining volume purchases on the demand side without the risk of bankruptcy of a supply firm. While this seems to counter the abovementioned strategy to reduce the total number of supply firms, it has become an important cornerstone and necessity after the experience of the tsunamis that hit Japan in 2011. The tsunami eradicated key supply firms in the value chain that proved very difficult to substitute. Moreover, the multiple supplier strategy allows Volkswagen to strengthen its bargaining position and compare prices with multiple active supply firms. Through the combination of the two strategies, the reduction of

globally active supply firms together with the multiple-supplier-strategy, Volkswagen creates a global competition of globally active supply firms in its supply base, rather than the previously regional orientation.

To achieve the global harmonization of its supply base, Volkswagen follows a strict local-to-local strategy, through which Volkswagen localizes as much value added activities in the value chain as possible. The local-to-local strategy enforces that the production of components is in close geographic proximity to the Volkswagen assembly plant. This allows smooth transportation, which is important for just-in-time and just-in-sequence delivery of a lean production system. Moreover, large local content ratios make Volkswagen less dependent on exchange rate fluctuations and the global macroeconomic environment. It is also important in countries with high import duties. The local-to-local strategy requires the supply firms to operate internationally and to develop a footprint in all the regions Volkswagen produces (on all continents). The strategy is enforced in two ways: First, one of the selection criteria for supply firms is to have a location in close proximity (less than 300 km) to the supplied manufacturing plant, which in the case of carry-over components, require the supply firm to have maintain the capabilities in close geographic proximity to most manufacturing plants of Volkswagen globally. Second, Volkswagen actively incentivizes existing supply firms to localize production in close proximity to their global manufacturing sites by offering long-term supply contracts in the new locations. Volkswagen may not renew contracts with firms that are not able to comply.

Supplier selection criteria and strategic role for Volkswagen

Supply firms are selected on a project basis, to supply parts and components for the production life cycle of a vehicle. When a new vehicle is rolled-out into production,

an assembly plant is selected for the pilot roll-out, followed by additional assembly plants, including international plants, to ramp-up production to the expected volume. The supply firms are selected by the central sourcing committee for the particular project prior to start of production (SOP): "Our purchasing is oriented by individual projects. A project can be for a platform, when the engineers develop a component that is used across all vehicles of the platform. Or, it can be for a vehicle, if components are developed for a specific vehicle, like body parts. Where the new vehicle is rolled out does not matter, because all the lead developers are in Wolfsburg [Volkswagen's headquarters]… Our purchasing department is responsible for all purchases world-wide." (Interview, Volkswagen case). Most supply firms are selected for the entire production life cycle, especially if they are innovating or developing firms. Produce per blueprint and commodity suppliers may be swapped during production.

The purchasing department has developed a supplier-matrix to distinguish between strategic relevant and less relevant suppliers, and to document the capabilities and competencies of each supplier (Table 4). Strategic relevant supply firms are all firms with innovation and development capabilities, as these firms have capabilities that Volkswagen depends on during its vehicle development process. Such firms are highly integrated in the R&D process, have regular exchange with Volkswagen and are difficult to substitute or change. Volkswagen therefore develops an intimate relationship with such supply firms, to ensure their services for the future. Long-term supply contracts are the norm for such suppliers. Produce per blueprint suppliers and commodity suppliers are easier to substitute or change, and therefore often have short-term contracts. The table below summarizes and exemplifies the supplier categories.

Once running, the mass production of vehicles runs relatively smoothly and requires only few and small updates and efficiency programs. Therefore, key supply

chain decisions and integration of the supply firms occurs during the previous product development phase.

Due to the dynamics in the R&D process, the developing engineers have a significant impact on the final decision of supply firms of innovating and developing suppliers. Because of the close interaction during the vehicle development process, the role the development engineers at Volkswagen play in the supplier nomination process for the group of developing suppliers is decisive. Well-functioning engineering teams with good relationships are important. To ensure well-functioning teams, the engineers working on a project can effectively select the involved supply firms. Furthermore, the Volkswagen engineers get deep insights into the specific capabilities of the supply firm – with a strong impact on the choice of supply fir for the next project. If the Volkswagen development department made good experience with a particular developing supplier, it will want to resume working with the supply firm. This way, the supply firm can develop strong ties with the assembler, and win follow-up projects that are out of the scope of its contracts, significantly strengthening the ties between the two firms. The developing engineers of Volkswagen and the supply firm work closely together during the development phase of the project. Through weekly meetings, relationships are developed.

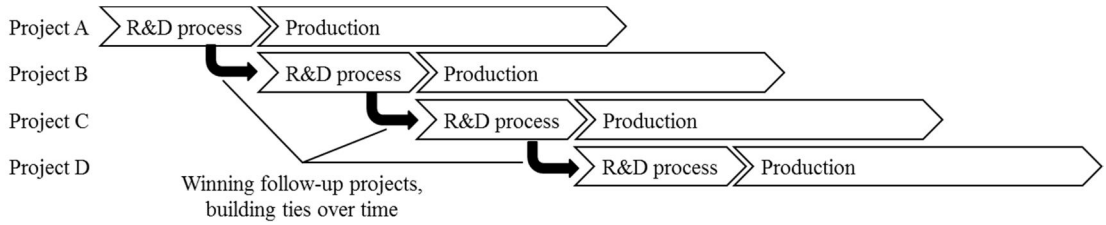
Table 4: Supplier categories and relevance to Volkswagen

Supplier category	Exemplary component	Exemplary supply firm	Supplier characteristics	Involvement in R&D	Strategic relevance
Innovating suppliers	New innovative products: ABS, driver assistance systems, lighting solutions	BOSCH, Marquardt	Often large multinational enterprises; some niche manufacturers	48-60 months prior to start of production (SOP)	Highly relevant
Developing suppliers	Technologically demanding parts & systems: interior parts	Fuyao, Yanfeng, Witzenmann	Mostly large multinational enterprises	36-48 months prior to SOP	Relevant
Produce per blueprint	Mechanical components: white body parts, engine mounts	ASIMCO, CIE Automotive	Mostly local enterprises, some multinationals	12-24 months prior to SOP	Little relevance
Commodity suppliers	Steel, chemicals, nuts and bolts	BASF, ThyssenKrupp	Often large multinational enterprises; some local enterprises	12 months prior to SOP	Little relevance

Source: Author's own table, based on fieldwork

Once the project is over, the engineers' team will immediately be allocated to new projects. With over 200 vehicles, Volkswagen has a full pipeline of future development projects, which start immediately after one project phases out (i.e. after start of production). The engineers that were involved in project A now take on project B, and take with them their relationships to the core supply firms and their experience with them, influencing which firms to nominate for the new project (Figure 12). The longer the supply firm is involved during the simultaneous development process, the stronger the relationships that are established. New supply firms may be proposed by procurement department, but it is the engineers that have the final say, and new firms have very little chances of winning a development project.

Figure 12: Building buyer-supplier ties over time



Source: Author's own figure

The influence of the developing engineers erects barriers of entry for new entrants to the supply industry. New entrants need to gain the trust by the engineers, and develop good working relationships, in order to become part of the "inner circle" and be recognized as value experts and partners during the simultaneous engineering project. However, first entry is often prohibited by the selection of incumbent supply firms. Especially supply firms from the emerging markets such as Brazil or China that tend to lack a good reputation, are rarely considered as potential suppliers from the developing engineers.

Supply firms that are not involved in the vehicle development, i.e. parts per blueprint suppliers, commodity suppliers, or even developing suppliers of components that require little knowledge exchange between engineers due to the few interdependencies to other components, do not enjoy such advantages. For such supply firms, the engineers have much less say during the selection process, so that the procurement and quality departments can make the final call. Such suppliers are selected based on price, and are governed by a price-mechanism. Therefore, it is easier for new entrants to enter the value chain in this group, but difficult develop ties with the assembler to win follow-up projects.

Volkswagen's supplier development program

Volkswagen has established a supplier development program, through which it can support its supply firms to become more efficient, adapt to new technologies, upgrade its processes, or to take on new activities within the value chain. Through annual audits and firm visits, Volkswagen is well aware of the capabilities and challenges of its supply firms. The data on supply firms is further enhanced by open-book relations to most of its smaller supply firms. Volkswagen can identify development gaps in its supply base. By mapping all supply firms according to strategic relevance and capabilities, Volkswagen can identify the most relevant cases for further development, or identify possible candidates to take on new responsibilities and tasks in the value chain, for instance when components are combined to be supplied as a module in the future.

The supplier development program works like a consulting service from the assembler to the supply firms. Volkswagen sends expert teams to the supply firms, for instance to establish shop floor management tools, or upgrade the processes of the supply firm. Rather than charging the supply firm for the services, Volkswagen offers them free of charge. The supply firm agrees to share the gains made from the increased efficiency. Supply firms that receive the services are able to upgrade their processes or products, or even value chain activities, if chosen to perform new tasks.

Through its supplier development program, Volkswagen can increase efficiency in the supply base, and has a better grip on actively coordinating the activities within the global value chain, by allocating specific activities to the most capable supply firms.

Collocating supply firms in new markets

When entering a new country with manufacturing capabilities, Volkswagen aims to build up a local supply base. Localization of Volkswagen's production capabilities is a gradual process. It starts with CKD (complete know-down) plants, to which fully finished vehicle kits are shipped for final assembly. This if followed by a gradual localization of components and parts production. As a mass producer, VWs strategy is a strategy of economies of scale. Localizing production is only feasible if large volumes can be expected. For new Greenfield investments in assembly plants, Volkswagen has developed a standardized blueprint for production facilities that follows a ramp-up in two steps. The final manufacturing plant consists of two identical, mirrored production sites. At first, only one half of the production site is gradually built, until it reaches its capacity limits. If further production increase is expected, the second half is built. The final facility has a production capacity of approximately 300,000 vehicles annually under full load.

Throughout the gradual ramp-up of assembly capacities, Volkswagen starts the localization of parts and component manufacture. In the past, localizing the production of components has been mostly driven by national policies that incentivized a high ration of value-added activities in the target country. For instance, Brazil gradually increased the local content requirements, so that other components or vehicles can be imported without free of import duties. With the introduction of the global purchasing strategy, Volkswagen shows its own interest in building a local supply base.

Establishing a local supply base can be done in two ways: First, the assembler can nurture existing local supply firms so as to enable them to meet its technological and quality requirements. Second, the assembler can incentivize its existing supply firms from abroad to collocate to its new manufacturing location. As purchasing managers explained, the second option is favored: "We try to bring our own supply

firms wherever we go… When we bring our own suppliers, they already know exactly what we need… We have made a good experience with them. We know they can meet our requirements. [Brining our own supply firms] is faster and easier for us, than establishing or helping local supply firms." (Interview, Volkswagen case). Collocating existing supply firms to new production hubs has several advantages for Volkswagen. First, it is much faster than nurturing new supply firms. Developing a new supply firm to become an audited and qualified supplier takes years, according to Volkswagen interviewees. Second, it requires less development effort by Volkswagen, as the supply firm already has all the capabilities required for the production. If existing supply firms are collocated, they are responsible for establishing the required knowledge, skills and capabilities. If Volkswagen nurtures new supply firms, Volkswagen has to localize such capabilities. Third, collocating existing supply firms requires less knowledge transfer and coordination of supply firms, and supports Volkswagen's strategy to reduce the number of global supply firms.

Inter-firm dynamics between supplier and assembler

The role of the supply firm for the vehicle development has important implications to the bilateral relationships between Volkswagen and the supply firm, and the nature of the contracts between the two firms. The four different categories, innovating, developing, produce per blueprint and commodity suppliers, are handled differently be the assembler.

Supply firms with own innovation capabilities are of highest strategic relevance. The assembler firm that first brings those externally developed technologies to the market has a competitive advantage. Hence, Volkswagen has a great interest to be the assembler of choice for such supply firms. While Volkswagen has no power to control

the decision of the supply firm, it can incentivize the supply firm to select Volkswagen as first customer, e.g. by offering attractive contracts with prestigious and trendsetting premium brands like Porsche and AUDI, for initial launch to the market, in combination with long-term contracts with mass volume brands for Volkswagen, Skoda and SEAT for later volume production.

Supply firms with own strong R&D capabilities but no innovation capabilities are also of strategic relevance, not as a source for differentiating technology, but as a key partner in the R&D process. Such supply firms are more difficult to be substituted by competing supply firms, because they customized their components to the particular needs Volkswagen, and own the intellectual property rights and drawings for the components. As these firms have large upfront investment costs, they also receive long-term contracts for the full duration of the production life cycle of a particular vehicle. Produce per blueprint, on the other hand, are of little strategic relevance, as they can be easily interchanged. The highest investment for this group is the tooling, which is owned by Volkswagen and not the supply firm. Hence, these firms mostly receive shorter contracts, and are governed by an arms-length price driven mechanic.

Due to the early involvement in the vehicle development process, and their high investment costs for components that are specifically designed for a particular vehicle, innovating and developing supply firms categories can negotiate long-term contracts. The earlier the supplier is involved in the process, and the more R&D capabilities it has, the longer is the contract, often spanning over the entire vehicle life cycle to allow the supply firms to reach a return of their investments and maintain the high investment costs for new technologies and innovations.

Supply firms in the produce per blueprint category are of least strategic relevance. Such supply firms have no own R&D capabilities, and therefore little to no

IPR for the component they are supplying. The drawings and often tools required for manufacturing are provided by Volkswagen. The knowledge-transfer between the two firms is one-directional, and the knowledge can be digitized in the form of precise drawings. Very little exchange is required between the two firms. Hence, such sub-contractors receive contracts for manufacturing services that have no differentiation from other manufacturing service firms. The barriers of entry are low, and the firms are relatively easy to substitute. With no own firm specific advantage, such supply firms have no bargaining power. As a result, firms in the produce per blueprint category are governed via hands-off price mechanism. This entails little interest of Volkswagen to establish long-term relations or to upgrade such supply firms through supplier development programs.

Finally, commodity suppliers fall into two different distinct categories. Some commodity suppliers, in particular such that offer internationally standardized commoditized components such as nuts and bolts, are small and often local companies in close proximity of manufacturing hubs. Such supply firms are governed the same way as the produce per blueprint category supply firms, even though no drawings are required from Volkswagen. Hence, even less knowledge transfer between the firms is required. Commodity suppliers of mass materials like steel or chemicals, on the other hand, are governed differently. These supply firms are multinational firms like ThyssenKrupp or BASF with large scale manufacturing capabilities, to produce sheet steel or car paints with specialized chemicals. Specialized metal alloys or plastic raisins with particular characteristics require IPR and can therefore often be produces by only a handful of firms. However, unlike multinational automotive supply firms, the commodity suppliers are more diverse, supplying multiple industries and being less dependent on a single automotive assembler. Assemblers such as Volkswagen make

only few percent of their sales. Therefore, automotive assemblers have less bargaining power over such firms, compared to auto component suppliers. Prices are mostly determined by global market prices, rather than dictated by the assembler. And since very little knowledge transfer is required for such commodities, the inter-firm ties are lose and resemble hands-off market driven relations.

Participants in the value chain: Supply firms from the advanced markets

BOSCH

The BOSCH GmbH is a German firm producing white goods, industrial equipment and automotive components. The company was founded in 1886 by Robert Bosch, and is one of the oldest automotive suppliers in the world. The automotive division of BOSCH is the largest automotive component supplier in the world, with a revenue of 51.4 billion US$ (43.9 bn EUR) in 2016. As the largest supplier, BOSCH surpasses some of the well-known assembly firms such as Kia (approx. 47 bn US$) or Suzuki (approx. 26 bn US$).

BOSCH's automotive division produces key components such as gasoline systems, diesel systems, chassis control systems, brake control systems, sensors, airbag control systems, driver assistance systems based on radar and video sensors, starter motors, entertainment and multimedia systems, electronics and steering systems. With new business units in automated driving, connected vehicles, electronic powertrain and automated manufacturing techniques through Internet of Things technology, BOSCH is developing new products to adapt to the ongoing technological revolution in the

automotive industry.

Global turn-key suppliers like BOSCH have developed a global footprint that is on par with the largest assembly groups, and have turned into lead-firms in their own upstream value chain, with powerful positions over supply firms in the same way as large assemblers. In 2016, 80% of BOSCH's revenues were made outside of Germany, with 20.8% made in the Asia Pacific region, 18.6% in the rest of Europe, 12.3% in North America and 1.4% in South America. The company has around 440 subsidiaries in 60 countries, highlighting how global the company is. Its automotive division is active in all important production hubs in the world, with production plants that are in close geographic proximity to the major assembly lines. The interviewees have highlighted the importance of the global footprint as a competitive advantage to be selected by assemblers as a global supplier. .

BOSCH is a developing and innovating supplier. As a developer and producer of key automotive modules and components of highly integral nature like anti-lock braking systems (ABS), or engine injection systems, BOSCH has a very close working relationship with assemblers such as Volkswagen, and acts as the "glue" that holds together the value chain. With 8.137 billion US$ (6.959 bn EUR) spending in R&D, BOSCH is one of the most R&D intensive companies in the world, and a key innovator and developer in the automotive industry.

BOSCH adapting its R&D process to sync with Volkswagen

With the increasing shift in demand for globally standardized components used for global vehicle platforms, BOSCH needed to adapt its operations to the new market realities. When one of the most important customers, Volkswagen, changed its purchasing strategy, demand shifted from regional adapted components to globally

standardized. Reacting to these changes, BOSCH adapted its global R&D and production configuration, and subsequently introduction of the global purchasing strategy to reflect the operational changes. R&D of core platform development was centralized, and production plants reconfigured, so that BOSCH is able to comply to the local-to-local policy of its customer.

BOSCH is one of the most innovative companies in the automotive industry, with close to 10% of its revenue being reinvested into R&D. The market for BOSCH's products is very different from that of finished vehicles. Vehicles are first developed and finalized, and then sold to individuals with predefined performance, functionality and features. System components, on the other hand, need to be customized to the client's needs (i.e. the vehicle in which they are to be used), and need to meet the clients performance and functionality requirements before being sold. This requires intensive exchange between BOSCH and the potential buyer during the vehicle development process. Once a project is won, and the client is satisfied with the product, the component is ordered for the entire production cycle of the vehicle, i.e. one supply contract is worth millions in terms of volume and value, and extends over years. Naturally, the customization process needed to be aligned with its customers, as BOSCH needs to be able to meet deadlines and start of production of the vehicle. The adaptation and customization of the component, however, is decoupled from its core development.

Because of the different nature of the market for components compared to vehicles, the R&D process of BOSCH differs from that of Volkswagen. While the R&D process of Volkswagen is linear, in the sense that first the vehicle is development, and then put on the market, the process for firms of highly customized products is split into two different processes: First, core platform development, independent of the client and

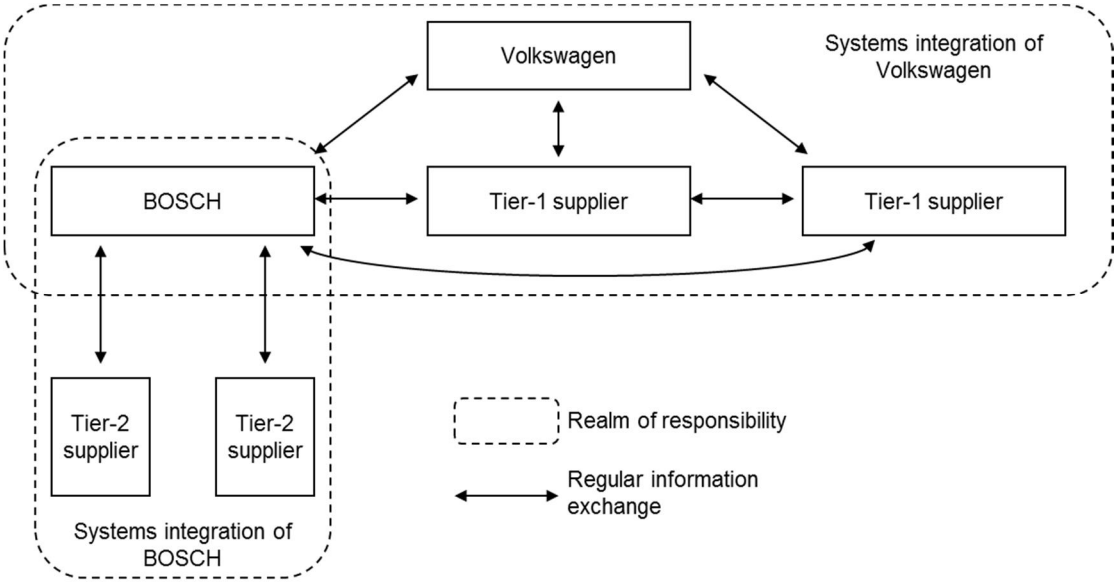
vehicle requirements, and second product customization and development in close interaction with the client. For instance, the capability, knowledge, intellectual property (including patents) and core products (hardware and software) for driver assistance systems was developed independently from the assemblers, in the core platform development process. Once developed, the new product can be pitched to assembly firms. But before being sold, it requires intensive customizing for each specific vehicle.

Once a completely new component has been developed, BOSCH can chose which client to first approach with the new product. Since some products have an impact on customer perception of the final vehicle, assemblers tout for such innovative components to be selected first and bring new innovations in their vehicles to the market. This is in particular the case for premium vehicles that differentiate via innovative features. BOSCH is therefore an innovating supplier, that develops new products and features for vehicles. In the past, such innovations included control systems like ABS, flexfuel systems that allow use of ethanol as a substitute for gasoline, or innovations in the injection systems like high pressure diesel injection systems with high frequency controlled injections for optimal performance.

Once the core platform for a product is developed, it can be marketed to the assemblers. Since almost all components of BOSCH are highly integral in nature, a high level of customization is required to successfully integrate the component or system into the overall vehicle. This is when the second development process begins, that of customization and adaptation to the specific vehicle requirements. This process is in synchronized with the vehicle development process of the assembler. Because of the integral nature of the components, adaptation and vehicle specific developments begin approximately 3-4 years prior to start of production. In Volkswagen's vehicle development process, this is during the concept and development phase, at the very

beginning of the process. Most of BOSCH's systems and components (e.g. injection systems, control systems) have two-way interdependencies to other components. This means that other components in the vehicle that are not necessarily developed by BOSCH influence the performance of BOSCH's product, and vice-versa. For instance, driver assistance systems require configuration with other components such as chassis architecture, bumpers, engine, differentials, tires, and other drive control systems. All these different parts and systems influence each other's performance. But they are developed by a number of different companies that come together for the development of the final vehicle. The interdependencies require BOSCH's engineers to be in regular exchange with both, engineers from the assembler as overall systems integrator, and the engineers of other suppliers of core systems. Furthermore, BOSCH needs to be in contact with its own suppliers throughout the development process, in case internal components have interdependencies with other components within the product of BOSCH or even with the systems and components of other supply firms. For the development of its own products and systems, BOSCH takes on the role of systems integrator, thereby linking the upstream development activities with those of Volkswagen's overall systems integration (see Figure 13).

Figure 13: Interaction during the vehicle development process



Source: Author's own figure

Through the ongoing modularization of the vehicle architecture, the task of systems integration has been pushed down the value chain to the tier-1 suppliers. Supply firms of modules are increasingly responsible for entire systems rather than individual components. Hence, supply firms such as BOSCH increasingly take on more systems integration activities. "We now handle more suppliers during development phases, compared to the past… We supply systems instead of components. Steering systems, not hydraulic parts for steering support. Gasoline systems, not nozzles and pumps… Because of this, we now have to develop in the same way [as assemblers], and work together with multiple component and material suppliers" (Interview, BOSCH case).

Configuring the international R&D activities

Bosch has a very international R&D structure, with 13 R&D locations in total, of which 5 are in its home country Germany, and 8 in foreign locations in China, India,

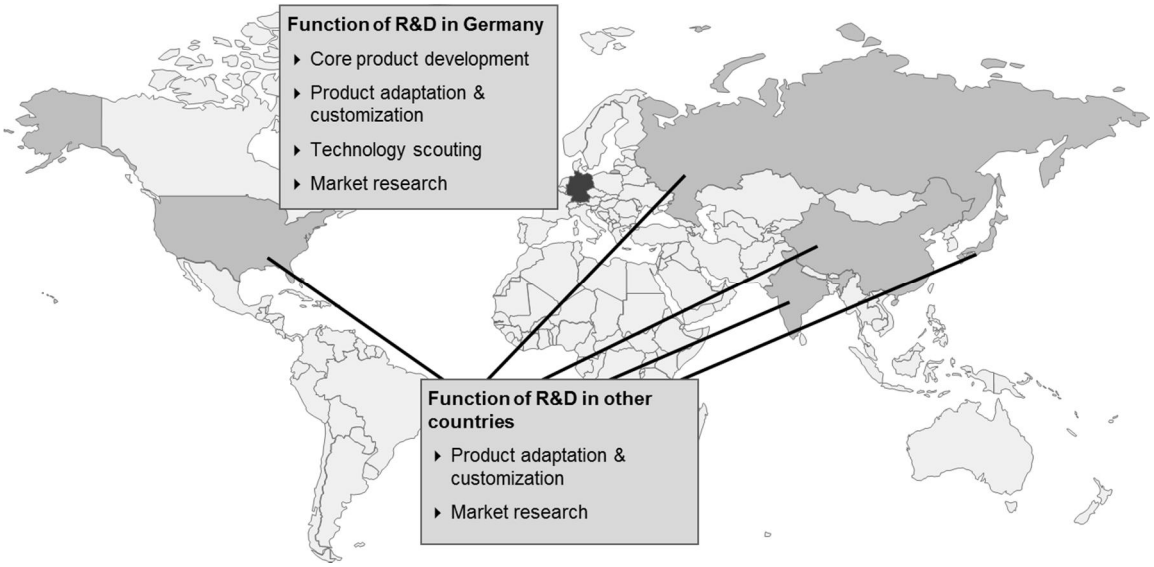
Japan, Russia, Singapore, and USA. As the world's largest automotive supplier, BOSCH serves global assembly firms around the world, which necessitates BOSCH to collocate its regional R&D centers in close geographic proximity to its customers' R&D centers. The international R&D centers are primarily responsible for product adaptation for the specific market as well as some technology scouting and market research activities through local collaborations, research labs and local universities (Figure 14). Collocating R&D with the assemblers has become a requirement of the new R&D process of global assemblers, when simultaneous engineering has become the norm with close interaction between engineers from the assembler and developing supply firms. To facilitate efficient interactions with their suppliers assemblers have established a 'simultaneous engineering' process, in which all involved parties simultaneously develop the components and systems for the new vehicle which is centrally coordinated, assembled and tested (as a holistic system) by the assembler. During this simultaneous engineering process, BOSCH's engineers meet with assembler's engineers and managers as often as once per week to closely coordinate the development process. To enable this close interaction it is important that the R&D activities of BOSCH are located in close geographic proximity to the customer and that engineers can communicate with the assembler to efficiently co-develop their components for the project. BOSCH's close proximity of R&D to large assemblers provides the company with an advantage over less internationalized companies.

While collocating of the adaptation and customization process is essential, core product development is independent from the vehicle development process of the customer. Consequently, BOSCH's core R&D activities are still located in the company's home market in Germany, where all advanced engineering, research

(including material science and production process advances) and platform development for its products take place across its five German R&D centers.

One exception to this is the R&D center located in Palo Alto which has the unique role to develop new products incorporating IT-enabled future technologies such as future entertainment systems and connected, IT-assisted, and automated driving technologies.

Figure 14: International R&D centers of BOSCH



Source: Author's own figure, based on fieldwork

Adapting the purchasing strategy

In alignment with the adapted R&D processes, and the demand for global components, BOSCH changed its purchasing strategy. BOSCH's new purchasing strategy, which was introduced in 2012, closely resembles that of Volkswagen and consists of the same cornerstones: the centralization of procurement, the reduction of direct supply firms, a local-to-local policy and a multiple supplier strategy. In order to strengthen the bargaining power and centralize the supplier knowledge, BOSCH centralized its purchasing. However, because of BOSCH's vast international footprint

and the diverse and scattered structure of the supply base, bade of relatively small supply firms, BOSCH has not been able to centralize its global purchasing to the extend of Volkswagen.

BOSCH introduced a central sourcing committee. Compared to Volkswagen, BOSCH's central committee has a stronger regional focus split in four regions in Europe, North America, Asia and Latin America. Each region is responsible for the global purchasing of the components that are developed in these regions. Parts per blueprint components and materials that require no development at the supply firm, are purchased globally where possible and economically feasible. However, since most of the supply firms have only a regional footprint, BOSCH often purchases such components on a regional basis.

The reason for the regional setup is that BOSCH has fewer innovating and developing supply firms in its upstream value chain. Instead, the company relies more on produce per blueprint and raw material suppliers with hands-off relations. The produce per blueprint component suppliers are often small firms with little international exposure, so that many of BOSCH's suppliers are local or regional companies. Rather than making all decisions central, regional sub-offices can coordinate locally sourced parts and materials. BOSCH actively internationalizes its supply base to move to a more global purchasing strategy: "We do incentivize our supply firms to go abroad and collocate to our important production hubs. But only slowly. Our supply firms are often quite small and not as international as tier-1 firms like us. Therefore we can only gradually globalize our purchasing, as our supply base becomes more international…" (Interview, BOSCH case).

Similar to Volkswagen, BOSCH has introduced strategies to reduce the number of direct supply firms. "The fewer supply firms the better. Why? For three reasons:

First, fewer supply firms means larger firms, with more capital to be invested into research. This becomes increasingly important, because we see that components that were relatively simple in the past become more and more high-tech. Second, larger supply firms have power to be more resilient to economic downturns. And third, they are able to develop an international footprint which we will need from our suppliers in the future" (Interview, BOSCH case). To reduce the number of supply firms, BOSCH incentivizes the regional supply firms to develop a global footprint, encourages M&A between supply firms, and modularizes component suppliers where possible. "The extent to which we modularize our suppliers is very limited. We buy materials and some mechanical parts, but not large modules like [the assemblers]… What we do, is encourage our suppliers to expand their product portfolio. Rather than buying injection molded parts from several suppliers, and metal components from others, we want to move to batch orders of different components from a single supplier" (Interview, BOSCH case). Despite the efforts to reduce the number of supply firms, BOSCH also introduced a multiple supplier strategy. "Ideally, we aim for three to four suppliers per component. At the moment, we often have more – but regional. For instance, we may have two supply firms in Europe, three in China, and four in Americas. In the future, we would like to have three global firms" (Interview, BOSCH case).

Through its local-to-local policy, BOSCH ensures that the majority of parts and materials are sourced locally. This enables the company to incentivize collocation of some of its key supplier.

In its effort to build a global and capable supply base, BOSCH encourages M&A between the supply firms to accelerate the consolidation: "Our suppliers are much smaller than the tier-1 firms supplying to the assemblers… [We] sometimes encourage mergers [between suppliers] to develop stronger suppliers… If we know that

a company is for sale, we can find suitable buyers" (Interview, BOSCH case). But M&A are not the only way to strengthen the supply base. Similar to Volkswagen, BOSCH has established a supplier development program, through which it provides consulting services to its supply firms for continuous process and quality improvements and to increase efficiencies. The profits gained by the increased efficiency are shared by the two companies, by lowering component prices. This requires an open book relationship, which BOSCH can enforce upon its supply firms, when they are dependent on BOSCH as a client.

Schaeffler

The Schaeffler Group (Schaeffler AG) is a German supplier of anti-friction bearings, engine components, chassis components, transmissions, dampers and clutch and transmission systems. With annual revenue of 13,2 billion Euros, Schaeffler is one of the top 20 global automotive supply firms by revenue. The company was founded in 1946 as INA (Industrie GmbH) by the two brothers Dr. Wilhelm Schaeffler and Dr. Georg Schaeffler, and had early success after the invention of needle roller bearing cage in 1949 by Georg Schaeffler. In 1965, the brothers duo went on to found LuK (Lamellen und Kupplungsbau GmbH), which quickly became the world's largest clutch manufacturer and drive train specialist, and was merged into the Schaeffler Group in 1999. Through the additional acquisition of FAG (Fischers Aktiengesellschaft), the leading firm and innovator of the ball mill that enables mass production of ball bearings, Schaeffler became the global leader for precision bearings. In 2003, FAG, LuK and INA formed the Schaeffler Group as it is known today. As a manufacturer of components and systems, Schaeffler suppliers to assemblers directly, as well as to other tier-1 supply firms. The company claims that it supplies "all major automotive manufacturers worldwide" (Schaeffler, 2015).

Upgrading in the value chain

Schaeffler started out as a typical tier-2 supplier, albeit for high precision and high value-added components. Precision bearings are mechanical components that are modular rather than integral, so that little exchange of tacit knowledge is required during the development process. As a producer of bearings, Schaeffler was a typical component producer, and not a module manufacturer with close ties to the assemblers. At the turn of the century, the Schaeffler Group realized it had to upgrade to maintain its position as a high value-added supply firm in the industry. Three trends in the automotive industry required rapid adaptation and rethinking the business model: First, the accelerated globalization of the industry, and growing demand for supply firms to develop an international footprint. Second, the ongoing product architecture evolution towards systems and modules. And third, the increasing role of digitalization for the industry in both, production systems as well as changing nature of key components on the vehicles through the emergence of alternative power-train systems and connectivity of components.

A central strategy has been to upgrade the capabilities and value chain position from a component supplier to a systems integrator. Schaeffler has made an effort to move up the value chain and move into high value added components and systems, through two distinct strategies: First, through internal incremental innovation and development, and second, through M&A of system integrators in the automotive supply industry. This requires a new thinking in systems, rather than individual and isolated components: "In an increasingly networked world, it is no longer expedient to optimize individual components or production processes in isolation. Only those who understand and integrate the entire system will be able to offer maximum possible efficiency and customer benefit… To be able to develop innovative drive solutions for energy-efficient hybrid and electric vehicles, Schaeffler needs to understand the entire

drivetrain including the driving behavior of the car." (Schaeffler, 2015).

To adapt its product portfolio, provide more modules and system solutions and become a systems integrator, Schaeffler undertook a series of M&A. Through the M&A, Schaeffler attempted to perform a functional upgrade and move up the value chain, to become a key tier-1 supply firm in the industry. To this end, Schaeffler acquired REGE Motorenteile GmbH in 2000, a system provider in the area of mechanical processing and assembly of complex components, such as cylinder heads, piston rods, engine blocks and gear systems. However, the aspired transfer of systems integration knowledge to Schaeffler's core components did not materialize, because of the very different nature of REGE's components compared to Schaeffler's, which require different approach to building systems. Consequently, REGE was sold off in 2008. In 2008, before the financial crises hit, Schaeffer made an attempt to upgrade into systems, and tried to overtake the much larger Continental AG. However, the timing shortly before the financial crisis was unlucky, and the takeover attempt ultimately failed as the credit market froze. In 2011 the Schaeffler Group had to reduce its stake from 75.1% to 60.3% (for 1.8 billion Euros) to maintain liquidity. The Schaeffler Group subsequently further reduced its shares, and as of 2016 owns 46% of Continental shares.

Furthermore, Schaeffler started to seriously globalize its operations and adapt to the growing need for global supply firms. Even though the Schaeffler Group only began a quick and serious internationalization after the turn of the century the foundation for a global footprint was already laid, and much international experience gained. The groups earliest foreign direct investments were made as early as 1956 in Hagenau, France. Further early expansion followed, with investments to Llanelli in the United Kingdom in 1957, Sao Paulo, Brazil in 1958, the opening of a production plant in Puebla, Mexico in 1975, a production plant in Skalica, Slowakia in 1991, and

production plants in Ansan in South Korea and Taicang, China, in 1992 and 1995 respectively.

The largest and most aggressive internationalizing began after forming the Schaeffler Group in 2003. In 2007, Schaeffler opened new production plants in India, China and Hungary, as well as a research and development center in China, and in 2014 opened a production plant in Russia, Ulyanovsk. In 2015, a second production plant was opened in Puebla, India, which focuses on torque converters for U.S. and Japanese automobile manufacturers for the US market. Between 2007 and 2016, Schaeffler established additional five production plants in China, to operate a total of seven production plants at four locations in China, as well as one localized R&D center.

These investments to China were strongly encouraged by assembly firms, especially Volkswagen, with strong growth trajectories and a need for deep localization. “Take Taicang, for instance. When we opened that plant, it was purely because Volkswagen told us to do it. At that point, Schaeffler had no vision to enter the Chinese market, but we had to follow our biggest customer.” (Interview, Schaeffler case).

As of 2015, the Schaeffler Group operates 74 plants worldwide, with approximately 60,000 employees. Each of the production plant is in close proximity to an automotive cluster led by a major assembly firm. As a traditional German company with strong roots in Europe, 48 of the 74 plants are based in Europe, 14 in the Americas region (including 2 plants in Brazil), 5 in the Asia Pacific region and 7 in China, of which the Taicang plant is now the largest production plant of Schaeffler worldwide. The production plants are designed to allow for just in time and just in sequence delivery for customized system solutions, as well as common mass production for standardized components. The global production network is established, so that

Schaeffler can maintain cost efficiency and reliability of supply through cross-network supplying from different plants, as demand shifts. Efficiency gains have recently been achieved from increased interconnected plants and machinery within the network, through modern “Industry 4.0” machines.

Adjusting R&D processes

As a producer of non-integral components, Schaeffler’s core R&D process was somewhat independent from the vehicle development process of the assemblers. The 6,650 R&D staff at Schaeffler worldwide registered a total of 2,643 patents in 2015, making Schaeffler one of the most innovative companies in the world. The deep level of technological knowledge can be exemplified with what seems to be a rather simple product: bearings. Schaeffler operates a ‘Acoustics Network’, that offers improvements and investigation into any kind of noise or vibration, and is therefore a leader in the field of electronic motors. The Schaeffler Group developed a very methodically innovation system in place. At its core is the annual “Technology Dialog” that sets the fundamental direction of future R&D efforts for a time period of five to ten years. It incorporates different aspects, such as consumer demand, mega trends, current product portfolio, firm capabilities, and the firm strategy. This Technology Dialogue helped Schaeffler to identify future demand for new components and modules, enabling the company to gradually upgrade towards modules and systems. Through incremental development, Schaeffler started to move from components to developing modules, such as the dry double clutch system developed by the Schaeffler daughter LuK in 2007, a fully-variable hydraulic valve control system in 2009, a sensor bottom bracket for e-bikes in 2011 or an electric axle system for electric power trains in 2013. These efforts have clearly positioned Schaeffler as one of the core tier-1 suppliers in the industry,

and a key innovator in the automobile value chain.

Close collaboration with assemblers

In order to upgrade and develop a deeper understanding of the finished vehicle, close collaboration with the assemblers are inevitable. Furthermore, the Schaeffler Groups' products are a key factor in reducing the fuel consumption and CO2 emission of combustion engines and electronic power trains. This requires deep knowledge of the components, as well as of the high-tech leading edge processing methods for production. For such deep knowledge in key technologies, Schaeffler is a strategic supplier for Volkswagen, and consequently deeply involved in the development process of new engines and vehicles. To upgrade from a modular component producer to an integral systems supplier, Schaeffler had to adjust its R&D system towards a close simultaneous development process with the assemblers.

One requirement for close collaboration with the assembler is, to collocate the R&D activities with that of the customer. As of 2015, Schaeffler operates a total of 17 R&D centers and additional market research centers in 19 countries. The international R&D centers' primary role is product customization and adaptation to specific vehicles in the simultaneous engineering process during the vehicle development phase. The R&D centers are distributed to be in close geographic proximity to R&D clusters of the major OEMs: e.g. five in the Americas region, and one R&D center in China.

The limits of Schaeffler's orchestration activities in the value chain

As one of the top 20 large suppliers in the global automotive industry by revenue, and at the brink to become a top systems-integrator through the acquisition of Continental, the Schaeffler group clearly aspires to be one of the largest and most influential supply firms in the industry. However, several setbacks and failures in the

past decades show the limits of Schaeffler's influence in the value chain, and indicate that the firm is not at the level of the likes of BOSCH. The group of top systems integrators with similar orchestrating roles as the assembly firm appears to be very small. The following three examples highlight the differences between the top turn-key suppliers such as BOSCH and Continental, to the large but much less influential firms such as Schaeffler. First, the ability to globally centralize its purchasing falls beyond that of Volkswagen and BOSCH,. Second, the supplier development program, while existing, is not as impactful as that of BOSCH or Volkswagen, as Schaeffler struggles to implement open book relations to its suppliers, most of which are not dependent on Schaeffler as a client. And finally, the ability to establish own production hubs, is limited at best.

Unlike Volkswagen and BOSCH, the purchasing of Schaeffler is structured much more regional. Purchasing is divided into four regions: Europe, Americas, Greater China, and the Asia Pacific region. These regional purchasing offices are responsible for all production plants in the region. However, no cross-regional purchasing is made as of 2015 for further volume bundling, the way Volkswagen or BOSCH introduced in their purchasing systems. One reason Schaeffler seems to lack behind in terms of globalized purchasing may stem from the failed Continental takeover efforts, as both companies have started combining their procurement to achieve higher volumes, but could not fully integrate and consolidate due to the subsequent investments.

Schaeffler's supplier development program is a second indication, that Schaeffler has little power over its supply firms. Through its development program, Schaeffler tries to improve the quality provided by the suppliers by "coordinating extensively" (Schaeffler, 2015). The program includes process optimization and

logistics optimization. However, as Schaeffler is typically only one of many buyers to its suppliers, and most supply firms are not dependent on Schaeffler as a customer, the willingness to develop an open book relationship and let Schaeffler see and optimize internal processes are limited. Moreover, many of Schaeffler's supply firms are family enterprises too small to justify expensive optimization programs.

Schaeffler follows similar strategic purchasing goals, and wants to consolidate its purchasing through supplier reduction and supply base internationalization, as currently, Schaeffler has approximately 33,000 supply firms from 80 countries. Despite its attempts, efforts to internationalize the supply base have shown relatively little results. Schaeffler's purchasing volume for a single production location does not justify collocating production for most of the supply firms. Especially, because most of the supply firms are relatively small German family owned businesses. Only in locations where Schaeffler's production plant is itself part of a larger production cluster, is it able to attract supply firms to collocate.

The example that underlines Schaeffler's limited ability to orchestrate and restructure the value chain the most is that of a failed attempt to establish its own production hub by collocating several of its supply firms. In 1991, Schaeffler made a deal with the local authorities in Skalica, Slowakia, to establish a thriving production cluster around Schaeffler. The idea was simple: Schaeffler would invest in a greenfield production plant and invite its supply firms to collocate in close proximity. More and more supply firms were supposed to follow, until the cluster gained momentum and further production industries would collocate to benefit from the infrastructure and knowledge in the cluster. What sounded good on paper turned out to become a costly mistake for Schaeffler. While Schaeffler committed to the idea and opened one of its largest production plants at that time, not a single supply firm would follow. Schaeffler

was unable to create the critical mass to attract their suppliers to collocate: “We have tried to collocate our suppliers with us, but with limited success. Whenever we followed [an assembly firm like] Volkswagen in China, it was easy to convince our suppliers to follow us as well. However, our production plant in Slovakia is a disaster. We invested there, because we thought we could pull other firms with us and build a cluster around us, but that never materialized. We are just not big enough to build an industrial cluster around us, like Volkswagen is.” (Interview, Schaeffler case). To this date, Schaeffler is the only operating firm in this location, an isolated production plant detached from the large production hubs in Europe’s automotive industry, resulting in hefty transportation and logistics costs to run operations.

Brose

Brose was founded as an automotive trading company in 1908 by the 24 year old Max Brose, a son of a coachwork manufacturer who watched as the motorization of automobiles changes the industry. The trading company quickly grew and expanded its product portfolio, to include all important automotive parts at that time such as tools, wind screens, lights, horns, mirrors, speedometers, jerry cans, shock absorber, ignition plugs, automobile clothing such as jackets, helmets and glasses. In 1919, Brose pivoted its business model and entered a new phase, as it moved from trading with automotive components, to developing and producing own components. The first patent for a “Schlingfederbremse” (a spring breaking system) was filed in 1919. This innovative component allows the window lifter to stop and hold the window in place in any position. This simple idea marks the beginning of a great automotive company. For almost 50 years, this product becomes the key product of the Brose Company, with further break through inventions for the same component.

In the 1960s, Brose develops the first electronic window lifter. The first assembly firm to implement this technology are the two German assembly firms BMW and Mercedes. Additionally, Brose begins to upgrade. The company used its acquired knowledge and capabilities to develop further key technologies and products. For instance, its electronic drive system was used for other components, such as electronic seat positioning systems, which became important as the automotive industry started to focus on comfort.

In the late 1980s, Brose performs a functional upgrade and becomes a systems supplier for modularized doors. As the supplier of electronic window mechanics, Brose had capabilities in the most complex technology of doors, and was therefore the ideal firm to add assembly activities of additional door components. This falls into the era of a new production system: The lean manufacturing system. The modularized door is first used in 1987 in the Audi 80 (a Volkswagen daughter). From then on, Brose is not only responsible for the development of key components of the door, but takes on new responsibilities for the development, production and assembly of the entire system, including logistics and quality controls for the upstream value chain. Additionally, the in-house production system is revolutionized, and Brose opens a new production plant in Germany in 1997 that produces "in the tact of the automobile assembly firm": just-in-sequence, and for just-in-time delivery. This becomes the model plant for all new production plants of Brose worldwide – which are always collocated to the target assembly firm. The blueprint production plant marks the beginning of a new phase of internationalization and collocation in the auto industry.

The upgrading to a systems integrator and successful supplier of modules further opened doors for product upgrading, as Brose acquired key capabilities and knowledge for systems integration. Brose added complementary key components for

the door system into its product portfolio, such as locking systems (acquired from BOSCH in 2002). Additional key developments were made in weight reduction to overall vehicle weight in order to reduce fuel consumption and CO2 emissions. Brose thereby enables assemblers to comply with the tightening emissions regulations. Further product upgrading outside the key door-system is achieved through acquisitions such as the acquisition of the Siemens-VDO Electric Motor Drives division, or the Continental Cooling and Fan division in 2007. In 2016, Brose's additional divisions include powertrain division, which develops and produces braking systems (including ABS and electronic parking brakes), electronic steering and transmissions. Through its leading position in the automotive industry, Brose claims that at least every third vehicle on the road has one or more Brose components installed.

As shown throughout its history, Brose is not only a firm with development capabilities, but also innovation capabilities that constantly innovates new features for automobiles. As such, Brose is at the forefront of innovation, ahead of the assembly firms, and in a good position to bargain with its customers. This makes Brose one of the strategically most important supply firms in the industry, and enables Brose to develop very close ties to its customers. In fact, the close relations lead to numerous opportunities to expand its role in the global automotive value chain in the past, and enabled Brose to perform one of the most aggressive and impressive internationalization strategies.

Global operations and reaction to VW's changes

Parallel to the introduction of lean manufacturing, modularization and the inherited upgrade and increased responsibility of Brose, begins the age of globalization. In 1988, Brose opens its first international production plants in the United Kingdom

and Spain. What follows is a rapid internationalization of the company. In 1993, Brose opens its first North American production plant in Mexico. One year later, three development and sales offices are opened in Detroit (USA), Tokyo (Japan) and Paris (France). From 1997 on, Brose expands with its new just-in-sequence production plants, and all international offices follow the same appearance. This includes Brose's joint venture in China, which was opened in 1999. What follows is a rapid internationalization of sales offices. By 2008, Brose has over 50 sales representation offices in international locations. What follows is a rapid internationalization of production capabilities, to collocate to the production plants of the assembly firms. The purpose of this internationalization was to follow the western assembly firms, which actually incentivized Brose to open production plants in the growing markets. As an interviewee said: "We don't have a good experience with suppliers in China. They cannot develop, only copy. They are good in producing, but not as partners to develop products" (Interview, Brose case).

In 2009, Brose opens its second joint-venture in China together with Shanghai STEC Transportation Electric Compant Ltd. It produces electronic window lifter, seating systems, and door systems. Its customers are SAIC-Volkswagen, Changan Ford Motor Company, and SAIC-General Motors. The rapid growth of the Chinese market leads to further investments. In 2011, Brose localizes a research and development center in Shanghai, and invests into a new production plant in Chongqing. By then Brose operates gfive locations in China. In 2012, Brose opens its new production plant in Beijing, the second plant for door systems in China, and the seventh location. Further Asian production plants opened in Thailand (a joint-venture with Delloyd Electronics) in 2009, and in South Korea in 2011 through the Mando-Brose Corporation, and joint venture with Mando, for the production of electronic motors for Mando steering and

braking systems. An additional production plant openes in Pune, India, in 2011. In 2014, Brose opens a production plant in South Africa, for seating and door systems. As Brose says on their homepage: “Manufacturers are increasingly managing the juggling act between globalization, localization and customization with global platforms and modular systems. Brose has successfully faced up to this challenge and produces identical seat systems on three different continents.”

In parallel to its impressive globalization, Brose established a global purchasing strategy similar to Volkswagen. Through its “global sourcing network”, Brose involves its supply firms in its R&D and production, demands constant product-optimization, invites supply firms to collocate, enforces open book relationships and ensures quality requirements. In exchange, Brose offers long-term contracts and stable supplier relations: “We involve our suppliers in our development, production and business processes at an early stage. This generates a close, intensive exchange of know-how, ideas and expertise – and ensures optimum product realization. In return, we offer our suppliers excellent opportunities for development, attractive conditions and long-term partnerships” (company webpage). As an interviewee said: “We bring German supply firms with us to China, if we have a good relationship with them.” (Interview, Brose case).

Mahle-Behr

The Mahle Behr GmbH & Co. GK is a German automotive supplier that resulted from the merger of two traditional German automotive suppliers, Behr and Mahle, in 2013. The group specialized in air conditioning and engine cooling systems. Before the 2013 merger, both Mahle and Behr were in the top 50 of the global automotive suppliers list of 2012 (Automotive News, 2013). Through the merger, the Mahle Group were able

to enter into the top 20 of the global suppliers by revenue, with an approximate revenue of over 12 billion US dollars in 2014 (Automotive News, 2015).

In 1905, Julius Friedrich Behr joined a local car cooling workshop, and overtook the small company in 1907. By 1910, he managed to move from repairs to manufacturing, and opened a small production plant near Stuttgart, Germany. Its engine cooling was used in iconic models, such as the Ford Model A, the Mecedes "Silberpfeil" and the VW Beetle. Key inventions were the wind channel for cooler testing, and the oil cooling system developed in cooperation with Porsche. However, the Second World War disrupted operations. In 1957, Behr upgraded its product portfolio and added air conditions for passenger cars. Until the merger, these two products were the core business of Behr.

Mahle was founded in 1920 as combustion engines testing company. However, it was the piston unit that made the company profitable, as Mahle was the first company to build pistons from lightweight metals such as Aluminum (patented in 1927). Mahle continuously upgraded its product portfolio via further products in the engine group, such as aluminum cylinders in 1951, aluminum motor blocks in 1976, camshafts in 1988, new cooling concept for diesel engines in 2001 or the full plastics oil filter in 2003. In 2015, the Mahle Group is a leading automotive component manufacturer with four core business units: Engine systems and components, filtration and engine peripherals, thermal management and mechatronics. Its engine systems and components division includes piston systems, cylinder components, piston rings, pins, connecting rods, bearing brushings and cylinder liners. The filtration and engine peripherals division includes air intake modules through to the combustion chambers, and exhaust gas recirculation. The thermal management unit is of crucial importance to combustion engines, and increasingly for new electronic driver trains as well. It

includes cooling water pumps, water flows, and oil cooling systems.

The wide spectrum of products was achieved through a number of portfolio optimization M&A in recent years. In 2005, Mahle developed its first whole engine, which was used in a university student lead formula race. In the same year, Mahle acquired Cosworth Technology Ltd. with production in the USA and United Kingdom, which laid the basis for Mahle Powertrain, as well as Brockhaus Soehne GmbH, a German steel and measurement instruments company. In 2009, Mahle followed up with the acquisition of KTM Kuehler GmbH, a cooling system producer. In 2013, Mahle acquired Behr to strengthen its thermal management unit. Further upgrading was achieved through the acquisition of the InnoWa Membrane GmbH in 2012 for the filtration business unit, the acquisition of the Slovenian based electric motor manufacturer Letrika, including its manufacturing plants in Slovenia, Bosnia-Herzegovina, Belarus, China and Brazil, and complemented this with a follow up acquisition of the Japanese company Kokusan Denki in 2015, a specialist in ABS and ESC units, dynamic driving control, and steering assistance. An additional acquisition followed in 2015, when Mahle carved-out the thermal business unit from Delphi, making Mahle the second largest automotive supplier for thermal management.

Through such acquisitions, Mahle was able to constantly upgrade its products and develop into a systems integrator within the global automotive value chain. However, the basis for innovation and development capabilities has already been established throughout its long history – which enabled the company to integrate the acquired knowledge effectively and bundle the competencies in a way to develop new ones. The prerequisites were previous development capabilities and strong absorptive capacity by the engineering teams.

Global operations and reaction to VW's changes

The Mahle Group operates production plants in over 170 locations around the world, the majority of which has been established in close proximity to the customers. China has been the main focus on Mahle's recent organic growth. Mahle entered China late – the first operations were established in 1999. Since then, Mahle has drastically increased its presence in the growing market, opening more than one new location per year. In 2015, Mahle operates 22 locations with approximately 7,000 employees.

Interestingly, the core clients in China are the global assembly firms, rather than indigenous Chinese firms. The driver attracting leading western supply firms to the Chinese market have been the western assemblers such as Volkswagen: "On the one hand, MAHLE's customers in China come from the who's who of the global automotive industry. This means that they expect the same specifications and standards as in Germany, the USA, or Japan, which requires identical production conditions and above all, employees with the same level of qualifications" (company homepage). The Chinese assemblers, on the other hand, handle projects rather different: "They are accustomed to working without long schedules and in-depth processes," (Interview, Mahle case). If circumstances change, like expected sales of a vehicle, "the business partner is expected to respond to this change of heart—both quickly and flexibly. Any difficulties that may arise also need to be solved instantly" (Interview, Mahle case).

Adjusting to changing R&D processes for global platforms

Mahle set up a widespread network of R&D centers to accommodate to its global clients. Mahle employs approximately 6,000 engineers in research and development. These work in 15 major R&D centers, which are distributed to ensure collocation in all major automotive hubs: Stuttgart, Northampton, Detroid, Tokyo, Shanghai, Pune, and Sao Paulo (Germany, Great Britain, USA, Brazil, China, India and

Japan respective). Such a network of collocated R&D centers is necessary for Mahle, due to the nature of its products. Mahle produces highly integral systems, and has a unique systems knowledge in engine thermal management and engine peripherals. Such systems require extensive information exchange with the other developing firms like engine manufacturers or assemblers. Mahle is deeply involved in the engine development process of Volkswagen. Since emission standards are different in regions (e.g. EU, NAFTA, China), engines are adapted to meet different regulations. This requires Mahle to have R&D centers in close proximity to where the engines are adapted to local requirements. "Mahle has established itself as a leading global development partner to the automotive and engine industry" (Mahle, 2015). "Vehicles on the whole are becoming increasingly complex, since more and more components and systems are networked and interact with each other" (Mahle, 2015).

Components such as engine cooling systems are highly integral. Mahle-Behr is therefore closely cooperating with the assemblers, and is an integral part of the vehicle development process. Thermal management of engines is crucial for combustion engines to achieve maximum efficiency and research emission standards. Mahle's expertise in thermal management is highly valued by the assemblers and engineers developing the new generations of engines. Furthermore, thermal management is also important for future electronic drive train systems (especially for battery cooling).

Global purchasing

Mahle-Behr purchases mostly raw materials such as aluminum, steel, copper, and resins. Such supply firms are in itself large global suppliers like ThyssenKrupp, BASF or DuPont, which are not receptive for open-book relations. Therefore, Mahle has limited power over its supply base. Still, Mahle has a centralized global purchasing

approach. Recently acquired firms have been integrated into the purchasing system of the Mahle Group, since the acquired companies had common suppliers. Even for the year 2015, the integration of the purchasing departments enabled the company to leverage purchasing synergies, which goes to show how similar their supply base was. Only the compressors units have autonomous purchasing departments. All other business units are unified in a global purchasing department for volume bundling and supply firm reduction. And like most large firms, Mahle carries out supply visits and reviews and supplier development for smaller suppliers, such as component manufacturers and sub-contractors.

Marquardt

The Marquardt Group is a producer of what would traditionally be seen as a relatively simple product: switches. However, Marquardt is now a producer of R&D intensive high-tech systems and therefore an ideal case study to explore how technology advances change the value proposition and value-added of supply firms below what used to be called the first tier of supply firms. As technology advanced, switches, sensors and controls have evolved to become high-tech components in what could be called ‘deep technologization’. Like the previous supply firms, Marquardt moved from a manufacturer of simple components, to take on design and R&D for entire systems, and has thereby established itself as the leader for ‘drive authorization systems’, ‘operating components’ and ‘switches and applications’.

The Marquardt Group was founded in 1925 as a producer of switches for household appliances. During the Nazi Regime, and in the aftermath of the Second World War, the company lost most of its employees and machinery to the French occupants. However, a severe shortage of surface mount light switches in Germany

kept the company from going out of business. Beginning its own R&D, Marquardt developed complete switching keyboards for appliances in the 1960s. Customer demand rapidly evolved in regards to the design of the switches, and smaller, slimmer switches were developed for high volume production. This allowed the company to enter the automotive market in 1978 as a supplier of small standard switches, such as snap-action and control switches. It was not until the 1990s, that Marquardt moved to high value-added products and became a leading technology driven company, as the microprocessor changed the function of switches. As an early adopter of the new technology, Marquardt introduced the first micro-processing power-controlled units for electro power tools at the appliance expo in 1991. Marquardt was able to introduce the same technology to the automotive industry. Through the adaption of micro processed switches, Marquardt became an innovating supply firm in the industry, and played a key role in future innovations. The use of microprocessors in switches marked a milestone in the product evolution towards high-tech switching- and control systems. One year later, Marquardt established itself as a leading automotive switch producer by introduction the smallest dust and water protected volume production snap-action switch that enabled inventions such as central controlled electronic seat positioning. With two consecutive innovations, Marquardt became a strategically important supplier to the assembly firms. Marquardt proved the ability to upgrade and innovate, and used the momentum for a further functional upgrade in the value chain. In the next five years, Marquardt moved from component to system supplier, and in 1997 introduced its first driver authorization system with electronic key and ignition switches to set new standards in theft protection. Through the incremental innovation and development, Marquardt developed an originally simple component into a high-tech security system of high value.

Since the introduction of the first driver authorization system in 1997, Marquardt moved up the value chain and focused on the development of entire systems rather than components. Marquardt moved on to develop multifunctional control panels and console systems for vehicle cockpits. In 2003, the first keyless system was developed my Marquardt, again setting new trends for the industry. Material research enabled the company to introduce high-gloss control panels that add luxury and quality perception to the vehicle and set a new standard for premium cars in 2004. It also enabled the company to rapidly expand its product portfolio of interior design, interior trimming and user interface components of the vehicle. In 2007, Marquardt developed a ground breaking electronic gear selection switch for a completely new product: the "shift by wire" gear switch, where the gearbox is shifted through electronic controls rather than mechanically. This requires complex systems integration of the control unit, switching unit, gearbox and engine control units by the assembler, in which Marquardt is highly integrated in the long-term strategic development plan of the assemblers, and has become a key partner and innovator in the value chain. Marquardt plays a key role and is now deeply imbedded in the long-term strategic development plans of the assemblers.

Other key innovations include the electronic steering column lock for key-less systems (2010), the "BlueID Drive" system to lock, open and start vehicles using identification on smartphones (2011), a touchpad for use in vehicle cockpits (2012), move into other industry segments such as e-bikes or boats (2013), technology for even smaller robust switches (2014), a battery management system for electronic vehicles (2014).

Such innovations are based on in-house research and development efforts that go well beyond the expected innovation by the assemblers and makes Marquardt a

strategic supplier that pushes innovation and technology down the value stream. This was rewarded by VW, which nominated Marquardt as an “A-Supplier” in 2014.

The ascent to a strategically important system supplier further helped the company to quickly establish an international footprint. Marquardt was initially a late adopter to the internationalization trend. The first foreign subsidiary, headquartered in Cazenovia, New York, USA, was founded in 1981 as an export supporting office, and expanded to a production plant in 1985. But it was not until the 1990s, that Marquardt begun to seriously and rapidly expand its international operations.

In 1991, Marquardt acquired the tool switch manufacturer Russenberger, including its subsidiaries in France, Spain and Tunisia. Five years late, Marquardt entered the Chinese market by opening the Marquardt Switches Shanghai production plant. In the same year, Marquardt also opened a joint venture with the Indian switch manufacturer RG Keswani in India. In 1999, Marquardt opened a new production in Switzerland. By 2000, Marquardt further expanded its global footprint, entering the Indian and the US markets through the acquisition of the Indian R. G. Keswani company and a new green field investment in the US. In 2006, a new subsidiary was opened in Romania. 2012 saw a year of several milestones in terms of building a global footprint. A new administrative and R&D center was opened in Shanghai, China. In the same year, a new production line opened in Romania and the production of a new plant in Tunisia and Mexico. Further subsidiaries were founded in Macedonia in 2014 and Pune, India, in 2015.

This very rapid internationalization to establish a global footprint was made due to the requirement shift of the global assembly firms, to which Marquardt had suddenly become a key supply firm, and which increasingly required their top suppliers to establish a global footprint since the introduction of lean manufacturing in the 1990s.

The process was rapidly accelerated at the turn of the century, when Volkswagen introduced a new purchasing strategy, and accelerated even more after the new introduction of the MQB platform and the fully globalization of purchasing by Volkswagen in 2012. The majority of Marquardt's production locations were selected at the invite of the assembly firms to collocate with their production.

Additionally, process upgrades of Marquardt were steered by the assemblers In 2003, the company redesigned its production lines to meet current just-in-time and just-in-sequence production standards. The new plant in Rietheim-Weilheim, Germany, became the new standard layout for future production lines worldwide. This was designed with the support and expertise of Volkswagen.

Witzenmann

The Witzenmann GmbH is a relatively small German producer of flexible metal elements. With annual revenue of just over 500 million Euro and around 4,000 employees worldwide, Witzenmann can still be considered a typical German "Mittelstand" company. While some definitions only allow small and medium enterprises, typically with a cap at 50 million Euro revenue or 500 employees, the German KfW bank defines "Mittelstand" as companies with a maximum annual revenue of 500 million Euros. Witzenmann's products are used for industrial purposes, in the construction industry, in the aerospace industry and the automotive industry. With over 40% of the revenue, the automotive industry is the most important industry for Witzenmann.

The company was founded in Pforzheim, Germany in 1854 as a producer of jewelry. In 1877, the company expanded to Paris, where the founder Heinrich Witzenmann met Eugene Levavasseur. Together, the duo developed the first metal

tube, which laid the groundwork of the company today. Through a number of early developments and patents, the company quickly became the market leader in flexible tubing. After reviving the company after the Second World War, Volkswagen became the most important customer of Witzenmann, and should remain its most important customer and co-developer. At the same time, the product portfolio was expanded with complementary products via the acquisition of the Fleitmann GmbH in 1960 (a German producer of shower hoses), and the Metallslangfabriken Huddinge AB in 1969 (a Schwedisch producer of metal tubes).

Products include components that are close to the engine or used in the exhaust system, such as flexible metal hoses, tubes and pipes, pipe supports, special connection fittings, and compression fittings. Through the flexibility of the metal pipes, the pipes can absorb heat induced material extension, vibrations and noise from the engine, and are thereby used to decouple the engine from the vehicle chassis. Furthermore, Witzenmann has developed an expertise in exhaust systems, including thermodynamics to simulate exhaust flows for optimal re-circulation, and a knowledge that positions Witzenmann close to the engine developers of the assembly firm.

Today, Witzenmann operates in 24 locations in 19 countries across Europe, Americas and Asia and has established itself as the market leader for flexible metal tubing solutions. As the industries leader, Witzenmann supplies all major assemblers in the world, including increasingly new entrants from China, such as BAIC, SAIC or FAW.

Apart from the early acquisition of the Swedish Metallslangfabriken company in 1969, the internationalization of Witzenmann began in 1979 with the founding of a subsidiary in France. 1985, Witzenmann licensed a Czech company to produce Witzenmann tubes for Each Europe. The rapid internationalization began with the

introduction of lean manufacturing and the increasing need for a global footprint of supply firms in the 1990s. 1989, Witzenmann established a subsidiary in Spain. 1993 marked the first foreign direct investment into East Europe, as Witzenmann opened a subsidiary in Slovakia, and acquired the licensee in the Czech Republic. Further subsidiaries were established in France, Italy and Belgium. In 1996, Witzenmann invested outside of Europe for the first time, and established a subsidiary in the USA.

The internationalization was further accelerated around the turn of the century and the increased modularization of vehicle platforms and the demand for standardized components worldwide. Between 1999 and 2003, Witzenmann entered key markets in the automotive industry, especially in emerging markets and opened subsidiaries in Brazil, China, India, Korea and Russia. This was followed by additional investments into India in 2008, a new production line in Russia in 2011, as well as the market entry into Japan, a new production plant in Poland and a new production line in the US in 2012. In 2015, Witzenmann opened a production plant in Mexico, to solidify its position in the North American market. As the interviewee said, the company always collocated with assemblers by invitation of the assemblers.

While the production of the component remains relatively low-tech, the science behind its development has become high-tech and very demanded. The optimal design of the tubes require knowledge in exhaust flow dynamics, thermal management, thermal expansion, and noise and vibration reduction. The assemblers constantly develop new exhaust systems for combustion engines, in which exhaust gases are re-cycled to reduce nitrous gases as required by current and future emissions standards. The flexible tubes from Witzenmann play a crucial role in the exhaust system development, and an integral part of engine development. The key value added for the automotive industry is the flexible metal tube that enables to assembler to decouple to

engine from the vehicle chassis, which in turn drastically reduces noise and vibrations in the vehicle and increases driving comfort.

Global purchasing

As a relatively small company compared to the likes of Volkswagen, BOSCH, Continental or Schaeffler, Witzenmann has a much smaller impact on its supply base through purchasing strategy changes. Unlike the industry's giants, Witzenmann is not able to attract smaller supply firms to collocate with them if they decide to open a production plant in a new location. Furthermore, as a traditional tier-2 or at times even tier-3 company, Witzenmann if further upstream. Its supply firms are therefore either very small supply firms, or for most parts, raw material suppliers, mainly metals, some resin, and industrial gases for processing and testing. These firms in turn are often giant multinationals, which themselves have a global footprint, and to which a company like Witzenmann is a small customer.

Ricardo

Ricardo is a British technology service company in automotive, clean energy, defense, rail and marine industries. The company was established in 1915 by Sir Harry Ricardo as 'Engine Patents Ltd', and maintained its focus on developing key engine technologies for the use in different industries, of which automotive is the most important. The company has an annual revenue of approximately 250 million £, and a total of 2,700 employees.

While Ricardo has developed its own engines, the main focus is on technological service to other engine developers such as Cummins or large automotive assemblers that develop their own engines like Volkswagen. Large commercial or

passenger car manufacturers like General Motors or Volkswagen develop their own engines in-house and are thereby the most important customers of Ricardo. Ricardo has developed some very iconic engines, such as the Ferrari 456 V12 engine, the four wheel drive dual clutch transmission for the record breaking 1001 horse-powered 16 cylinders Bugatti Veyron engine (which is part of the Volkswagen group), or the famous McLaren M838T V8 engine. For over 100 years, the company has engineered and innovated in combustion engines, and has recently moved into hybrid and electric power-train development as well.

The service business follows different rules and dynamics compared with parts supply business. Rather than long-term supply contracts, Ricardo is only contracted to support the development of a specific engine. "We are extremely deeply involved in the engine development of all [assemblers]" (Interview, Ricardo case). The company is impacted by the change towards global platforms based on modules: "We had to increase our 'systems knowledge'. In the past, the engine, gearbox and exhaust system were developed independently from another. However, technology has developed so much that we now have to look at the entire system to lift further efficiencies… A little deviation in the past didn't matter, and we couldn't measure precisely enough. Now, every tiny change in one system has a measurable impact on the other, so we have to develop everything in conjunction with other parts of the system… This process involves a multitude of suppliers with superior proprietary information along the powertrain value chain, which are all sitting at the same table during the product development process" (Interview, Ricardo case). This goes to show how the engineering process of vehicles has changed over the years, towards a simultaneous engineering process that blurs ownership and creates new forms of value chain governance.

Even though Ricardo is a service provider for powertrain development, it is also impacted by the assemblers' globalization. In 2015, Ricardo has offices in the Europe (UK, Germany, The Netherlands, Denmark, Spain, Italy, Czech Republic), USA, Asia (China, Korea, Taiwan, Hong Kong and Russia) and the Middle East (Qatar and Dubai).

However, the company is not dependent on its western clients: "The fastest growing market for us is China, and not the western assemblers in China, but the local car producers. The reason for this is, that the new entrants from the emerging markets lack the ability to develop engines by themselves. They need our help to develop engines that can meet the China V emission standards for 2018. China's emission standards are moving very fast, and unlike the European OEMs, they have very little experience in how to build a fuel efficient power train." (Interview, Ricardo case). While Ricardo supports the development of western assembly firms, the company takes on much larger development contracts for the new entrants. The firms from China rely much more heavily on Ricardo's expertise.

MBtech / AKKA

The MBtech Group is an automotive engineering service provider that was founded in 1995 as a subsidiary of Daimler. In 2011, Daimler sold the majority stake of 65% to a competitor service company, AKKA Technologies.

The MBtech group operates four different services lines, vehicle engineering, powertrain solutions, electronics solutions and management consulting. This case study will focus on the first three service lines, which are deeply involved in the vehicle development of Daimler and since the acquisition of AKKA increasingly so for other assemblers as well.

The vehicle engineering service line focuses on the concept development of

whole vehicles, design and styling services of vehicle bodies (including prototyping), vehicle construction and testing of vehicles, systems and modules. The powertrain solutions service line provides services for the entire powertrain development, in particular for engine development, system integration of the powertrain (e.g. integrating exhaust systems to the power train), and power train integration into the vehicle concept. The electronics solutions service line develops and tests electronic solutions such as control systems, network systems, electronic architecture integration and increasingly e-mobility solutions. Combining the three service lines, the MBtech group claims to have capabilities along the entire vehicle development process – and is essentially able to develop a new vehicle from scratch to mass production, and is offering services along the entire development process. In fact, MBtech developed a fully functional plug-in-hybrid concept car in 2010, the Reporter.

As a daughter company of Daimler, MBtech originally operated mainly in Germany, with a small subsidiary in the USA as a remnant from the Chrysler-Daimler period, and another subsidiary in China, to provide services to the Daimler joint-venture with BAIC (also inherited from the former Chrysler joint-venture with BAIC). As core R&D of vehicle development internationalizes, the MBtech group saw itself challenged to rapidly internationalize. This proved to be impossible with the limited opportunities from within Daimler, and the decision was made to sell MBtech off to a competing engineering service company with a global footprint, to allow expanding the international footprint and the customer base of MBtech. As a result, MBtech was sold to the French based AKKA in 2011. The AKKA/MBtech group now operates 21 locations in 20 countries, albeit with the strongest presence still in France and Germany. New investments were made possible through the joint operations, such as a new engineering office in Beijing (in close proximity to BAIC) and the EMV-testing

facilities in China.

With its strong position in China, and in-depth knowledge of Daimler technology, MBtech was in a prime position to be contracted for the development of a luxury vehicle for the BAIC Motor Group. BAIC Motor Group – which has a joint-venture with Daimler, acquired the old e-class platform technology from Daimler to build own luxury vehicles. In addition to the platform, BAIC acquired the right to use engines from Daimler in its vehicles. The D80 will be the first vehicle based on the e-class platform.

MBtech was contracted by BAIC to support the development of the adapted chassis and chassis components. But as the project dragged on and several engineering teams experienced delays because of lack of experience with developing a whole vehicle, MBtech's contract was extended several times. The scope of development support was extended to include body design, prototyping, and finally powertrain and overall systems integration. "In the end we effectively developed the entire vehicle for Them… BAIC did not know how to develop a vehicle from the scratch. We had to start by establishing the development process, which we are very familiar with." (Interview, MBtech case). Through its extended involvement, MBtech took on ever more responsibilities. "This was really clever: First Daimler sold its old technology, then the development capabilities. This way, BAIC would not be able to learn how to develop own vehicles." (Interview, MBtech case). With MBtech's involvement for all core development activities, the majority of won experience and acquired knowledge and capabilities have been built within MBtech instead of BAIC. According to several interviewees involved in the process, this has been the ideal scenario for Daimler. Daimler is not afraid of BAIC having one good vehicle on the market, which is based on old Daimler technology. Instead, Daimler is interested in prohibiting BAIC to learn

and build up capabilities that would enable to company to continuously develop vehicles and become a serious contender and competitor on the market.

Participants in the value chain: Supply firms from Brazil

Metal Leve / Mahle

Metal Leve is a Brazilian piston maker that was established in 1950. Today, it has become the leading supplier of forged and sintered automotive components in Latin America, producing pistons, rings, bearings, filters, valve trains, lingers and ring inserts. Metal Leve has seven subsidiaries across Brazil and one in Argentina. In 2012, Metal Leve generated approximately 70% of its revenue from supplying automotive assembly groups, 37% domestically in Brazil and 33% from abroad. With production facilities in Argentina, and significant revenue from exports, Metal Leve is one of Brazil's most internationalized automotive component producers, with a solid position in the automotive value chain.

As a producer of forged and sintered engine components, Metal Leve is a typical produce per blueprint manufacturer that receives the drawings and tools for the components from its clients. This means the components are developed by its clients and not Metal Leve. Its clients are both, tier-1 suppliers as well as assembly firms. But as a produce per blueprint supplier, Metal Leve has a relatively shallow relationship to its clients and is not involved in the R&D processes. What Metal Leve offers is manufacturing capacity and process expertise, but no superior knowledge of the components and the systems in which they are used.

With the introduction of the first international vehicle platforms in the 1990s, the assemblers introduced a great cross-national use of common parts, effectively

opening the Brazilian market for foreign suppliers. This increased the competition with foreign suppliers, and Metal Leve had to upgrade its capabilities and products to stay competitive. This required new capital and external knowledge. In order to rapidly upgrade its technology, Metal Leve, like many other suppliers from Brazil, had to establish relationships with overseas competitors. Being unable to upgrade on its own, Metal Leve entered a number of partnerships with foreign competitors that could transfer knowledge and technology to Brazil.

To this end, Metal Leve entered an agreement with the German supplier Mahle in 1996, which were offered a share in the company for the transfer of technology. The assembly firms played a key role in establishing the partnership with Mahle. “The merger with Mahle was strongly advised by the assemblers. It was either that, or the German company would come to Brazil with its own production, and we would lose the contract with our customer. This would not benefit either of us.” (Interview, MML case).

Mahle increased its share in Metal Leve in its effort to internationalize and injected further capital to sustain Metal Leve’s position in the Latin American market. In 2016, Mahle Indústria E Cómercio is the largest shareholder, owning 60.81% of Metal Leve, followed by Mahle Industriebeteiligungen GmbH with 9.29% and Credit Suisse Hedging-griffo Asset Management with 5.32%, giving Mahle a controlling stake of 71%. After the de-facto takeover, the company was renamed Mahle Metal Leve. The injected capital from Mahle enabled Metal Leve to strengthen its domestic position by consolidating the industry through a number of acquisitions, like the acquisition of Metallurgy Mogi in 1998.

The consolidating of the Latin American market was important to maintain the position in the rapidly harmonized global market. In the early 2000s, competition with

foreign competitors increased, as the assembly firms decreased the country-specific components through the steady roll-out of vehicles based on the new platform with increasingly standardized carry-over components. At the same time, the pressure to internationalize increased for the supply firms, and Mahle Metal Leve slowly began internationalizing its Latin American operations with the help of Mahle. In 2007, Mahle Metal Leve acquired Dana Indústria, a local manufacturer of bearings. In the same year, the company began its international expansion with the acquisition of Evidal, an Argentinian based valve producer that was subsequently renamed Mahle Argentina. The shift in purchasing strategy of Volkswagen in the early 2010s, one of Mahle Metal Leve's most important customers, accelerated Mahle's efforts to further restructure its Latin American business. Mahle Metal Leve was to become the spearhead for Mahle in Latin America. Other operational units in Latin America were subsequently restructured to become part of Mahle Metal Leve, including businesses for additional products and in other Latin American countries. In 2010, Mahle Metal Leve acquired the piston rings business from the Brazilian based Mahle Engine Components (Mahle Componentes de Motores). In 2013, after Mahle increased its shareholding in the Behr Group from 36.8% to 51%, Mahle Metal Leve incorporated Behr's operations, which was renamed Mahle Behr Gerenciamento Térmico Brasil Ltda. The integration of Behr further expanded the technological capabilities and product portfolio of Mahle Metal Leve, strengthening its position in the lead-firms' value chain.

The rapid succession of technology upgrading mergers and acquisitions took place as an effort of Mahle to restructure its Latin American business, at the decision of the headquarter in Germany, and in close alignment with the changing requirements of the assembly firm. Metal Leve was integrated into the value chain by being bought out by a foreign competitor, and is now controlled from a headquarter in a foreign

country. Other examples of Brazilian high tech supply firms that were acquired by overseas companies in the time period are Plascar, PST Electronica and Sabo.

Metal Leve's position in the global automotive value chain

Metal Leve has been fully absorbed by the Mahle Group, as it has become the major branch for pistons in Latin America for Mahle. The piston rings business has been highly consolidated in the global automotive industry for quite a while, with Federal Mogul from USA as the largest manufacturer in the world with an estimated market share of >60% of the global automotive market (see Table 5). As the second largest piston rings manufacturer, Mahle sought opportunities to expand and catch up to Federal Mogul in the past decades, before revising its strategy to prepare for the electrification of the powertrain in the 2010s. In its efforts to increase its global footprint and market penetration, Metal Leve played an important role in Mahle's expansion to the Latin American market.

Table 5: Global market share in pistons market

Company	Global market share
Federal Mogul	60-70%
Mahle	10-20%
Reihnmetall Automotive	>5%

Source: Author's own table, based on a report from the European Commission (COMMISSION OF THE EUROPEAN COMMUNITIES, 2007)

Similar to Metal Leve, multiple automotive suppliers were acquired by foreign firms in the wave of platform and component industry global consolidation. As some interviewees expressed, the automotive component industry has been sold out to foreign investors.

Autometal / CIE Automotive

Autometal was a Brazilian auto supplier of stamped metal components such as white body and chassis parts. Founded in 1965, the company enjoyed early success and was quickly established in the local Brazilian automotive industry to become a major supplier of metallurgy and later plastic injection components. Transactions requires little exchange of tacit knowledge between buyer and supplier. Therefore, industry of stamped metal components has stayed fragmented when other parts of the industry consolidated on a global level. Assemblers put little pressure on the supply base for stamped parts to consolidate, because transactions to produce per blueprint producers are easy to manage. And since such products have few competitive advantages from large scale production vis-à-vis localized manufacturing, the industry stayed fragmented well into the 1990s. As a producer of produce per blueprint components, the drawings are provided by the buyer.

As a manufacturer of such components, Autometal survived the first wave of foreign competition entering the Brazilien market when the market opened in 1990. However, with the increased use of global platforms, and the overall consolidation of the global supply base steered by large assemblers like Volkswagen, Autometal fell victim to an emerging group of global supply firms in the 2000s when it was acquired by the French company CIE Automotive.

CIE Automotive is a global supplier for forging, casting, machining, metal stamping, tube forming, aluminium, and plastic components. The company was created from the merger between the Egaña group (founded 1996) and Aforasa group in 2002. CIE Automotive is a young automotive supplier in the industry. Its strategy has been to inorganically grow via (international) M&A, to develop a global footprint in the metal processing and machining sector of the auto supply industry. Since the foundation of the original company Egaña in 1996, the group has been involved in almost 70 M&A

transactions to develop into a global supply firm.

The Brazilian company Autometal was one of the earliest targets and was acquired in 2000 by Egaña as a major acquisition in the Latin American region to strengthen the footprint in this region, and to this date plays a key role for CIE in the region.

CIE Automotive offers a variety of manufacturing services as a subcontractor to produce a wide range of components: crankshaft, CV-joints, axle shaft, axle beam, gearbox housing, clutch housing, ladder frame, steering housing, camshaft cover, turbo housing, differential housing, brake drum, body in white, steering columns, brake booster, seat structure, emblems, ash trays, trim parts, roof system products, or diesel and gasoline injection rails. The company has a diversified customer base from assembly firms to tier-1 suppliers. Its largest customers are Renault and Chrysler, each of which amount to 7% of CIE's revenues, followed by Daimler and Ford (with each 6%) and Volkswagen and General Motors (with each 5%). The remaining customers are below the 5% revenue mark, and almost 30% of CIE's revenue comes from customers that contribute less than 1% to its revenue.

CIE Automotive is a classical produce per blueprint supplier that receives the drawings from its customers and provides manufacturing services to its clients. As such, CIE has very little product ownership advantages. Instead, its advantage lies in its processing and manufacturing expertise. Combined with the diversified customer base, CIE has no significant market leader position for any of its key components.

Industrias Arteb

Established in 1934, as Artur Eberhardt Group, Arteb initially manufactured head lights, tail lights and side lights for the automotive aftersales market in Brazil

(which is now sold under the brand Lynx Vision). Since 1959, Arteb supplied lights directly to the four major assembly groups, Fiat, Ford, General Motors and Volkswagen.

When the Brazilian market opened in 1990, new assembly groups rushed into the market with new modules, and the big four assemblers had to rapidly introduce new passenger car models with the newest technology. As the market opened to new assembly groups, Arteb successfully expanded its customer base, supplying lights to brands such as Audi, Fiat, Ford, GM, Hyundai, Mercedes, Mitsubishi, Renault, Toyota, Troller and Volkswagen. With four production facilities in Brazil, Arteb has a production capacity of over 800,000 lighting units per month, and gained a 27% market share in lighting products for assembly groups in Brazil.

However, the new competition at the assembly level also accelerated the introduction of global platforms in Brazil, in which lighting systems used new technologies and are a common part supplied by global suppliers. At this cross-roads, Volkswagen decided to phase out its new vehicle, based on its then common PQ platform logic. Consequently, Arteb began to struggle for its position in the market. The big four assemblers tried to rapidly upgrade their local supply base in order to compete with the new entrants at assembly level. A popular method was to encourage the local supply firms to sign Technical Assistance Agreements with foreign competitors that owned superior technological capabilities. Volkswagen was no exception to that, and advised Arteb to upgrade its Technical Assistance Agreements with foreign partners.

In the rapidly changing market, Arteb had to quickly expand its capabilities to accommodate for the new designs, technologies and lightning systems of its existing customers. For this reason, Arteb expanded its license agreement with the German

automotive lights producer Hella, an internationally renowned and large automotive supplier at that time, that was already capable of producing the newest lights for almost all vehicles on the market. The contact to Hella existed through a previously established technical assistance agreement between the two companies and was further facilitated through the lead-firms pressure. Additional technical assistance agreements were signed in 1994 with Japan's Koito, Italy's Carello and Austria's ZKW.

Equipped with the leading-edge technology, Arteb tried to solidify its position in the Latin American market by expanding its production capacities. To this end, Arteb established a new production plant in Gravataí in 1998, within General Motor's industrial complex, and in Camaçari in 2001, in close proximity to the Ford Company. Expanding its production required fresh capital, which Arteb received from Hella and IFC (part of the World Bank Group) in 1998. Still, the holding family behind Arteb was able to maintain their majority stake in the company. When it became evident that the family was not willing to sell Arteb, Hella divested its equity stake in 2003, and terminated its licensing agreement. Arteb maintained its Brazilian ownership. However, without its key licensing agreement with Hella, Arteb was in a situation where it had to develop its own lightning systems.

To this end, Arteb set up its own R&D facility Centro Tecnológico Arteb for USD100m. The R&D center is a critical component of Arteb's strategy. Its purpose is to enable Arteb to develop new high value-added front-end lightning modules independently, to maintain their product portfolio. However, the timing coincided with rapid technological changes in the lighting systems industry and new vehicle development processes. At that time, the assemblers shifted towards more simultaneous engineering and co-designing of components for the upgraded product architecture that require new development processes. Accordingly, the focus of the R&D center was to

develop new capabilities for lightning products and upgrade the development process to install simultaneous engineering techniques and routines. “We had to enhance our design capabilities, to accommodate the [assemblers] requirements. We now have a team of designers that is involved in new vehicle designs from day one. They almost spend more time at the customer than in our labs.” (Interview, Arteb case).

Furthermore, demand for new lighting systems based on LED and laser technologies is growing and slowly replacing halogen technology. Whether or not Arteb will be able to design modern automotive lights and maintain its position in the market is questionable, for two reasons. First, the divestment from Hella came at a critical time when the introduction of LED lightning modules became popular in the automotive industry and generates higher profits than conventional lightning systems. Arteb has no capabilities in the LED lightning business, and cannot bid for projects in a technology that seems to become the norm in the future. As of 2015, it is clear that Arteb is far behind in regards to new key technologies in the high value LED and front-end module segment. Second, the industry is under massive pressure to globalize and expand its production capabilities internationally. So far, Arteb has been avoiding the pressure to globalize. The company’s goal is to become the largest automotive lighting supplier in Latin America. The company is looking to leverage its leading position in Brazil, to supply other automotive markets in the region, especially Argentina. “For foreign markets, we focus on Argentina. We try to win projects in North America and Mexico, but the Brazilian Real was too strong” (Interview, Arteb case). This severly limits the opportunities for Arteb to win future projects, as lighting systems will be standardized globally with the introduction of global platforms that are to be rolled out to Brazil soon (the MQB from Volkswagen was planned to be introduced to Brazil in 2017). It is questionable that a Latin American footprint with capabilities limited to old

technology will be enough for Arteb to survive the intense competition in the industry. With the double pressure to upgrade its products by developing entirely new capabilities and simultaneously develop a global footprint, it is unclear how well Arteb is positioned to face the future challenges in the industry.

Arteb's position in the global automotive industry

With the decision to stay independent of Hella, Industrias Arteb made the decision to remain a relatively small and local supply firm in the Latin American region. This is a risky move in an industry that is currently consolidating on a global level, with five very large lighting system suppliers with a global market share of over 10% and a number of additional relevant companies which each have a global market share of over 3% (see Table 6). As a relatively small supplier, Industrias Arteb is endangered to lose relevance for the assembly firms, as vehicles are increasingly based on global platforms, using the same common part across national borders, often supplied from the same global component or system supplier. With no global footprint, and no relevant market share in the global market, Industrias Arteb will find it difficult to maintain its market position even in the Latin American region.

Table 6: Global market share in automotive lighting systems

Company	Global market share*
KOITO MANUFACTURING CO.,LTD.	16%
Valeo	15%
Magneti Marelli	14%
Hella	11%
Stanley	10%
Visteon	6%
Samlip	4%
Ichoko	4%
Magna	3%
ACH	3%
Other**	14%

Source: Author's own summary, based on company information

Furthermore, the lighting industry is currently undergoing massive technological changes that are coming both from within the industry and from converging trends in the automotive industry. Future technologies that are coming from within the lighting industry include the move to LED and laser supported lighting systems for enhanced visibility fields through stronger and more focused light beams that do not distract other participants in the traffic. Furthermore, headlights are increasingly developed as adaptive headlights that turn the beam around the curve for a better view. Such adapting headlights need to be connected to the steering system for correct adaptation of the light beam. Converging trends from formerly unrelated aspects in the automotive industry that have an impact on the lighting system include, for instance, automated driving. In support of automated driving, future lighting systems have to support sensors and camera systems that are part of the automated driving system. Such sensors need enhanced visibility without distracting external participants in the traffic through visible and invisible lighting to ensure proper functioning. This is achieved by integrating the lighting system into the overall automated driving system through additional feedback and data exchange and constant adaptation of lighting in dependence on weather and light conditions.

Large companies such as Koito, Valea, Magneti Marelli, Hella or Stanley are better positioned to upgrade their products and serve future demands in the fast technologically changing environment. First of all, these companies have larger budgets for the required R&D, have easier access to financing M&A deals to buy additional technologies such as laser technologies, or build the capabilities in-house from the scratch. More importantly, however, is their integration into the value chain of the globally leading automotive assembly firms that helps them co-engineer headlights together with the assembly firms and suppliers of automated driving

systems. Through the close interaction, the lightning systems suppliers stay on top of the leading-edge technology through constant exchange of information and a close relationship to the customer. Future demands and trends are discussed years before they are implemented, providing the supply firms with the necessary time to adapt to the changes.

Iochpe-Maxion

Iochpe-Maxion, founded in 1918 as a wood processor, is Brazil's largest automotive supplier and the only Brazilian supplier that made it into the top 100 list of global automotive suppliers by revenue. The groups' main products are wheels, chassis components, and frame and stamped components.

As of 2014, Iochpe-Maxion supplies all major assembly groups, such as Daimler, Ford, Fiat, GM, VW, Renault, Toyoa, Volvo, PSA, as well as Tata from India. With 30 production plants in 14 countries (both, developing and developed) – Iochpe-Maxion is not just the largest, but also the most internationalized Brazilian automotive supplier, generating a significant portion of its revenue outside South America (which accounts for 40.8% of its revenue): 23.9% in North America, 28.0% in Europe and 7.3% in Asia. Iochpe-Maxion followed a very focused strategy that included a complete overhaul from its original product portfolio to achieve such impressive growth. The process started in the 1990s when the company started focusing on the automotive and railroad industries, divesting from unrelated businesses such was wood processing. In 2000, as purchasing shifted to regional structures and the pressure to internationalize increased, Iochpe-Maxion sold 50% of its railway equipment business to Amsted Industries to focus on maintaining and expanding its position in the automotive industry. The automobile business, originally one of the smallest business units,

contributed 93% of the company's revenue in 2014 with the remaining 7% coming from related railroads industry.

With the shift to a global purchasing of lead firms in the 2000s, Iochpe-Maxion rapidly internationalized through a number of cross-border mergers and acquisitions. In 2009, the company entered the North American market by acquiring the wheel business of America's Meritor, which was subsequently re-named Fumagalli Automotive Wheels. In late 2010, Iochpe-Maxion acquired the wheels production plant in Mexico from the Nugar S.A.P.I. de C.V. company to further solidify its position in the NAFTA region. The Mexican operations were expanded with the acquisition of the Galaz Group in 2012. In the same year, Iochpe-Maxion acquired Hayes Leymeny, a US based manufacturer of steel and aluminum automotive wheels. To increase its firepower for the bolt-on acquisitions, Maxion continuously divested from other products, such as high value added structural chassis components, brake systems, interior trimming and lock systems. The company realized that it had to develop a global footprint for one component, in order to stay competitive in the globalizing market environment. Refocusing the business helped Maxion to achieve this goal. However, in the process, Maxion divested from high-value-added components that offer high profit margins. Maxion decided to divest from such high profit components, because these components experience high levels of international competition, strong pressure for consolidation, and the markets are effectively dominated by a handful of large incumbent supply firms from the triad region of North America, Europa and Japan. In this environment, Iochpe-Maxion was losing in the market for high value-added components due to its limited R&D and design capabilities as well as lacking research in material sciences and process technologies.

The divestment from the high-value-added products enabled Maxion-Iochpe to

aggressively internationalize through acquisitions and establish itself as one of the globally leading manufacturers in the less crowded and consolidated market environment of steel wheels, which are a relatively simple and low technological driven products. As of 2014, the wheel business makes approximately 80% of the groups automotive business, and Maxion-Iochpe has successfully established itself as a global market leader in this segment.

While the acquisitions in the wheel sector enabled the company to upgrade its wheel products, the total product portfolio of Iochpe-Maxion was downgraded through the focus on what is the simplest and lowest value-adding product of its prior portfolio. Maxion-Iochpe has established itself as a global player in a little value-added position in the global value chains of the foreign assembly groups. The downgrading process proved to be necessary to catch-up in a segment where the global competition had no advantage through advanced technologies that could not be quickly developed by the Brazilian company.

Maxion's position in the global automotive value chain

The internationalization and expansion of Iochpe-Maxion is one of the most impressive trajectories of any Brazilian company, and one of the few success stories of firms from the emerging markets in this case study. Maxion is the only Brazilian automotive supplier that ever made it into the list of top 100 automotive suppliers in terms of revenue (2013, 2014). Through its focus on wheels, Maxion has been able to establish itself as the leading automotive wheel manufacturer in the industry, with a global market share of 10% (see Table 7). This is an impressive result for a Brazilian company during a time in which most Brazilian automotive suppliers lost out to international competition and were bought by foreign multinational firms. It has been made possible by focusing on a product that requires very little interaction with the

assembly firms, as it has no interaction to other components in the vehicle. Hence, supply firms that originated from the same countries as the largest assembly firms had no advantage from close proximity of R&D activities to its clients. Instead, cost advantages and an effective use of funds made available from divesting from other business units enabled Maxion to rapidly expand to other regions and establish a global footprint required to become a leading firm in the wheels industry.

Table 7: Global market share in automotive wheels

Company	Global market share
Maxion Wheels	10,1%
Central Motor Wheel Co., Ltd.	5,1%
Dicastal	3,8%
Enkei	2,9%
Topy	2,9%
Wanfeng	2,7%
Ronal	2,7%
Mefro	2,6%
Borbet	2,6%
Magnetto	2,2%

Source: Author's own summary, based on company information

However, its shining success has been somewhat tarnished in recent years. Maxion dropped of the top 100 automotive suppliers list of 2015 and 2016. And Maxion has little chances to make it back into the list with its focused approach on a relatively low value-added component that shows little opportunity for above normal growth. The company has an extremely focused product portfolio compared to most other top 100 automotive suppliers. With such a focused industry specialization and little requirement for close interaction with the assembly firms, Maxion is not in a prime position to receive support from its clients to perform value chain (process) upgrading. Since the component require relatively little knowledge transfer between supplier and buyer, and

is not affected much by the current technological developments in the industry, Maxion cannot expect to expand beyond its current business through in-house capability development.

Even within the relatively simple wheel industry, Iochpe-Maxion has a strong focus on the low value-added steel wheels, rather than on high value-added aluminium wheels. Steel wheels require relatively little technological know-how or R&D capabilities. To escape its low value-added position and stimulate future growth, Maxion Wheels would have to upgrade via M&A to acquire additional technologies for higher value-added components such as aluminium or carbon fiber wheels, or diversify its product portfolio again.

Participants in the value chain: Supply firms from China

Yanfeng

Yanfeng is a producer of automotive interior systems and Chinas most successful auto supplier. As one of two of the Chinese case studies, the company belongs to the Huayu Automotive Systems Co., Ltd. (in the following HASCO). HASCO is the component manufacturer subsidiary of the SAIC Motor Corporation Ltd., China's largest state-owned automotive producer that has joint-ventures with Volkswagen and General Motors since 1984 and 1998 respectively. HASCO is the largest automotive component supplier in China. As a holding company, the HASCO conglomerate consists of 28 business branches that are active in a wide range of components. The 28 business branches range from wholly-owned subsidiaries to joint-ventures with foreign partners. As part of the SAIC group, the pre-existing network ties that SAIC had developed to foreign companies proved to be instrumental in Yanfeng's later success. As a subsidiary of HASCO, Yanfeng had strong relationships with

assembly groups since its inception: “At the moment we make 60 % of our revenues from SAIC [including their two joint ventures with VW and GM] and 40 % from external OEMs, but we provide parts and services to all OEMs in China” [interviewee, Yanfeng case]. Most of the senior management of Yanfeng and its parent company HASCO previously worked in the assembly joint ventures. This included the chairman Hu Maoyuan (previously a managing director of Shanghai GM) and the vice president Xun Yizhong (former deputy manager of the cylinder shop and assistant to the plant manager of Shanghai VW). Through its network ties, Yanfeng was able to rapidly internationalize and develop into a large multinational supplier. Yanfeng’s foreign investment projects have been linked closely with its relationships to foreign firms. Yanfeng utilized its business networks at two different levels. First, it exploited the vertical networks with General Motors, which it previously established in China. Second, it drew from its horizontal network ties with its international joint venture partners.

Yanfeng originated as a joint venture between HASCO and Visteon, a US based leading supplier of electronic components. “We are expanding into the global markets using the joint ventures. … We are expanding into the US, into Germany, into developing and developed markets” [interviewee, Yanfeng case]. The horizontal relationships also provided learning opportunities to increase its international competence: “Through the joint ventures, Chinese managers get international experience, because they have to travel overseas to the joint venture partner” [interviewee, Yanfeng case].

Initially, all technological capabilities originated from its joint-venture partner Visteon, which had a centralised R&D centre in Michigan, USA. Over time, Yanfeng was able to take over some core activities from its joint-venture partners, and thereby

upgrade its position in the global automotive value chain through process, product and functional upgrading. The opportunity for an international expansion arose when Yanfeng's joint venture partner Visteon had to file for bankruptcy in the US in May 2009. HASCO (Yanfeng's parent firm) was able to inject capital into Yanfeng-Visteon. Through the capital injection, Yanfeng-Visteon was able to build much needed production facilities in Harrison Township, Ohio, close to GM (operational in 2011).

The bankruptcy of Visteon in 2009 was the first opportunity for Yanfeng to overtake core businesses of one of its joint-venture partner and thereby become technologically independent from the foreign competitor. , Yanfeng was able to acquire the electronics business from Visteon and buy out Visteon from the joint venture, including all of the Visteon operations in the US (Hertenstein, Sutherland and Anderson, 2017).

This marks Yanfeng's first large investment abroad, and is a significant commitment to its network ties with General Motors. The operations that Yanfeng acquired from its joint venture partner Visteon supplied General Motors in the US. The injected capital from HASCO and the integrated operations from Visteon enabled Yanfeng to further rapidly develop an international footprint within General Motors business network. New production facilities were build in Kalol, India (in 2011). Both new production sites were Yanfeng's first international operation sites, and were branded "Yanfeng" rather than "Yanfeng-Visteon." This was partly because Visteon was "not strong enough" and had a tarnished reputation [interviewee, HASCO case], but mostly to expand the presence of its own brand internationally, in order to strengthen its own network position within GM's global value chain.

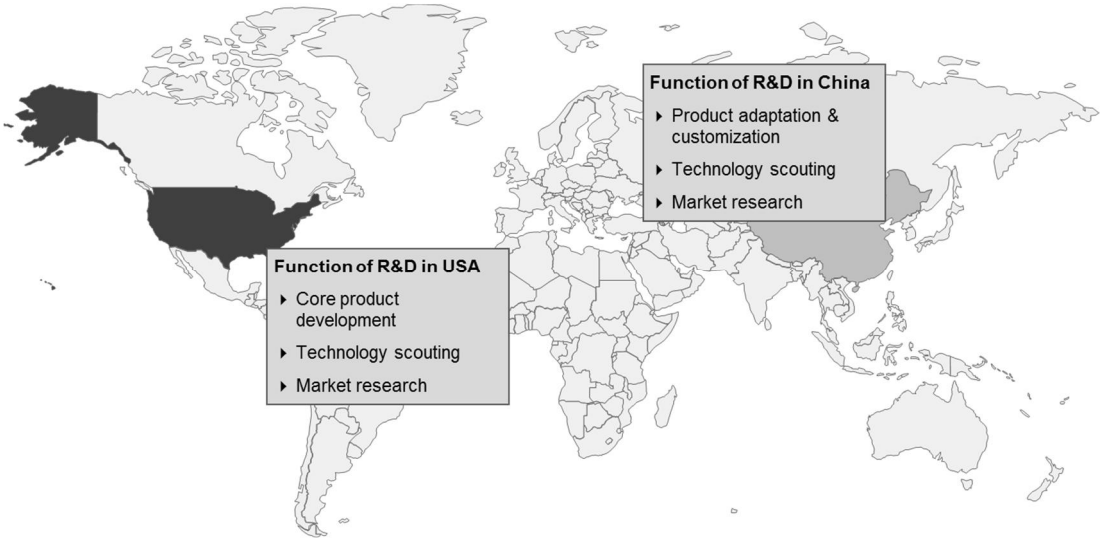
In August 2013, four years after the initial investment, Visteon agreed to sell its remaining shares in the joint venture to HASCO for US$1.2 billion. At that time,

Yanfeng-Visteon had already established three locations outside of China, two in the US and one in India. These now became fully integrated into Yanfeng, and performed under the Yanfeng brand. Through its investments, HASCO committed to the business network of General Motors and has become a global supplier of interior trimming and seating to General Motors, eliminating the relationship with its former joint venture partner Visteon. It has fully established its position in General Motors' business network, with the necessary scale and global presence to fulfil this role without further horizontal network partners.

International R&D configuration of Yanfeng's electronics business

Due to the historic trajectory, the USA still plays a central role in the R&D activities of Yanfeng's electronics business and enables the company to closely interact with its US customers during the vehicle development process. Because of its strong market presence in China, and the growing localization of R&D activities of large assembly firms in China, Yanfeng established an R&D location in Shanghai, China. Many testing facilities have been relocated to China, to build the capabilities in the company's home market. Nevertheless, the R&D center in the USA still plays the central role for Yanfeng's core product development and as source of core technologies and the new product development capabilities. The Chinese R&D location is mainly involved in product adaptation and customization. Capabilities for core product development for indigenous Chinese assemblers in China is only gradually being developed, as the Chinese assemblers build up their development capabilities.

Figure 15: International R&D centers of Yanfeng



Source: Author's own figure, based on field research

Break-through and making of a global giant

Yanfeng's break-through came through its ties to a second joint-venture partner. In 2015, after Yanfeng-Visteon had turned from joint-venture to wholly-owned subsidiary of HASCO, Yanfeng founded a new joint-venture, the Yanfeng Automotive Trim Systems Co. Ltd, together with Johnson Controls. The joint-venture was created when Johnson Controls divested from the majority of its interior business. As the interior business suffered for many years from low profit margins, Johnson Controls pivoted its business model to focus on its core businesses: heating and cooling equipment, controls for buildings and batteries for cars (the company carved out its automotive seating business a year later, which created Adient – the world's leading automotive seating business). In the new joint-venture, Yanfeng holds 70% of the shares, while Johnson Controls retained the remaining 30%. The joint-venture immediately became the world's largest supplier of automotive interior systems, as it continuous all of the former operations from Johnson Controls interior business. It produces cockpit systems, central consoles, door panels, and roof systems.

As the majority holder, Yanfeng's brand name was used for the new joint venture. Over night, the Yanfeng brand became a recognizable and serious brand in the automotive supply business. Since all of Johnson Controls' former interior operations were integrated into the joint-venture, Yanfeng Interior Trim had a global footprint with more than 90 manufacturing sites in over 17 countries, and global customer base from inception. Yanfeng relocated headquarter of the joint-venture to Shanghai, while all remaining operations remained untouched. This means the core product development is still located in the US, as is the majority of the business activity. Nevertheless, an additional R&D center was created in China, to strengthen the capabilities for the increasingly important market.

Through the Yanfeng Interior Trim joint-venture, Yanfeng joined the ranks of one of the largest automotive suppliers in the world – and China's most recognizable brands in the automotive industry. In the 2015 top 100 supplier list by revenue, Yanfeng ranks 18th, the highest rank of any supply firm from the emerging markets ever reached (Automotive News, 2015).

Yanfeng's position in the global automotive value chain

Yanfeng is the most successful automotive supply firm from emerging markets, and has recently established itself as a leading company for interior parts in a highly competitive the automotive market. The company focuses on door panels, instrument panels and consoles for the assembly firms. In the top 100 automotive supplier list of 2015, Yanfeng ranked 18, its highest ranking yet. In order to achieve such growth, Yanfeng, as a subsidiary of HASCO, skilfully utilized its close ties to SAIC and its two joint-ventures with Volkswagen and General Motors, to grow on the back of the rapidly growing Chinese market for mass produced vehicles. In order to gain access to leading

edge technologies, Yanfeng initially relied relatively little on cross-border M&A, but instead established alliances through technology assistance agreements and in particular joint-ventures with leading automotive suppliers such as Visteon or Johnson Controls. When opportune, Yanfeng used the crisis of its partners (in particular during the financial crisis of 2008) to acquire additional shares and gain more control over its joint-ventures or entirely take over the operations, as in the asset-swap with Visteon. Through such moves, Yanfeng has been able to establish the 70-30 joint-venture Yanfeng Automotive Interior Systems Co., Ltd. together with Johnson Control, which immediately became the largest automotive interior supplier in the world. With an approximate market share of 24%, Yanfeng overtook the likes of Faurecia or Grupo Antolin or the captive suppliers Hyundai Mobis and Toyota Boshoku (Table 8).

Table 8: Global market share in automotive interior business

Company	Global market share
Yanfeng	24%
In-house	20%
Faurecia	14%
Grupo Antolin	7%
Hyundai Mobis	7%
Toyota Boshoku	6%

Source: Author's own summary, based on company annual reports

Yanfeng's market share for interior systems in general is not equally reflected in all business units. For instance, in the automotive seating business, Yanfeng does not yet play a key role in the global market, despite its joint-venture with the market leader Adient. The two giants Adient and Lear are far out of reach for Yanfeng, and even the

followers Toyota Boshoku, Magna and Faurecia each have significantly larger market shares (Table 9).

Table 9: Global market share of automotive seating companies

Company	Global market share
Adient	34%
Lear	16%
Toyota Boshoku	7%
Magna	6%
Faurecia	6%
TS Tech	2%
Other	28%

Source: Johnson Control Investor Relations information

Nevertheless, Yanfeng in undeniable one of the most successful cases of automotive supply firms from the emerging markets, and has established itself as a core tier-1 supplier to assembly firms.

YAPP

YAPP is a global supply firm of plastic fuel tanks for passenger cars and commercial vehicles. The company was founded in 1988, and is part of the HASCO group. With 24 production locations, and operations in Germany, India, USA, and Russia, YAPP has become one of the largest automotive plastic fuel tank suppliers in the world. Compared with Yanfeng, YAPP has been less reliant on foreign technologies since its inception. Instead, the company focused on building own capabilities in-house for what was initially a niche market. In the 1970s, all fuel tanks were made of steel. Even in the early 2000s plastic fuel tanks played a minor role in the auto industry, and were the exception rather than the rule. But because fuel tanks offer a significant cost advantage compared to conventional steel fuel tanks, YAPP has become the largest

producer of plastic fuel tanks in China. Moreover, ever stricter emission standards worldwide have given the plastic fuel tank a steep rise. Plastic fuel tanks weigh about two-thirds less than those made of steel, thereby lowering overall vehicle weight to help decrease CO2 emissions. Hence, plastic fuel tanks have emerged to play a critical role for assembly firms to meet ever tighter emission standards. They also have other advantages including: better safety, cost-effectiveness, biofuel compatibility and lower corrosion. Such characteristics helped plastic fuel tanks to displace steel fuel tanks in the past years. As of 2016, approximately 80% of all fuel tanks were made of plastic. In Europe, even close to 95% of fuel tanks are made of plastic.

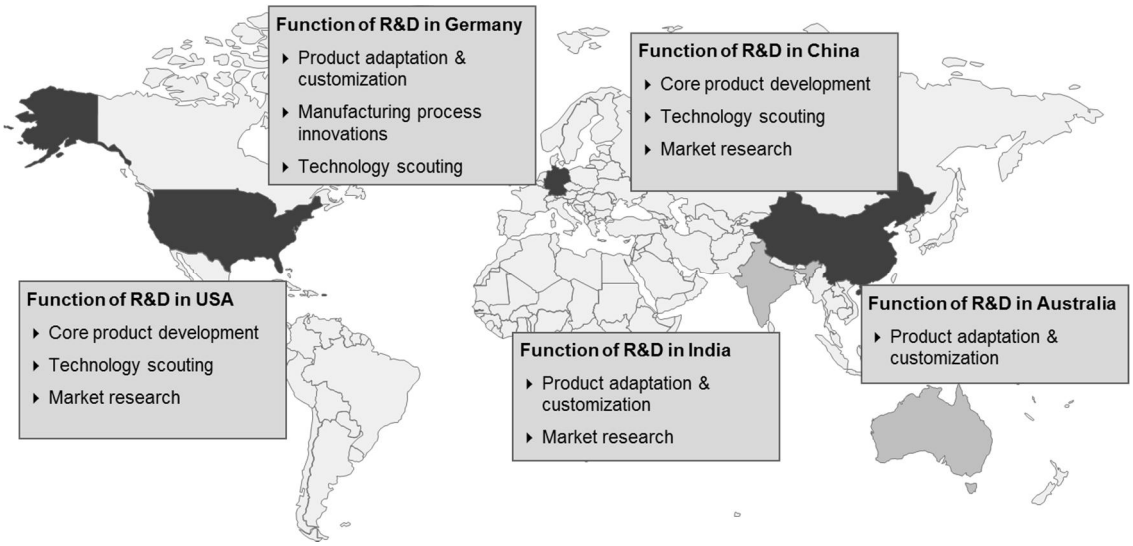
As a market leader during the period of rapid market growth for plastic fuel tanks, YAPP was able to move into high end, 5 layer plastic fuel tanks for the China market. YAPP was able to internationalize vie Greenfield investments to establish a global manufacturing footprint with new facilities. During the time of strong global market growth, YAPP established manufacturing locations in Australia (2010), India (2010 and 2012), Russia (2011), and Czech Republic (2012). Furthermore, YAPP developed a strategic alliance partnership with ABC Corp Fuel Systems Inc., for the US market in 2010, a company that YAPP subsequently acquired and integrated in 2014. As the General Manager of the holding company, Lui Xuewu, explained: “This acquisition is part of our strategy to support our customers on global platforms. Over the past few years automotive [assemblers] have been moving to global platforms and we have been working with ABC to support our customers in North America” (Miel, 2014). Through the acquisition, YAPP added an additional plant in Gallatin, Tennessee. Like Yanfeng, YAPP extended the relationships it had previously established to foreign customers in China (General Motors, Volkswagen, and Ford). Through a number of international investments, YAPP was able to comply with the requirements of its global

clients, which require their supply firms to have a global footprint and supply to all production plants worldwide. Each of YAPP's investments was made to establish production sites in close proximity to the production plants of a particular customer, so as to enhance its position within these business networks.

As the management stressed, the strong relationships YAPP had established in China were vital in winning these overseas projects. Moreover, localizing its production in close proximity to its customers internationally was particularly important to further strengthen its network ties [Interviewee, YAPP case]. The global footprint enabled YAPP to supply its products to all large automotive assembler, and serve international customers abroad. In order to support the development of its products for the vehicles of international clients, YAPP also developed an international network of R&D centers, comprised of four locations: Germany, India, Australia and the former ABC R&D center in the US. An important factor driving the international co-location to its customers is the "simultaneous engineering" process of the global assemblers. Co-operating in R&D has become central to modern day automotive competition that use global platform strategies. As a developing supplier, whose products require adaptation and customization to the vehicle, YAPP is involved in the R&D process early on. Through early involvement in the R&D process of its customer, YAPP insured a deeper integration in the business network and further built strong inter-firm relational ties. The early integration in the R&D process of the customer opened further learning opportunities within the network and enabled YAPP to become an early adopter of changes in technology and vehicle designs owing to its position as an insider. Through the acquired knowledge as an insider of the business network, YAPP could thereby continuously upgrade its products and positioned itself at the cutting-edge of plastic fuel tank provision. YAPP had actively sought to become more actively involved in the

R&D process of its customers: “We want to engage in the global platforms from an early stage on. But we have just started to do so” [Interviewee, YAPP case]. In order to effectively learn from its network and to strengthen its position within the network, YAPP hired key engineers that were former employees of its customers: “We have to hire retired experts, maybe engineers from those OEMs because they have a very smooth communication with the system engineers in the technical center in the global OEM” [Interviewee, YAPP case]. The primary function of the German and US centers is research and product development, to deepen the technological ties with innovation systems on site as well as enabling simultaneous engineering of products for local assemblers (Figure 16).

Figure 16: International R&D centers of YAPP



Source: Author’s own figure, based on field research

YAPP’s position in the global automotive value chain

Even though YAPP has the same mother company HASCO, its strategy differs significantly from that of Yanfeng. Unlike Yanfeng, YAPP relied much less on external available technology and alliances with foreign supply firms. Instead, the firm

internally developed the capabilities and technology that eventually led to its successful rise in the global automotive industry. YAPP's trajectory is a case of "the right idea at the right time". When YAPP developed its plastic fuel tank, such fuel tanks were a niche product in the global automotive market. Over 90% of fuel tanks used at that time were made of steel, and there was no signs indicating that this would change. Only through the rapid succession of ever stricter emission standards worldwide, did the assemblers start to put emphasis on decreasing vehicle weight by reducing weight of components such as the fuel tank. The rise of the plastic fuel tank market put YAPP on the map as one of the leading fuel tank suppliers based on first mover advantages and leading technology in the formerly niche product. In 2016, YAPP had a global market share of 12% in the overall fuel tank market, which puts YAPP in the top four global fuel tank suppliers, together with Plastic Omnium, Kautex and TI Automotive (see Table 10). Furthermore, with its strong focus on emerging markets, YAPP is well positioned to further benefit from the fast growing automotive markets in the emerging economies.

Table 10: Global market share of leading fuel tank manufacturers

Company	Global market share
Plastic Omnium S. A.	21%
Kautex	15%
YAPP	12%
TI Automotive	11%
Others (<5% market share)	20%
Steel fuel tanks	21%

Source: Based on MarkLines industry data

Fuyao

The following case study has previously been published in an article in the Asia Pacific Journal of Management (Hertenstein, Sutherland and Anderson, 2017).

Fuyao has risen to become one of only a handful of major international auto glass suppliers that dominate the global market. Less than a decade ago, Fuyao was only a local supplier in China. Since then, it has dramatically transformed itself from its former position as a loss-making state owned plant that supplied glass for water meters. It has witnessed rapid expansion in the US and Europe through which it has become deeply embedded in the value chains of most major international assembly firms. In 2015, Fuyao supplied the world's largest auto groups (i.e., VW, General Motors, Toyota, Hyundai) on an international basis and has become a main supplier for numerous well recognized brands like Mercedes-Benz, Audi, Bentley, Ford, Honda, Nissan, PSA, and Volvo (Sevestapulo, 2014).

Fuyao's vice president of global sales related to us how Fuyao's rise had been significantly shaped by its relationship with VW and how the relationship was "extremely important" to Fuyao [interviewee, Fuyao Glass case]. The network commitment building commenced in China. A lengthy gestation period, involving building successively higher levels of commitment, preceded the foreign investment. Prior to undertaking its first FDI project in 2007, Fuyao successively established production plants in close geographic proximity to all of VW's major operation sites in China (Figure 17): Changchun (2000), home to VW's major joint venture with First Automotive Works (FAW) (in operation since 1991 and VW's second largest production plant in China, employing 15,991 people), Chongqing (2001), the third largest automotive centre in China, to supply VW in Chengdu (VW's third largest production plants), and Shanghai (2002), the location of VW's second joint venture, with the Shanghai Auto Industry Corporation (SAIC).

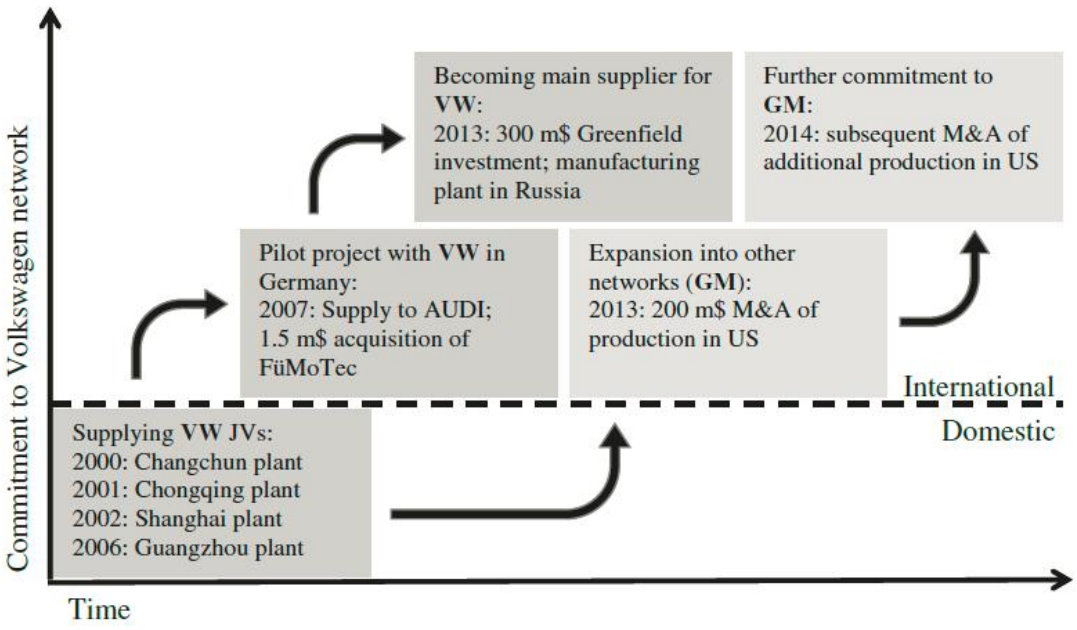
Through the domestic investments, Fuyao assiduously developed its relationship with VW. In 2007, Fuyao started supplying to the VW Group internationally for the first time. Because of its long-standing relationship domestically, Fuyao was "requested" by Audi, a subsidiary of VW, to supply windows for the Audi A6 on a trial basis for their main production location in Ingolstadt, Germany. This first FDI project with Audi can be directly traced to Fuyao's involvement in the VW value chain in China: "The contact to Audi was established via FAW-VW [a VW joint venture in China], ultimately via Audi Changchun, and their global purchasing department approached us" [interviewee, Fuyao Glass case].

During the trial project, Fuyao acquired a local German firm, FüMo Tec GmbH for US$1.5 million in 2007. While only a comparatively small FDI project, it proved an important first international commitment to VW. The acquisition provided Fuyao with two key assets for the future learning development within the business network: First, the services of the CEO of FüMo Tec, who used his long working relationship with VW in tandem with Fuyao's pre-existing knowledge of supplying to VW to help Fuyao work with Audi in Europe. His help greatly accelerated Fuyao's learning of how to do business in Europe, eventually meeting the required technological and quality standards [interviewee, Fuyao Glass case]. Second, Fuyao obtained essential complementary technologies required to supply the European market. As a manager explained: "the automotive glass companies in Europe had more value-added activities than those provided by Fuyao in China" [interviewee, Fuyao Glass case]. Fuyao used the acquisition to upgrade its product offering by adding the chemical application for the glue between the glass and the chassis, which in China had previously been carried out by the assembler.

The pilot project was highly successful and Fuyao's engagement with VW expanded: "After the A6 project followed a project for the VW Passat, and then more others" [interviewee, Fuyao Glass case]. Eventually, Fuyao became the main supplier of automotive glass for the whole VW group, which included the brands such as Audi, Seat, Skoda, Volkswagen, and later Porsche.

Larger commitments to VW's international business network followed. In September 2013, a US$375 million investment led to the opening of a production plant in Kaluga, Russia (Figure 17). Again, this was directly linked to VW: "[they] invited us to open this production plant in Russia because of our good relationship with VW here in China" [interviewee, Fuyao Glass case]. With a capacity of 1 million units, the new production plant will serve VW's newly established Kaluga manufacturing plant, but also the European market, as Fuyao planned to increase its volume to 3 million units per annum.

Figure 17: Fuyao building networks over time



Source: Hertenstein et al., 2017

The relationship Fuyao established with VW in China was considered "path breaking" for Fuyao because it was to lead to further and closer interactions with Audi, VW, and even other foreign assemblers outside of China [interviewee, Fuyao Glass case]. Successfully supplying to Audi in Germany solidified Fuyao's reputation for quality, which, according to one interviewee "hugely improved our brand perception" [interviewee, Fuyao Glass case]. This led to further supply chain involvement with other assemblers in different locations: "without the Audi project, we would not have been considered an option for other [assemblers] in Europe" [interviewee, Fuyao Glass case]. This was partly because Audi had a reputation for having the very highest quality standards, and partly because the particular windscreen for the Audi A6 was considered to be the most complex and difficult to produce at that time [interviewee, Fuyao Glass case]. Successfully supplying this windscreen to German quality standards opened doors beyond the VW network: "After Audi came VW, after VW came Volvo, then Jaguar and Landrover, Bentley [which belongs to the VW Group], General Motors, BMW, Daimler and Fiat. Step by step they approached us" [interviewee, Fuyao Glass case].

Subsequent commitments to business networks of other assemblers followed. In 2011 Fuyao made a number of smaller US investments in General Motors' network, and in 2013 bought a large former General Motors site in Dayton, Ohio. This $200 million investment was at that time the largest Chinese investment in Ohio. In 2014, Fuyao acquired a US based glass production plant from PPG, a business partner it had been working with in China for 13 years and from which it had licensed technology and has had a strong collaborative relationship. The acquired assets were in close geographic proximity to major US automotive manufacturers that Fuyao previously supplied in China. Through the investments, Fuyao further committed to its existing

business networks and strengthened its international relationship ties with its major customers.

But it was especially the close relation established with Volkswagen in China that brought the break-through for Fuyao. As interviewees from Volkswagen confirmed, Volkwasgen was interested in establishing a new global automotive glass manufacturer, and deliberately selected and nurtured Fuyao, supported and steered the companies internationalization and capability building, by continuously selecting projects for Fuyao that would help the company to build its capabilities. Such steps included the selection of Fuyao as the key supplier for specific windscreens, as well as encouraging the merger with FüMoTec and putting the two companies in contact.

Volkswagen had own strategic objectives in developing Fuyao. At the time Fuyao was selected, the global automotive glass market was highly consolidated and consisted of few large companies. In Europe, four companies controlled 90% of the market in the EU: Saint Gobain, Pilkington, AGC Asahi and Soliver. As often in such oligopolistic structures, the companies did not compete on price, and enjoyed above normal profits for years. In fact, in 2008 the European Commission unveiled a glass cartel in the EU that included all four dominating firms. The fines totaled 1.384 million EUR at that time the highest fine imposed on a cartel in Europe. In this market environment, prices for automotive glass were very high in Europe for years, and Volkswagen wanted to put pressure on the prices by establishing a new low-cost competitor in the EU. The low-cost producer Fuyao, with which Volkswagen had made positive experience in China, was selected for this purpose and gradually developed to be able to compete in the European market.

Fuyao's position in the global automotive value chain

Fuyao is one of the most impressive cases of a company that has been able to catch up with global competition in terms of technological and manufacturing capabilities, market share, global footprint, and involvement in the vehicle development process of its customers. After its rapid and aggressive internationalization, Fuyao has been able to develop a manufacturing footprint that enables the company to service its clients in all key automotive production hubs. Moreover, Fuyao has been able to break into the group of leading automotive glass companies in the world, despite its highly consolidated nature and high entry barriers. In 2016, Fuyao was among the largest four automotive glass manufacturers in terms of revenue, amidst the traditional firms such as Asahi Glass, Saint-Gobain and Nippon Sheet Glass (see Table 11). While data for sales units is difficult to obtain, it can be expected that Fuyao exceeded the other producers, given its low cost advantage in recent years (Interview, Fuyao case & VW case).

Fuyao showcases a classical example of value chain product upgrading via the acquisition of products complementing the existing products in the portfolio, which enabled the company to play a more important role in the value chain. The case furthermore highlights the key role the automotive lead firms play in the development of the supply firms, in particular for latecomer firms from the emerging markets that have to fight their way into the global industry through the development of own firm specific advantages in conjunction with its clients.

Table 11: Revenue of largest automotive glass manufacturers

Company	Revenue mUSD	Origin
Asahi Glass Co (AGC)	$3.681,1	Japan
Saint-Gobain S.A.	$3.128,0	France
Nippon Sheet Glass Company (NSG)	$2.676,0	Japan
Fuyao Glass Industry Group Co., Ltd.	$2.398,8	China
Xinyi Glass Holdings Limited	$484,2	China

Source: Author's own summary, based on company annual reports

Even more importantly, however, Fuyao has been able to develop an R&D capability that is on par with its foreign rivals. Through its close ties to the assembly firms, in particular Volkswagen, Fuyao has been able to get involved in the vehicle development process of its clients. While car glass has little interdependencies with other components, and hence involvement is more one-directional and does not require heavy bi-directional knowledge and information exchange, it is still considered a key component of the vehicle, and suppliers are managed very carefully by the assembly firms. After all, the glass is one of the defining characteristics for customer perception of the final product. Despite this, Fuyao has been able to meet the quality and design requirements of its international clients, and has been able to establish itself as a trusted supplier even for the highest demands of luxury vehicles in the western markets.

Lawrence of the Huaxiang Group

Ningbo Huaxiang Electronic Co., Ltd. is a tier-2 supplier of electronic components and interior solutions. Its interior trim business unit illustrates the depth of value chain orchestration by lead firms in the automotive industry. The interior trim business unit was originally organized in an independent legal entity, and marketed under the brand “Lawrence Automotive”. The interior business produces door trims, door panels, wooden trims, center consoles, pillars, dashboards, grills and provides instrument panel assembly services. The following case study solely focuses on the interior business of the Huaxiang Group.

The interior business was built through a number of cross-border acquisitions of established automotive suppliers in the advanced economies. The Huaxiang Group acquired Lawrence in the UK in 2007, a supplier of high-grade wooden interior panels for luxury vehicles. “The way we do things: we buy companies… That is an easier and

much faster way of doing it [than developing new technologies/products and related capabilities]" (Interviewee, Huaxiang case). Huaxiang relocated the operations to China, established manufacturing in the city of Ningbo, but maintained the development and marketing capacities in Europe. This acquisition proved instrumental in building the necessary capabilities for Lawrence Automotive and the subsequent development of the interior business in the Huaxiang Group.

What followed was a number of additional cross-border acquisitions: Veneer Manufacturing Center in the UK in 2010, Northern Automotive Systems in the UK in 2011 and Northern Engraving Corp in the US in the same year. Through the subsequent acquisitions in the US and Europe, Lawrence Automotive extended its product portfolio with complementary products such as aluminum trims, door and dashboard interior assembly and plastic molding. Finally, in 2016, the interior business under the "Lawrence Automotive" brand was acquired and integrated into the Ningbo Huaxiang Electronic Co., Ltd. – a formerly independent company that is part of the Huaxiang Group belonging to the same owner.

What is most fascinating about this case is the level of influence the assembly groups, in particular Volkswagen, had over the Huaxiang Group during its time of capability building and reorganization of its business activities. In the interviews, the CEO of Lawrence Automotive emphasized the close relationship to Volkswagen, and how being part of Volkswagen's business network helped the company to build capabilities and elevate its position within the automotive value chain. This is odd, as Lawrence is a tier-2 company, supplying its components to tier-1 suppliers that then supply the assembly group with readily assembled doors or consoles. Lawrence automotive has no direct supply contract with Volkswagen. Yet, Volkswagen had

significant influence on Huaxiang. It appears Volkswagen exercised a level of control over Huaxiang that is unexpected for companies that have no direct supply contract.

Even though Lawrence is only a tier-2 supplier to the assembler, it has developed a very close relationship to Volkswagen. Volkswagen oversaw the reorganization of the production processes of Lawrence through regular company visits in the new manufacturing location in Ningbo, to approve the production line and methods. Through its supplier development program, Volkswagen established a continuous support of Lawrence in China to develop its manufacturing capabilities to meet the requirements and standards of production for the German assembler. Its process optimization development program also included support and alignment regarding supply chain management, to ensure just-in-time and just-in-sequence delivery to the tier-1 supplier and assembler of panels and to mitigate potential disruptions in the supply chain. Even though Lawrence has no contract to supply directly to Volkswagen, as it suppliers to another tier-1 supplier, Lawrence had to be approved by Volkswagen as a tier-2 supply firm to the tier-1 supplier of doors and consoles.

Even long-term ties between Volkswagen and Lawrence that go beyond the initial operational reorganization and relocation of manufacturing to China were established. This includes simultaneous engineering process of vehicles in the Volkswagen group and Lawrence's interior products, which are important for customer perception of the final vehicle. Engineers from Lawrence and Volkswagen are in regular contact to fine-tune drawings, discuss finishes and production methods. Strategic decisions made by Lawrence are being influenced by Volkswagen, such as the expansion and development of complementary capabilities via mergers and

acquisitions and the expansion of Lawrence to foreign locations via cross-border acquisitions.

But Volkswagen's influence and value chain governance did not end with the tier-2 supplier Lawrence. Volkswagen reached even deeper into the value chain to orchestrate the extended activities. For instance, supply firms to Lawrence, tier-3 suppliers in the Volkswagen value chain, had to be approved by Volkswagen. When Lawrence wanted to substitute the supplier for specialized glue between the wood trim and the plastic holder, Volkswagen insisted it would have to approve the supply firm. In the end, Volkswagen was not satisfied with the proposed new tier-3 supplier, and Lawrence had to keep using the special glue provided by BASF, which has previously been approved by Volkswagen. This illustrates how tightly Volkswagen is controlling its upstream value chain, and goes to show how far the orchestrating activities of lead firms can go in its GVC.

Huaxiang's position in the global automotive value chain

Huaxiang is a case with many similarities to Yanfeng, but a very different trajectory. Like Yanfeng, Huaxiang entered the interior trim market. However, unlike Yanfeng, Huaxiang has used a different strategy and has seen very different results. While Yanfeng relied heavily on joint-ventures with leading foreign multinational suppliers, Huaxiang opted for M&A in order to acquire foreign technological capabilities, know-how, and access to a foreign client base. This somewhat limited Huaxiang's ability for rapid growth, as the company had to put a lot of effort into ramping up production in China, complying to quality standards set by international customers, maintaining the knowledge and development capabilities, while being constrained to its own financial resources with no external joint-venture partner. Even

though the initial customer base from the acquired target Lawrence UK was based in Europe and in particular the UK, orders shifted with the production capacities to China. The same customers, most importantly Land Rover and Jaguar, shifted orders of wooden panel trims for European based production lines to its newly opened assembly line in the Chinese joint-venture Chery Jaguar Land Rover. While the Chinese automotive market has been the fastest growing market in the world, the market for luxury components such as wooden panels still lags behind the mature markets in Europe and North America. Lawrence put too much focus on the Chinese market, to some extend neglecting the European and North American market, and thereby missed a chance to establish itself as a globally leading supplier of wooden panels. Therefore, Huaxiang has still a long way to go to become a truly global automotive supplier, and is currently an insignificant player in the highly consolidated global automotive interiors industry (Table 12).

Table 12: Market share of leading interiors supply firms

Company	Global market share
Yanfeng	24%
In-house	20%
Faurecia	14%
Grupo Antolin	7%
Hyundai Mobis	7%
Toyota Boshoku	6%

Source: Author's own summary, based on company information

ASIMCO

Founded in 1994 by an American citizen, ASIMCO is one of the largest, private-owned components manufacturers in China. Located in Beijing, the company supplies to both Chinese and global automotive markets. The company offers engine

and chassis products: power train products, including fuel injection systems, piston rings and castings, rotating electrics, cylinder blocks and heads, camshafts, and aluminum castings. It also offers chassis products, including air compressors, brake drums, disc and slack adjustors, rubber products like engine mounts, isolations and dampers, seals for braking systems, semi-active suspension mounts, and plastic brackets. In addition, the company offers powdered metal products and starters and alternators.

ASIMCO is a remarkable case study exemplifying the struggle of companies from emerging markets to upgrade within the global automotive value chain beyond a certain point.

Since its inception, it has been the strategy of ASIMCO to use capital and technology from the US and Europe to establish a leading automotive supply firm for the growing market in China. To this end, ASIMCO started off by establishing a number of joint-ventures for a wide variety of products. In 1994, two joint-ventures were founded: ASIMCO Meilian Braking Systems and ASIMCO Tianwei Fuel Injection Equipment Stock for diesel engines. Additionally, ASIMCO NVH Technologies was founded as a wholly-owned subsidiary. One year later, in 1995, three additional joint-ventures were created: Hubei Super-Elec Auto Electric Motor, with its daughter joint-venture Remy Electricals Hubei Company, and Yizheng Shuanghuan Piston Ring. After initial struggles to fight corruption and establish a trusty relationship with the top management in its joint-ventures, ASIMCO established two additional business branches in 1997 and 1998: ASIMCO International Castings as a joint-venture, as well as an additional ASIMCO Castings company as a wholly-owned subsidiary.

Through the rapid successive creation of business units mostly with foreign partners, ASIMCO was able to quickly meet the product requirements of the local industry. However, to get to a new level and upgrade its quality, ASIMCO realized it had to start exporting its products and serve international clients in the high demanding advanced economies. This proved to be a major challenge for ASIMCO. As one interviewee put it:

"At first, we did not understand the clients at all… For instance, one of our components was 2 grams too heavy… This is a 2.5 kg component, and we were only 2 grams off! But they would not approve it this way... It was a difficult learning experience. It took us weeks to manage and reduce [the weight] … The international clients challenged us to achieve this, and we really learned a lot. Not how to manufacture lightweight components, but how western engineers think and how we had to adapt to meet their requirements." (Interview, ASIMCO case).

Despite the early difficulties, ASIMCO managed to raise its quality and become approved by multiple international clients. In 1999, ASIMCO exported components to advanced economies for the first time, to Delco Remy and BOSCH. Additional international clients followed, and more and more of ASIMCO's products were approved by global automotive suppliers and assemblers for use in advanced economies. After the increasing success, additional joint-ventures were established with the ASIMCO Foundry and ASIMCO Camshaft in 2003 and 2004 respectively.

In 2004, shortly after the initiation of its two new joint-ventures and its growing international success, ASIMCO started to transform its business. The focus shifted from an investment-oriented strategy to an industry-focused supplier that puts the specific needs of its clients first. The company was renamed "ASIMCO Technologies Limited".

With its new strategy, ASIMCO initiated a new focus on building sustainable firm specific advantages through internal R&D and innovation.

To this end, ASIMCO set off to acquire foreign suppliers in order to obtain leading edge technology. In 2004, the company made its first notable cross-border acquisition of the camshaft plant of Federal-Mogul Corporation. In 2005, it acquired NVH Concepts LLC in the US. To utilize its cost advantage from China, operations were relocated to China. Additionally, ASIMCO started to build a number of R&D centers for its different business units. In 2006, ASIMCO Shuanghuan opened a Research and Development center for the development of piston rings. Two years later, in 2008, ASIMCO Shuanghuan created an alliance with the Chinese Academy of Sciences to further strengthen its piston research center. Later in the same year, ASIMCO Shendian launched the development of own start-stop starters. In 2013, ASIMCO Shuanghuan established additional joint-ventures with the US and Japan based ASM and NPR supply firms, to further strengthen its technological know-how and R&D capabilities. Six independent new products were developed for international companies such as JMC, SFH, Cummins and Weichai, marking the first success of its own R&D capabilities. A further R&D center was established by ASIMCO Shanxi in 2014, for the development of castings like cylinder blocks and cylinder heads.

Nevertheless, the company struggles in its efforts to upgrade from a produce per blueprint supplier to a developing supplier. While continuous relationships in particular to international customers such as Volkswagen, Cummins, General Motors or Daimler helped to company to upgrade its processes and be able to manufacturing contemporary products, the company made little progress to break into the category of developing or even better innovating supply firms. To this date, ASIMCO is essentially a “produce per blueprint” sub-contractor that receives the drawings from its clients to

manufacturing components to the requirements of the client. The development and design activities for each component are done by the assembler or tier-1 supplier. The strategy to build own R&D capabilities and become a developing supplier has not paid off as of 2016. The top management is acutely aware of the challenge to upgrade to the next level:

"We are only what we call a PPT [produce per blueprint] supplier… We are like a service company with no own intellectual property. We provide manufacturing services. But the part designing is done by the client. This is where the real value is created. And we don't have this yet – and we don't know how to get there." (Interview, ASIMCO case). Another interviewee made an example: "Even though we produce the five C of an engine [key components of combustion engines: connecting rod, cylinder head, cylinder block, camshaft, and crankshaft], we are not able to upgrade and produce the entire engine like Cummins, let alone develop our own engine. We produce all parts, but don't have the assembly capabilities. But even more critical, we are not experts on how engines work – we don't know how to design the components. We can only copy. The parts are cheap, the engine is expensive!" [Interview, ASIMCO case). The assembly and developing of engines require a different set of capabilities than manufacturing components based on drawings received. Developing such skills in-house and from the ground up proved to be extremely difficult. Ten years after putting emphasis on the development of such capabilities, ASIMCO is still at the beginning and has made only little progress towards its goal to become a developing supplier for such complex systems as engines.

While the company has not been able to become an engine assembler, let alone developer, it has been able to successfully build up development and innovate capabilities in other categories, like NHV components. "We build engine mounts…

Those have to absorb the vibrations from the engine for years. In the past, they used to be made from rubber. We developed own hydraulic engine mounts… This is a better way to build them, with a fluid chamber insight to dampen the vibrations. But manufacturing is difficult. It requires top-notch technology – and we can now do so. We were the first [supplier] in China [to produce hydraulic engine mounts]" (Interview, ASIMCO case). Therefore, over 12 years after launching its initiative to build own development and innovative capabilities, ASIMCO has shown the ability to do so, albeit for relatively simple components, and not entire systems.

ASIMCO's position in the global automotive value chain

While ASIMCO has been one of the most successful independent Chinese automotive supply firms, and has become one of the largest automotive suppliers in China based on revenue, the company plays an insignificant role in the global automotive market outside China. In its main components, ASIMCO has not been able to establish a global footprint of any significance, despite recent capital injections of its new owner Bain Capital.

In the global disc brake market, ASIMCO has not been able to break into the leading group of global suppliers. The disc brake market is dominated by four large suppliers Nissinbo, Federal Mogul, Akebono and ITT, each of which have a global market share of over 15% (see Table 13). The remaining 23% of the market constitutes of a multitude of smaller companies with regional or market niche focus, such as brake manufacturers for high performance vehicles, for specific commercial vehicles, or companies with a strong regional focus like ASIMCO in China.

Table 13: Global market share of disc brake suppliers

Company	Global market share 2014	Origin
Nissinbo / TDM	21%	Japan
Federal Mogul / Honeywell	21%	USA
Akebono	19%	Japan
ITT	16%	Italy
Other	23%	

Source: Based on MarkLines data

Similarly, in the global piston rings market, ASIMCO plays a minor role (Table 14). While ASIMCO has been able to solidify its position in the Chinese market, in particular for larger diesel engines used in commercial vehicles, it has not been able to break free of its dependency on the Chinese market and into international waters.

Table 14: Global market share of piston rings suppliers

Company	Global market share
Federal Mogul	60-70%
Mahle	10-20%
Reihnmetall Automotive	>5%

Source: Based on report from European Commission

Furthermore, ASIMCO is still admittedly a „produce per blueprint“ supplier, and has very little own R&D capabilities to build a sustainable competitive advantage through internalized knowledge or intellectual property. As the interviewee said “we [ASIMCO] are trying to break into more profitable segments, what you call high value-add. We want to become a tier-1 engine supplier. But it is difficult. We are what we call a PPT company – produce per blueprint. We only receive drawings.” (Interview, ASIMCO case). As a produce per blueprint supplier, ASIMCO is not able to develop close relations with assembly firms during the vehicle development process – a key

strategic asset for long-term contracts and an indicator for high value-added components.

Still, through an increased focus on own innovation and development capabilities, ASIMCO has achieved to become an innovating company for some components. For instance, ASIMCO developed engine mounts that better absorb reciprocating vibrations of engines through liquid induced synthetic engine suspension mounts. Through such initiatives, ASIMCO tries to develop a closer relationship based on trust with the assembly groups, and to enter the inner circle of business networks in the global automotive market that would help the company to further upgrade within the value chain and develop to become a leading global automotive supplier.

Hebei Lingyun

Hebei Lingyun was founded in 1996 and is a listed state-owned company that produces plastic components, such as hoses for air-conditioning, air brakes and gas pipes, PE pipe systems, fitting and joining pipes, as well as metal components such as bumpers and side door beams.

As a local tier-2 supplier of non-core products, Hebei Lingyun had limited access to the global automotive value chain, in particular outside of China. Even though Hebei Lingyun also directly supplied components to the joint-ventures of western assembly groups in China, its access to the business network was extremely limited, and chances or upgrading and further expanding through the network were very slim. This is because its products are viewed as commoditized and “non-core” products that require little to no customization, and that can be easily sourced or substituted from other suppliers. Hebei Lingyun had no firm specific advantages in the sense of product

knowledge, intellectual property or capabilities that are required and valued by the assembly groups or large tier-1 suppliers. With no specific intellectual property or R&D capabilities, it was not possible to build long-term relationships with its customers.

To gain deeper access to the business network and use the network for further expansion, Hebei Lingyun opted for a leapfrog strategy by acquiring a large supplier with such access and network ties to the global automotive value chain. In 2012, Hebei Lingyun bought 55% stock in Kiekert GmbH, a German based supplier of door lock systems. As a locking systems company, Kiekert is involved in the vehicle development of the assembly groups, in particular for the integration of new technologies such as E-latch door openers that render door handles obsolete.

The strategic objective of this acquisition was twofold: First, Hebei Lingyun wanted to upgrade its products, by introducing door locking systems to its portfolio and support Kiekert in its expansion to the Chinese market, to which Hebei Lingyun could provide access and expertise. Second, through the acquisition, Hebei Lingyun hoped to gain a deeper access to the international business networks of the automotive assemblers, to utilize this network for cross-selling of its commoditized components in other regions.

To avoid brand bleeding and to ensure a sustainable access to the global value chain, Hebei Lingyun opted for a hands-off approach, rather than a rapid integration. Kiekert operations and management in Germany remain intact, and Hebei Lingyun is only slowly developing the European market for its Chinese products.

Still, the case shows an interesting way how a firm from the emerging markets can enter and participate in the global value chain of the automotive industry, and perform rapid upgrading and leapfrogging via M&A into unrelated, high value-added components.

Part VI: Findings

Case study summary

The case studies have shown how the inter-firm relations between firms have changed following the evolution of the product architecture. New global purchasing strategies are emerging, which set in motion a global restructuring of the automotive value chain. In the following chapters, the findings regarding the inter-firm relations and the structure of the global value chain are summarized. This is followed by a discussion of the impact on theory and implications for development and late industrialization of emerging economies.

As the Volkswagen case shows, there are currently ongoing trends in the industry that change the approaches to value chain governance by the lead firms. The reduction of vehicle platforms and introduction of globally used platforms has altered the purchasing strategy, which in turn changes the competitive dynamics between participating supply firms.

The purchasing power of lead firms has increased with the introduction of global platforms, and their governing function has become even more relevant as a driving and defining force of global supply chain setups and for international trade. The global approach to procurement has changed the structure and composition of the value chain. The number of tier-1 supply firms is gradually decreased by the assemblers. Interdependencies between assembly firms and the global leading automotive suppliers are increasing. Large global supply firms take on the role of systems integrators and have increased their importance in the global auto component industry. They are the "glue" that holds the supply chain together, orchestrating and organizing the large amount of tier-2 supply firms in the industry.

The lead firms put the automotive parts industry under pressure to consolidate at several levels of the value chains. Through efforts of the assembler to reduce the number of direct suppliers, evermore components are combined into systems that are supplied from large systems integrator firms. Moreover, the globalization of the vehicle platform and use of common parts has changed the nature of competition from national to global. The pressure for supply firms to internationalize has been intensified, triggering a global consolidation even for the lower tiers of the supply chain. Somewhat surprisingly, even the market for components with little advantage from economies of scale, such as heavy stamped or forged metal components, have started to consolidate, as large and global supply firms such as CIE have emerged.

The abovementioned trends coincide with the rapidly changing technological environment through the electrification of the powertrain, the increased use of "intelligent" components and connectivity of vehicles[4], or automated driving. The coinciding trends and changing economic environments have different implications for supply firms from the advanced vis-à-vis emerging economies. Well established supply firms, mostly from the advanced economies, have benefited from the changing environment, the globalization of the components and harmonization of markets. Their close interaction with the assembly firms helped them to rapidly develop an international footprint and gain access to new markets. Moreover, through deep involvement in the vehicle development process of the assembly firm, years before start of production, the largest supply firms from the advanced economies are constantly at

[4] "Intelligent" or "internet of things" components play an increasing role in the industry. Such components are used for instance in modern entertainment systems of vehicles that offer internet radio, or in the navigation unit of the vehicle that uses real-time data to calculate optimal routes and arrival times based on actual traffic data available over the internet, for many classical controls such as mirror adjustment, air conditioning, seat positioning or window controls are increasingly controlled through a centralized and connected control unit, like in the Tesla 3, which offers zero control knobs outside its central screen controlling unit.

the forefront of technological developments and gain insights into future demands that help them adapt their business models in a timely manner. This helped the firms to embraced new responsibilities and activities in the value chain, and upgraded from component producer to systems integrator, as in the case of Schaeffler.

In the new global value chain structure, and inter-firm dynamics, geographic proximity of production has become a necessity for supply firms, while geographic proximity and close interaction of R&D activity has become a major competitive advantage. Supply firms that are developing their own components and have R&D centres close to the assembler (i.e. firms from the advanced markets), are an important part of the value chain, and of strategic relevance to the assembler. Through close relationships to the engineering teams of the assembler, they can build network ties that help them win more projects and be part of the assembler's expansion to other markets. Innovating supply firms are touted by the assemblers, to pitch the newest components and ideas to the assembler. Supply firms that produce per blueprint, on the other hand, have little chance to develop such ties to the assembler, and are governed via hands-off approach.

While the case study approach can only shed light into few individual cases, the general trend seems to be supported by industry wide data. As evident from the top 100 automotive supplier list of 2015, the global automotive components industry is dominated by firms from the advanced economies (Table 15). The companies from the advanced economies are firmly occupying the highest value adding and revenue generating activities in the global automotive value chain. Only very few companies from the emerging economies partake in the global supply industry, despite the size and relevance of their markets for the global automotive industry.

Table 15: Top 100 largest automotive suppliers by revenue

2015 rank	Company	Country of origin	Revenue in million US $	Products
1	**Robert Bosch GmbH**	Germany	**$44.825**	Gasoline systems, diesel systems, chassis system controls, electrical drives, starter motors & generators, car multimedia, electronics, steering systems, battery technology, exhaust gas turbochargers & treatment systems, service solutions
2	**Denso Corp.**	Japan	**$36.030**	Thermal, powertrain control, electronic & electric systems; small motors, telecommunications
3	**Magna International Inc.***	Canada	**$32.134**	Body, chassis, exterior, seating, powertrain, electronic, vision, closure & roof systems & modules
4	**Continental AG**	Germany	**$31.480**	Advanced driver assistance systems, electronic brakes, stability 3 management systems, tires, foundation brakes, chassis systems, safety system electronics, telematics, powertrain electronics, interior modules, instrumentation, technical elastomers
5	**ZF Friedrichshafen AG**	Germany	**$29.518**	Transmissions, chassis components and systems, steering systems, clutches, dampers, active and passive safety systems
6	**Hyundai Mobis**	South Korea	**$26.262**	Chassis, cockpit & front-end modules; stability control steering, airbags, LED lamps, ASV parts, sensors, electronic control systems, hybrid car powertrains, parts & power control units
7	**Aisin Seiki Co.**	Japan	**$25.904**	Body, brake & chassis systems, electronics, drivetrain, and engine components
8	**Faurecia**	France	**$22.967**	Seating, emissions control technologies, interior systems, exterior components, modules & structural parts
9	**Johnson Controls Inc.**	USA	**$20.071**	Complete automotive seats & seat components
10	**Lear Corp.**	USA	**$18.211**	Seating & electrical distribution systems
11	**Valeo SA**	France	**$16.088**	Micro hybrid systems, electrical & electronic systems, thermal systems, transmissions, wiper systems, camera/sensor technology, security systems, interior controls
12	**Delphi Automotive**	USA	**$15.165**	Mobile electronics; powertrain, safety, thermal, controls & security systems; electrical/electronic architecture, in-car entertainment technologies
13	**Yazaki Corp.**	Japan	**$14.104**	Wiring harnesses, connectors, junction boxes, power distribution boxes, instrumentation, high voltage systems
14	**Sumitomo Electric Industries**	Japan	**$13.510**	Electrical distribution systems, electronics, connection systems

15	**JTEKT Corp.**	Japan	**$11.670**	Bearings, steering systems, driveline systems and machine tools
16	**Thyssenkrupp AG**	Germany	**$11.395**	Steering, dampers, springs & stabilizers, camshafts, forged machined components, bearings, undercarriage systems & components, axle assembly, assembled camshafts, forged crankshafts & drivetrain components, high-strength lightweight steels, electrical steel, tailored tempering, cell & battery production lines, valve control systems
17	**Mahle GmbH**	Germany	**$11.339**	Piston systems, cylinder components, valvetrain systems, air & liquid management systems, vehicle climatization, climate compressors, engine & powertrain cooling, battery cooling, actuators, electric drives, starters & alternators, electrical driven auxiliaries, powertrain engineering, services
18	**Yanfeng Automotive Trim Systems Co.**	China	**$11.242**	Interiors, exteriors, electronics, seating, safety
19	**BASF SE**	Germany	**$10.613**	Coatings, catalysts, engineering plastics, polyurethanes, coolants, brake fluids, lubricants, battery materials
20	**CalsonicKansei Corp.**	Japan	**$10.232**	Climate control, engine cooling & exhaust systems; instrument clusters, console boxes, cockpit modules, instrument panels, front-end modules
21	**Toyota Boshoku Corp.**	Japan	**$10.075**	Seats, door trim, carpet, headliners, oil & air filters, door panels fabrics & substrates
22	**Schaeffler AG**	Germany	**$9.990**	Anti-friction bearings, engine components chassis & transmissions, wheel & axle bearings, clutch & transmission systems, dampers
23	**Panasonic Automotive Systems Co.**	Japan	**$9.987**	Audio & video equipment, cameras, video, premium audio systems, navigation systems, compressors, batteries, motors, monitors, sensors, switches, HUDs
24	**Toyoda Gosei Co.**	Japan	**$9.386**	Safety, sealing & interior systems; optoelectronics, exterior trim, rubber/plastic functionals, fuel systems
25	**Autoliv Inc.**	Sweden	**$9.170**	Airbags, seat belts, safety electronics, steering wheels
26	**Hitachi Automotive Systems**	Japan	**$9.110**	Engine management, electric powertrain, drive control
27	**Gestamp**	Spain	**$8.511**	Metal components & assemblies, body-in-white, chassis & mechanisms
28	**BorgWarner Inc.**	USA	**$8.023**	Turbochargers, engine valve-timing systems, ignition systems, emissions systems, thermal systems, transmission-clutch systems, transmission control systems, torque management systems & rotating electric machines

29	**Hyundai-WIA Corp.**	South Korea	**$7.480**	Halfshafts, sideshafts, engines, manual transmissions/transaxles, transfer cases, power transfer units, chassis modules, axles
30	**Magneti Marelli S.p.A.**	Italy	**$7.425**	Lighting, powertrain transmissions, electronics, suspensions systems, active & passive shock absorbers, exhaust systems, plastic parts
31	**Samvardhana Motherson Group**	India	**$7.245**	Rearview mirrors, plastic modules cockpits/IPs, door trims & bumpers, wiring harnesses, molded plastic parts & assemblies, molded & extruded rubber components, lighting systems, air intake manifolds, pedal assemblies, shock absorbers, HVAC systems, roof hatches
32	**HELLA KGaA Hueck & Co.**	Germany	**$7.192**	Electronic and lighting components & systems
33	**Cummins Inc.**	USA	**$7.098**	Diesel & natural gas engines
34	**Brose Fahrzeugteile GmbH**	Germany	**$6.718**	Window regulators, door modules, seat structures and components, closure systems, power closure systems, power head restraints,electric motors and drives, electronics
35	**GKN**	United Kingdom	**$6.505**	Driveline halfshafts, driveshafts & AWD; powder metal engine & transmission components; automotive structures & chassis systems
36	**JATCO**	Japan	**$6.282**	Automatic transmissions, continuously variable transmissions
37	**Plastic Omnium Co.**	France	**$6.210**	Fascias, front-end modules, rear-end modules, fenders, body panels, fuel systems
38	**Flex-N-Gate Corp.**	USA	**$6.102**	Interior & exterior plastics, metal bumpers and hitches, structural metal assemblies, forward & signal lighting, mechanical assemblies, prototyping & sequencing
39	**Dana Holding Corp.**	USA	**$6.060**	Axles, driveshafts, sealing and thermal management products
40	**Goodyear Tire & Rubber Co.**	USA	**$6.000**	Tires
40	**Mitsubishi Electric Corp.**	Japan	**$6.000**	Engine management, ignition, audio & navigation systems; alternators & starter motors
42	**Tenneco Inc.**	USA	**$5.972**	Emission control systems, manifolds, catalytic converters, diesel aftertreatment systems, catalytic reduction mufflers, shock absorbers, struts, electronic suspension products & systems
43	**IAC Group**	Luxembourg	**$5.900**	Cockpits including instrument panels, consoles, doors, headliners & overhead systems; flooring, acoustics
44	**Koito Manufacturing**	Japan	**$5.879**	Exterior lighting
45	**Mando Corp.**	South Korea	**$5.560**	Brakes, steering & suspension & integrated driver assistance systems & components
46	**Takata Corp.**	Japan	**$5.360**	Airbags, seat belts, electronics, steering wheels, interior trim & textiles

47	**Federal-Mogul Corp.**	USA	**$5.077**	Pistons, rings, cylinder liners, piston pins, ignition and spark plugs bearings, valve seats & guides, valvetrain products, gaskets, seals, heat shields, brake friction materials & products, systems protection products, lighting products, wipers, fuel pumps
48	**NSK**	Japan	**$4.858**	Bearings, hub bearings, steering columns, electric power steering, automatic transmissions products
49	**Eberspaecher Gruppe GmbH**	Germany	**$4.726**	Silencers, catalytic converters, particulate filters, manifolds, vehicle heaters, electrical vehicle heaters, electronics
50	**Hyundai Powertech Co.**	South Korea	**$4.554**	Automatic transmissions
51	**Nemak**	Mexico	**$4.482**	Aluminum cylinder heads, engine blocks, transmissions, structural components & other components
52	**NTN Corp.**	Japan	**$4.366**	Constant velocity joints, axle bearings, needle roller bearings, tapered roller bearings, intelligent in-wheel parts for EVs
53	**Draexlmaier Group**	Germany	**$4.100**	Electrical systems, electrical & electronic components, interiors, system assembly
54	**TS Tech Co.**	Japan	**$3.948**	Seats, door liners
55	**American Axle & Mfg. Holdings Inc.**	USA	**$3.903**	Driveline & drivetrain systems & related components
56	**Linamar Corp.**	Canada	**$3.887**	Engine camshafts, connecting rods, cylinder heads & blocks, balance shaft assemblies, fuel rails, transmission gears, differentials, clutch modules, shafts & shell assemblies, all-wheel-drive systems and axles
57	**Grupo Antolin**	Spain	**$3.868**	Overhead systems, door module & panels, window regulators seat functions, interior and exterior lighting, cockpits
58	**Martinrea International Inc.**	Canada	**$3.867**	Steel & aluminum body, chassis & engine components; fluid handling components, assemblies & modules
59	**TI Automotive**	USA	**$3.400**	Automotive fluid systems technology
60	**Nexteer Automotive**	USA	**$3.361**	Electric power steering, hydraulic power steering, steering columns, halfshafts
61	**Cooper-Standard Automotive**	USA	**$3.343**	Systems & components including rubber & plastic sealing, fuel & brake lines, fluid transfer hoses & anti-vibration systems
62	**NHK Spring Co.**	Japan	**$3.292**	Stabilizer bars, coil springs, seats & valve springs
63	**Sumitomo Riko Co.**	Japan	**$2.301**	Anti-vibration molded rubber, fuel delivery systems
64	**Visteon Corp.**	USA	**$3.245**	Cockpit electronics: instrument clusters, head-up & information displays, infotainment, connected audio, connectivity & telematics
65	**Hyundai Dymos Inc.**	South Korea	**$3.200**	Manual transmissions, DCT, axles, seating systems

66	**Webasto SE**	Germany	**$3.179**	Sunroofs, panorama roof systems, convertible roof systems, vehicle pre-heating systems
67	**DuPont**	USA	**$3.060**	High-performance polymers, elastomers, renewable sourced polymers, fibers & fluoropolymers; battery separator & electronic material technologies, fabricated products, advanced composite materials, specialty chemicals, lubricants, refrigerants, films, bio-based fuels
68	**Leoni AG**	Germany	**$3.000**	Wires & strands, optical fibers, cables, cable systems, wiring systems, fuse and relay boxes, special connectors
69	**Infineon Technologies AG**	Germany	**$2.840**	Microcontrollers, intelligent sensors; power semiconductors & power modules for powertrain (combustion, hybrid, electric); safety; security and body & convenience applications
70	**Mitsuba Corp.**	Japan	**$2.665**	Wiper systems, power window motors, starter motor, fan motors seat motors, sunroof motors, power slide door assemblies, power tailgate systems, electric power stealing motors
71	**Dow Automotive/Related Businesses**	USA	**$2.600**	Glass bonding adhesive, structural adhesive, epoxy composite polyurethane foam, acoustic foam, fluid elastomer
71	**Inteva Products**	USA	**$2.600**	Closure systems, interior systems, roof systems, motors & electronic systems
73	**KSPG AG**	Germany	**$2.568**	Pistons, emission control products, oil/water pumps, engine blocks, manifolds, bearings
74	**Leopold Kostal GmbH und Co.**	Germany	**$2.535**	Steering column modules, roof modules, center console modules, driver assistance, body network control units, interior control units, power application control units, switch panels & face plates, switches, connector systems
75	**Asahi Glass Co.**	Japan	**$2.530**	Glazing systems
76	**Metaldyne Performance Group Inc.**	USA	**$2.499**	Transmission, engine, driveline & safety-critical applications
77	**CITIC Dicastal Co.**	China	**$2.429**	Aluminum alloy wheels, aluminum casting parts
78	**CIE Automotive SA**	Spain	**$2.401**	Engine & powertrain components, chassis & steering components, exterior & interior trim, roof systems components
79	**Showa Corp.**	Japan	**$2.386**	Shock absorbers, power steering gearbox & pump; propeller shaft, gas springs, CVT pumps
80	**Vibracoustic GmbH****	Germany	**$2.154**	Engine mounts, chassis mounts, chassis bushings, exhaust mounts, MCU spring carrier, bumpers, torsional vibration dampers, air springs & tuned mass dampers
81	**Ryobi**	Japan	**$2.117**	Aluminum high pressure die castings powertrain & structural components
82	**Bridgewater Interiors**	USA	**$2.092**	Automotive seating systems

83	**Kautex Textron GmbH**	Germany	**$2.059**	Fuel tank systems, clear vision systems, selective catalytic reduction systems, camshafts, packaging
84	**Autoneum**	Switzerland	**$2.023**	Engine covers, engine encapsulations, hoodliners, outer dashes water box shields, inner dashes, nonwoven carpets, tufted carpets, floor insulators, floor mats, underbody shields, floor pans, heatshields, outer tunnel insulators, wheelhouse outer liners, dampers/stiffeners, sealants, acoustic parts
85	**Flex**	Singapore	**$2.020**	Infotainment, telematics boxes, displays, clean tech, battery – cables & wire harnesses, solenoids, recuperation modules, vehicle electrification, mirror controls, liftgates & seat controllers, body control modules
86	**Alpine Electronics Inc.**	Japan	**$2.000**	Navigation, telematics, drive assist, sound & video systems
86	**Sensata Technologies Holding NV**	Netherlands	**$2.000**	Pressure, temperature, speed and position sensors, motor protectors, switches
88	**Tower International**	USA	**$1.956**	Body structures & assemblies, lower vehicle frames & structures, chassis modules & systems, suspension components
89	**AB SKF, Automotive & Aerospace**	Sweden	**$1.948**	Bearings, bearing units, automotive specialty products, seals, molded rubber products
90	**Novelis Inc.**	USA	**$1.940**	Flat-rolled aluminum sheet for vehicle structures, body panels, heat exchangers, heat shields & other automotive applications
91	**Keihin Corp.**	Japan	**$1.919**	Air & fuel management systems; electronic systems, HVAC systems, electronic management systems
92	**Pioneer Corp.**	Japan	**$1.906**	Audio/video entertainment, navigation systems
93	**F-Tech Inc.**	Japan	**$1.634**	Chassis, suspension systems, control arms, pedal assemblies, hydroforming
94	**Michelin Group**	France	**$1.601**	Tires
95	**Dura Automotive Systems**	USA	**$1.600**	Lightweight structural door & body systems; mechatronic control systems including shift-by-wire systems; exterior systems including glass systems and electronics infused exterior trim
96	**Key Safety Systems Inc.**	USA	**$1.575**	Inflators, airbags, seat belts, steering wheels, active safety & electronics
97	**Gentex Corp.**	USA	**$1.510**	Interior & exterior auto-dimming rearview mirrors, advanced – electronic features & components, smartBeam HBA & DFL advanced lighting-assist, rear camera displays, compasses, LED turn signals, side blind-zone indicators, driver assist features

98	**Akebono Brake Industry Co.**	Japan	**$1.480**	Brake friction materials, foundation brake assemblies
99	**U-Shin**	Japan	**$1.416**	Steering lock unit, lock sets, keyless entry, door latches, heater control panels, door handles, switches, sensors
100	**Nissin Kogyo Co.**	Japan	**$1.385**	ABS & vehicle stability assist foundation brake systems, rear toe control, aluminum knuckles, aluminum mounts, clutch master & slave cylinders

Source: Top 100 Automotive Supplier List, 2015

The abovementioned trends in the automotive industry have altered the prospects for participating and upgrading of supply firms from the emerging markets. Deep involvement in R&D and close interaction with the assembly firms through well-developed global business networks has become a necessary but not sufficient condition for supply firms to partake in the highest value adding activities of the global automotive industry. Collocation of R&D activities as well as the ability to supply to all production hubs globally has become critical for the further development of the supply firm. Furthermore, development capabilities or better innovation capabilities have become essential to be valued as an attractive partner for the simultaneous engineering process of the assembly firms. These trends put supply firms from the emerging markets at a disadvantage, which have less funds available to bolster R&D and a rapid internationalization at the same time, typically have fewer development capabilities and firm specific advantages, and the disadvantage of geographic distance to the R&D centers of the leading assembly firms in the global auto industry.

Data on company R&D expenses indicates that supply firms from the advanced economies are better placed for future positioning of the companies in the industry (European Commission, 2016, summarized in Table 16). Automotive supply firms from the advanced economies have increased their R&D expenses in recent years, which helps them to solidify their position in the global industry. On the other hand, as indicated in the case study and supported by the data on R&D spending, supply firms from the emerging economies do not seem to be so deeply involved in the R&D process of vehicles. Apart from few examples, such as Yanfeng, the supply firms from the emerging markets are mostly limited to manufacturing of produce per blueprint components.

Table 16: Top 20 automotive suppliers in R&D spending

World rank	Company name	Country of origin	R&D spending 2015 (€million)	R&D intensity (% of revenue)	R&D 3 years growth (CAGR-3y, %)
1	ROBERT BOSCH	Germany	5.202,0	7,4	1,8
2	DENSO	Japan	3.041,5	8,8	5,9
3	CONTINENTAL	Germany	2.528,3	6,4	11,4
4	ZF	Germany	1.350,0	4,6	17,9
5	AISIN SEIKI	Japan	1.239,7	5,0	6,4
6	DELPHI	UK	1.102,2	7,5	0,0
7	VALEO	France	954,0	6,6	10,6
8	FUJI HEAVY INDUSTRIES	Japan	780,4	3,2	27,5
9	BRIDGESTONE	Japan	724,0	2,5	4,7
10	MICHELIN	France	689,0	3,3	3,5
11	HELLA	Germany	662,5	10,4	9,3
12	MAHLE	Germany	657,0		31,4
13	SCHAEFFLER	Germany	647,0	4,9	4,7
14	AUTOLIV	US	459,7	5,5	4,7
15	HYUNDAI MOBIS	South Korea	454,6	1,6	17,3
16	TOYOTA INDUSTRIES	Japan	419,0	2,5	12,1
17	GOODYEAR	US	350,9	2,3	1,1
18	JOHNSON CONTROLS	US	338,9	1,0	-10,2
19	GKN	UK	303,5	3,1	7,4
20	TOYOTA BOSHOKU	Japan	293,1	2,7	1,9

Source: Based on (European Commission, 2016)

In the EU top 2500 R&D companies, 113 are automotive supply firms of which 23 firms originate from the emerging markets.

As the cases from the two emerging markets of Brazil and China have shown, only very few supply firms are capable of developing rapidly to escape the current globalization and increased pressure in the global automotive components industry. The globalization of vehicle platforms has a massive impact on the competitive landscape for the supply firms from the emerging markets, and puts them in a disadvantageous

position in the global industry. First, it necessitates them to rapidly develop a global footprint to be able to supply to all major automotive production hubs in the world, amidst the most rapid technological changes in the industry. Second, the proximity of R&D centers of the western companies to the respective assembly firms puts western supply firms at an advantage. Third, the harmonization of vehicle platforms globally and the increased use of common parts across national borders intensifies competition between companies from different regions, as it effectively merges the markets into one global automotive supply market.

Only few supply firms from the emerging markets managed to enter the list of top 100 global supply firms by revenue (Table 17).

Table 17: Emerging market firms in the top 100 supplier list

2015 rank	Company	Country of origin	Revenue in million US $	Products
18	**Yanfeng Automotive Trim Systems Co.**	China	**$11.242**	Interiors, exteriors, electronics, seating, safety
31	**Samvardhana Motherson Group**	India	**$7.245**	Rearview mirrors, plastic modules cockpits/IPs, door trims & bumpers, wiring harnesses, molded plastic parts & assemblies, molded & extruded rubber components, lighting systems, air intake manifolds, pedal assemblies, shock absorbers, HVAC systems, roof hatches
51	**Nemak**	Mexico	**$4.482**	Aluminum cylinder heads, engine blocks, transmissions, structural components & other components
77	**CITIC Dicastal Co.**	China	**$2.429**	Aluminum alloy wheels, aluminum casting parts

Source: Based on Top 100 Automotive Supplier List, 2015

*Companies from Singapore and South Korea were excluded from this list, following the IMF definition that sees both countries as advanced economies.

Similarly, only 23 of the 114 automotive supply firms in the list of top 2500 R&D expenses, are from the emerging markets (Table 18).

Table 18: Top automotive suppliers from emerging markets in R&D spending

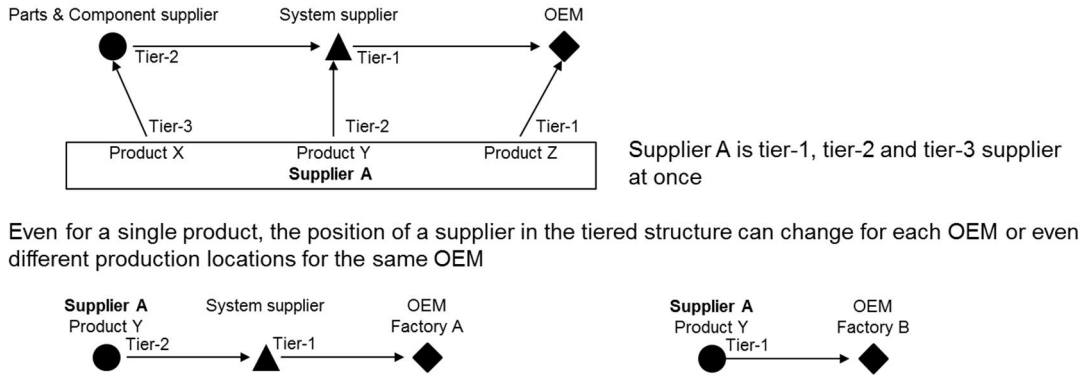
world rank	Company name	Country of origin	R&D spending 2015 (€million)	R&D intensity (% of revenue)	R&D 3 years growth (CAGR-3y, %)
36	CHENG SHIN RUBBER INDUSTRY	Taiwan	120,5	3,7	23,6
44	XIAMEN JINGLONG MOTOR	China	88,3	2,4	15,2
46	WEICHAI POWER	China	82,8	0,8	-14,2
53	NINGBO JOYSON ELECTRONIC	China	75,1	6,8	60,3
57	CHINA MOTOR	Taiwan	68,1	6,6	5,9
61	WANXIANG QIANCHAO	China	56,2	4,1	7,6
73	MINTH	China	46,8	4,3	12,6
74	ASHOK LEYLAND	India	45,3	1,7	-4,1
75	LINGYUN INDUSTRIAL	China	42,1	4,2	39,6
77	BEIJINGWEST INDUSTRIES INT‘L	China	41,2	11,8	
80	NINGBO HUAXIANG ELECTRONIC	China	39,3	3,0	18,1
81	WULING MOTORS	China	38,0	2,0	32,4
86	ANHUI ZHONGDING SEALING PARTS	China	35,3	4,0	34,6
87	ZHEJIANG WANFENG AUTO WHEEL	China	34,1	2,9	14,9
93	T V S MOTOR COMPANY	India	31,4	2,0	21,2
94	APOLLO TYRES	India	31,0	1,9	24,3
95	KENDA RUBBER INDUSTRIAL	Taiwan	29,3	3,4	37,5
97	AEOLUS TYRE	China	28,6	3,3	-15,2
102	LIFAN INDUSTRY	China	26,3	1,6	-25,1
107	SAILUN	China	24,0	2,0	89,9
109	DEPO AUTO PARTS INDUSTRIAL	Taiwan	23,1	5,5	4,0
112	DONGFENG ELECTRONIC TECH.	China	22,4	3,5	27,5
113	GUIZHOU TYRE	China	22,2	3,9	-10,1

Source: Based on European Commission, 2016

Role of the supply firm in the value chain

In the past, what defined a supply firm has often been its position in a tiered supply chain (Womack, Jones and Roos, 1990; McCann and Kim, 2008). The firm's position in a tiered supply chain was used to differentiate between roles of suppliers. In the globalized production network of today's automotive industry, the tiered structure is becoming increasingly mixed up and has lost its meaning as a defining category of the supply firm. The tier in which a supply firm is situated does no longer indicate its role and importance to the value chain. Most of the supply firms in the case study were situated at different tiers of the supply chain, depending on the product and at times on the customer. For instance, BOSCH is a tier-1 supplier of engine injection systems to Volkswagen for their in-house developed engines, but is at times a tier-2 supplier for the same component in a different supply chain setup, if the assembler buys engines from external engine manufacturers (Figure 18). Similarly, supply firms supplying the same component to multiple production lines of the same customer, can be situated at different tiers in the supply chain, depending on the particular setup of the assembly line. One such example is Marquardt, which supplies switches to Volkswagen. While it mostly supplies the switches to tier-1 supply firms for interior panels, at some locations, the assembly of the panels is done by Volkswagen and the switches directly supplied to Volkswagen. Another examples is Witzenmann, a supplier of steel pipes used for exhaust systems, which mostly supplies its components to the exhaust system supplier, while at other locations supplying the same components directly to Volkswagen for assembly.

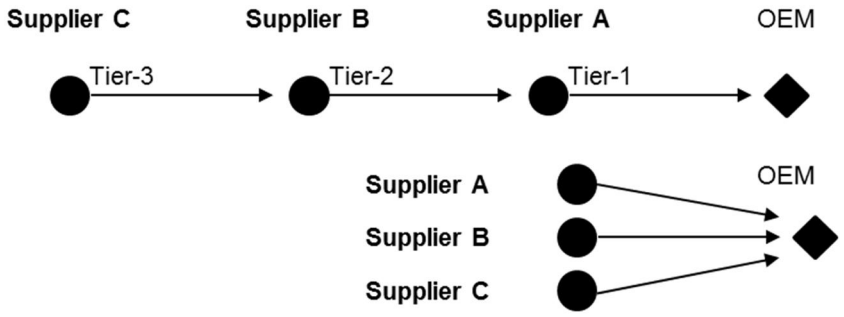
Figure 18: A supply firm can have several positions in the supply chain



Source: Author's own figure

The more components are grouped and modularized, the longer the supply chain becomes, as fewer components are directly supplied to the final assembly line, but are bundled and assembled into modules at sub-assembly lines of the sub-system integrators. However, the particular organizational setup of such production lines differs from location to location, depending on the level of in-house assembly activities of the final assembler and the localization of (sub-assembly) competencies of the supply firms in the geographic proximity to the final assembly line. The 'supply chain' for each production location looks different. Depending on the depth of the value creation within the production location, supply chains can be longer or shorter (Figure 19).

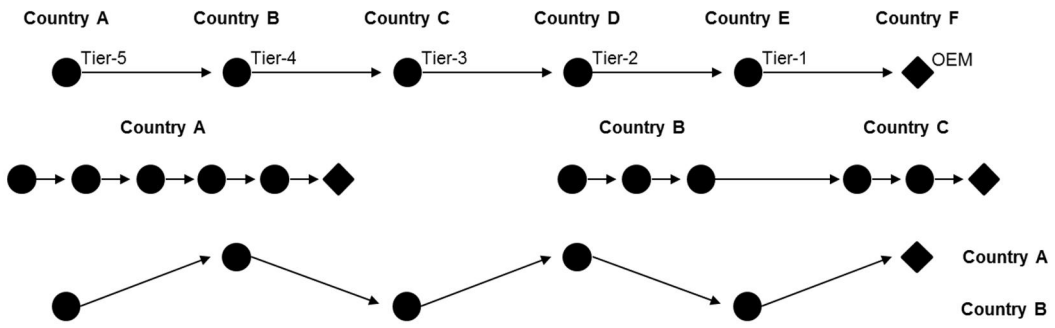
Figure 19: Depth of supply chains depends on assembly setup



Source: Author's own figure

Additionally, the geography of activities can vary, in particular for components that require little effort and cost for transportation. While the production of customized components or the sub-assembly of modules should ideally be close to the final assembly line to ensure just-in-time and just-in-sequence delivery, some standardized components can be manufactured in entirely different continent (Figure 20).

Figure 20: Global setup of supply chains



Source: Author's own figure

Consequently, the descriptive consideration of the position in a tiered structure become increasingly blurred, and does not indicate the role or relationship of a supply firm to the final assembler. Instead of a tiered structure to differentiate the position and importance of supply firms in the value chain, supply firms should be differentiated by strategic relevance to the assembler, and its role in the value chain. Volkswagen differentiated between three groups of supply firms: strategically highly-relevant supply firms, strategically relevant supply firms, and strategically non-relevant supply firms. Highly relevant components are such that are key for the vehicle's performance, safety, or design. Additionally, highly relevant firms can be such, that provide own innovations and inventions and have superior knowledge for key components in the

vehicle. Relevant suppliers are such, which have development capabilities for key components, but develop the components as per the requirements of the assembler. Non-relevant supply firms are such that produce components per blueprint that is provided by the assembler (Table 19). The following table summarized the categories of supply firm relevance to the assembler.

Table 19: Supply firms grouped by strategic relevance to assembler

	Highly-relevant	Relevant	Non-relevant
Product characteristics	▪ Innovative products, invented by the supply firm ▪ High-tech products, requiring leading-edge technology ▪ Products visible to the customer, e.g. interior design ▪ Products relevant for vehicle safety, e.g. airbags	▪ Developed by the supply firm ▪ High-tech products, requiring leading-edge technology	▪ Mechanical products ▪ Parts produced per blueprint provided by the customer ▪ Simple standardized and normed products ▪ Commodities
Value-added	▪ very high	▪ high	▪ Low
Aspects of buyer-supplier relationship	▪ Supplier "pushes" innovation to buyer ▪ Ahead of buyer in regards to innovation ▪ Own market research ▪ Market trends and future customer demand ▪ Supplier defines specifications and performance requirements	▪ Buyer "pulls" development capabilities and knowledge from supplier ▪ Core deep insights and specialized knowledge of component and development expertise ▪ Specifications and performance requirements set by the buyer	▪ Buyer utilizes production capabilities ▪ Technical drawings supplied by buyer - supplier has no advantage ▪ Tooling provided by buyer ▪ Specifications and performance requirements set by the buyer

Source: Author’s own table

Therefore, it is not the position of the supply firm in a tiered structure that defines its role and importance in the value chain, but it is its overall relevance to the final product and role in the value chain, based on the competencies it adds to and activities it provides in the value chain.

Product architecture and inter-firm relations

Instead of the position in the supply chain, the product architecture of the components involved in a transaction define the role of a supply firm in a value chain. The case studies show that the product architecture depends on the components' characteristics and can differ from component to component. For instance, injection systems are highly interdependent with the entire power-train and in particular with control systems and other engine components (closed-integral architecture). By contrast, entertainment systems are designed as modular units with interfaces that are defined industry-wide so that the unit can be easily interchanged, thereby falling into the open-modular category. Other components, such as seats, have clearly defined interfaces set by the assembly firm – enabling the firm to develop different seats that can be easily interchanged, yet that do not have industry norms or interfaces (closed-modular architecture).

Most of the existing literature suggests there should be little scope to adjust the product architecture, arguing that the automobile is a systemic, closed integral product (Hill, 1989; Fujimoto, 2007; Sturgeon *et al.*, 2009). Yet the case studies indicate that different choices about product architecture lie at the heart of the changing roles of suppliers in product development. By adapting its product architecture, Volkswagen has changed the role supply firms play for development and how these firms are integrated and participate in the mostly in-house driven R&D processes.

Restructuring of the global components supply industry

Through the concentration of power within the GVC, and the continuous globalization of the lead firms, such lead firms are able to consciously restructure the entire upstream value chain. As the global purchasing and supply chain strategies of

the powerful lead firms evolve, the GVCs are undergoing permanent structural changes. Through the global purchasing practices, the leading automotive assemblers have restructured the international supply base in an effort to internationalize the footprint of the most capable supply firms. While the production footprint is globalized, R&D and marketing activities within the supply base are increasingly becoming centralized around the headquarters and R&D centers of their customers.

Explicit restructuring of the supply base by the lead firm

The industry has converged and consolidated at the assembly level, to form quasi oligopolistic structures with few firms dominating the largest share of the market. Just in the same way, the supply industry has consolidated in the past years. In this chapter, I argue that this has been strongly shaped and accelerated by the new purchasing strategies of assemblers such as Volkswagen, following the globalized product architecture. The rationale is that the globalization and modularization of the product architecture enables the globalization of purchasing, which in turn shapes the structure of the global supply base.

Several policies of Volkswagen's adapted purchasing strategy lead to a restructuring of the supply base. The policy to reduce the number of supply firms involved in the value chain accelerates the consolidation of the supply base. Volkswagen actively encourages and steers the restructuring of the supply base, for instance by initiating M&A between different supply firms, or by modularizing components to reduce the number of direct suppliers to Volkswagen.

Enabled by the globalization of platforms, Volkswagen introduced a global procurement approach that encourages the globalization of the supply base. With its local-to-local policy, Volkswagen forces supply firms to internationalize and collocate

with its largest production hubs. This in turn triggers a global consolidation of the industry, as it harmonizes the global supply base of Volkswagen. Through this policy, Volkswagen creates a globally harmonized supply base of large, transnational supply firms.

Other examples, such as the conscious nurturing of Fuyao, show how Volkswagen can strategically restructure its supply base in any given region, by introduction new entrants to the market and nurturing them in a way that they can become fully competitive. This way, Volkswagen can break up the competitive dynamics in a place. Volkswagen uses some of its suppliers like pawns on a chess field, to strategically reshape its supply base, and ensure capabilities are available in key regions, prices are acceptable, and quality standards are met.

The mechanism to restructure the supply base: the cascade effect

With the oligopolistic position of the lead firm as only one of few global buyers, strategic decisions made at the lead firm level have an impeccable impact on its value chain. Large suppliers at all tiers along the value chain, like BOSCH, Continental, ZF or BASF, adapted their strategies to match these of the lead firm, passing on the pressure to internationalize and consolidate to their supply firms (Nolan, Zhang and Liu, 2007). Like the assemblers, large tier-1 suppliers act as systems integrators and actively steer and control this process, taking the initiative to invite suppliers to collocate, or else to merge with other suppliers.

System integrators are large MNCs that manufacture sub-systems. Unlike single components, sub-systems are complex systems comprised of several components, some of which are produced externally by supply firms. Hence, the systems integrator plays a similar role as the assembler, in that it is responsible for an entire system for which it

takes on activities such as assembly, integration of different components to a coherent system, and orchestration of its value chain. Systems integrators are typically powerful and large firms in the value chain, with close ties to the assembler.

Nolan coined the term ‘cascade effect’, which describes the process of passing down the pressure for concentration at multiple levels of the value chain (Nolan, 2001a, 2014). Nolan observed that lead firms pass on the pressure for consolidation to their supply base, leading to international and large supply firms with similar market share as the lead firm (Nolan, Zhang and Chunhang, 2007). The pressure is further passed on by the tier-1 supplier to tier-2 supply firms, as tier-1 supply firms adapted their strategies accordingly.

What has been conceptualized to describe how the pressure for consolidation is passed on along the value chain can be further extended, to describe how different strategic objectives set by the lead firm are passed on along the value chain. Such objectives include setting of quality standards, standardization of management techniques, establishing of worldwide logistics standards such as just-in-time or just-in-sequence delivery, but also strategic objectives such as the internationalization of supply firms and the reduction of suppliers globally through mergers and acquisitions. As shown in the case of BOSCH, large supply firms have adapted their sourcing strategy to mirror the purchasing strategy of Volkswagen. This way, BOSCH can accommodate the requirements set by Volkswagen, and simultaneously further increase efficiency in its own value chain. By behaving in such a way, the system integrator passes on the strategic objective set by the assembler and sets the cascade effect in motion.

The oligopolistic equilibrium along the value chain

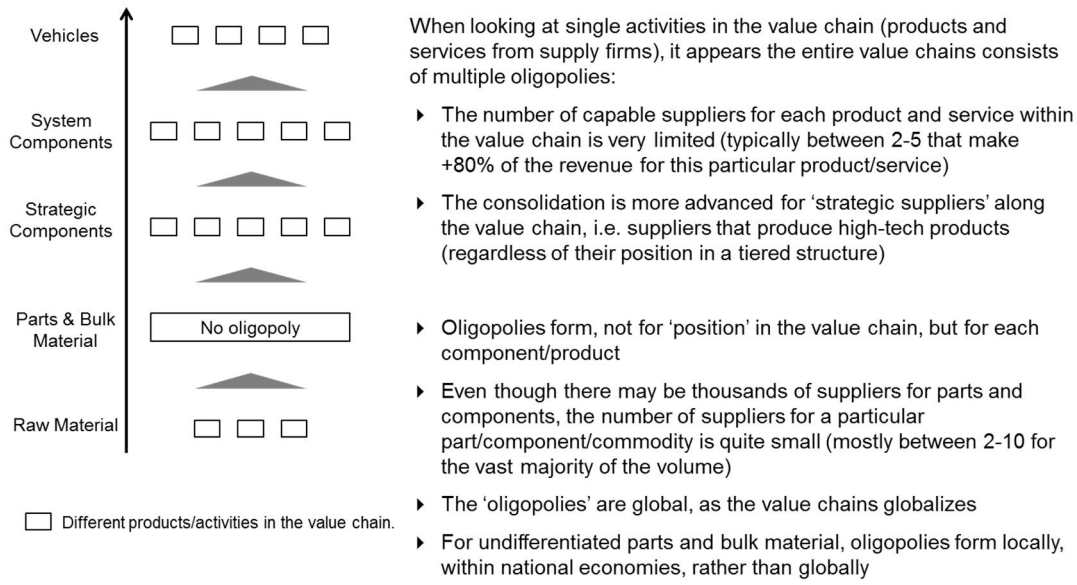
Through the cascade effect and the consolidation of the supply base at several levels of the value chain, the component supply industry has developed oligopolistic features. One strategic objective of Volkswagen is to decrease the complexity of its supply chain, by decreasing the total number of suppliers for their global production network. Volkswagen seeks to have the same supplier for any given component for every location globally. This has created a situation in which only few supply firms have developed into multinational suppliers for each component. As internal data from Volkswagen has shown, Volkswagen was able to reduce the number of suppliers for any particular component from over 10 in the early 2000s to an average of below 3.5 in 2015. Since Volkswagen has a global market share of over 10%, each of Volkswagen's suppliers has a calculated average global market share of at least 3% – just by supplying to Volkswagen. But because of another policy, the actual market share of Volkswagen's suppliers has to be larger than 3%.

This procurement policy states that each supplier must make a maximum of 30% of its revenue from business with the Volkswagen Group, to ensure that no supplier becomes too dependent on Volkswagen. The majority of the revenue – 70% - has to come from other assemblers. This increases the calculated minimum global market share to approximately ~10%. The exemplary calculation is based on the 3.5 suppliers per component, which is the average for supply firms across all components. The number of supply firms for strategically important components tends to be lower, while the number of suppliers for non-strategic components, such as mechanical parts produced per blueprint by local sub-contractors, is significantly larger. Unfortunately, no detailed data for strategically important components was disclosed, but according to interviews, the number of supply firms for such components is mostly below four. Moreover, interviews with managers from other large assemblers such as General

Motors have confirmed that there are "essentially just two to three international supply firms for any component… [and that these] supply all large [assembly firms]. We all have the same suppliers…" (Interview, General Motors). The picture was further confirmed by interviews with the supply firms in the case study. Through its policies and active restructuring of the supply base, Volkswagen encourages the global consolidation of the supply base for strategically relevant components to the point that the market for each component has turned into an oligopoly (Figure 21).

Eventually, the consolidation would lead to monopolies in the value chain. To prevent this, Volkswagen has another set of policies that effectively creates an oligopolistic equilibrium in the supply base. To maintain independence from any given supplier and to ensure a certain degree of competition in the supply base, Volkswagen implemented a strict multiple-supplier strategy. This means, that no supplier can become the exclusive supplier for any particular component. This strategy counters the above to a certain degree, preventing the emergence of pure monopolies for any component.

Figure 21: Oligopolistic equilibrium along the value chain



Source: Author's own figure

Interestingly, the largest automotive supplier, BOSCH, has enforced the exact same procurement policies, thereby creating the same structure for its key suppliers. Through such strategies, an oligopolistic equilibrium is created for core companies along the value chain.

Part VII: Implications for economic theory

Orchestrated value chains and the limits of governance theory

Through the intensified efforts to restructure and control their global supply chains, leading multinationals have created global value chains in which power asymmetries enable the lead firms to govern and control the activities beyond the boundaries of the firm (Nolan, 2001b; Sturgeon, 2002; Cantwell, 2013). Recently, scholars have begun to talk about a new wave of globalization (Milberg and Winkler, 2013), in which the asymmetries of corporate power between the participating firms in the value chains increase (Dembrinski, 2008). This thesis shows the power asymmetries have increased to a point that the mechanics of governance have changed. New forms of governance have emerged that cannot be explained by contemporary theory. In the following, the theory of economic governance is amended and new mechanics described to explain the observed phenomena.

The problem: governance beyond the contractual realm

The theory of governance is a theory of contracts (Coase, 1984, 1990; Casson, 1987; Williamson, 2002). As a theory of contractual relations, it fails to explain some of the observed phenomena in this study. In particular, one of the most surprising findings of the study was the reach of influence the lead firm has in its value chain. This is best exemplified by the case of the Huaxiang Group, a tier-2 supplier with no direct supply contract with Volkswagen. Despite the absence of a supply contract, Volkswagen developed close ties to the supplier, which shows the depth of value chain orchestration of Volkswagen and calls into question contemporary governance theory. In the observed setup, Huaxiang has a contract with a tier-1 supplier that assembles the

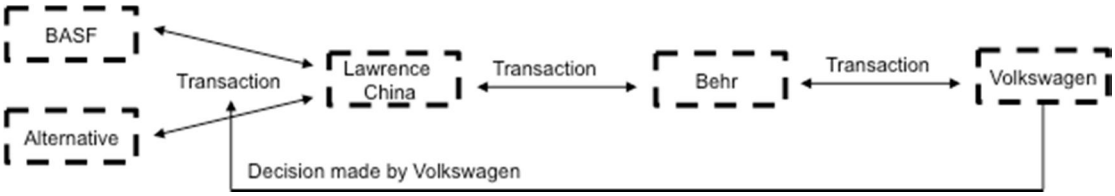
side panels for vehicle doors. The blueprints and technical documents for the component are provided by the tier-1 supplier. There is no direct contractual relation between Huaxiang and Volkswagen, and no direct transaction between the two firms. Yet, Volkswagen influenced Huaxiang and established a degree of control over the supply firm. The setup is not a unique phenomenon. Other research has found similar setups of lead-firm influence on non-direct suppliers (e.g. Dembinski 2008). Such examples are impossible for contemporary governance theory to explain.

The general literature on economic governance (Casson, 1987; Williamson, 1996), which is based on transaction cost theory (Coase, 1937) cannot explain the influence Volkswagen has over Huaxiang. As a theory of contracts, its explanatory power is limited to that of contractual partnerships. The theory is inherently unable to explain inter-firm relations and governance mechanics that are non-contractual by nature. Non-contractual relations are not in scope of the theory. The general assumption would have to be, that Volkswagen has no degree of control over Huaxiang, as influence is created and enforced via contracts. Yet, multiple interviews of people involved in such setups revealed that there is very direct contact between the two firms, that Volkswagen influences decisions of Huaxiang and exerts a certain degree of control over the company, and that Volkswagen has a governance approach in place that includes non-direct suppliers in the 2nd and 3rd tier of the value chain (Interviews with Lawrence, Volkswagen, BOSCH and Witzemann).

In the case of Huaxiang, Volkswagen made regular firm visits for the approval of the production setup and processes in China, a prerequisite to become an approved tier-2 supplier. Volkswagen furthermore required a quasi-open-book relation to assess the capabilities and efficiency of the tier-2 supplier. Through the supplier development program, Volkswagen further helped to develop Huaxiang to become more productive.

And the influence over supply firms did not end at Huaxiang. The penetration of Volkswagen's governance went one level deeper. Core suppliers of Huaxiang, which are tier-3 suppliers to Volkswagen, had to be approved by Volkswagen before supplying to Huaxiang. In the case described by interviews from Huaxiang, the selected supplier for a glue was not approved by Volkswagen, and Volkswagen demanded that BASF would supply the glue in the manufacturing of components that would eventually go into Volkswagen vehicles. By controlling transactions along the value chain, the lead firm can influence transactions, even if not directly involved (see Figure 22). Therefore, the theory of governance needs to be adapted to explain such new phenomena.

Figure 22: Governance and influence beyond direct suppliers



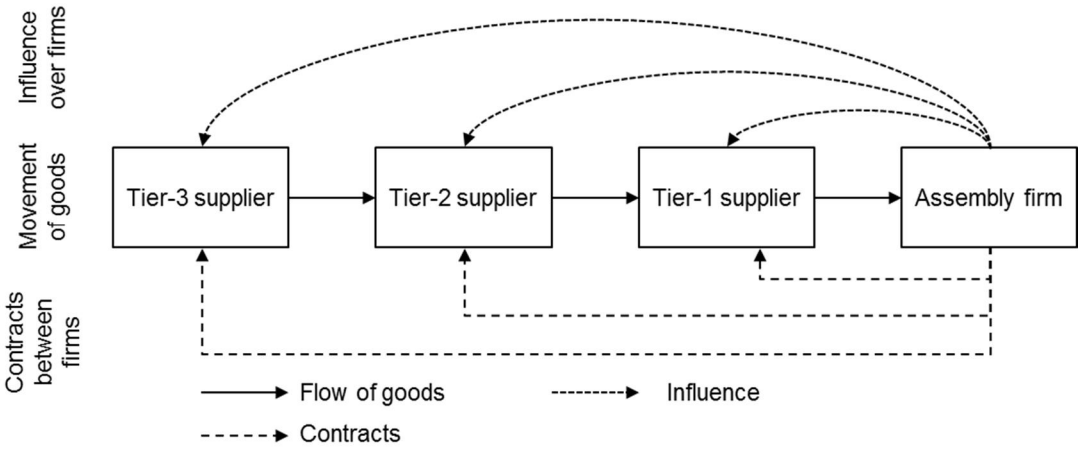
Source: Author's own figure, based on field research

Similar lose forms of collaboration can also be observed in other instances. For example, the automotive supplier ZF Friedrichshafen has announced a strategic alliance with Hella for the development of camera systems and radar sensors. "This strategic partnership for sensor technology with HELLA enhances our position as a complete systems supplier for modern assistance systems as well as autonomous driving functions" (Stefan Sommer, CEO of ZF). This partnership is, on purpose, not structured as a joint-venture: "We are faster this way. In the Silicon Valley, innovation works this way" (Stefan Sommer, CEO of ZF, in Buchenau 2017). The alliance is not exclusive,

and very loosely regulated: “If we are to regulate everything, we would be much slower” (Stefan Sommer).

How can firms exert control over suppliers in the 2nd tier? One option that can be explained by contemporary governance theory is to gain control over lower tier suppliers is by establishing direct contractual relations with the supply firms. In this case, the value adding activities are sequentially spread out among multiple supply firms – all of which have direct contractual relations to the lead firm. The lead firm owns and provides the technical drawings to all firms.

Figure 23: Separating contracts, influence and logistics



Source: Author’s own figure

As studies in the 1980s have shown (Casson, 1986a, 1986b), the extended supply base can indeed be part of the contractual realm, when the materials or blueprints for production are owned by the parent firm and undergo several processing steps in the value chain each by independent firms. For efficiency purposes, logistic flows are established directly between the involved supply firms without the lead firm in-between (Figure 23). But the parent firm maintains control over the production or process steps, by owning either the material, or the intellectual property such as technical drawings required for the process steps. Blue prints, technical drawings, material and tooling are

provided by the lead firm, and only manpower, machinery and processing capability is provided by the sub-contractor (Casson, 2013). Such arrangements involve contracts, to define ownership, license agreements and such arrangements between the parties, regardless of the logistical process and the question where the component is shipped to for further processing. However, such a contractual setup has not been the case with Huaxiang, which had no supply contracts with Volkswagen. Still, Volkswagen is able to extend its control beyond the tier-1 suppliers – a phenomenon that cannot be explained by contemporary theory of governance.

The contemporary theory of governance

The leading theory on governance mechanics is based on transaction cost theory (Coase, 1937; Williamson, 1979; Casson, 1986b). Ronald Coase ingeniously described the transaction cost principle, what became the basis model for modern transaction cost economics (Coase, 1937, 1984). In his view, a firm either internalizes or externalizes processes of the overall production value chain for a final product. For instance, it can be better for a firm to internalize a process in order to avoid the cost of transportation or the cost of information transfer. At the same time, a firm can externalize other processes, to allow market forces to lower prices through the principle of supply and demand. A firm is assumed to always choose the setup with the least cost (Coase, 1937).

In the neoclassic economic literature, governance structures are mostly simplified to distinguish between hierarchy and market structures (Casson, 1987; Williamson, 1998). For such simplification, neoclassic governance theory has received much criticism (Williamson, 1996). Hybrid forms of governance are often ignored, even though hybrid governance structures are increasingly becoming the norm. In such hybrid governance forms, firms can excerpt a certain degree of control over others,

without the necessity of partial ownership (Casson, 1986b).

Despite the widespread ignorance towards hybrid governance structures, the concept of such hybrid forms has deep roots in neoclassic transaction cost theory (Williamson, 1979, 1996; Casson, 1987; Gereffi, Humphrey and Sturgeon, 2005). Transaction cost theory and the mechanics of governance explicitly allow hybrid forms of governance in contract relations (Casson, 1987; Williamson, 1996). Yet, research on hybrid forms of governance has been relatively scarce.

In traditional transaction cost theory elastic contract law allows to describe hybrid forms of governance with long-term contracting and bilateral dependency of the involved parties (Williamson, 1996). Based on such elastic contracts, Casson developed a typology of hybrid forms of governance (Casson, 1987). In his typology, Casson distinguishes between outright control, where the parent's equity stake needs to be high enough to give outright control; joint venture, in which the parent's equity stake needs to be high enough to give some control over quality and price of product; industrial co-operation agreement, which is a similar form to the joint venture, but with a time limit; subcontracting, in which the parent receives a fee for each supplied unit to the parent; sales franchising, in which the partner purchases products from the parent; licensing and production franchising, in which the parent receives a fixed fee for produced or sold units (see Table 20).

Table 20: Definitions of contractual arrangements

Arrangement	Control allocated to			Comment
	Parent	Partner	Other partner	
Main types				
Outright control	APM	-	-	Parent's equity stake need not be 100 per cent but is sufficient to give outright control
Joint venture	APM	PM	-	Parent's equity stake need not be 50 per cent, but is sufficient to give some control over quality and price of product
Industrial co-operation agreement	APM	PM	-	Similar to joint venture, but with time limit on equity holding and possible restruction on nature and timing of payment to parent
Subcontracting	AM	P	-	Partner receives mainly a fixed fee for each finished unit supplied to parent
Sales franchising	AP	M	-	Partner purchases product from parent mainly for a fixed fee
Licensing and production franchising	A	PM		Parent receives mainly a fixed fee for each unit produced (or sold)
Some other possibilities				
Chain management	A	P	M	
Interlocking joint ventures	APM	P	M	

A: advantage, P: production, M: marketing

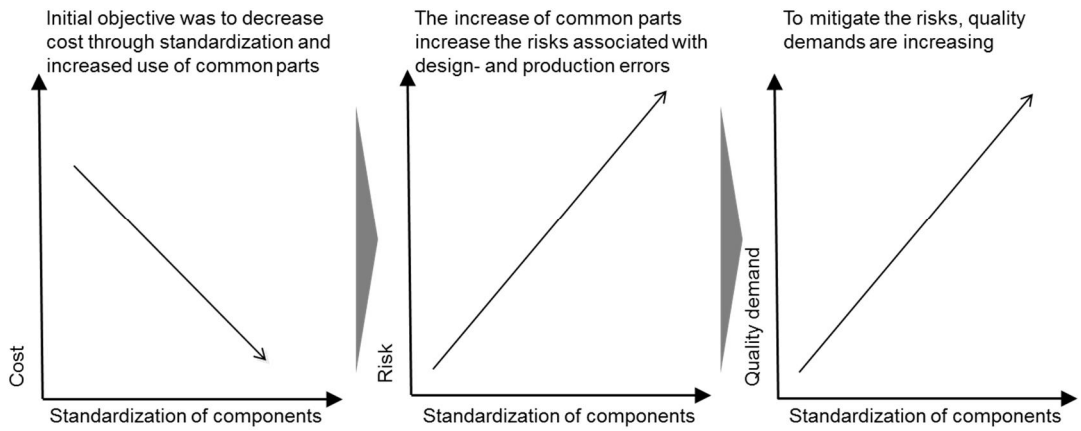
Source: Casson, 1987

As seen in the table, the parent firm is assumed to have the advantage in each of the governance forms. Advantage refers to proprietary advantage that comes from superior technology, brand recognition or cost efficiency (de Bretani, Kleinschmidt and Salomo, 2010; Scalera *et al.*, 2014). This, however, is not the case in some of the inter-firm relations in the case studies of this research. The advantage, production and marketing are all at the supply firm level, which in transaction cost perspective would mean that there is a market type relation between the firms. Still, the supply firm is dependent on its customer, and the inter-firm relations do not resemble that of market-type relations.

Distorted consequentiality through the evolution of product architecture

The globally aligned product architecture changes the quality requirements and consequentiality of the contracts between firms. The increase of common parts is a cornerstone of Volkswagen's strategy to increase economies of scale. Such components can be used across multiple vehicles and in a variety of markets across multiple countries. This leads to a much wider use of components from the same design drawings and from few production lines, which increases the risk associated with design flaws or production process errors. The wide use of a component enhances the cost associated with malfunctions based on design or production flaws (Figure 24). Where in the past, such errors would impact only few vehicles that used the component in some countries, it now impacts many different vehicles types, produced and sold around the world. The malfunctioning component is used widely, leading to recalls of large magnitude and massive cost implications. The effect of such recalls can be observed in the automotive industry that has been plagued with increasingly large and widespread recalls in recent years.

Figure 24: Globally standardized architectures lead to increased consequentiality



Source: Author's own figure

The increased risks increase the interdependencies between supplier and buyer. In case of a malfunctioning component, the firm closest to the customer (i.e. assembler) suffers the most direct consequences of loss of quality and brand perception by the customer. The assembler also directly suffers the consequences and high costs associated with a recall. Even though some of the costs can be passed on to the supply firm that caused the issue, it is not always a feasible option for the assembler.

The supplier might collapse under the burden of the recall, like Takata insolvency during the 2017 airbag recall. Such insolvencies are not in the interest of the assembler. A full substitution of a supply firm would take great time and effort to achieve. In the oligopolistic structure of the value chain, each supply firm plays a crucial role in the well-oiled supply chain. In times of zero stock manufacturing, any disruption in the supply chain has an immediate effect on production which generates even higher losses than the recall. Furthermore, the assembler has an interest to keep the number of supply firms for a certain component at a certain level, to be able to interchange supply firms for certain projects. As there are typically only a handful of alternative supply firms, insolvency of single firms can have an unwanted impact on the global supply base structure. Keeping the supply base healthy is of great importance to the assembler.

Therefore, instances of large scale production errors have to be handled through joint efforts of buyer and supplier. Williamson refers to such instances as “disturbances”, which are mediated by elastic contracting mechanisms (Williamson, 1996: 96). He differentiates between three kinds of disturbances: inconsequential, consequential and highly consequential. Inconsequential disturbances do not justify any mitigation, as the mitigation cost exceed that of the disturbance. Consequential disturbances on the other hand, require mitigation via mediating as enabled by elastic

mechanisms employed in the contract (Williamson, 1979, 1985, 1998). Elastic mechanisms are such that allow the firms to jointly find a solution of the lowest cost. Instead of hard and defined penalties, both firms have an interest in finding a suitable solution. An example of such an elastic mechanism in a contract is from the supply agreement between Northwest Trading Company and the Nevada Power Company, as quoted in Williamson's book:

"In the event an inequitable condition occurs which adversely affects one Party, it shall then be the joint and equal responsibility of both Parties to act promptly and in good faith to determine the action required to cure or adjust for the inequity and effectively to implement such action." (Williamson, 1996: 96)

Elastic contracts need to contemplate unanticipated disturbances, state tolerances for the disturbance, define information disclosure in the event of a disturbance, and define escalation to arbitration if voluntary agreement fails (Williamson, 1996).

Highly consequential disturbances are such, in which the cost of terminating the contract is lower than mitigating the issue that has caused the disturbance. Such drastic measures, however, are only viable under the assumption that alternative sources for the product are readily available, as in a perfect market. In the oligopolistic value chain of the 21st century, where few to none alternatives are available, the cost of terminating the contract is almost certainly higher than the cost for mitigation. The oligopolistic structure of the automotive supply industry in combination with the global standardization of components has raised the threshold for mitigation to such a high level that even for highly consequential disturbances there is no alternative to mitigation.

Consequently, the product architecture and value chain setup of Volkswagen

has drastically increased the company's dependency on key supply firms, to the degree that even highly consequential disturbances have to be handled as consequential ones, with no alternative for immediate drastic measures. In order to mitigate such risk, Volkswagen has adapted its governance approach through increased quality requirements, and increased number of supply firm audits and visits. The closer control for quality and closer alignment of production and management techniques between the firms, in turn, requires closer collaboration and interaction between buyer and supplier on multiple levels, including firm visits, quality and process optimization from supplier development programs, open book relations to assess damage in the case of instances, and joint R&D process to minimize errors in the design and development phase. The mitigation efforts go beyond the first tier of supply firms, as errors in the lower tiers can lead to the same consequential results. To mitigate any such risks, Volkswagen conducts similar audit visits, quality controls and supplier development supplier to tier-2 and at times tier-3 firms. Such a degree of interaction and knowledge exchange strongly resembles hierarchy forms of governance, despite a lack of ownership in the supply firm.

Shifting attention to hybrid forms of governance

Because of the increased interdependencies between firms, hybrid forms of governance are increasingly becoming the norm (Schmitz and Humphrey, 2000; OECD, 2013). While Williamson's arrangements of elastic neoclassic contracts allows for the required flexibility to have non-control partners with flexible long-term contracts, neoclassic economists nevertheless focused heavily on thin spontaneous governance as described by Adam Smith's "invisible hand" concept, i.e. market-type hands-off governance mechanisms in the market. Intentional mechanisms of

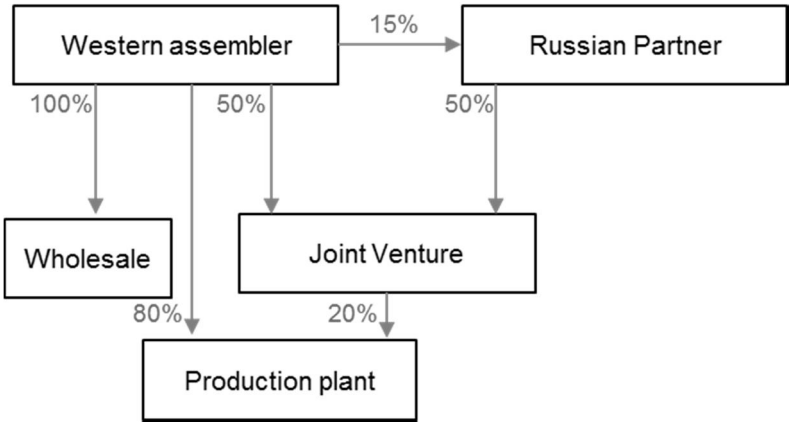
“conscious, deliberate, purposeful” kind have been largely ignored (Williamson, 1996: 170), as “hyperrationality” prevails in economic science (Barnard, 1938), whereas there is a growing need to describe “man as he is, acting within the constraints imposed by real institutions” (Coase, 1984: 231).

As the product architecture evolves and becomes increasingly integral (something this can be further expected through digitalization that requires customized coding), evermore inter-firm relations resemble hybrid forms of governance. Because of the increasing use of hybrid forms of governance, the attention has shifted to research on such governance forms (Schmitz and Humphrey, 2000; Humphrey and Schmitz, 2002; Williamson, 2002; Dolan and Humphrey, 2004; Gereffi, Humphrey and Sturgeon, 2005; Frederick and Gereffi, 2009; Ponte, 2014; Ponte *et al.*, 2014).

Developing a deeper understanding of hybrid forms of governance becomes important, as even the two extremes, hierarchy and market, vary in degree of control. As recent studies about the management of subsidiary in MNC has highlighted, the degree of control over 100% fully owned subsidiaries varies significantly (Andersson, Forsgren and Holm, 2002; Cantwell and Mudambi, 2005; Bouquet and Birkinshaw, 2008; Ambos, Andersson and Birkinshaw, 2010; Pananond, 2013; Zeschky *et al.*, 2014). Furthermore, partial ownership structures can take very different forms and shapes, resulting in different degrees of control. For instance, a recent study highlights that almost 50% of the German DAX is owned by foreign countries (EY, 2017). Yet, these firms are assumed to be of “German origin”, and no serious scholar would argue that they are under foreign control. Furthermore, in times of globalization and the multinational enterprise, what is typically considered as a “firm” consists of a multitude of legal entities. The degree of ownership over different legal entities can vary. In some countries, firms can only enter via joint ventures with local companies, often

competitors in the same industry. Such joint ventures can have a multitude of different organizational structures, with unlimited possibilities to spread the shares between the involved shareholders. Even in simple structures, like the 40-60 joint venture between Volkswagen and FAW in China, the percentage of ownership does not necessarily indicate the level of control. In the abovementioned joint venture, Volkswagen has more power over core strategic decisions like product portfolio, and full control over R&D. Furthermore, some groups have developed complex structures involving multiple legal entities, blurring the clear ownership structure even more. For instance, the following example depicts the joint venture between a German automotive assembler, operating a production site in Russia with a Russian strategic partner (Figure 25). In such cases, the question to what degree the activities performed in the different legal entities are still considered "internalized" is difficult to judge.

Figure 25: Hybrid governance in complex joint-venture structures



Source: Exemplary corporate structure from automotive assembler

As the literature on global value chains has pointed out, hybrid forms of governance with no ownership play an increasing role in the globalized economy (Gereffi, 1999; Humphrey and Schmitz, 2002; Gereffi, Humphrey and Sturgeon, 2005;

Milberg and Winkler, 2013; OECD, 2013; UNCTAD, 2013). As the cases in this study show, most inter-firm relations in our sample deal with hybrid forms of governance. While the supply firms are independent firms rather than internalized business units of the assembler (as in the hierarchical governance structure), "market" type of governance mechanics do rarely apply, as most supply firms are not governed via a pure price mechanism. Instead, the integral nature of components in the vehicle lead to bilateral and multilateral dependencies of the involved firms that force the supplier and buyer to work together, develop joint long-term plans, and build production clusters and a joint international footprint for global production.

Extending the theory of governance

Since all hybrid forms of governance described above are based on direct contractual supplier-buyer relations, the question remains how firms can govern the extended value chain beyond the contractual realm.

In this chapter, a theory of governance is proposed that is not based on contracts, but on the power of the firm. It is argued, that power enables a firm to exert a degree of control over other firms without ownership and supply contracts. The unit of analysis is not the contract between two firms, but the power asymmetries in inter-firm relations. Thereby, the theory of governance can be extended, to describe mechanics of governance that are neither based on ownership, nor contracts.

Choosing contracts as unit of analysis to understand non-ownership governance mechanics has been practical as the act of enforcement can be observed in the court. As Hennart describes: "Contracts are promises, enforceable in court and valid over a specific amount of time… contracts reduce enforcement costs by defining, for the life of the contract, actions that would breach the promise and the compensation to be paid

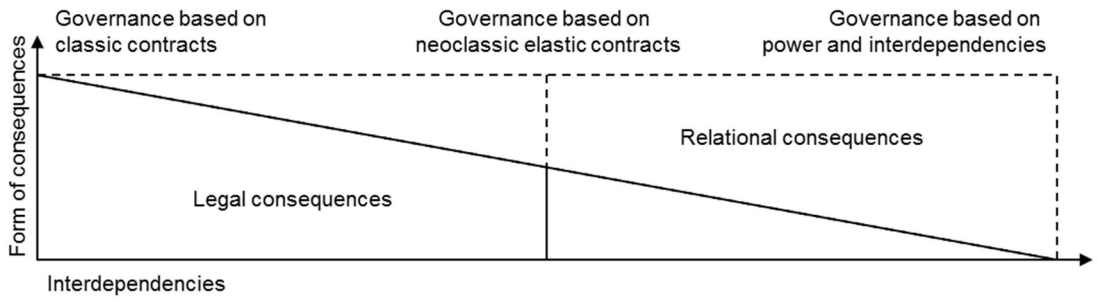
to the damaged party" (Hennart, 1982). The written contracts clearly outline the incentives to keep the promise, and consequences of breach. It is enforced by a functioning legal system that can inflict the consequences upon the involved firms. But the understanding of hybrid governance forms has evolved over time, and so has the role of contracts.

In classical contract law, contracts are static and not elastic. Any deviation from the contract is a breach. Rules are strictly applied and in case of dispute, contracts are interpreted in a legalistic way (Williamson, 1996). As Williamson describes, application of static contracts is possible under perfect market conditions, "in which individual buyers and sellers bear no dependency relation to each other" (Williamson 1996: 95). As such perfect market conditions rarely apply in reality, the theory was developed further in neoclassic contract law. Neoclassic contract law allows for elastic contracts that relieve the firm from strict legalistic enforcement (Williamson, 1979, 2002). Elastic contracts contain special adaptation mechanisms to restore efficiency after unforeseen disturbances that facilitate long-term inter-firm relations. This is important if dependencies are involved in the relations. To enforce such elastic contracts, the courts are not necessarily involved. Litigation is substituted by arbitration as the main forum to handle disputes (Williamson, 1996). Even in the event of highly consequential disturbances, when the contract reverts back to a legalistic regime, "neoclassic contract law averts truly punitive consequences by permitting appeal to exceptions that qualify under some form of excuse doctrine" (Williamson 1996: 97). As Macneil argues, even the legal regime acts modest in enforcing the keeping of promises (Macneil, 1974). The ability to legally enforce the keeping of promises is limited by the severity of the consequences – be it in the relation between firms, or within the firm.

In the proposed theory of governance, power asymmetries between (inter)dependent firms replace the regime of external arbitrage and litigation. The threat to release one party from the relation or put the other firm in an unfavourable position in the value chain replaces the legalistic consequences of contracts. In an environment of great inter-firm dependencies (such as in the oligopolistic automotive industry), the consequences of damaging the good inter-firm relation build on trust can be more severe than the consequences of the law. In this concept, long-term relations are built on a shared advantage of continued business relations that is greater than potential opportunity gains from litigation, even for consequential disturbances. Long-term inter-firm relations are based on trust, common objectives and joint planning and strategizing (McDermott and Corredoira, 2010; Park and Hong, 2012).

This is a progression from the governance theory based on neoclassic contract law. In classic contract law, the ability to enforce the keeping of promises was based on consequences of the law. In neoclassic contract law, it is based on two instances: First arbitration, so that the involved parties can find the common ground of least cost for all involved parties, and second, the law, if arbitration fails to solve the dispute. The consequences of breach of contract are therefore defined through negotiations in arbitration and the law. In the cases of non-contractual relations, the contract becomes irrelevant, and legal consequences are fully replaced by arbitration. This can only function if the consequence by arbitration are more severe than the legal consequences (Figure 26). Governance, then, is not based on contracts, but on the power to inflict consequences. In this extended theory, legal measures are just one tool of the firm to inflict consequences on another firm, as consequences can be either legal, or not.

Figure 26: From classic contract law to non-contractual governance



Source: Author's own figure

Power is at the core of the new theory, and is understood in relative terms in relation to the other firms involved in the value chain, and the firm's capability to effectively orchestrate the value chain in order to enforce its objectives. While the power enables the firm to enforce its strategies, the orchestration capabilities are required to identify key activities in the value chain and to effectively steer the extended value chain in the desired direction. In such market structures, firms can not only be dependent on a direct trading partner, but also on other firms that are involved in the chain of activities along the value chain, if such firms are non-substitutional and occupy and dominate a key link in the value chain.

The notion of power has been used in the GVC literature to define governance mechanics (Humphrey and Schmitz, 2001, 2002; Kaplinsky, 2004; Gereffi, Humphrey and Sturgeon, 2005; Gibbon, Bair and Ponte, 2008). However, the term 'power' is elusive and requires further definition.

Dahl defines power as "A has power over B to the extent that he can get B to do something that B would not otherwise do" (Dahl, 1957: 202f). Power is thereby a relational value between two (or more) parties. The parties involved can be all sorts of individuals or groups of people, organizations, institutions, or in this case firms. In the proposed theory, the parties are simply called "actors". In reality, multiple actors are

often involved in any given decision, and oftentimes with conflicting propositions and reactions to the outcome. To simplify, the proposed theory concerns itself with the power-delta between just *two* actors. The two actors will be called *influencer*, and *reactor*. In some instances in the literature, terms like "submissive" are used for the reactor (e.g. Dahl, 1957; Galbraith, 1983), but it is important to note that the *reacting* party may not necessarily be found to be the weaker of the two – it is simply the party that reacts on the proposition of the *influencer*, i.e. does something it would otherwise not do. Moreover, the power asymmetries between the two actors is situational. A does not have a static amount of power over B. Instead, the power asymmetries appear to be spontaneous and bound to a specific situation. Furthermore, in many instances, both parties may play both roles of influencer and reactor simultaneous. Such is the case in any win-win scenario, in which both parties were able to assert what is important to them – and compromise in what is important to the other party. In such scenarios, both parties can be equally seen as influencer and reactor.

To describe the power asymmetries, Dahl argues that two different perspectives have to be taken into account: First, the attributes of the influencer that equip the influencer with a certain power, and second the reactions in relation to alternatives of the reactor (Dahl, 1957). In describing the resources of the influencer, he distinguishes between the means or *instruments* by which power can be yielded, and the *base* or source of power (Dahl, 1957). In his work on the "Anatomy of Power", Galbraith identified three types of instruments to yield power: *Condign* power, *compensatory* power and *conditioned* power (Galbraith, 1983). Condign power is often called coercive power and is based on the ability to inflict or threaten adverse consequences sufficiently high so that the reactors abandons his or her preferred alternative (Raven, 1992). Conversely, compensatory power works with the offer or affirmative reward that

gives value to the reactor upon the reactors compliance. Finally, conditioned power targets at changing the reactors belief through persuasion, education and reasoning so as to influence “the social commitment to what seems natural, proper or right causes” (Galbraith, 1983: 6). The decision of the reactor thereby reflects the preferred alternative, so that the fact of an influence may not be recognized (ibid.). In particular the first two types of power have been observed in the case studies. For instance, in the case of HuaXiang, Volkswagen used condign power to inhibit the suppliers wish to select an alternative glue supplier. In the case of Fuyao, Volkswagen used compensatory power to convince the company to invest into Germany and collocate some operations in Europe.

Galbraith also identified tree sources of power: Personality, property, and organization (Galbraith, 1983). Personality power can come from personal attributes, such as great appearance and strength, ability to produce clear and resounding speeches, expert power and the like, which can create loyalty and trust in the ability to inflict either coercive or compensatory measures. Property as a source of power provides the influence with the ability to compensate the reactors. Organization, or sometimes called legitimate or positional power (Pierro, Cicero and Raven, 2008), is the power given by a position held by the influencer. While Galbraith’s sources of power described the power of *people* rather than organizations, it is nevertheless a helpful typology to understanding power of companies. In particular the concepts of personality and property traits can be useful to describe attributes or resources that equip a company with sources of power, such as ability to offer favourable terms and conditions such as long-term supply contracts or minimum order quantities, as Volkswagen did on several occasions when influencing its supply base. The sources of power and the instruments of power are important attributes to define the power of a company. For instance, while

Schaeffler used the same type of power (i.e. compensatory power) and the same sources of power (i.e. offering long-term contracts), its suppliers did not collocate with Schaeffler follow the company in its expansion to Slovakia. Hence, Schaeffler appears to have less resources available to incentivize its supply firms to collocate.

The abovementioned sources and instruments of power are concerned with the influencer. Equally important are the scope and the extent to which the reactor reacts on the influencer. Following Dahl's concept of power, scope describes the type of response evoked, while the extent describes the number of comparable respondents (Dahl, 1957). The reactors response is required to describe the amount of power a company has. For instance, while Volkswagen is able to enforce open book relations with its small supply firms, Volkswagen is unable to enforce the same on large supply firms such as BOSCH. While Volkswagen uses the same sources and instruments of power, it is the difference in the reactors response that is needed to fully understand the power asymmetries between the two actors.

The mechanic of power-asymmetries is based on inter-firm dependencies in oligopolistic market structures. The degree of interdependencies between buyer and supplier depends on three factors: First, the level of asset-specificity. The higher the asset-specificity, the higher the degree of interdependency between supplier and buyer (Williamson, 1979, 1981). Second, the product architecture and the product characteristics as defined by its interfaces (modular vs. integral) and its 'importance' to the final product (such as design feature or safety relevant) (Park and Ro, 2013). Third, the degree of consolidation in the market that enables firms to gain monopolistic positions as either supplier or buyer (Coe, Dicken and Hess, 2008; Dicken, 2011; Nolan, 2012).

The ability to orchestrate the value chain, in turn, is key for the lead-firm to utilize its power effectively. This includes the ability to generate a deep understanding of its value chain beyond the tier-1 supply firms. Identifying high value-adding activities, core components and strategically relevant firms in the value chain is a necessary prerequisite for effective value chain orchestration beyond the direct suppliers. This is greatly enhanced through open-book relations, which can offer insights into the extended value chain, beyond the immediate realm of the direct suppliers (Womack, Jones and Roos, 1990). Furthermore, the ability to develop a deeper understanding of the supply firms' processes and activities enables the lead-firm to benchmark and identify capability gaps in the value chain. Such knowledge can be acquired through supplier development programs, which can go beyond the first tier of supply firms. Finally, and most importantly, the ability to enforce standards and orchestration principles beyond the first tier of suppliers is important. This requires close interaction between the two firms – even if no direct supply contract exists. The basis for such inter-firm relation is trust, which can be developed over long periods of time. Through close ties based on trust, the firms can identify common objectives to jointly develop strategies and bundle efforts to achieve these.

The ability to orchestrate the extended value chain is increasingly important in volatile markets or converging industries that undergo rapid technological changes through disruptive innovations (Christensen, Verlinden and Westerman, 2002; Christensen, 2006; Markides, 2012). In the automotive industry, the large players are challenged by disruptive technological changes that require the firms to judge the viability of such new technologies and the role such technologies may or may not play in the future. Such new technologies are inherently uncertain (Utterback, 1994; Christensen and Raynor, 2003); yet, the expertise of the industry, combined with

expertise of new technologies and a high absorptive capacity and high degree of dynamic capabilities at the lead firm can enable big businesses to adapt to disruptive technologies (Teece, Pisano and Shuen, 1997; Eisenhardt and Martin, 2000; Teece, 2014b). Capabilities to orchestrate the value chain beyond the direct suppliers will enhance the firm's ability to identify key future technologies and key firms for potential strategic alliances (Fine, 1998).

Asset specificity and power

Asset specificity increases the dependency of one firm to another. Asset specificity describes "the degree to which an asset can be redeployed to alternative uses and by alternative users without sacrifice of productive value" (Williamson 1996: 59). This means investments of high asset specific nature only have value for the particular transaction or customer to which they were made for. If the transaction is not concluded, the investing firm would have to depreciate its investment at great loss. Hence, the investing firm is dependent on the realization of the transaction. Transactions that involve high degree of asset specificity are often remunerated by long-term relations (Carney, 2005).

The literature commonly distinguishes between five kinds of asset specificity (Williamson, 1996): site specificity, e.g. if one firm collocates production to a particular customer; physical asset specificity, such as customized tooling or dies; human asset specificity, by acquiring particular skillset for a particular transaction; and brand name specificity, if a brand has value for a particular use or purpose, to which it is attached.

The higher the asset specificity of a transaction, the higher the dependency between the two firms. This can lead to considerable power asymmetries between the involved firms, if one firm becomes dependent on the other.

Product architecture, component characteristics and power

Gereffi et al. identified that the degree of required knowledge-transfer in a transaction, together with the ability to codify such knowledge, is a source of power for the lead firm (Gereffi, Humphrey and Sturgeon, 2005). The requirement and form of knowledge exchange, in turn, is influenced by the product architecture and the characteristics of the components. The contemporary literature on product architecture differentiates between two aspects of product characteristics: open and closed product architecture, and the integral or modular nature of a product (Henderson and Clark, 1990; Ulrich, 1995).

Open architecture is given when the interfaces are known and standardized beyond the boundaries of the firm or firms involved in the production of the final product. For instance, industry norms define interfaces for open architectures. A closed architecture, on the other hand, is given, when products information, technical drawings and interfaces between components are customized for a particular final product of a firm, and the information is handled as proprietary information of the firm. Only the firms directly involved in the production receive the required information from the lead firm that owns the technical information. Detailed designs are only known to the firm, and can be subcontracted to an outside firm, but the basic design of the tool system is contained within one company (Fujimoto, 2007).

Modular and integral nature of a product describes the level of standardization for interfaces between components (Fujimoto, 2012). Modular products can be “mixed and matched” in a Lego-like system. The interfaces between components are clearly defined and standardized, allowing the individual components to be configured in any way chosen. Integral products, on the other hand, are defined by interfaces that are difficult to standardize. Due to lack of standardization, the information is also difficult to codify. In order to create the final product, each component needs to be adapted and

customized to fit to the other component (Pavitt, 2003; Sapolsky, 2003). This requires a large effort of coordination and knowledge-exchange between the different parties involved in the development and production of the components (Zeschky *et al.*, 2014). Alignment of the interfaces often requires two-way exchange of knowledge, not only from the buyer to the supplier, but also vice-versa (van Schewick, 2010). This blurs the clear lines of ownership of proprietary knowledge, and requires a high degree of absorptive capacity at the buyer firm for the reverse knowledge transfer (Cohen and Levinthal, 1990; Criscuolo, 2009; Nair, Demirbag and Mellahi, 2015).

The interviews with Volkswagen and multiple supply firms have indicated that a deeper understanding of product characteristics in integral systems is required to fully understand the degree of required information exchange on s transaction. Different components that all fall into the closed-integral category show very different characteristics and require different forms of interaction between the firms providing and integration such components. The defining parameter is the degree and form to which the component interacts with other components. In the product architecture view, each component is a small piece in an integrate web. Together, the components form the product architecture. The level to which the components interacts with one another can differ between components in the same overall product architecture.

The key difference defining the characteristics of the components is the form of dependency, whether design-parameter changes during the R&D process impact the interfaces to other components (Menz, Kunisch and Collis, 2013). Parameters for interfaces are pre-defined at the beginning of the detailed development of each component. However, parameters for a component often change during the R&D process as the engineers acquire further knowledge through an ongoing learning process during development (Williamson, 2010; Wan, Williamson and Yin, 2015). If

changing design-parameters during the R&D process are contained within the component, such changes have no impact on the interface, and interaction with other components are not affected and do not change (van Schewick, 2010). If, however, changing parameters are not contained within the component, interfaces to other components require adaptation, which in turn affects the development and design of the neighboring components.

Such cross-component adaptations can be one-directional or two-directional. One-directional dependency occurs if one component is dependent on the design of another. Alternatively, interdependencies can be cross-component in nature, i.e. two-directional, or even multi-directional. Two-directional interdependency occurs if both components are interdependent on one-another, i.e. if changes in one component influence the other and vice-versa. In such instances, changes to one component require adaptations to the other, which in turn might trigger follow-up iterations of the first component. This can trigger a cascade effect if multiple components have cross-component interdependences in complex systems.

The different product characteristics require different forms of inter-firm interactions (Hertenstein and Williamson, 2018). Suppliers that develop and produce components in which changing parameters are contained within the component can be organized in arms-length relationships, as there is no need for interaction if the internal parameters of the component change during the R&D process. In such cases, the boundaries of the component are clearly defined and not changing. Suppliers that develop components without such clear boundaries and cross-component-interdependencies in which changing parameters are not contained within the component, by contrast, require knowledge-exchange with other developing suppliers of interdependent components and the systems integrator (Principe, 2003; Sapolsky,

2003). For components with one-directional dependencies, a simple update often suffices, and irregular updates and interaction are enough to ensure overall product performance. However, for inter-dependent components with two-directional interdependencies, close interaction for continuous alignment and knowledge-exchange of the changing parameters and necessary iterations to the involved components is required with other developing parties and the systems integrator (Hertenstein and Williamson, 2018). This can involve participation of multiple parties from multiple firms, if multiple components are affected. The overall design team has regular update meetings that comprise of members of multiple firms involved in the R&D process, and that is orchestrated by the systems integrating firm. Such setups are required for complex adaptive systems such as power-trains, in which a collection of interdependent components affect each other, and in which changes occur during several stages of the development process through an ongoing learning process at all levels of the involved parties.

The different product characteristics determine the assembler's dependency on the supply firms, and thereby the approach to governance. Volkswagen chose different forms of governance with its supply firms, depending on the component characteristics and interplay with other components. For components with high level of interdependencies to other components, but that are developed externally by supply firms with superior proprietary knowledge for such components, Volkswagen adopted a closely integrated and in-house driven approach to vehicle development that gives tightly-specific development requirements to suppliers, delivered through close, two-way interaction over long cycles. Volkswagen acts as detailed system integrator working at the level of individual components and their interactions, in charge of the simultaneous engineering process, to develop vehicles of superior performance. In the

‘integrated system approach’, Volkswagen has a close interaction with the external technology service providers and the key technology suppliers. While the components are produced and developed externally, the German firm is highly involved in their development process, controlling the R&D process through systems integration testing, and specifying the requirements. Because of the highly specialized and customized interfaces between components, Volkswagen developed the “simultaneous development process” that goes beyond the “drawings approved” relationship as described by Asanuma (1989), who differentiates between two types of assembler-supplier relations: parts manufactured by supply firms based on the supply firms drawings (“drawings approved”), and parts manufactured by supply firms based on the assembler’s drawings (“drawings supplied”).

While transaction-cost theory might suggest that a make-strategy would be better for such integral products, such close interaction and cooperative simultaneous engineering process seems to be the norm among Western automotive assemblers, as managers from General Motors and large global supply firms like BOSCH, Continental or Marquardt have confirmed (Interviews, GM, BOSCH, Conti, Marquardt). These efforts are necessary if the supplier has superior knowledge of key technologies that are required for the product performance of the final vehicle. If the external supplier can specialize in a key technology within the integrated system, it can devote more resources to this particular component and thereby create superior knowledge and technologies.

Volkswagen only uses such elaborate “simultaneous engineering” approaches for key components of integral systems, when the supplier has superior technologies and knowledge. For non-integral (modular) components, normal buyer-supplier relations apply. Body parts, by contrast, once designed have little interaction with other

components, and few interfaces and little inter-dependencies. While such components are customized to the vehicle, thereby need adaptation if other components in the vehicle change, it is a form of one-directional impact. The body part can be adapted to meet the new specifications, without interfering or changing interfaces to other components. The adaptation is contained within the component. For such components, Volkswagen often uses sub-contracting relations which are characterized by little interaction and resemble market-driven hands-off relations, as little information and knowledge transfer is required during the R&D process. However, even for components with relatively little interdependency to other components, Volkswagen chose a close governance approach. This is the case for strategically important components, such as any components relevant to safety, or components that are visible to the customer and have an impact on overall customer perception of the vehicle. Examples for such components are the switch manufacturer Marquardt, or the wooden panel producer Huaxiang. Two factors determine the value of the products designed and produced by Marquardt: the immediate visibility to the customer (and thereby the customer's quality perception of the finished vehicle), as well as safety and security issues regarding drive authorization systems and control systems. Other examples of components that are developed by firms with R&D capabilities that are of strategic importance for the lead-firm are engine cooling, air conditioning and components that are directly seen be the final customer and have an impact on the customers' perception of the vehicle quality (including plastic interior, window lifters, or sealing for vibration and noise reduction). While firms producing such components are in close contact with Volkswagen, the interaction during the R&D process is much lower compared to components with two-directional interdependencies to other components.

As seen in the case study, the product characteristics determine

interdependencies, which in turn determine the approach to governance. The highest degree of interdependencies occurs in complex transactions involving closed-integral products as interfaces between components are not standardized and two-way knowledge-transfer is required. The second most complex transactions occur in closed-modular architecture, in which interfaces are defined and standardized, but not known to the supplier. This requires one-way knowledge-transfer between buyer and supplier, to ensure the requirements are met. Closed-modular architectures allow some degree of codification, reducing the complexity of the knowledge-transfer and the transaction. Such transactions suggest hybrid forms of governance, such as joint-ventures, alliances, or sub-contracting (Williamson, 1981, 2002; Casson, 1987). Transactions in open-modular architecture, on the other hand, require little knowledge transfer, are not complex, and can be handled via hands-off price like mechanics (Williamson, 1979, 1998).

Consolidation and power

As in transaction theory, firms can obtain power by capturing a monopolistic position in the market (Chamberlin, 1933; Robinson, 1933; Bain, 1956). A high degree of consolidates means that fewer alternatives are available, leading to higher dependencies. If the market shows oligopolistic features along the value chain, key firms along the entire value chain are difficult to substitute. If a firm is difficult to substitute, other firms become dependent on it – be it as a buyer of components from a non-substitutional supplier, or as a supplier to a large firm in an oligopsonic market. If firms can control bottlenecks in the value chain that are crucial for the entire value chain, they can become the sole influencer and controller of the bottleneck (Ponte *et al.*, 2014). Such a crucial link or position in the value chain can be superior product

knowledge of essential components, systems integration capabilities required and owned by just one firm, or unique access to the market (Nolan, 2001a; Gibbon, Bair and Ponte, 2008; Teece, 2014b). To establish a sustainable powerful position, the advantage must be valuable, rare, inimitable, non-substitutable, and exploitable (Porter, 1987; Barney, 1991; Fine, 1998). Once obtained, the firm can utilize its advantage and gain power over other firms. The other firms involved in the value chain become dependent on the firm that occupies the bottleneck activity.

Aspects of non-contractual governance

Influence observed in such non-contractual inter-firm relations includes influence over operational aspects such as quality control and logistics, but also strategic aspects such as FDI location choice or M&A (Hertenstein, Sutherland and Anderson, 2017). In the following, the aspects of influence observed in the case studies are summarized in Table 21.

Table 21: Operational and strategic influence on extended value chain

Operational	**Strategic**
Quality standards	Production location choice
Process setup und optimization	FDI and market entry
Material selection	M&A for consolidation and product portfolio optimization purposes
Logistics	Alliances and partnerships
Management tools	
Supplier selection	

Source: Author's own table

The operational aspects of governance seem to be enforced through the tier-1 supplier contract. The strategic aspects are mostly non-contractual. In such instances, the two companies operate on basis of a common, non-written agreement out of a common objective. Nevertheless, they can be negotiated prerequisites for extending the activities in the value chain.

The mechanics of non-contractual governance

How can powerful firms enforce their influence over firms with which they have no contracts?

The cases indicate that the lead firms have two ways to excerpt control over tier-2 firms: First, by enforcing tier-2 suppliers to pass on requirements to the second tier (Figure 27). The requirements and specifications set by the lead firm are passed on by its contractual partners. Such requirements can be materials to be used, the choice of supply firms, definition of processing steps etc. In case the specifications include steps that are not performed by the direct supplier, these are passed on from the direct supplier in its contracts and technical documents to the upstream supplier (see Figure 27 and 28). Such governance mechanisms beyond the contractual realm are supported by open book relations, when the supplier has to provide the customer a list of suppliers (Womack, Jones and Roos, 1990). Through the open-book relationship, Volkswagen is able to force the tier-1 suppliers to implement Volkswagen's policies in the contracts between the tier-1 and tier-2 suppliers. In the case of Huaxiang, if Huaxiang did not comply, Volkswagen would force the tier-1 door supplier to substitute Huaxiang with an alternative supplier. Given Volkswagen’s size and market share in the global automotive industry, this is a serious threat, as many suppliers are at least partially dependent on doing business with Volkswagen.

Figure 27: Passing on requirements in deep value chain orchestration

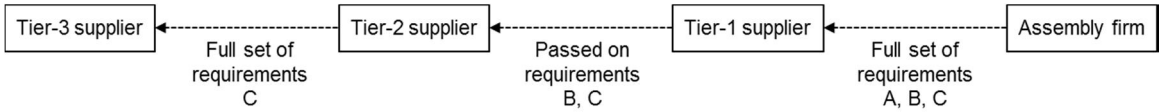


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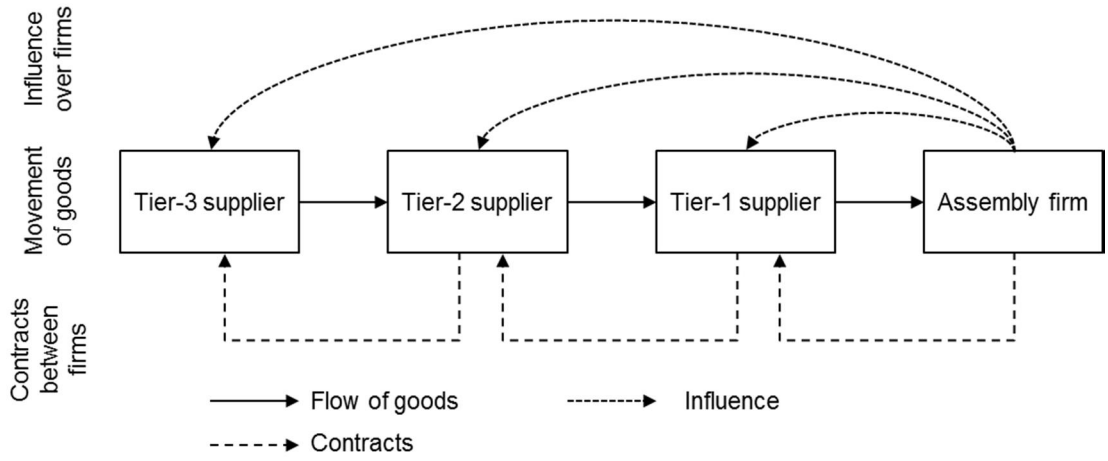
Figure 28: Influence beyond the supply contracts



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Second, Volkswagen can incentivize tier-2 companies to align their strategies. For instance, Volkswagen can provide free of charge consultancy services for performance improvement and process optimization to its supply firms (including, in this example, the tier-2 firm Huaxiang). Through such services, the supplier can become more profitable, and Volkswagen gains deep insights into its value chain. Other incentives are extending the role of the supply firm in the value chain, e.g. by offering to collocate production in additional markets or assigning the supplier to other tier-1 firms as core supplier. For large commitments of the supply firm, such as high investments to collocate to a Volkswagen production site, Volkswagen offers long-term

relationships and involvement in large projects. For services directly provided to the tier-2 supply firms, such as supplier development support, the lead firm can implement service level agreements that are independent of direct supply contracts.

The choice of product architecture

Extant literature identifies a number of key influences in the product architecture a firm will choose. One theoretical explanation for choice of product architecture the characteristics of demand the firm faces depending on its competitive positioning in the market. Firms who seek to offer more innovative products to higher-end market segments, competing on superior performance will need to deal with less familiar technologies and uncertain customer demand (Christensen, 1997; Adner, R. and Levinthal, 2001). As a result, they will need to experiment with components in new combinations where interdependencies are high and interfaces undefined, necessitating an integral product architecture (Park and Ro, 2013). Firms competing at the lower end of the market where technologies and component combinations are more standardized, by contrast, will have the option to choose a more modular architecture (Utterback, 1994; Christensen, Verlinden and Westerman, 2002). The choice of a more modular product architecture will be encouraged by the need to compete on speed-to-market and cost reduction in these segments (Baldwin and Clark, 2000). As a producer of performance oriented vehicles, Volkswagen opted for a highly integral architecture. As some of the capabilities for key integral components are embedded in the supply base, this requires close interaction between assembler and supplier.

Power distribution along the value chain

The power is distributed asymmetrical in the GVC, enabling the more powerful firms to exert control over less powerful firms (Rugman and D'Cruz, 2000). The automotive value chain resembles that of a multipolar value chain, with multiple powerful actors along the value chain, since key activities that can be dominated by one firm are spread out along the value chain (Ponte, 2014). While large assembly firms, such as Volkswagen, act as the most powerful firm and systems integrator, large sub-system suppliers such as BOSCH take on the role as systems integrator for their particular sub-system (Humphrey and Memedovic, 2003; Pavitt, 2003).

Unlike earlier concepts, this research shows that even small supply firms of niche products can develop powerful positions. For small firms to become powerful requires proprietary knowledge acquired through extensive innovation or development capabilities to enable the firm to control the market for their niche product. Through such firm specific advantages, relatively small firms can gain considerable bargaining power toward the assembler. This can be illustrated with small niche producers that have own technology and expert knowledge. One example that illustrates the important role of niche suppliers in the value chain is that of Merck KGaA, a Japan based producer of aluminum-flaked Xirallic pigments that are used in automotive paints to make the car sparkle. The company came to fame after the 2011 earthquake destroyed the company's factory in Onahama, and the entire automobile industry worldwide had to stop producing vehicles of certain colors that needed the specific pigment that was produced only by this particular company, in this particular location. There was no alternative supplier available for such pigments, and it took months to reopen the production plant and start production again. Such a niche firm, little known even to industry experts, has the ability to control the bottleneck for its niche product worldwide, as no alternatives are available. This unique position in the value chain

lends the firm considerable bargaining power towards its customers – so long as it can protect and sustain the firm specific advantage of a non-substitutable product.

Only firms with undifferentiated products, such as bulk material like nuts and bolts, mechanical parts that are produced by sub-contractor firms to which the assembler provides the blue print, such as stamped parts, have little power. These firms have little to no ownership advantages, and face low barriers of entry for new entrants and are interchangeable for the assembler. Such firms are loosely integrated in the value chain, are governed by market mechanism and can be interchanged or substituted at relative low cost.

Two sides of power: up- and down-stream

This thesis builds on the concept of power in the GVC literature, and extends it by introducing two sides of power. In the extant literature, the power of a firm in a specific value chain is assumed as one value for a company. A firm either has power, or not (Gereffi and Korzeniewicz, 1994; Ponte, 2014). This concept of power needs to be extended, to enable more precise analysis of inter-firm relations based on the power dynamics between two actors in the value chain. The power of a firm is always relative in relation to its counterpart. Therefore, in its most abstract form, a firm has at least two values for power: First, as buyer towards its suppliers, and second, its power as a supplier towards its customers.

An example for a firm with power towards its customers is a producer for specialized exhaust pipes, Witzenmann. While there are many steel pipe manufacturers available, producing pipes for exhaust systems requires expertise and knowledge in exhaust flow dynamics, heat development, and vibrant tolerance, to produce an exhaust system that can support strict emission standards, supports complex in-take pressure

management for turbo-charged engines, and ensures the quality and durability despite extreme temperature development and constant vibrations. Such a firm offers a valuable contribution to the assembler, and has unique knowledge and experience, which are of strategic importance to the assembler or the tier-1 systems integrator supply firm of exhaust systems. Only few companies are able to produce such pipes, which lends the company a strong position towards its customers. Due to its relative small purchasing volume, however, the firm is an insignificant buyer of steel and materials, and possesses little power towards its suppliers. The 'power' of the company in the value chain can therefore differ for its two roles as buyer and supplier.

The opposite example is CIE. As a large global metal processing firm, the company has developed relatively strong buyer power. As a produce per blueprint manufacturer, however, it is an interchangeable supplier to the assembler, and therefore has little power towards its customers.

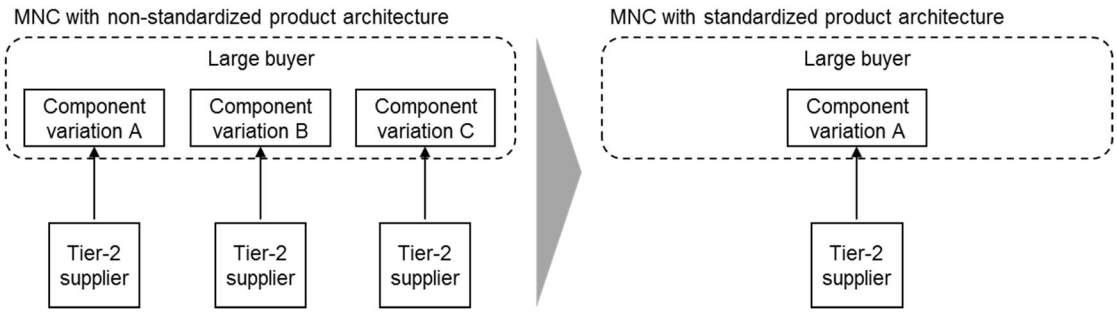
The invisible consolidation of markets within the boundaries of the firm

A necessary condition to develop a powerful position is the oligopolistic market structure in which the lead firms operates with quasi-monopolistic buyer power (Sturgeon, 2002; Gibbon, Bair and Ponte, 2008; Nolan, 2012). This effect is currently accelerated through deep structural changes at the firm level. In the past, the market for a single component within the large MNC buyer was diverse. The buyer needed multiple varieties and adaptations of the same component for its range of final products. The components were constantly adapted and updated, for which the buyer had to ask for new quotes from a variety of supply firms. As adaptations were made for specific locations, the lead firm nominated local supply firms for such locally adapted components. With the drastic increase of globally used carry-over components, the very

nature of the market for such components changes. The number of transactions decreases for the same volume of output, as in a further consolidation of the industry. The 'internal market' within the MNC buyer has been consolidated, drastically decreasing the number of adaptations and newly developed components, and increasing the volumes of orders. Supply contracts are long-term, transnational, and for large volumes, limiting the number of available opportunities to win orders for the supply firm. The importance of a single order increases as the volume for a component is increased. Substituting one supply firm becomes more difficult, and the supply base becomes more static, limiting the potential of individual firms to move along the value chain.

The findings therefore suggest that the evolving product architecture changes the market for intermediary goods, as the homogenization of global products effectively decreases the number of different components and 'internal buyers' of the lead firm (Figure 29).

Figure 29: Product homogenization and consolidation of component industry



Source: Author's own figures

Product architecture and the nature of the market

Through the ongoing globalization and especially the centralization and consolidation of activities within the multinational firm, the nature of the market for intermediate goods has changed. As the MNC harmonizes its product architecture globally and centralizes its global purchasing activities, formerly separated markets become merged into a single, homogenized and global market. Through its globally centralized procurement, the MNC can control a global market for intermediary goods. This is particularly the case for intermediary goods that have a high degree of asset-specificity.

Such globally harmonized markets, dominated by powerful lead firms and orchestrated as discrete value chains, have other properties compared to what is normally seen as a market. In the contemporary understanding of a market, the market is defined by product type and geographic determinants such as national borders (Coase, 1990). Take the market for apple juice in Germany. This market is defined by the product, apple juice, and the geographic boundaries of Germany. Both determinants, the geographic scope and definition of a product scope, are defined by the viewer. A different scope could be beverages in the European Union. The market for apple juice in Germany is a subset of the beverage market in the European Union. Geographic boundaries are typically selected to resemble areas of similar trade legislation, like nations, sub-national economic zones or supranational free-trade areas (Rugman and Doh, 2008). Product determinants are selected by clustering similar products (ideally products that can substitute each other), into one type, regardless of the characteristics such as asset-specificity.

In the case studies presented in this thesis, markets appear to be shaped by a different set of properties. It is proposed that in the modern, globalized economy, markets are organized in global value chains. By selecting different determinants to

define a market, we can create a different view and gain a better understanding of the dynamics of such market structures. As previously discussed, value chains with hierarchical structures defined by strong inter-firm ties are often the structure of choice for products with closed-integral product architecture. In such value chains, the goods are highly customized and have highly specialized properties, or a high asset specificity. The effort and costs for customization can be larger than the cost and effort for core development. The market for such highly customized intermediary goods is very narrow, as the specialized components can only be sold to a specific buyer (Williamson, 1996). How narrow the market for goods with a high degree of asset-specificity is, depends on the form of asset-specificity.

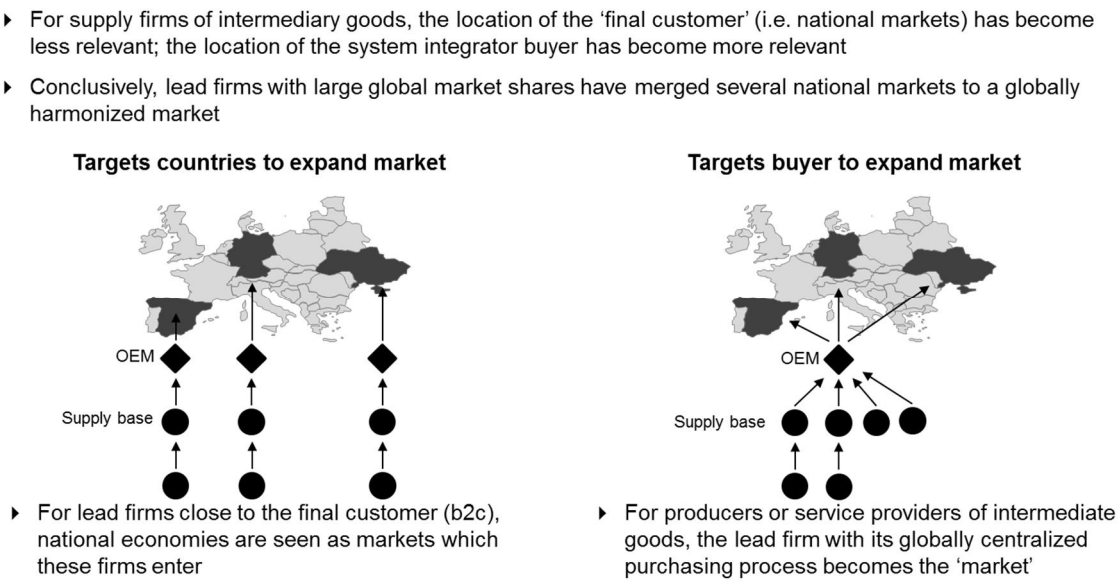
Two factors determine the asset-specificity: the scope of the market for the specific component, and the cost of customization vis-à-vis the cost of core development. The scope of the market can be industry-wide (e.g. similar components used across all passenger cars from various assembly firms, but not used in commercial vehicles, agricultural machinery, heavy machinery or shipbuilding), or singular to a specific buyer as in closed-integral systems (Fujimoto, 2007). In the case of the automotive industry, with assembler specific platforms, the market for highly asset-specific intermediary goods can be as narrow as one assembly group. If, in such narrow cases, the cost of customization vis-à-vis the cost for core development is high, so that any adaptation to other customers is as expensive as developing a new product, the market for any particular finalized product is effectively limited to the specific buyer. This increased the interdependencies of the supplier and buyer.

The trend of increased asset-specificity falls together with the globalization of the assemblers and the global harmonization of the platform. As a consequence, value chains have become global, duplicating the buyer-supplier relations made at home in

the target markets (Anderson, Håkansson and Johanson, 1994; Ge and Wang, 2013). In our sample, the lead firm harmonized its product to use one globalized platform across national borders. When previously, different vehicles in two countries needed different designed and manufactured components (e.g. lights), now they require identical. As a result, purchasing has been globalized, i.e. one company can be selected to supply a specific component to all production locations worldwide. This enables the lead firm to directly compare attributes, price, quality, quantity, and logistics across national borders. The market has been merged into one harmonized market. In such global value chains, geographic perimeters of the market are no longer primarily shaped by political borders, such as national, sub- or super-national economies are, but are shaped by the footprint of the global buyer, i.e. the lead firm and system-integrators in the value chain (Johanson and Vahlne, 2011). The global value chain with its product architecture, governance structure and geographic expansion determines the borders and properties of the market. In cases where lead firms occupy large shares of the market, and components have a high degree of buyer specific asset-specificity, the role of a single buyer becomes disproportionately large for the supply firms. The notion of "key accounts" has a widespread use among the supply firms, and sales managers are measured and often structured around key accounts, rather than countries. The sales force targets particular customers across all national borders, and is measured by sales to the customer, and not sales by region. The focus for growing future sales is put on the "key accounts", i.e. "developing key customers", rather than generating sales in a particular country. As business networks are considered to be "borderless," once embedded in a value chain in one country, the relationship may be replicated elsewhere. Consequently, the distinctions between international and domestic expansion diminishes in the global value chain (see Figure 30). "Distance", that played a key role

in the theory of the MNC (Ghemawat, 2001; Sousa and Bradley, 2005; Dikova, 2009), plays a less significant role, owing to the ability of inter-firm relations in GVC to bridge distances and reduce the liabilities of foreignness when entering new markets (Johanson and Vahlne, 2009, 2011; Hertenstein, Sutherland and Anderson, 2017).

Figure 30: The GVC as a market



Source: Author's own figure

Moreover, production has become "unbundled" from consumption in the modern GVC (Milberg and Winkler, 2013; OECD, 2013; Baldwin, 2014). This is particularly the case of goods with a high value over shipping cost ratio. Even though the firms in the study employed a local-to-local strategies, in which production is in close proximity to the final market, some components are not produced locally. Examples are electric components, such as semiconductors, or entire entertainment systems. For such components, the country of origin of the supplier and the location of production has become detached from where the component is used by the buyer in the final product. Firms involved in the production of intermediary goods may not even

have transparency in which country its products end up being used by the final customer.

The nature of the market and dynamics of competition

The globally harmonized markets through MNC-buyers have significant implications for participation of firms in such markets. First, through the harmonization of national markets, competition has become global, even for local firms from different countries that have not internationalized. Companies with no international footprint face direct competition from companies in other parts of the world, due to the globalized purchasing practices of the MNC buyer, and the transnational transparency and comparability it brings along. Under a globalized purchasing strategy of the buyer, the participating companies have to compete on a global level against one another, changing the nature of competition within the value chain. These dynamics drive three important trends in the global automotive industry: First, an accelerated and global consolidation upstream and downstream the value chain of the lead firm (see 'cascade effect' chapter). Second, an accelerated internationalization of participating firms which now face global competition (see upgrading chapter). And third, an asphyxiating effect for weaker and local supply firms, in particular from the emerging markets, which will be discussed in the next chapter.

Additionally, the dynamics of competition for economies have changed. In hierarchical value chains, the role of national competitive advantages diminishes for supply firms, as it is overruled by the powerful lead firm's strategy (OECD, 2013; UNCTAD, 2013). For instance, when considering FDI projects for production location, national advantages such as low labor cost plays a decreasing role vis-à-vis the influence of the lead firm (Hertenstein, Sutherland and Anderson, 2017). While national advantages influence the MNC-buyer's strategic decisions, it plays a decreasing role

for the decision-making of the producers of intermediary goods (Dembrinski, 2009). This effect is especially strong in hierarchical value chains. The less hierarchical the value chain governance structure, the higher the direct influence of national advantages for strategic decisions of the supply firm.

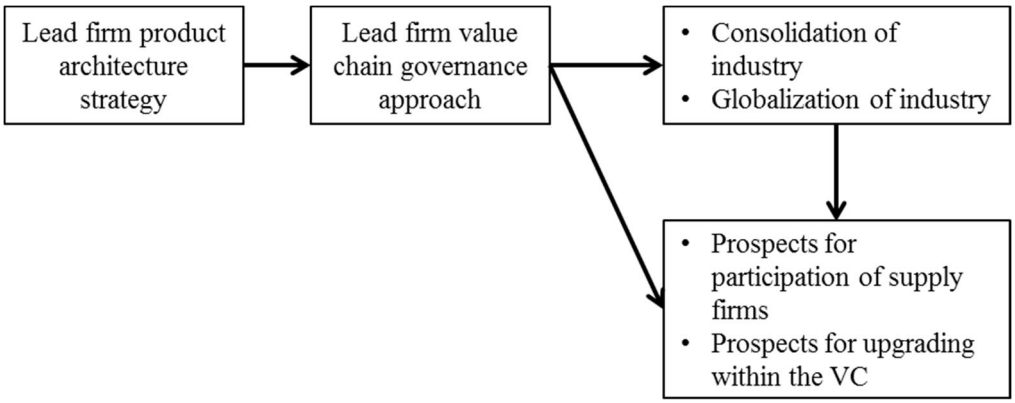
This has implications for research on the economic advantage of national economies. Some argue that the national economy as a unit of analysis is superseded by free trade agreements form regional economies that should be the new unit for analysis (Rugman and D'Cruz, 2000). Other studies focus on sub-national geographic boundaries to do justice to inner-national market differences (Thun, 2006; Dicken, 2011). Based on this research, I argue that the increasing transnational orchestrating role of MNCs necessitates a shift from political borders to discrete value chains of the leading firm in an industry as a unit of analysis to capture the dynamics of international trade, and deepen our understanding of the global market.

Part VIII: Implication for development: The challenge of emerging markets to integrate into the world economy

Through the orchestrating activities of the lead firms in GVCs, such firms have a significant influence on their supply base in each of their production hubs (Figure 31). The evolution of product architecture, the globalized purchasing strategies and the deliberate restructuring of the GVC lead to highly structured and controlled GVCs. Clear set requirements by the lead firms, as well as deliberate supplier development programs steer the future development of the local supply firms. Through its high quality standards and approval processes, Volkswagen effectively managed the participation of even tier-3 supply firms with which the company has no direct contractual relation. Through the supplier development program, Volkswagen is able to adjust and steer the capabilities in its supply base, including the allocation of activities, development and upgrading of their suppliers, expanding to new locations and the consolidation of the supply industry. Furthermore, the requirement for a global footprint increases the barriers of entry for local companies and squeezes some firms out of the value chain. This has implications for the prospects of supply firms to participate and upgrade in the global value chains, in particular for firms from the emerging markets. As seen in the Brazilian cases, the local firms with a high demand for technology were in many cases acquired by suppliers from the developed countries, while most firms with less technological products remain in Brazilian ownership. In a market environment, in which supply firms are forced to internationalize, competition is effectively globalized and not contained within a single national market – even for supply firms that have not developed an international footprint.

In this chapter I discuss the implications of the abovementioned trends in the automotive GVC for the development of emerging markets. In particular, the prospects for participating of local indigenous supply firms in GVCs are discussed. This is followed by considerations for upgrading of the supply firms in the GVC.

Figure 31: Supply base restructuring and development



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The prospects of participating in global value chains

Role of the supply firm and barriers of entry

The evolution of the product architecture has changed the requirements for participating in the value chain, and thereby the prospects of supply firms from the emerging markets to integrate in the global value chains of western MNCs. Depending on the characteristics of the product provided by the supply firm, the prospects to enter and participate in the GVC differ for new entrants.

The product characteristics determine the required capability for manufacturing and development of the supplier. Moreover, the product characteristics determine the codifiability of information required to define interfaces between components, and the requirements for knowledge exchange (Gereffi, Humphrey and Sturgeon, 2005; Sturgeon, Van Biesebroeck and Gereffi, 2008; Frederick and Gereffi, 2009). In

particular for integral product architectures, intensive information exchange between the buyer and supplier is required (Gereffi, 2001; Fujimoto, 2012). In case of extensive knowledge exchange, the supplier and buyer are involved in simultaneous development processes that is steered by the assembly firm. The value chains are tightly governed and controlled by the lead firms in the value chain (Nolan, 2001a; Gibbon, Bair and Ponte, 2008). This includes the selection of supply firms for each component, in dependence of their respective capabilities.

Analog to the strategic importance of supply firms to Volkswagen, the following groups were developed to distinguish between supply firms and their level of interaction and relevance to the buyer (Table 22). This extends the differentiation matrix by Asanuma, who differentiates between “drawings approved” and “drawings supplied” relationships between buyers and suppliers (Asanuma, 1989).

Table 22: Typology of buyer-supplier interactions

	Innovating	Developing	Produce per blueprint
Strategic relevance	▪ very high	▪ high	▪ low
Involved in R&D	▪ 4-6 years prior to SOP	▪ 2-4 years prior to SOP	▪ 1/2 - 2 year prior to SOP
Barriers of entry	▪ very high	▪ high	▪ low
Value-added	▪ very high	▪ high	▪ low
Asanuma	▪ "drawings approved"	▪ "drawings approved"	▪ "drawings supplied"
Aspects of buyer-supplier relationship	▪ Supplier "pushes" innovation to buyer ▪ Ahead of buyer in regards to innovation ▪ Own market research ▪ Market trends and future customer demand ▪ Supplier defines specifications and performance requirements	▪ Buyer "pulls" development capabilities and knowledge from supplier ▪ Core deep insights and specialized knowledge of component and development expertise ▪ Specifications and performance requirements set by the buyer	▪ Buyer utilizes production capabilities ▪ Technical drawings supplied by buyer - supplier has no advantage ▪ Tooling provided by buyer ▪ Specifications and performance requirements set by the buyer

Source: Author’s own table

Innovating supply firms are of highest strategic relevance to the buyer. They have developed own market research capabilities to detect consumer trends, enabling them to generate innovation based of future consumer demand. The innovating suppliers are thereby ahead of the buyer in terms of innovation and the development of new functionalities. The supply firm can chose a buyer, to which it presents its new products. It is thereby involved in the vehicle development process at the earliest stage, approximately four to six years before start of production. The innovating capabilities give the supply firm considerable bargaining power towards the buyer. Since new functionalities are an advantage and differentiator for the final product, the buyer has an interest to be the first assembler to bring the new function to the market. The buyer is therefore vying for such innovations from the supplier. Furthermore, as the innovation and development is located within the supplier, the supplier is in full control over the components' core development, setting the specifications and requirements independent from the buyer. This gives the supplier a large degree of independence from the buyer. On the other hand, the assembly industry is highly consolidated and consists of only few very large buyers. In this oligopsony market environment, the supplier is dependent on each buyer. Hence, the relationship between supplier and buyer is shaped by a large degree of interdependency. The integration and integrating and interaction between the two firms is based on bilateral interdependency and steering of the supply firm, even though the overall systems integration is located within the assembly firm (Principe, 2003; Tell, 2003). Barriers of entry to this group are very high. The supply firm has to develop superior innovation and development capabilities (Lall, 1990; Guo, Jiang and Yang, 2014; Teece, 2014b). Furthermore, it has to develop a high level of trust with the buyer, to be seen as a competent firm that is on par with the buyer (Menkhoff, 1992; Johanson and Vahlne, 2009).

Developing supply firms are such with own development capabilities, but no innovation capabilities. Unlike innovating supply firms, developing supply firms are more dependent on the buyer. The assembler sets the specifications and requirements for the component, and the supplier develops the component to meet the buyer's specifications. Still, developing suppliers are of strategic relevance to the buyer, and are therefore closely integrated in the value chain and governed by the lead firm in a quasi-hierarchical form. Barriers of entry are high, as the supply firms have to own development capabilities and develop trust with the buyer (Argyres and Silverman, 2004). Only the most competent firms are selected by the lead firm, as the buyer depends on the development capability of the supply firm.

Supply firms in the produce per blueprint category, on the other hand, have neither innovation nor development capabilities. They have production capabilities, and produce components that have been developed by the buyer. Firms in this group have little ownership advantage, and are of little strategic relevance to the buyer. Firms in this group mostly have sub-contracts from the buyer, and are governed by hands-off market-type price mechanisms. These firms are only loosely integrated into the value chain, are interchangeable and thereby mostly not coordinated by the lead firm. Barriers of entry are low for these supply firms.

Globalization and changing prerequisites for participation

Several tendencies have changed the requirements Volkswagen sets to its supply firms. At the center is the new vehicle platform and evolution of the product architecture. All supply firms must be able to integrate into Volkswagen's management and production system, which includes harmonization of software interfaces, participation in regular meetings, and ensuring logistic interfaces and supply chain

planning to allow just-in-time and just-in-sequence delivery. Furthermore, Volkswagen requires its innovating and developing supply firms to develop a global footprint. Production of customized components should be collocated to key production hubs of Volkswagen, with a minimum distance of 300 km, to enable seamless just-in-time delivery. To facilitate the knowledge transfer with development and innovation suppliers during the vehicle development process, R&D centers of supply firms should be located in close proximity of Volkswagen's core development center in Wolfsburg, Germany. And last, supply firms must meet the increased quality demand to mitigate risks from increased volume production of common parts. Supply firms must submit to stricter controls, including annual audits, participating in the supplier development program if necessary, and often to open book relations.

Such demands raise the barriers of entry for new companies. In particular, firms from the emerging markets struggle to meet the requirements set by the assembler. Moreover, suppliers from the advanced markets have significant advantages from their inherited proximity to production and R&D locations of the assembler, as well as early mover advantage in building a global footprint. The firms from the advanced markets have further advantages from the reduction of supply firms. By building trusting relationships over years, the firms from the advanced markets are more likely to be selected as suppliers going forward. Trust based on previous experience plays an increasing role for the buyer-supplier relationship. Only the most capable and trustworthy supply firms are selected to support Volkswagen's internationalization of production and globalization of the new platform strategy while other firms are squeezed out of the value chain. For innovating and developing supply firms, developing engineers of Volkswagen have a significant influence on supplier selection. Personal relationships build over time between engineers from Volkswagen and the

supply firm are often the decisive factor. This gives an advantage to supply firms from the advanced markets that had more time to develop close relationships, have less distance to the assembler so that developing future relationships is easier, and have further advantages from cultural conformities. Overall, suppliers from the advanced markets are more likely to meet the requirements of assembly firms, while supply firms from the emerging markets are more likely to be squeezed out of the GVC.

The integration of emerging market firms in the GVC

The findings of the research indicate that participation of supply firms from the emerging markets in the global value chains of the lead firm is often limited to relatively low-value added component supply firms. Only few supply firms from the emerging markets break into the group of high value-adding global supply firms. A notable exceptions is Yanfeng. In the case of the Brazilian firms, the intensified competition among developing and innovating supply firms in the emerging markets squeezed the local supply firms out of the market. From the cases of Brazilian firms, only the produce per blueprint firms have been able to maintain their position in the value chain.

Moreover, none of the Brazilian firms in the initial selection of case studies produces components that require very strong technological and R&D capabilities, such as anti-lock braking systems, injection systems or control units. The products with the highest technological demands are produced by international supply firms from the developed economies, such as BOSCH, Delphi or Continental. The highest technological demanding products by a Brazilian firm in our sample are engine cooling and air conditioning systems, by Metal Leve – a company that is now owned by a foreign competitor.

Only the firms with very simple products were able to maintain full control and independence. Maxion-Iochpe even actively streamlined its business towards less value-added products to stay competitive and to provide simpler products, so as to maintain its position in the value chain through downgrading.

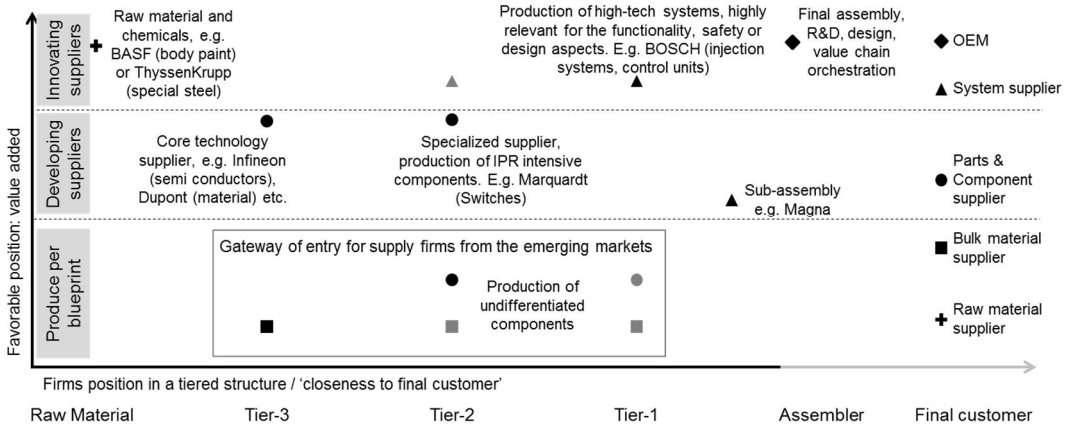
For the supply firms from China, the picture is slightly different. Some of the firms are in the group of developing supply firms. These firms have been able to maintain the position in the value chain by developing close relations to the western assemblers, often by utilizing the joint ventures. For instance, both Yanfeng and YAPP are subsidiaries of HASCO, which in turn is controlled by SAIC, one of the joint venture partners of Volkswagen in China. The selection of suppliers has to be aligned between the joint venture partners Volkswagen and SAIC. Yet, for the highest value-adding components, such as airbags, safety relevant components, or sub-systems, western supply firms dominate the market in China. Their key advantage are long-term relationships and trust with the western assemblers, superior technology and intellectual property, close proximity of R&D centers to those of western assemblers, which enables a close interaction during the simultaneous development process that further strengthens the ties between the two firms. Nevertheless, based on the good experience made with Chinese supply firms in China and their price advantage, some Chinese firms have been able to develop close relations to Volkswagen and expanded their role in the GVC as discussed in the next chapter.

In summary, there appears to be a separation of highly capable high-tech suppliers with high value added activities and companies with relatively low value added activities. While the high value added positions are occupied by western supply firms such as BOSCH, Delphi, ZF, Infineon, DuPont or BASF, participation of supply firms from the emerging markets seems to be limited to a relatively low value added

position within the value chain (Figure 32). This observation has further been strengthened by the list of top 100 supply firms and the most R&D intensive suppliers in the automotive industry, both of which are dominated by western incumbent firms.

The observation goes beyond the largest tier-1 suppliers. The strategic role of innovating and developing supply firms is not limited to tier-1 supply firms, i.e. direct suppliers. Instead, there are tier-1 suppliers that fall in all three categories, from innovating to developing and produce per blueprint suppliers. Similarly, innovating supply firms are found along the entire supply chain, from tier-1 to tier-3 and even raw material suppliers. As discussed in the governance chapter, Volkswagen is able to control the selection of strategically relevant supply firms along the entire value chain, even outside the realm of tier-1 suppliers with direct supply contracts. Therefore, the prospects for participating in the value chain do not differ for different tiers in the value chain, but is determined by the role of the supply firm as defined in the three groups of innovating, developing and produce per blueprint supply firms. Entering the GVC of western assembly firms such was Volkswagen seems to be restricted to the produce per blueprint group of supply firms. Even the most capable supply firms of this study, such as Yanfeng, began by supplying relative simple components to the assembler, and only gradually upgraded to become a developing supplier with own strong R&D capabilities. The following figure summarizes the concept and highlights the prospects for participation and gateways of entry for supply firms from the emerging markets (Figure 32).

Figure 32: Participation of emerging market firms in GVCs



Source: Author's own figure, based on field research

Approaches of lead firms to build a local supply base

If capabilities are lacking in a specific region or for a specific component, Volkswagen can effectively build up the capabilities in its supply base through the continuous support of selected supply firms. Interviewees from Volkswagen described two potential ways to build a local supply industry when entering a new market: Either, by developing and nurturing local supply firms, so that the required capabilities are being built over time. Or, by collocating existing supply firms from other locations. As several interviewees from Volkswagen, BOSCH and Continental expressed, the option to collocate existing supply firms is mostly preferred, as it brings several advantages. First, the number of global suppliers is kept low – one of the objectives of the global purchasing strategies. Second, by collocating existing supply firms, most of the responsibility to meet the requirements of the assembler lies with the supply firm. The existing supplier is aware and experienced in achieving quality standards, knows the required management, production and supply chain standards, and has an experienced team that can ensure the standards are met in the new location. When nurturing new supply firms, on the other hand, the assembler is involved in lengthy supplier development programs to reach the necessary requirements. And finally, the process of

collocating existing suppliers is significantly faster than nurturing new supply firms. "Collocating supply firms takes one to two years to reach the full volume. If we help local supply firms, it takes years to develop them… Based on our experience, it is usually between six and eight years, until the supplier finally meets our requirements. And then we still need to build up capacity" (Interview, Volkswagen case). The prospect for participation of new entrants is thereby dependent on Volkswagen's strategic need to establish new supply firms.

The role of national champions

Large developing economies have long used the automotive industry as a driver for economic and industrial development (Dicken 2010: 332), Brazil and China are no exception to that (Shapiro, 1994; Thun, 2006). The automotive industry acts as a pillar industry that can transform a nation's economy. Not only does it create rents and direct jobs in the industry, but also spillover effects to other industries, from a trained manufacturing workforce, increased knowledge base, and industrial base, to large demands in steel, rubber and oil, to mention just some of the spillover effects a working car industry can have on an economy (Shapiro, 1994).

In the past, the emergence of new large scale production hubs in late industrializing economies took place with a parallel rise of a new 'national champion' in the form of new rising global players: Both, the rise of Japan's auto industry as well as the South Korean industry brought forth giant firms such as Toyota and Hyundai, which are today amongst the top 4 largest firms worldwide and at eyes-length with US and German firms (Amsden, 1989; Kimura, 2006; OICA, 2013). The rise of the Chinese and Brazilian industry, however, looks vastly different. China is only slowly able to create a 'national champion' in the form of a leading and world-class large

multinational enterprise that could compete in the global industry (Sutherland, 2003; Nolan, 2012, 2014). It appears that both countries have become centrepieces in the global strategies of the leading firms, and have been deeply penetrated by global value chains that are controlled by foreign owned firms (Dicken, 2011; OECD, 2012). As Chang argues, such dominance of foreign owned firms can lead to a loss and slow economic development as the foreign owned MNC shows little interest in re-investing rents into the target market (Chang, 2004). Therefore, the creation of national champions has long been viewed as the way to go for emerging markets in the development studies literature. Thun even claims that "*by definition*, a 'late' developing nation confronts the challenge of creating [such] strong and independent firms..." (Thun, 2006: 3, emphasis added). Most of the research on China's automotive industry, like Thun (2006), Liu and Zhao (2006), Ramasamy (2011) and Hang et al. (2011), focused on the creation of indigenous independent firms. The aim of the so-called 'national champions' is to become strong enough to compete with the established foreign transnational firms to eventually become global players themselves. As Gerschenkron (1962) points out, there are certain advantages for late-coming firms, as they can learn from the success and failures of the preceding companies. Moreover, new entrants can incorporate the latest technology and thereby leapfrog certain stages of development (Luo and Tung, 2007). For more on the argument of late-comer advantages, see (Young, Huang and McDermott, 1996; Khanna and Palepu, 2006; Mathews, 2006).

However, the creation of 'national champions' is not without debate. Especially in the automotive industry, there is some debate as to whether or not the concept of a 'national automotive industry' still holds valid in today's globalized environment. As the case of Brazil demonstrates, there are clearly different paths for a successful

development of a national industry, such as “dependent industrialization” (Kim & Lee 1994: 284). Dicken even goes so far as to describe the “concept of ‘national’ automobile industries virtually meaningless”, due to the highly transnational nature of the industry (Dicken 2011: 333).

This research highlights the importance of own ‘national champions’ at the assembly level to build a supply base comprised of indigenous firms. The most successful cases in this study, Yanfeng, YAPP and Fuyao, all had close ties to the indigenous assemblers at the early stages of their development. The ties to the assemblers helped the firms to build up capabilities, develop ties with foreign assemblers and eventually internationalize to become globally competitive. As described in the chapter above, if such ties cannot be developed in the absence of national champions, foreign assemblers are inclined to develop a local supply base by collocating existing supply firms from their home market – which can lead to an eradication of the local indigenous industry, as in the case of Brazil.

Prospects of upgrading in global value chains

Once a firm has entered the network of a lead firm and participates in the value chain, the firm can try to upgrade to do more profitable activities in the value chain (Humphrey and Memedovic, 2003; Mei, 2008; McDermott and Corredoira, 2010). In particular for firms from the emerging markets that enter the value chain at a relatively low-value-added position, upgrading is key to establish a sustainable long-term relation to the assembler and capture higher value-added activities by becoming a developing or innovating firm (Ponte *et al.*, 2014). The following chapters analyze the prospects for upgrading of supply firms in the emerging markets, drawing on the observations from the case study sample.

The concept of value chain upgrading

In the value chain context, upgrading refers to the process of capability building that enables the firm to produce better products, increase its efficiency and productivity, or more into more skilled activities to create more value (Kaplinsky and Morris, 2000; Humphrey and Schmitz, 2001; Gereffi and Fernandez-Stark, 2011). A commonly used typology of upgrading differentiates between four ways of upgrading (Schmitz and Humphrey, 2000):

(1) *process upgrading*, by increasing the productivity through process efficiency. This can involve processes within individual firms as well as inter-firm processes at the interface between two firms in a value chain. Process upgrading can be achieved by reorganizing the production system, or by establishing better processing and production technologies (Schmitz, 1999). (2) *product upgrading* refers to the ability to offer additional products or services, thereby moving to more sophisticated and profitable segments in the value chain. This can be achieved through innovation and fast product updates, including innovative product development processes (Gereffi, 1999). (3) *functional upgrading* refers to a fundamental functional change in the value chain. For instance, a supply firm can upgrade from manufacturing to designing and developing products (Bair and Gereffi, 2001). Other examples are expanding the function within the value chain, such as providing the same products or services to a wider extent within the value chain, or upgrade from component supplier to system supplier by adding assembly and orchestrating functions to the product capabilities. (4) *chain or inter-sectorial upgrading* refers to supply firms that moves to a new value chain either by providing the same activities and functions to a new lead firm in the same industry, or by applying the capabilities in the new, potentially more profitable sector (Humphrey and Schmitz, 2002; Giuliani, Pietrobelli and Rabellotti, 2005).

The role of lead firms for upgrading: Supplier development programs

It has been observed that large global buyers facilitate the upgrading process of local firms in the emerging markets in the manufacturing industries (Gereffi, 1999; Schmitz and Humphrey, 2000; Bair and Gereffi, 2001; Bazan and Navas-Aleman, 2004; Giuliani, Pietrobelli and Rabellotti, 2005). Multiple studies have documented links between value chain governance and upgrading (Gereffi, 1999; Schmitz and Humphrey, 2000; Giuliani, Pietrobelli and Rabellotti, 2005). Lead firm orchestration and coordination of global value chains include the allocation of activities within the value chain (i.e. selecting and allocating activities to capable supply firms), developing and enabling supply firms for technological upgrades (Giuliani, Pietrobelli and Rabellotti, 2005), collaborative expansion to new (international) production hubs (i.e. location choice for FDI) (Hertenstein, Sutherland and Anderson, 2017), and restructuring and consolidating the supply chain (Nolan, Zhang and Chunhang, 2007). Consequently, the upgrading prospects of participating supply firms depends to a large extend on the lead firms' orchestrating activities. Supply firm development often occurs in the emerging markets, in which some of the supply firms lack in quality controls and production process standards to deliver the components to the requirements at a low price. Lead firms may choose to assist the supply firm, because they rely on the competencies of their suppliers, and feel "obliged to assist them in improving products and processes" (Giuliani et al. 2005: 562).

Of the four value chain upgrading types, process upgrading and functional upgrading are often steered and facilitated by the orchestrating lead firm. The lead firm supports the supply firm to increase process efficiency, or allocates new activities and responsibilities to the supply firm, e.g. by handing over one sub-system assembly and orchestrating activities of the upstream value chain to a systems-integrating supply firm in order to modularize the overall product architecture.

Product upgrading and chain- or inter-sectorial upgrading, on the other hand, are rarely influenced by the lead firm. Chain- and inter-sectoral upgrading occurs outside the lead firm's value chain, where the lead firm's influence is limited. Product upgrading is mostly based on internal R&D efforts and innovation capabilities based within the supply firm, to enhance the product performance and functionality (Brandt and Thun, 2010). However, even for product upgrading, lead firms can facilitate the supply firm's development, during the simultaneous development process of new vehicles.

In the case studies of supply firms from Brazil and China, the firms were able to upgrade products, processes and functions. The majority of the case firms were actively incentivized by Volkswagen to expand their activities within the GVC by collocating new production locations in additional markets and globalize production to become a global supplier for their respective component. This is a form of functional upgrading that was facilitated by Volkswagen. Process upgrading was also widely observed in the case studies. Through Volkswagen's supplier development program, Volkswagen installed efficient logistics, supply chain and management capabilities within the supply firms, and offered production process consultancy to the supply firms, in order to increase efficiency. The facilitation of upgrading was not limited to functional and process upgrading, but even included product upgrading in rare cases. In the case of Fuyao, a Chinese glass manufacturer, Volkswagen encouraged the merger with a German specialized firm that provides the glue between the glass and the vehicle body. Through the merger, Fuyao was able to apply the glue on the windows before delivery, thereby upgrading its product and performing a sub-assembly activity. The product was upgraded through merger that was initiated by Volkswagen. Hence, product upgrading can be achieved through M&A aiming at portfolio optimization by

acquiring firms with additional or complementary products. Else, product upgrading can be achieved through innovation capabilities, by upgrading the performance or function of a product through internal R&D.

Upgrading can also indirectly be facilitated by lead firms. Firms with products of medium strategic importance to the assembler were required to establish Technical Assistance Agreements with foreign competitors. Even though these firms were able to maintain Brazilian ownership, such agreements limit their future development in several ways. Through such co-competitive relationships, the indigenous Brazilian firms are limited in their regional reach and internationalization aspirations to the Latin American market, serving as production service providers for their international competitors and paying high licensing fees for the technology of the foreign partner. Moreover, as evident in the case of Arteb and Hella, such relationships are asymmetric and often instable, ending either in a takeover by the foreign partner or by terminating the licensing agreement, after which the local supply firm is left where it was before.

Geographical upgrading in the global value chain

This following argument has been published in a similar form in Hertenstein et al., 2017.

While many indigenous supply firms from the emerging economies may be able to successfully supply domestically, many lead firms require their supply firms to develop an international footprint so as to supply globally to the different production locations of their customer. This has been a growing trend for the supply firms in the manufacturing sector, as lead-firms introduce global standards for their components, simplify the supply chain by reducing the number of supply firms, and set global standards for the supply firms' product and process requirements (Schlie and Yip, 2000;

McCann and Kim, 2008; Morris and Barnes, 2008). The easiest way to achieve their objective is to build a supply base of the same supply firms at all production hubs. As a result, supply firms in the automotive industry are under immense pressure to internationalize and to serve their customers globally. This has led to a rapid internationalization of the local supply firms in the emerging markets that successfully entered the GVC of Volkswagen (Hertenstein, Sutherland and Anderson, 2017).

The rise of the emerging market multinational corporation and the increase in outward FDI from the emerging markets has somewhat puzzled academics, as firms from the emerging markets are expected to lack the firm specific advantages that are prerequisites to internationalize (Child and Rodriguez, 2005; Cuervo-Cazurra, 2012; Ramamurti, 2012). The core puzzles in the debate are the accelerated internationalization of emerging market firms, i.e. outward FDI at early stages of the firms development, the choice of location of foreign investments into psychic distant mature markets, and the fact that some emerging market firms seemingly internationalize without the firms specific advantages of superior technologies or brand awareness that are prerequisites in international business theory (Buckley and Casson, 1976; Johanson and Vahlne, 1977; Hennart, 1982; Dunning, 1994). What is overseen by mainstream international business theory, is the role that lead-firms of global value chains can play in actively nurturing and developing supply firms, including their internationalization process (Gereffi and Korzeniewicz, 1994; Buckley and Ghauri, 2004; Sturgeon, 2008; Buckley, 2009a; Dicken, 2011).

Recent studies have emphasized the important role that business networks play for the internationalization (Johanson and Vahlne, 2009; OECD, 2012; Meyer and Thaijongrak, 2013; UNCTAD, 2013; Hertenstein, Sutherland and Anderson, 2017). Mathews (2006), for example, in developing the link, leverage, and learn (LLL)

framework, noted the vital role of prior network relationships in East Asia: “Many of the most successful latecomers from the Asia Pacific have begun their international career as a contractor to an incumbent MNC and then been drawn by this MNC to supply its regional operations across regional borders” (Mathews 2006: 22).

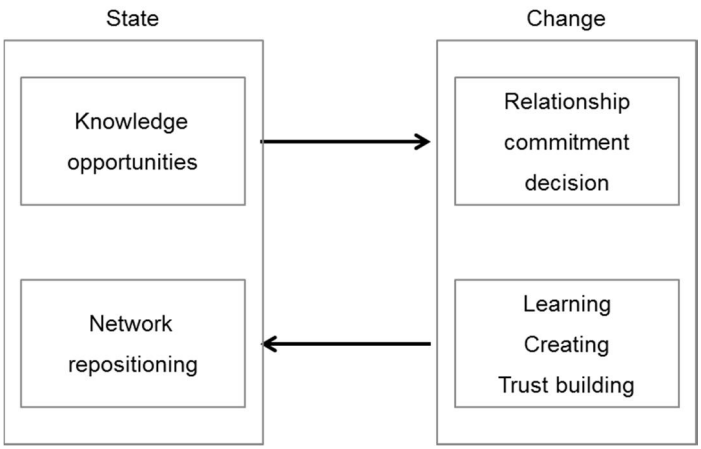
According to Johanson and Vahlne, participating and committing to business networks has become a “condition for successful business development” (2009: 1415) The updated internationalization process model emphasizes the vital role played by business networks (including international and domestic networks) in driving FDI (Johanson and Vahlne, 2009; Vahlne and Johanson, 2013). Through the lens of the GVC framework, I argue that inter-firm relations offer explanatory power as to how and why some emerging market firms can successfully internationalize, despite lacking some core firm specific advantages (such as technologies, brands). Further, I argue that they are indeed under huge pressure to internationalize if they are to maintain their position in the automotive supply industry, and that a rapid internationalization has become a requirement for many auto supply firms to participate in the global automotive value chain.

The internationalization process model by Johanson and Vahlne offers a framework to explain the dynamic relationship between supplier and lead-firm in the joint internationalization and upgrading efforts (Johanson and Vahlne, 2009). The process model describes how firms deal with uncertainty they face in a new market. The uncertainty from a foreign location can be mitigated through relationships to large MNCs that already operate in the new market. The supplier can learn from that network. In the original model, the firm would gradually learn and commit to a new market (Johanson and Vahlne, 1977). In the revamped model, such learning and committing to reduce uncertainty and increase learning is between the firm and the business network

(i.e. lead firm) (Johanson and Vahlne, 2009). Firms must learn to "create or strengthen relationships in order to exploit opportunities" from within such networks (Johanson & Vahlne, 2009: 1423).

In the internationalization process model knowledge and opportunity lead to commitment decisions, which in turn may change the quality of the relationship, leading to further trust, so enhancing the network position of the firm. This can then lead to new knowledge opportunities (Figure 33). Indeed, initially knowledge opportunities come from "insidership" in networks. According to Johanson and Vahlne (2009) exclusion from a relevant network, more so than "psychic distance," has become "the root of uncertainty" for businesses today (Johanson & Vahlne, 2009: 1412). Business network "insidership," in short, is considered crucial for internationalization to take place.

Figure 33: The internationalization process model



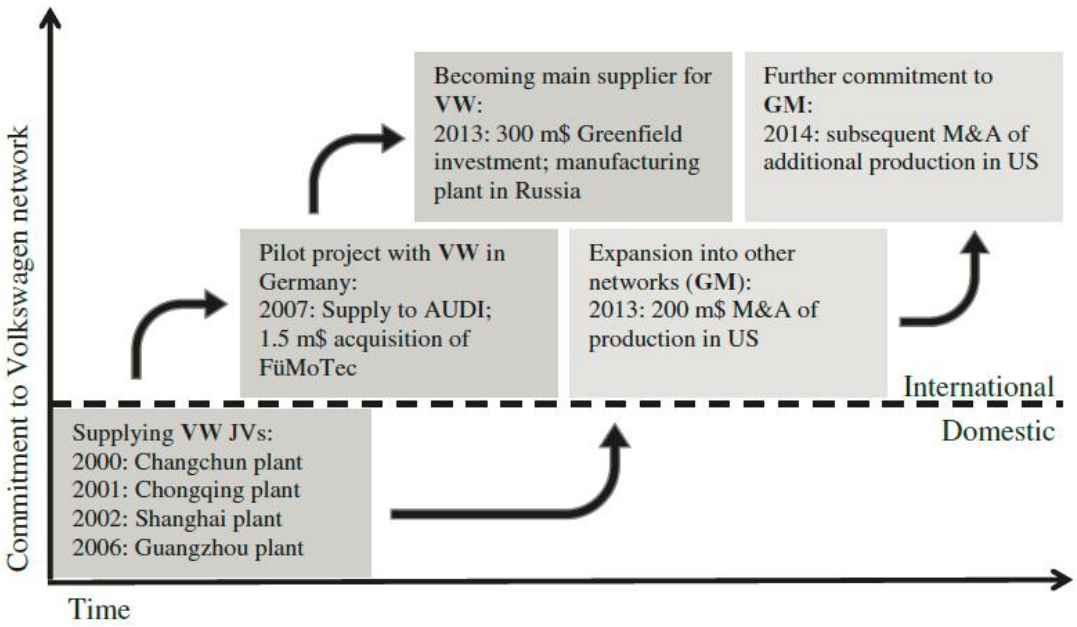
Source: Hertenstein et al., 2017

The GVC framework can extend the network based internationalization process model, by inducing the idea of asymmetric power relations and the role of dominant lead firms in a value chain (Hertenstein, Sutherland and Anderson, 2017). By adding

the notion of asymmetric power relations and hybrid forms of governance, the global value chain perspective can shed further light on the question how and why firms from the emerging markets, lacking firm specific advantages, can become multinational. The lead firms are actively involved in globalizing their supply base by incentivizing their supply firms to internationalize. These new entrants have the opportunity to establish strong relationships with the foreign firms in the home market and utilize these in order to expand within the value chains of the large incumbent firms.

Through supplier development programs, the lead firm can provide technical support, and through long-term contracts with the new production site, the lead firm can mitigate the risk associated with the investment of the supply firm. Figure 34 exemplifies a typical trajectory of internationalization within a GVC.

Figure 34: Fuyao's upgrading within the GVC



Source: Hertenstein et al., 2017

The downside of lead-firm facilitation for upgrading

While lead firm facilitation can be a good source for upgrading, there are limits to the degree of upgrading through such orchestrated activities. Due to efforts to reduce the number of supply firms, only few supply firms are nominated to create intensified ties with the assembly firm through assistance and co-development programs. The selected supply firms are under a huge pressure to internationalize to supply the standardized component globally. Rather than assisting a multitude of local supply firms for locally adapted components, Volkswagen can now assist a few globally active supply firms. Incentivizing strong and efficient supply firms with superior capabilities to co-localize in consistency to the manufacturing hubs is more economical, as it involves less purchase complexities, quality controls, process synchronization and fewer interfaces for tacit knowledge transfers. Transferring all the required tacit knowledge to enable a new production location to produce to the satisfaction of the buyer is now in the responsibility of the supply firm, and not the buyer. Only a handful of capable supply firms are selected for activity upgrading, i.e. processes of sub-assembled modules at the supply firm. Still, most supply firms receive some basic facilitation for process and product upgrading. However, the question remains how sustainable such upgrading paths are for the supply firm.

The strong role of the lead firm in the supply firm's upgrading limits the ability of independent upgrading of the supply firm. The process of upgrading is a capability building process and in itself a capability. Traditionally, research emphasized capabilities such as leading-edge technology or better access to the market through superior marketing and branding. Traditional capabilities are an important source for competitive advantage. However, for firms to sustain their competitive advantage, dynamic capabilities are required (Teece and Pisano, 1994). Dynamic capabilities can be understood as a higher order of capabilities, or as dynamic capabilities enable firms

to create new traditional capabilities through adaptation and innovation (Collis, 1994; Zollo and Winter, 2002; Teece, 2014b). This is necessary to ensure sustainable superior performance, especially in changing environments with constant technological updates (Teece, 2014b).

When lead-firms facilitate upgrading, the innovation and new technologies that lead to the upgrading are based on the dynamic capabilities embedded in the lead firm, not the supply firm. Hence, while technology is updated, the process of innovating to upgrade, a second order capability, lies outside the firm. The workforce may be trained in understanding and using the new technology and processes, but it is not trained to detect inefficiencies or to further develop new technology or processes. This is critical, as it leaves the "upgraded" firm dependent on the innovating lead-firm. Similar to the situation in Technical Assistance Agreements, the firm is able to increase its productivity (process upgrading), or introduce new products based on leading-edge technologies (product upgrading), the but remains dependent on the partner firm and is not able to create long-term sustainable advantages through upgrading.

Conclusion

This research project was conducted at a pivotal moment in the development of the automotive industry. After over 100 years of dominance of the internal combustion engine as the industry's core technology, unprecedented technological changes lie ahead. This thesis encapsulates the competitive dynamics, the structure of the value chain and the governance mechanics that matured over time and were developed and refined in more than 100 years of the industry. As the automotive industry is often at the forefront of developments in the economy, its current state may very well represent a peak in the development of conscious industrial restructuring and the evolving forms of governance.

In the upcoming years, the automotive industry will be shaken and changed by rapid technological changes. New technologies like the electrification of the powertrain or the advancements in autonomous driving based on intelligent systems with self-learning algorithms revolutionize the automobile and disrupt the industry. Some of the highest value-adding components of the past may be rendered obsolete if future technologies replace current technology. Some of the industry's most dominant and successful firms that owe their success to technologies relevant for the internal combustion engine may vanish, while new entrants with capabilities relevant for the new technologies will emerge to claim powerful positions in the automotive value chain. Formerly unrelated industries will converge with the automotive industry. This can already be seen, as large players from the ICT sector such as Alphabet or Amazon make advances into the automotive sector, by developing systems for automated driving, connected vehicles, and future entertainment systems. New ventures are rapidly emerging to create new technologies, like Tesla revolutionizing the powertrain, or Uber, which collecting key data relevant for driverless vehicles. Existing firms, like

BOSCH, react by reorganizing their business to focus on future technologies, carving out old technologies like the starter motor business that BOSCH sold in 2017. But the prevalence of new technologies is uncertain, and the future of the industry unknown.

While the structure of the industry, its key players, and the structure of the global value chain may change, the underlying principles and theory developed in this thesis are likely to be unaffected. The theory of governance developed in this thesis is based on the literature on product architecture and transaction cost theory, two streams of literature that have been used to explain dynamics observed in many different industries. The insights from this thesis may even become more relevant for the turbulent time that lies ahead. Understanding and effectively implementing the new forms of governance is arguably even more critical in times of uncertainty. Recognizing the relationship between product architecture (including the characteristics of components and systems) and dynamics of inter-firm relations help opt for optimum governance. This can enable firms to efficiently select the right strategic partners for joint R&D and strategic alignment, to gain insights and learn from the developed business networks, and become more agile and resilient against disruptive technologies. Lead firms that are effective orchestrators have developed the ability to identify core components, technologies and firms in the vast outstretches of the automotive value chain – a capability that can be transferred to identify future technologies and opportunities at an early stage, and react appropriately.

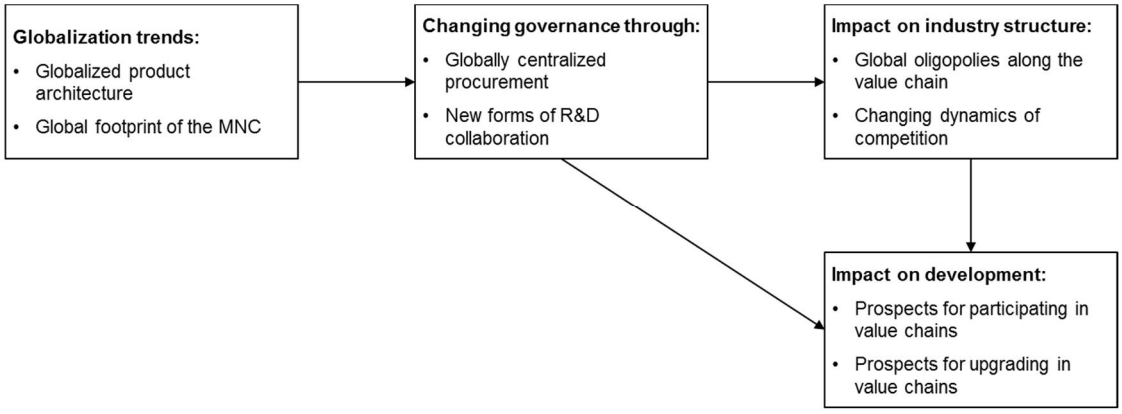
Furthermore, while the disruptive forces undoubtedly change some of the internal dynamics in the industry, other trends like the increasing power asymmetries in the value chain remain unaffected. This research shows how the ongoing global business revolution has changed the organization of economic activity and the nature of the firm (Coase, 1937, 1990; Chandler, 1977; Nolan, 2001a). The global business

revolution entails the restructuring of economic activities through fine-slicing of tasks, the reconfiguration of production the globalization of economic activity, including the internationalization of big business, and the liberalization of trade and capital flows and the privatization of industries. This converged with the evolution of product architecture that increased interdependencies between firms and requires new forms of cooperation in simultaneous development processes. These trends have triggered a reorganization of the firm, with new approaches to governance emerging. The "visible hand" as postulated by Chandler (1977) has globalized through the internationalization of big business and the emergence of the MNC as a dominant force in shaping international economic activity (Milberg and Winkler, 2013; OECD, 2013; UNCTAD, 2013). The dynamics of inter-firm relations between large and powerful MNCs and participants in their value chains have changed (Gibbon, Bair and Ponte, 2008; Milberg and Winkler, 2013; WTO, 2013). The existing theory on governance needs to be adapted to explain the new forms of governance (Williamson, 1979, 1996, 2002; Casson, 1987; Gereffi, Humphrey and Sturgeon, 2005). The observed deep value chain orchestration beyond the realm of direct suppliers requires a theory that is not build on the contractual relations of firms. By inducing the concept of power asymmetries, the theory of governance is extended.

Furthermore, this research describes how the evolution of product architecture enables MNCs to restructure their global operations in a way that leads to a restructuring of the global industry. By reorganizing their production and governance activities, large MNCs in the automotive industry reshape the supply base and build oligopolies along the value chain. The particular set of policies in their governance strategies leads to an oligopolistic equilibrium in the upstream supply components industry. By globalizing the product architecture and procurement, the MNCs

harmonize the global market for intermediary goods. This merges multiple markets into a global market following the footprint of the MNC that has a different set of properties compared to contemporary markets. The new nature of the market for intermediary goods changes the dynamics of competition between supply firms, as regionally separated firms face direct competition from one another. The new structure of economic activity in orchestrated value chains further influences the integration of emerging markets into the world economy and the prospects of firms from the emerging markets for participating and upgrading in such value chains (Morris and Barnes, 2008; Rugman and Doh, 2008; Buckley, 2009b) (Figure 35).

Figure 35: The restructuring of economic activity



Source: Author's own figure

The findings and results of this paper are important for policy makers and practitioners alike. The research analyzed the gateways of entry to participating in GVC for firms from the emerging markets, and how they can upgrade and internationalize within the GVC by utilizing the relationships with the foreign firms that they have established in their home market. Understanding the inter-firm dynamics between buyer and supplier for integral systems has important implications for the ability of

firms from the emerging markets to create own R&D capabilities and ultimately firm specific advantages, to become truly competitive in the global economy.

Can firms from the emerging markets catch-up?

Despite the increased outward FDI from emerging markets since the early 2000s, which indicates a rapid catch-up of firms from the emerging markets and the theories that support the assumed rapid catch-up via cross-border asset-seeking M&A (Luo and Tung, 2007), the evidence from this study suggests that the prospect of firms from the emerging markets to catch up with leading western MNCs are rather bleak. Only those firms with relatively low technological requirements, unspecified products and little R&D capabilities can become deeply integrated into the GVC that have been established by western firms. Yet, those are the qualities necessary to create the firm specific advantages that these firms so desperately need in order to compete in a globalized economy. From the case studies in this study, some of the firms that had become international had previously downgraded their value chain position, in order to become competitive in a selected core activity. The prospects for upgrading within the GVC of western firms appears to be limited to the development activities of the lead firm. The process of upgrading through such support of the lead firm limits the firm's ability to build own dynamics capabilities that are required for further independent upgrading (Teece and Pisano, 1994; Eisenhardt and Martin, 2000; Zollo and Winter, 2002). While a rapid internationalization within the GVC is indeed possible and can be explained from the theory (Hertenstein, Sutherland and Anderson, 2017), a further upgrading in the value chain appears to be a rather lengthy process. The ability to 'leapfrog' and jumps ahead in regards to upgrading, as suggested by some theories to be the norm for MNCs from the emerging markets, has only been observed in very rare

cases, such as Yanfeng (Luo and Tung, 2007). In summary, rather than a rapid catch-up of firms from the emerging markets as postulated by many scholars (Mathews, 2006; Luo and Tung, 2007; He and Lyles, 2008)

Contribution to literature

This dissertation contributes to several streams of research and theory. First, it extends the economic theory of governance beyond the contractual realm (Williamson, 1979; Casson, 1986a), by developing a theory based on firm power and deep value chain orchestration beyond the immediate direct suppliers. Dynamics of inter-firm relations and the mechanics of governance in such non-contractual relations in the GVC are discussed and developed. Furthermore, it highlights the role of product characteristics and product architecture for the choice of governance form.

Second, the concept of power in GVC is extended (Gereffi, Humphrey and Sturgeon, 2005; Ponte, 2014), by developing a framework that defines power as relative based on the firms directly involved in the transaction, rather than a vague notion of power allocated to a firm. This allows to explain the relative powerful position of small firms and niche players that control a small, yet necessary and non-substitutional part of the value chain.

Third, this research extends the mechanism of the 'cascade effect' (Nolan, Zhang and Liu, 2007) and conceptualizes the development of oligopolistic equilibrium along the integrational global value chain, based on deep value chain orchestration and deliberate supply base restructuring through the lead firm.

Fourth, the dissertation highlights how the internal process adaptation in large MNC influence the global economic structure by globalizing the "visible hand" of organized economic activity in hierarchical value chains (Chandler, 1977; Ruigrok and

van Tulder, 1995). In particular, it shows how the product architecture evolution of globalized MNCs change the nature of the market.

Fifth, the case study analysis contributes to the literature on the internationalization of the firm and the MNC, by highlighting the orchestrating role that lead firms play for the internationalization of supply firms (Buckley and Casson, 1976; Dunning, 1994; Johanson and Vahlne, 2009).

Sixth, the findings contribute to the body of literature on development studies, by assessing the implications of the trends in the globalized economy on the development of firms from the emerging markets (Gerschenkron, 1962; Nolan, 2014). In particular, the prospects for participating and upgrading of firms from the emerging markets in the GVC of western MNCs are analyzed and discussed.

Finally, this research exemplifies the value of in-depth case study research in the field of economics, by highlighting findings of inter-firm process evolution that are difficult to capture with quantitative methods (Strauss, 1987). Such research enables to analyze the role of a single firm in restructuring the global economy, while most quantitative methods use large samples.

Future research

This thesis is based on a case study approach. Future research is required to test the generalizability of the findings and propositions made in this research project, and its relevance outside the automotive industry. The theory proposed in this thesis needs to be tested and further developed. In light of the governance based on power, a deeper understanding should be developed for the concept of power. Concepts of governance types and structures can be drawn from further findings. Moreover, due to the disruptive forces that are currently at work in the industry, additional research is needed to capture

the dynamics of governance and its implications for adapting the business models during times of uncertainty and technological change.

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