2013

MODULARIZATION (MD) AND ITS IMPACT ON THE CHINESE AUTO INDUSTRY

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by
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A DISSERTATION

Submitted to
H. Wayne Huizenga School of Business and Entrepreneurship
Nova Southeastern University

in partial fulfillment of the requirements
for the degree of

DOCTOR OF BUSINESS ADMINISTRATION

2013

A Dissertation
Entitled

Modularization (MD) and Its Impact on the Chinese Auto Industry

By

Yunshan Lian

We hereby certify that this Dissertation submitted by Yunshan Lian conforms to acceptable standards, and as such is fully adequate in scope and quality. It is therefore approved as the fulfillment of the Dissertation requirements for the Degree of Doctor of Business Administration.

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Nova Southeastern University
2013

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ABSTRACT

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Modularization (MD) in the auto industry is relatively new when compared to its use in other industrial areas. It is regarded as the third revolution in the history of the auto industry after Henry Ford's assembly line production system and Toyota's JIT (just in time) management. Modularization brought a major reorganization to the automotive parts supplier industry by realizing the firm's strategic positional advantage through mass customization While academic interest in this area also experienced significant growth in recent years, few empirical studies have been conducted because it is a difficult task to operationalize the multi-faceted, complex modularization.

Although modularization has become a global trend in the auto industry, studies show that different characteristics of modularization are exhibited in various international automobile markets. China has been recognized as the largest car market and manufacturer in the world in recent times, yet the industrial structure is quite different from leading countries such as the U.S. and Japan. More than sixty percent of the vehicles in China are produced under foreign brands by joint venture factories.

Despite the importance and uniqueness of the Chinese auto market, only a few conceptual scholarly works have been conducted touching on the concept of modularization. This means that there is not a deep understanding of this topic as it exists in the Chinese auto market. To emphasize, no literature was found among the existing works about the cultural impact on modularization and its outcomes in China.

The purpose of this study is to fill in such a gap with an empirical analysis on the impact of modularization on the auto industry in China. Guanxi as a unique cultural phenomenon in China is covered in this study. Internalization theory, transaction cost economics, the knowledge based view of the firm, and the OLI model is reviewed as a base for the study.

In practice, this study will help managers in the auto industry make a more scientific decision of whether and how they should go into modularization, especially in the Chinese market. It is also helpful for automakers like GM and Ford who have an ambitious parts procurement plan from China to have a better understanding of the Chinese auto industry.

ACKNOWLEDGEMENTS

I feel God's love through each and every stage of my life, and I immensely thank God Almighty for His blessing.

I sincerely acknowledge the support from all of the people who gave me the strength, endurance, and confidence to complete this dissertation.

I am so thankful to my dissertation committee, Dr. Belay Seyoum, Dr. Ruth Clarke, and Dr. Randi L. Sims for their time, direction, advice, and assistance not only for my research, but for my entire academic life.

To the doctoral program chair, Dr. Suri Weisfeld-Spolter, I appreciate her inspiration and thoughtful guidance from beginning to end.

I am deeply indebted to Dr. Ramdas Chandra for his kind help which has been essential to attain my doctoral degree. I am full of gratitude for the voluntary assistance from Dr. Terrell Manyak and Dr. Lore Ayoub who did the proofreading of my dissertation.

To my respectful professors, Dr. Michael Bendixen and Dr. Cynthia Ruppel, I am appreciative for their advice and care in all these years. I am honored to be able to work together with them.

I am deeply thankful to all my family members and friends for their unconditional love and support. They are the resources of my strength as a warrior.

To all my dear colleagues and professors of H. Wayne Huizenga School of Business and Entrepreneurship, Fran Parker, Kathleen Cool, Dr. Albert Williams, Dr. Bahaudin Mujtaba, Dr. Baiyun Gong, Dr. Barry Barnes, Dr. Michael Hoffman, Dr. Thomas Griffin, Dr. Thomas Tworoger and Dean J. Preston Jones, I cherish their warm hands that they offered to me without any hesitation whenever I am in need. I love them all!

I close my acknowledgements with this quote, "You need to persevere so that when you have done the will of God, you will receive what he has promised" (Hebrews. 10:36 New International Version).

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Chapter I

Introduction

Background

Modularization (MD) in the auto industry is relatively new when compared to its application in other industrial areas. It is regarded as the third revolution in the history of the auto industry after Henry Ford's assembly line production system and Toyota's JIT (just in time) management (Collins, Bechler, & Pires, 1997; Sako, 2003). Modularization brought a major reorganization to the automotive parts supplier industry by realizing a firm's strategic positional advantage through mass customization (Pine II, 1993; Pine II, Bart, & Andrew, 1993; Ro, Liker, & Fixson, 2007) . As Starr (1965) suggested a half-century ago, it can be summarized as "a developing capacity to design and manufacture parts which can be combined in the maximum number of ways" (p. 165). While academic interest in this area also experienced significant growth in recent years, few empirical studies have been conducted because it is a difficult task to operationalize the multi-faceted, complex modularization (Fixson, 2003; Hoetker, 2006; Sako, 2003; Salvador, 2007).

Volkswagen and Mercedes-Benz initiated the strategy of modularization in the mid-1990s in Brazil by separating their products into modules. These modules were produced by designated suppliers in Brazil and shipped directly to the automakers' assembly lines in Brazil. For example, several modules (chassis, suspension, engine) were produced as complete units with more than one individual feature, and supplied to the automakers from different module suppliers (Parente, 2003; Pires, 1998; Ro, et al., 2007; Salerno, 2001; Starr, 2010; Takeishi & Fujimoto, 2001).

Eventually, the strategy of modularization was widely adopted by GM, Ford and other automakers worldwide due to the advantages of low cost, high variety, and speedy delivery (Ro, et al., 2007; Takeishi & Fujimoto, 2001; Veloso, 2000). In general, no clear boundaries exist for a module due to the significant differences between various car models (Sako, 2003). The definition of modularization is also unsettled throughout the literature (Fixson, 2003). Baldwin and Clark's (1997) definition seems to be the popular one: "Building up a complex product or process from smaller subsystems that can be designed independently yet functions together as a whole" (p, 84) (Doran, 2004; Kotabe, Parente, & Murray, 2007; Lin, Zhou, Shi, & Ma, 2009). This description emphasizes the attribute of module as "exhibiting relatively weak interdependencies between each other and relatively strong interdependencies within them" (Fixson, 2003, p. 12).In the auto industry, modularization means that automakers are delegating modules with a bundle of more complex functions to parts suppliers. Thus, modularization is a different concept from outsourcing, yet it could be one way of outsourcing: outsourcing modules instead of basic components or subassemblies. Figure 1 is a basic structure of the supply chain in the auto industry.

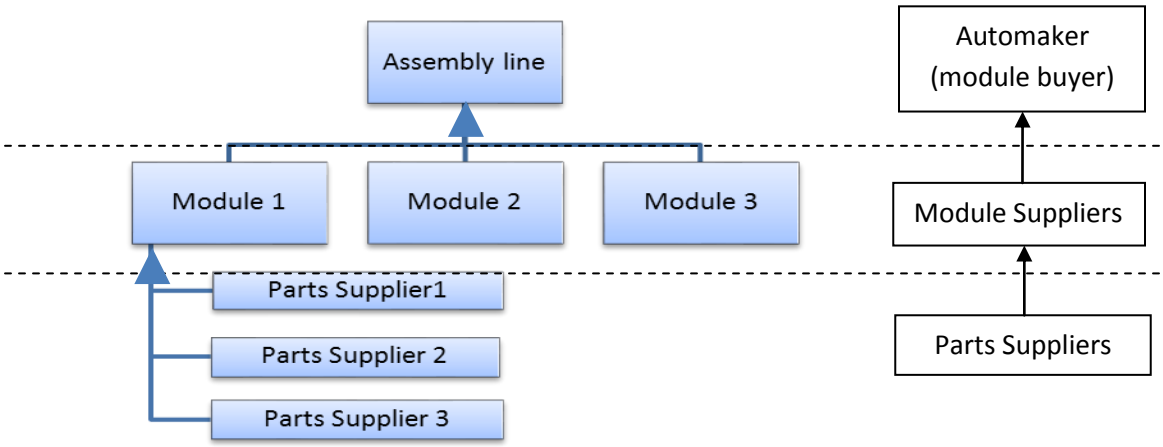


Figure 1. Conceptual Structure of Supply Chain with Modularization in the Auto Industry

Purpose and Justification of the Study

Although modularization has become a global trend in the auto industry, studies show that different characteristics of modularization are exhibited in various international automobile markets (Doran, 2004; Doran, Hill, Hwang, & Jacob, 2007; Kotabe, et al., 2007; Lin, et al., 2009; Ro, et al., 2007; Takeishi & Fujimoto, 2001). The People's Republic of China (hereinafter referred as China) has been recognized as the largest car market and manufacturer in the world in recent times (PTI, 2011; Wyman, 2007), yet the industrial structure is quite different from leading countries such as the U.S. and Japan (J. Chen, 2008; Harwit, 2001; Kim, Rhee, & Oh, 2010; KPMG, 2007, 2009; Lian, 2004; J. Luo, 2005; Sit & Liu, 2000; Sutton, 2005; Q. Zhu, Sarkis, & Lai, 2007). More than sixty percent of the vehicles in China are produced under foreign brands by joint venture factories (Brandt & Biesebroeck, 2007), hence China still does not lead in innovation and design.

Despite the importance and uniqueness of the Chinese auto market, only a few conceptual scholarly works have been conducted touching on the concept of modularization (Lin, et al., 2009; Liu, Sui, & Gu, 2008; Y. Zhu & Zhang, 2005). This means that there is not a deep understanding of this topic as it exists in the Chinese auto market. To emphasize, no literature was found among the existing works about the cultural impact on modularization and its outcomes in China. The purpose of this study is to fill in such a gap with an empirical analysis on the impact of modularization on the auto industry in China. In order to do this, the literature review covers the following areas. Guanxi as a unique cultural phenomenon in China is covered in this study. Internalization theory, transaction cost economics, the knowledge based view of the firm,

and the OLI model is reviewed as a base for the study, due to their relevance to the boundaries of the firm and the internalization of assets and activities.

In practice, this study will help managers in the auto industry make a more scientific decision of whether and how they should go into modularization, especially in the Chinese market. It is also helpful for automakers like GM and Ford who have an ambitious parts procurement plan from China to have a better understanding of the Chinese auto industry (Andersson, 2007; France-Presse, 2006).

Research Question

In order to analyze the impact of modularization on Chinese auto industry, the research will be conducted from two perspectives: (1) the impact on individual automotive firms; (2) the impact on the structure of the whole auto industry.

The impact on individual automotive firms can be measured by the firm's market performance and strategic positional advantage (Day & Wensley, 1988; Lanctot & Swan, 2000; Parente, 2003); the impact on the structure of the industry can be measured by the trend of merger and acquisition activities (Collins, et al., 1997; Doran, et al., 2007; Kotabe, et al., 2007; Lin, et al., 2009; Veloso, 2000). Thus, three research questions about the impact of modularization are listed as follows:

1. What is the impact of modularization on the automotive firms' performance in China?
2. What is the impact of modularization on the automotive firms' strategic positional advantage in China?
3. Is modularization a stimulus to the trend of mergers and acquisitions in the Chinese auto industry?

Several moderators are identified which affect the relation between modularization and its outcomes. The first of these is the impact of physical proximity. Physical proximity between module buyers and suppliers is found to have a positive effect on the relation between modularization and its outcomes on automotive firms (Kotabe, et al., 2007; Parente, 2003). More than 70% of Volkswagen's module suppliers in Brazil are located within 50 km from the automakers' production facilities (Howard & Squire, 2007; Salerno, 1999, 2001; Tu, Vonderembse, Ragu-Nathan, & Ragu-Nathan, 2004).

Knowledge sharing is another factor affecting modularization strategy and its outcomes. One of the core philosophies behind modularization is to make knowledge dissemination and exchange easier between module suppliers and buyers. A higher degree of knowledge sharing enables module suppliers to be in a better position to meet the demand of module buyers (Howard & Squire, 2007; Kotabe, et al., 2007; Lin, et al., 2009; Parente, 2003).

Business research in China can never ignore a special phenomenon named 'Guanxi', which refers to informal closed business relationship between business partners in China (Tsang, 1998). It is found that Guanxi can positively affect sales growth, competitiveness and some other indicators of firms' performance and strategic positional advantage (Luk et al., 2008; Park & Luo.Y., 2001; Yeung & Tung, 1996). Thus it is an essential task to study the role that Guanxi plays in the modularization of Chinese auto industry.

Therefore, the fourth research question will focus on the moderating effects of co-location, knowledge sharing and Guanxi:

4. What kind of effects do physical proximity, knowledge sharing and Guanxi have on the relation between modularization and its impact on the Chinese auto industry?

Definition of Terms

Guanxi – A Chinese term which is similar to but different from the interpersonal relationship in western world. It is rooted in Chinese culture, with attributes of connection, social interaction and exchange (Fan, 2002).

Hofstede's cultural dimensions – According to Hofstede (1980), national cultures can be categorized into five dimensions: collectivism, power distance, uncertainty avoidance, masculinity, and long-term orientation.

Internalization theory - Where the transaction costs of an administered exchange are lower than those of a market exchange, the market will be internalized and the collective efficiency of the group is thereby increased, and vice versa (Coase, 1937).

KBV – Knowledge-based View of the Firm. Firms are vehicles to create, carry, manage and transfer knowledge. The boundary of firms is dependent on their capability of managing knowledge (Hedlund, 1994; Kogut & Zander, 2003a, 2003b; Ranft & Lord, 2002).

Module - an independent and interrelated functional unit as a part of a system (Fixson, 2003; Miller & Elgard, 1998).

Modularity - an attribute of a system consisting of modules (Miller & Elgard, 1998).

Modularization - the activity and strategy by which a product or an organizational structure is modularized (Miller & Elgard, 1998).

Mass customization – 'A stable but very flexible and responsive process provide a dynamic flow of goods and services, enabling companies to achieve both low costs and high variety' (Pine II, 1993, p. 24)

Market performance – The effectiveness of a firm in products, programs and marketing activities (Homeburg & Pflesser, 2000).

MNE – Multinational enterprise (Buckley & Casson, 2003; Hymer, 1970; Teece, 1986)

OEM - Original equipment manufacturers. In the auto industry, OEM refers to automakers like GM and Ford who assemble vehicles that are based on 'original' designs (Sturgeon, 2000).

OLI model – This model is a further development of internalization theory in which multinational enterprises seek to maximize three categories of advantages: ownership, locational, and internalization advantages (Dunning, 2001).

Strategic positional advantage – The capability of a firm to deliver superior values to customers at a lower cost compared to its competitors (Porter, 1991).

TCE – Transaction Cost Economics (or Transaction Cost Theory). The total cost incurred by a firm can be grouped into transaction costs and production costs. A firm's decision of "in-house producing" or "outsourcing" is depended on the comparison between transaction costs and production costs (Williamson, 2008).

Tier suppliers – In the auto industry, parts suppliers are defined as "tiers" along the supply chain. Tier one suppliers are those that supply automakers like GM and Ford directly. Tier two are those suppliers to tier one, tier three supply to tier two (Armstrong, 2012).

Research Model

The preliminary research model for investigating the research questions is presented in Figure 2:

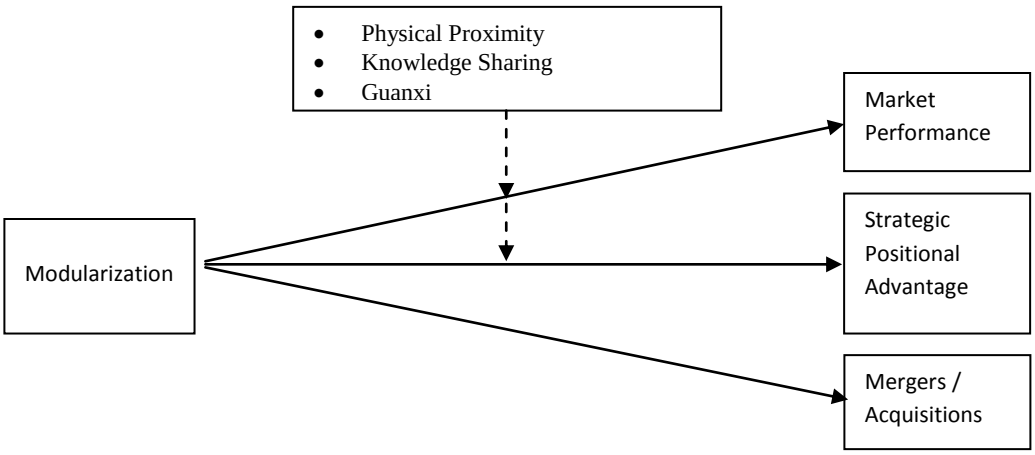


Figure 2. Preliminary Research Model

Delimitations

1. Research scope: auto industry

The study of modularization could be traced back to almost half a century ago with a wide range of industrial areas (Starr, 2010). The computer and software industry played a leading role with the application of modularization (Ethiraj, 2007; Tu, et al., 2004) with IBM, Microsoft, Dell and Oracle being premier examples (Baldwin & Clark, 1997; Langlois & Robertson, 1992; Tiwana, 2008)). The other venues include air cargo (Hoogeweegen, Teunissen, Vervest, & Wagenaar, 1999), home appliances (Worren, Moore, & Cardona, 2002), food and the nutraceutical industry (Saives, 2009), and consumer electronics (Langlois & Robertson, 1992). This study solely focuses on modularization in the auto industry.

2. Aspects of modularization

Different aspects of modularization in manufacturing industries have been recognized and discussed by researchers: modularization in design (MID), modularization in production (MIP), modularization in organizational architecture (MIO), and modularization in use (MIU). (Fixson, 2003; Galunic, 2001; Kusiak, 2002; Parente, 2003; Sako, 2003; Salerno, 1999; Sanchez & Mahoney, 1996; Takeishi & Fujimoto, 2001; Tu, et al., 2004).

For modularization in design (MID), the structure of a product is modularized and delegated to different designing groups, in order to reduce lead-time and cost for design and development. MID exists both in product architecture and designing processes.

For modularization in production (MIP), modules are sometimes interpreted as subassembly in the auto industry. The production process is segmented and assigned to different module suppliers for the purpose of operational efficiency.

Modularity in organizational architecture (MIO) refers to the organization adopting modularization with the corresponding organizational architecture, in order to enhance the flexibility and dynamics of the firm.

In modularization in use (MIU), the module makes it easier for the end user (automobile consumer) to repair or replace the product (e.g. stereo systems and GPS in a car).

MID, MIP and MIO will be discussed and measured in this study. They are reflected and measured by three dimensions of modularization, as suggested by Parente (2003): product architecture, tacit knowledge isolation and supply chain integration.

MIU is more concerned with the end user (automobile consumer), thus it is not a research interest in this study.

3. Research market: China

Studies on modularization in the auto industry have been made in different international markets, either within one single region(Doran, 2004; Doran, et al., 2007; Kotabe, et al., 2007; Lin, et al., 2009; Liu, et al., 2008; Parente, 2003; Pires, 1998; Ro, et al., 2007; Salerno, 1999, 2001) or by comparison between several regions(Sako, 2003; Takeishi & Fujimoto, 2001). This study will be conducted in the Chinese market by conducting quantitative research to measure the impact of modularization on the auto industry. Guanxi as a unique Chinese cultural element will be tested together with the other moderators on the relation between modularization and its outcomes.

Chapter II

Review of Literature

The purpose of this study is to examine the impact of modularization on the Chinese auto industry. To serve this purpose, four sections are covered in the literatures review: the concept of modularization; the theories underpinning such strategy; modularization in the auto industry; and Guanxi in China. Contents of these four sections are as follows:

Defining Modularization:

(1) Basic Concept;

(2) Module;

(3) Modularity;

(4) Modularization

Theoretical Framework

(1) Internalization theory

(2) Transaction Cost Economy

(3) OLI model

(4) Knowledge Based View of the firm

(5) Hofstede's cultural dimensions

Modularization and Auto Industry: Empirical Studies

(1) Modularization in the hardware and software industries

(2) Modularization in the auto industry

(3) Modularization: empirical studies

Guanxi: the Cultural Sensitivity

Defining Modularization

(1) Basic Concept

Since researchers started to show interest in modularization almost half century ago, various research works have covered both the software and hardware industries. However, just like the ongoing debate on the firm's boundary, MNE strategies, a lack of agreement exists on what exactly constitutes modularization due to its complexity, multiple facets and the different perspectives of the observers. Out of one hundred publications, more than forty different definitions were uncovered in this area. Terminologies like 'module', 'modular', modularity', and 'modularization' proliferate from the same concept existing in hundreds of papers in academic journals (Fixson, 2003; Salvador, 2007). It is not a research interest of this study to formulate and unify the concept of modularization, but those comparatively well-established concepts will be adopted in this research.

(2) Module

As the root of all the related concepts in this area, module has experienced three phases: physical module, non-physical module and modules as carriers of knowledge. Accompanied by the evolvement of module design and production in practice, three different but highly correlated and cited terminologies appeared in the literature: module, modularity and modularization.

The idea of module can be traced to the beginning of 20^{th} century when the industrial building block concept was introduced in architecture. Module was referred as a functional unit in buildings, like the kitchen, living room or bedroom. During that time, a module was merely a physical unit.

By the end of 20th century, non-physical products like computer software gained much benefit by utilizing the concept of module, and represents the beginning of the non-physical module(Miller & Elgard, 1998).

In recent times, modularization as a business strategy was introduced into management as an abstract carrier of knowledge. The design process of a certain product can be modularized into several projects and assigned to sub teams with different expertise, and a production process can be modularized into sections and outsourced to suppliers.

Over decades researchers tried to describe the unique characteristic of a module from different angles. Interchangeability: modules can be combined in various ways to meet the variety of customer demands (Starr, 1965, 2010); internal complexity and external exchangeability: module has to be an independent functional unit that can be separated and replaced by other modules (Parente, 2003); component separability and component combinability: modules within a system could be separated and recombined to form a new system (Salvador, 2007). Among these descriptions, Miller and Elgard's (1998) summary appears to be the best fit for the auto industry. They claimed that two attributes make a module fundamentally differentiated from a component, part, sub-assembly and all the others: (1) functionality and (2) compatibility.

Functionality means a module should have a certain function. Doing this helps to avoid everything becoming a module. Compatibility requires a module to fit into another different series of product. Such attributes could be observed from an audio system in a car: As shown in Figure 4, an audio system in 2010 Volkswagen Jetta is identical to that of 2010 Volkswagen Golf. Such an audio system is a module with the complete function

of a radio and CD player, and is interchangeable (compatible) between two different product series.

Figure 3. An Audio System of 2010 Volkswagen Jetta is Identical to that of 2010 Golf (New Cars, 2012)

(3) **Modularity**

Developed from the concept of module, modularity is a structuring characteristic of a technical or organizational system that consists of modules. It exists both in product and organizational design (Baldwin & Clark, 1997; Brusoni, Marengo, Prencipe, & Valente, 2007; Langlois, 2002; Miguel & Prieto, 2007; Schilling & Steensma, 2001; Tu, et al., 2004), and is discussed under different names like modular system, modular architecture or modular production with the basic meaning (Gershenson, Prasad, & Allamneni, 1999; Starr, 1965, 2010; Sturgeon, 2002; Ulrich, 1995). Starr (1965) was the first person to theoretically summarize and define "modular production" as a capacity to design and manufacture parts that can be combined in a maximum number of ways.

Modularity breaks down the complexity into less complex modules, allows organizations to run experiments at the level of business modules instead of entire entities (Baldwin & Clark, 1997). It enables faster product development; a higher degree of product variety; lower cost of design and production; and more technological innovation

(Baldwin & Clark, 2000; Fixson, 2003; Miller & Elgard, 1998). Despite of all the benefits from modularity, costs must also be considered. It is much more difficult to design a module system than a regular interconnected system. A poorly or incompletely designed module system can cause a multiplicity of problems (Baldwin & Clark, 1997; Hatton, 1996). It is also found that firms might be trapped into a situation of over relying on modularity which can reduce efficiency (Brusoni, et al., 2007; Ethiraj, 2007).

(4) **Modularization**

It is an activity or strategy to modularize the production process and organizational structure (Baldwin & Clark, 1997). Sometimes it is also referred to as "strategic modularization" when it is extended from physical and functional dimensions of module to organizational and managerial system (Kotabe, et al., 2007; Miller & Elgard, 1998). Similar to the concept of modularity, modularization as a strategy can help organizations increase the product development cycle, improve product quality, minimize cost, stimulate innovation, and especially, it can reduce the cost of managing tacit knowledge (Fixson, 2003; Kotabe, et al., 2007; Lehrer & Behnam, 2009). These attributes and advantages of modularization attract organizations to adopt this strategy.

Meanwhile observers also warn that modularization is not a silver bullet for all the problems. For example, despite Volkswagen's success with using a modularization strategy, some drawbacks are noticed and need further observation in a longer time frame (Pires, 1998), and excessive modularization might weaken the attraction of a product (Shimokawa, 2002). Thus firms should be cautious with the degree of modularization, just like being cautious with the degree of integration and outsourcing.

Modular products do not necessarily lead to the modularization of an organization, but it does enhance an organization's re-configurability and flexibility (Hoetker, 2006). On the other hand, a modular organization is more appropriate for developing modular products (Sanchez & Mahoney, 1996; Tiwana, 2008). The more complex the production is, the more tacit the production knowledge would be, and the more benefit organizations can acquire from modularization.

Theoretical Framework

Despite the various concepts and explanations for modularization that result from its complexity and ambiguities(Fixson, 2003; Hoetker, 2006; Sako, 2003; Salvador, 2007), the philosophy behind modularization in the Chinese auto industry is quite clear and logical when observed through the lenses of international business theories of internalization theory, transaction cost economics (TCE), the OLI model, the knowledge-based view (KBV) of the firm and Hofstede's cultural dimensions.

(1) Internalization Theory

As a pioneer of the "internalization" school, Coase (1937) argues that where the transaction costs of an administered exchange are lower than those of a market exchange, the market will be internalized and the collective efficiency of the group is thereby increased, and vice versa. In this theory, the firm is viewed as both the functional unit of exchange and as value-adding (Dunning, 2003). Intangible assets such as technology are especially costly to exchange in arm's-length transactions (Buckley & Casson, 2003, 2009; Buckley & Hashai, 2004; Hymer, 1970; Rugman & Verbeke, 2008), thus firm's competiveness mainly depends on its firm-specific advantages (Rugman & Verbeke, 1990).

Arguably, none of the older theoretical approaches could directly address the very reason of the existence of MNE until the application of internalization theory to MNE studies. Buckley and Casson are credited with the rapid spread of internalization theory among IB researchers. It became a powerful tool to explain the MNE due to its comparative institutional approach to analyze MNE choices on the firm's boundaries, the linkage to the external environment and the firm's entry mode. The MNE can adjust its strategy based upon its firm-specific advantages, country-specific advantages and its existing competitive strategies (Rugman & Verbeke, 1990, 2008; Safarian, 2003).

This can partially explain why automakers and auto parts manufacturers are expanding their business into China mainly through the mode of joint ventures or wholly owned subsidiaries, instead of trading or licensing. More than 1,200 automotive firms in China have been created through FDI, among which 70% are wholly owned subsidiaries (PCAUTO, 2007). Due to the technology complexity and labor intensity of the auto industry, it is much more feasible and profitable for MNEs to internalize their activities and set up joint ventures or wholly owned plants in the Chinese market. Compared to joint ventures, a wholly owned enterprise is an even better choice for MNEs in China due to the higher degree of internalization (Deng, 2001), this is proved by the trend in Chinese auto parts industry: "To Caterpillar, Bosch, BorgWarner as the representatives of a group of giant investment projects in China, are happy to take the form of wholly-owned or controlled" (China-Lutong,2012, para.2). Under pressure from those MNEs, a wave of mergers and acquisitions happening in this market has been observed (Asia Consulting, 2012).

According to internalization theory, boundaries of the firm are determined by the trade-offs between internalizing activities and externalizing market transactions or strategic alliances (Coase, 1937; Pisano, 1990; Rothaermel, Hitt, & Jobe, 2006; Williamson, 1975). In industrial value chains, firms are pushed by the logic of modularization to retain high control over components or processes that can generate the most value, and outsource operations that create less value (Bensaou & Anderson, 1999; Calantone & Stanko, 2007; Mudambi & Venzin, 2010). More often, firms are in a hybrid status of partially integrating and outsourcing activities, that is they engage in taper integration (Harrigan, 1984; Rothaermel, et al., 2006). Theories of MNE add a geographical dimension to such strategies (Buckley & Hashai, 2004; Contractor, Kumar, Kundu, & Redersen, 2010).

Automakers outsource module production to module suppliers in order to retain attention on the automakers' core competences. Meanwhile, module suppliers integrate their production to maximize their profit and enhance competitive advantages. The balance between outsourcing and integration forms the interface of the modules and boundaries of the buyers and suppliers (Holmstrom & Roberts, 1998). Firms are constantly seeking the optimal solution with outsourcing and integration. The case of GM spinning off its automotive parts subsidiary Delphi in 1999 is a perfect example in practice (Delphi, 1999). When GM became number one in the global automotive market by focusing on its design and assembly business, Delphi also became the largest parts manufacturer in the world by focusing on its own expertise in parts production.

(2) Transaction Cost Economy (TCE)

Parallel to internalization theory, transaction cost economics (TCE) is another corner stone for research on the MNE. TCE shares the same spirit with the internalization school, with a different emphasis of microanalysis. TCE sees the firm as the most efficient institution to organize interdependencies between individuals. A leading purpose of economic organization is to economize on the costs of business transactions over time. The existence of MNEs is evidence of TCE since they are more efficient than markets and contracts in organizing interdependencies in different countries or regions. On the other hand, MNEs constantly try to identify the most effective balance in global integration and outsourcing, in order to maximize their benefits and minimize the costs (Mudambi & Venzin, 2010; Rothaermel, et al., 2006; Rugman & Brewer, 2001; Teece, 1986; Williamson, 1975, 1979, 1991, 2008).

Arguably Oliver Williamson is the founder and chief developer of TCE, who also paved the theoretical base for the boundaries of the firm (Gibbons, 2010). When considering the issue of the boundaries of the firm, Williamson (1981) sees transaction costs as the penalties that firms suffer in the product market when making incorrect integration decisions. Such penalties could be examined by the performance of firms over time. Transaction costs have been found playing a significant role in make-or-buy decisions in the auto industry (Walker & Weber, 1984). The transaction cost approach to the MNE covers various issues from organizational structure to franchise contracting (Williamson, 1976). Under its impact, theories of the MNE were shifted to pay more attention to transactional aspects of international business (Horaguchi & Toyne, 1990; Safarian, 2003).

TCE posits that in the real world, market price and organizational hierarchy are two basic forms of transaction. Sometimes it could be in the form of a mixture of market and hierarchy. The structure and method in which an organization chooses to organize a transaction will decide the cost of it (Hennart, 1993). This explains why both internal production and module outsourcing exist in firms in the auto industry. Three issues of the MNE are addressed by TCE: firm's boundaries, interface with external environment, and the internal design of the organization (Rugman & Verbeke, 2005). These three issues are the very reasons for modularization: it is a redesign of firm's boundaries. From an engineering perspective, it means by standardizing interfaces of a module, it can fit well with other components in different ways of combination. From a management perspective, it refers to a firm's organizational restructuring which enables business units within the firm to become independent to and collaborative with the others.

In China, foreign multinationals have been required to partner with local firms in the auto industry, and to use local suppliers to provide components. Following from this, automotive MNEs have redesigned their supply chains in China to further recreate the boundaries of the firm, and to generate pecuniary and non-pecuniary externalities in this market. The organizational structure of the MNE will be modified with the accumulation of knowledge and experience along with policy changes in the Chinese market. Thanks to China's 2001 entry to the WTO and the liberalization of the auto parts market as a result, MNEs have changed their strategy dramatically by gaining more control in their subsidiaries in order to minimize transaction costs (China-Lutong, 2012; Clarke, Robles, Akhter, & Machado, 2008).

Nowadays, modularization has become a preferable organizational form for automakers and parts manufacturers in order to minimize transaction costs. As a combination of electronic, steel, plastic, hydraulic, computer, and human engineering, the auto industry is becoming much more specialized in various areas. Module outsourcing enables module buyers to maintain their core competences, and spin off those areas where they don't have competitive advantages. It also enables module suppliers to obtain more pecuniary and non-pecuniary externalities, in other words, the improvement of market performance and strategic positional advantage.

(3) OLI model

Based on the spirit of internalization theory and transaction cost economics, John Dunning's OLI model was developed to explain the 'origin, level, pattern, and growth of MNE's offshore activities' and became a dominant paradigm in IB studies (Eden & Dai, 2010, p. 13). OLI stands for Ownership, Location, and Internalization advantages.

Ownership advantages address the firm-specific advantages that allow the MNE to go abroad. Location advantages focus on the MNE's choice of location. Finally, internalization advantages have an impact on the MNE's entry mode and operational form in a foreign country. These three advantages are motivations for outward bound FDI and all are at the firm level. Merger and acquisition activity is a practice of OLI model for MNEs. A successful M&A creates synergy between the 'O' and 'L' advantages of different firms. It is a combination of superior productivity in the international value chain from the MNE on one hand, together with the knowledge and networks of the local market created by the local firms (Dunning, 1973, 2001; Eden & Dai, 2010; Neary, 2007).

Recently China has become the largest automotive manufacturer and market in the world, yet local automotive firms are still less competitive compared to the major players in the global auto industry (Brandt & Biesebroeck, 2007; J. Chen, 2008). MNEs in the auto industry are exploiting the 'O' and 'L' via their expansion into the Chinese market, and realizing 'I' through their wholly owned subsidiaries or joint ventures. For module suppliers, it is a way to maximize 'O' and 'I': the superior expertise of module suppliers in technology and management can be realized via modularization.

(4) Knowledge Based View of the firm (KBV)

Departing from the school of TCE, the MNE's activities and the firm's boundaries are explained from a different angle by the knowledge-based view of the firm. Arguably, KBV is an extension of the resource-based view (RBV) of the firm, treating knowledge as a special strategic resource which does not depreciate (Curado & Bontis, 2006). It has been noticed that sometimes MNEs will trade off economics on transaction costs in order to get access to dispersed knowledge and to enhance market flexibility, which will improve MNE's competitive advantage (Rothaermel, et al., 2006).

Edith Penrose is recognized as one of the earliest contributors to KBV. In her work she pointed out that the intra-firm learning process generates excess resources (knowledge). Such excess resources could yield profit without any marginal cost (Penrose, 1959). Other researchers see knowledge as a process of ongoing social construction and not as a resource (Spender, 1996). KBV is also seen as an additional cognitive dimension to the MNE and OLI theories (Pitelis, 2007).

In the knowledge-based view the firm is regarded as a vehicle for creating, transforming and transferring knowledge (Kogut & Zander, 2003a). Evidence shows that

MNE's decisions on location, boundary, control and value creation are highly affected by the knowledge of the firm (Griffith, Harmancioglu, & Droge, 2009; Kotabe, Martin, & Domoto, 2003; Kotabe & Swan, 1994; Mudambi, 2008; Shin, Kraemer, & Dedrick, 2009).

The knowledge based view of the firm sheds new light on organizational design, boundaries of the firm, organizational innovations and management practice (R. M. Grant, 1996b). Although tacit knowledge can particularly generate competitive advantages for firms, it is more difficult to codify, manage and transfer when compared to explicit knowledge (Kogut & Zander, 2003a). The degree of isolating and managing knowledge within a firm will decide the interface of the module, boundary of the firm, and relationship between module buyer and supplier (Parente, 2003; Parmigiani & Mitchell, 2009; Richard & Devinney, 2005). Through modularization, automakers can focus on their core competences, diversify investment risks, and become more flexible in meeting market demand. On the other hand, module suppliers can obtain more profit from the value chain due to their special knowledge, and enhance competitive advantages through technology innovation.

As a summary, this study draws on internalization, transaction cost economics, and knowledge-based view of the firm in order to examine the specific issue of modularization of the supply chains in the Chinese auto industry. The boundaries of the firm, the internalization of assets and activities, and the cultural impact on MNE's activities can be clearly explained through the lenses of these theories. Corporate managers must make decisions regarding the balancing of the demands of vertical integration and outsourcing of components of the value chains. Considerations during

these decisions are location, internalization and ownership as per suggested by OLI model, with a sensitivity of the national culture (Dunning, 2001; Dunning & Bansal, 1997). Once the firm has made the location and ownership decisions then the main issue to consider becomes internalization and the control of firm specific knowledge. The interface of within-firm and inter-firm expertise is fundamental to the consideration of supplier modularization in the auto industry.

Modularization and Auto Industry: Empirical Studies

(1) Modularization in Hardware and Software Industries

Since Starr (1965) brought up the research stream of modularization, it has been well recognized that modularization can provide a great deal of benefits like low cost, high quality, quick response to market demand, and a firm's strategic positional advantage (Collins, et al., 1997; Fixson, 2003; Kotabe, et al., 2007; Langlois & Robertson, 1992; Ro, et al., 2007; Salerno, 2001; Takeishi & Fujimoto, 2001; Worren, et al., 2002). On the other hand, some scholars argued that the modular approach can produce a negative impact on the firm's performance. If it is improperly applied or overused, these effects include: unplanned obsolescence; high costs of design and engineering; suppliers might increase their prices in order to absorb higher capital costs; the problem of low productivity cannot be solved; or, at the very least it is unclear whether the benefits of mass-customization could be fully achieved by modularization (Fleming & Sorenson, 2001; Parente, 2003; Pires, 1998; Sako, 2003; Starr, 1965, 2010).

New coordinating technology and knowledge management processes based on modularity are making it possible to improve strategic organizational management (Sanchez & Mahoney, 1996). Schilling (2000) built a model trying to answer the question

why the degree of modularization varies in different industries. It is found that organizational modularization is positively related to the heterogeneity of inputs and demands in an industry, and this relation will be enhanced by the level of standardization, technological development and competition in such an industry (Schilling & Steensma, 2001).

Baldwin and Clark (1997, p. 84) suggest that modularity has enabled companies to handle increasingly complex technology. "By breaking up a product into subsystems (or modules), designers, producers, and users have gained enormous flexibilities. Different companies can take responsibility for separate modules and be confident that a reliable product will arise from their collective efforts."

Sanchez and Mahoney (1996) suggest that the application of modularity in the design of products could make the firm's organizational structure a modular one. Therefore, modularity is now being applied not only to technological design but also to organizational design as a set of general principles for managing complexities (Langlois, 2002). Such a proposition was tested and proved in the home appliance industry by Worren, Moore and Cardona (2002).

According to Schilling (2000), modular product design makes possible for decentralized production. Indeed, such a decentralized structure allows individuals working on particular components to perform their jobs independently across many diverse departmental configurations. Therefore, an organization must create a "fully specified standardized interface" (Sanchez & Mahoney, 1996, p.73), which facilitates coordination and knowledge sharing in order to ensure that the components will interact effectively.

The strategic approach to modularization encompasses both the supply (i.e. design & production) and the demand (i.e. customer requirements) side of the business and it is being adopted in various industries. In the aircraft industry, Boeing produces different models with different length and capacities with some common modules like wing, nose, and tail components aircraft (Battershell, 1999). In computer and microcomputer industry, modular components like hard disk drives, flat screen displays, and memory chips are largely used together with some distinctive components such as a microprocessor chip and enclosures to produce new models (Baldwin & Clark, 2000; Langlois & Robertson, 1992). As a consumer electronics manufacturer, Sony utilizes some modules on a few basic modular products to produce more than 160 variations of the Sony Walkman (Sanderson & Uzumeri, 1995). Software designs are creating modules of routines which can be combined to create customized applications programs. Designers use loose coupling as a way of modularity, which makes modules more independent (Parnas, Clements, & Weiss, 1985). The existence of modularization both in design, production and organizational structure was tested and proved in the home appliance industry (Worren, et al., 2002).

(2) Modularization in the Auto Industry

In the auto industry, modularization is highly praised as "state of art" (Collins, et al., 1997, p. 507), as another "revolution" in management history (Pires, 1998, p. 232), and a "keyword" in today's global auto industry (Shimokawa, 2002, p. 26).

Modularization as an organizational activity and strategy was initiated by European carmakers and made great strides in achievement in Brazil during the 1990s. Scholars in **Brazil** first noticed this phenomenon at the end of 1990s and started to pay

attention to it (Collins, et al., 1997; Parente, 2003; Pires, 1998; Salerno, 1999, 2001). Eventually studies were expanded into several other countries.

China: Sufficient capabilities of the module supplier in a fully integrated network, or a third-party logistics provider in a partly integrated supply network were found to be antecedents for modularization in the Chinese auto industry supply chain. Thanks to the fast development of the auto industry in China, parts suppliers are going into modularization to upgrade their tier positions (Lin, et al., 2009; Liu, et al., 2008; Y. Zhu & Zhang, 2005).

France: Doran et al (2007) conclude that the French auto industry is in a stage of going for modularization, which has triggered a wave of mergers and acquisitions in the auto parts industry. Modularization has also pushed value transfer downwards in the supply chain of the auto industry, from OEM to module supplier, then to second or third tier suppliers. Doran also called for more attention to the shift taking place from automakers to parts suppliers;

Japan: As it is happening in Europe and the U.S., modularization is also a phenomenon both in the auto industry and in the research community in Japan. However, Japan is lagging behind its peers in Europe and the U.S. due to several reasons: (1) the wage gap between automakers and parts suppliers is not great enough to motivate outsourcing modules; (2) the requirement of physical proximity between automakers and module suppliers is a harsh condition for module suppliers since new land resources are quite limited and expensive in Japan; (3) not many large parts suppliers are capable of module design and production (4) automakers are worried about knowledge leakage

through modularization (J. Luo & Kim, 2009; J. Luo, Whitney, Baldwin, & Magee, 2009; Sako, 2003; Shimokawa, 2002; Takeishi & Fujimoto, 2001).

UK: Similar to his findings from France, Doran (2004) found that both automakers and parts suppliers would benefit from modularization in the UK. Modularization ignited value transfer from OEM to tier one suppliers, and subsequently to lower tier suppliers. In order to be qualified as a module supplier, tier one suppliers need specific capabilities.

USA: In order to gain a better understanding of Dell's successful modularization, the president of Ford held a meeting with the president of Dell specifically to seek his advice. Research has found that different from the personal computer industry, and different from other international markets, the primary drivers for the outsourcing of modules in the U.S. auto industry is cost reduction and lead-time saving, not customer satisfaction. In contrast to the Japanese auto industry, modularization in the U.S. has not enhanced long-term relationships between automakers and parts suppliers. Union resistance and the short-term accounting systems became two barriers that made the U.S. automakers less aggressive toward adopting modularization than their European peers (Ro, et al., 2007; Sako, 2003; Takeishi & Fujimoto, 2001; Veloso & Fixson, 2001).

Benefits of modularization in the above mentioned markets have been widely recognized:

1. Enhancing competitive advantage: Because of the instability and overcapacity of the auto industry, automakers are forced to adopt modularization to maintain competitive advantage and, consequently, parts suppliers are forced to do the same (Doran, 2004; Kotabe, et al., 2007; Lin, et al., 2009)

2. Integration: By reducing the number of component suppliers, it is easier for automakers to manage the whole parts supplying system. Thus consolidation is one of the driving forces for the wave of mergers and acquisitions in the auto parts industry (Camuffo, 2000; Collins, et al., 1997; Doran, et al., 2007; J. Luo, et al., 2009; Shimokawa, 2002; Takeishi & Fujimoto, 2001).

3. Cost reduction: once the design of a module is accomplished, it can fit into other product series. Thus the cost of repeating such design can be saved. The cost of logistics and inventories of the components for a module, and the cost of managing tacit knowledge within a module could be saved as well (Kotabe, et al., 2007; Salerno, 1999, 2001; Shimokawa, 2002; Veloso & Fixson, 2001).

4. Product development time reduction: The design work of different modules could proceed in parallel, and a module design could be applied to different product series. Thus the repetition of such design could be saved (Kotabe, et al., 2007; Salerno, 1999, 2001; Shimokawa, 2002; Veloso & Fixson, 2001).

5. Saving in investment: Investment for the production of all the components within the module can be saved. Actually, it is transferred from the automakers to module suppliers (Salerno, 2001).

6. Risk diversification: Investment for the production of the components within the module is saved on the automaker's side, and transferred from the automaker to the module suppliers (Salerno, 2001; Takeishi & Fujimoto, 2001).

(3) Modularization: Empirical Studies

In order to conduct an empirical study about the impact of modularization on the Chinese auto industry, the following domains are reviewed and discussed: (3.1)

dimensions of modularization; (3.2) outcomes of modularization; (3.3) moderating factors.

(3.1) Dimensions of Modularization

Among the empirical studies on modularization, three dimensions are recommended to reflect its attributes: modular product architecture, tacit knowledge isolation and supply chain integration. These dimensions reflect three basic aspects of modularizations accordingly: modularization in design (MID), modularization in production (MIP) and modularization in organization (MIO) (Miller & Elgard, 1998; Parente, 2003; Sako, 2003; Salerno, 1999; Takeishi & Fujimoto, 2001).

Modular product architecture. Product architecture enables a module to own its basic characteristics. It would be compatible with the other subsystems and entire system while having its own independent complex functions. The architecture is a determinant factor to the quality of a module, including compatibility, functionality, acceptability by customers and costs of product. The design of interfaces of a module has direct impact on the functionality (performance of modules) and compatibility (interchangeability between modules within a product), as illustrated in Figure 4 (Miller & Elgard, 1998).

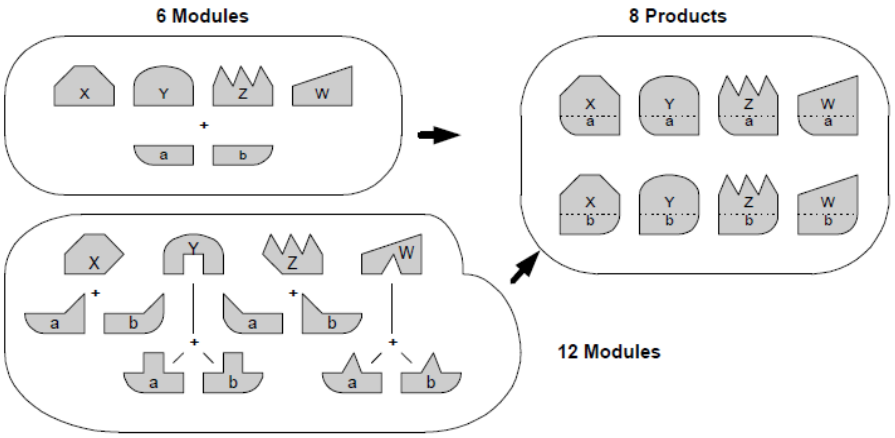


Figure 4: A Product Family Consisting of 8 Members could be Produced with 6 or 12 Modules, Depended on the Design of the Modules (Miller & Elgard, 1998).

Modular product architecture enables firms to satisfy customers' variety of demand, since a product family consisting of variety of products could be ready for customers in a timely manner through different combination of modules. It also reduces the lead-time and cost for design and development since the design process for different modules could be conducted in parallel. Furthermore, modular product architecture enables the production process to be modularized (MIP) and related costs will be greatly reduced due to the same reason as MID (Sako, 2003).

Tacit knowledge isolation. A module should have an effective interface with the other parts of the total system. "The tacit knowledge must be isolated at the module level. The only knowledge in the interfaces must be explicit and codifiable knowledge" (Parente, 2003, p. 41). According to the knowledge-based view of firms, the boundary of the firms is determined by the content of knowledge which could be managed by the firms. Related to modularization in the auto industry, this means boundaries between automakers and module suppliers are determined by the knowledge to be managed by

each side. One of the primary drivers of module outsourcing from automakers to module suppliers is to reduce the cost of managing tacit knowledge and reduce the investment risk for such tacit knowledge. During the 1990s when Toyota's 'just-in-time (JIT)' philosophy was well accepted by automakers all over the world, modularization became a great tool to realize this aim. Module suppliers take over the burden of managing the complex knowledge of producing the modules and simplify the management problems of automakers. Thus the capability of isolating tacit knowledge within the boundary of a module supplier through its modular product is a critical measurement of modularization. (Kogut & Zander, 2003a; Kotabe, et al., 2007; Parente, 2003; Ro, et al., 2007).

Doran et al (2006) prepared a case study of a French cockpit module supplier. The case indicated that all the manufacturing activities (assembling, plastic parts/electronics/small assemblies manufacturing) and supply chain activities (logistics, procurement from sub-suppliers) were managed by this firm, and all the related knowledge was isolated within this firm as well (Fig.5).

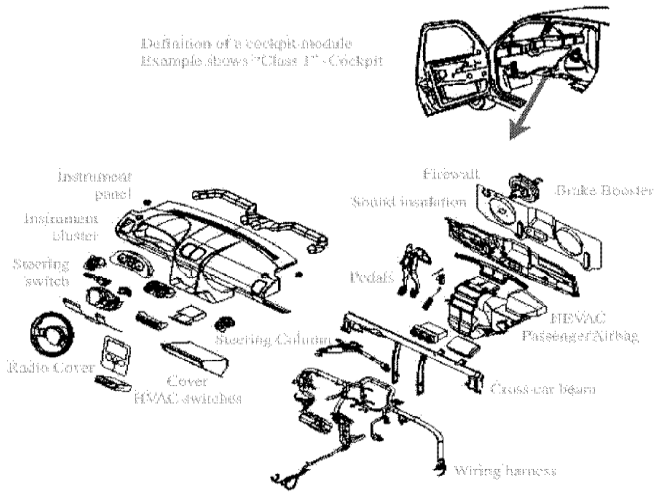


Figure 5: A Cockpit Module Supplier in French is Responsible for all the Manufacturing and Supply Chain Activities for such a Module (Adapted from Doran et al, 2007)

Supply chain integration. Parente (2003) explains the importance of supply chain integration as a measurement of modularization: Besides isolating the tacit knowledge within a module product and organization, another critical task for the module supplier is to work shoulder to shoulder with the buyer (automaker) to ensure the whole supply chain works smoothly and successfully.

Modularization itself leads to the disintegration of the supply chain. Automakers spin off the designing and production of modules to suppliers. However, once such modularization is completed and the boundary between the automaker and supplier is settled, it requires a high degree of teamwork between the two parties throughout the whole procedure, from design process to production, logistic, assembling, until customer service. Thus modularization also requires physical proximity and a high level of knowledge sharing between the two parties to enhance performance, which will be discussed in the later section of moderators.

(3.2) Outcomes from Modularization

Modularization is found in various industrial areas and markets and can benefit firms in many ways: higher profit margins, more reliable customer relations, lower costs, higher quality, quicker market response, etc. As such, modularization can improve a firm's market performance and strategic positional advantage (Collins, et al., 1997; Fixson, 2003; Kotabe, et al., 2007; Langlois & Robertson, 1992; Lehrer & Behnam, 2009; Ro, et al., 2007; Salerno, 2001; Takeishi & Fujimoto, 2001; Worren, et al., 2002).

Market performance is defined as the component of organizational effectiveness in products, programs and marketing activities, encompassing both financial and nonfinancial (operational) measurement. The financial measure was regarded as the most

significant measurement of a firm's performance until the 1980s when the trend towards a combination of financial and non-financial performance measurement emerged, which is recognized by some as a better way to understand a firm (Eccles, 1991; J. L. Grant, 1996; Homeburg & Pflesser, 2000; Kodrowski & Youngblood, 2008; Vytlacil, 2010).

Financial measures simply center on the financial outcome to reflect the fulfillment of the economic goals of the firm, which include the firm's profitability, revenue, and return on sales. Nonfinancial (operational) measures focus on key operational factors that could lead to financial performance, including market share, customer satisfaction and loyalty (Venkatraman & Ramanujam, 1986). There is a certain degree of relevance between financial and nonfinancial measures. Nonfinancial measures are found to have a positive but nonlinear relation with financial measures. It is suggested to combine these two measures as the indicator of market performance (Abdel-Maksoud, Dugdale, & Luther, 2005; Day & Wensley, 1988; Ittner & Larcker, 1998; Lanctot & Swan, 2000).

By achieving **strategic positional advantage**, a firm can keep its superior business performance against competitors. A firm's strategic positional advantage resides in two domains: The firm's capability of creating superior value to customers (differentiation advantage) or capability of offering the same value at a lower cost to customers (cost advantage) (Porter, 1991, 1997). The firm's strategic positional advantage comes out of the firm's superior capabilities in the form of superior skills and resources (Day & Wensley, 1988). In order to attain strategic positional advantage, a firm needs to develop distinctive competencies, lower costs and deliver superior customer value (Abernathy & Clark, 1985; Takeuchi & Nonaka, 1986). The firm's strategic

positional advantage is suggested to be a single construct out of a combination of low cost, speed to market and high product quality measures (Cusumano & Nobeoka, 1992; Kotabe, et al., 2007; Lanctot & Swan, 2000; Parente, 2003). These attributes are particularly important for suppliers in an industrial supply chain. During a supplier selection process, managers make their choice mainly based on quality, cost and delivery performance of the supplier (Choi & Hartley, 1996; Verma & Pullman, 1998).

Through modularization, a firm can reduce managerial costs and production costs (Garud & Kumaraswamy, 1995; Tiwana, 2008). The whole structure of the system is simplified through modularization by isolating the tacit knowledge within each module; costs of managing the complexity of the whole system, and knowledge transfer among different sections are reduced in this way(Lehrer & Behnam, 2009; Parente, 2003). Through the advantage of economies of scale, those firms who embrace modularization strategy can reduce their production cost. Modularization enables suppliers to serve a broader range of customers with standardized modular products. It also enhances the relationship with the buyer by providing better performance and higher level of cooperation. Consequently, production cost will be reduced in such a larger and more stable market.

The speed-to-market is always crucial in many industries, and it becomes more realistic via modularization. The virtue of modularization is to realize mass customization, flexible production and meet the variety and fast changing nature of customer demands (Baldwin & Clark, 2000; Gershenson, et al., 1999; Kotabe, et al., 2007; Kusiak, 2002; Pine II, 1993; Pine II, et al., 1993; Voordijk, Meijboom, & Haan, 2006; Worren, et al., 2002). In short, this means the speed-to-market is an essential factor

in a firm's success (Clark, 1989). During a hundred years' history of fierce competition, automakers are constantly pushed to integrate up-to-date technology, and the consumer's new preference into their products (Moral & Jaumandreu, 2007). In the automotive market, it is found that the timely introduction of a new model can improve market share, profitability and productivity (Clark, Chew, Fujimoto, Meyer, & Scherer, 1987), and sales could be drastically increased after a major model change (Dyer, 1996). Parts suppliers are always playing an important, indispensable role throughout the whole value chain of automotive market. Speed-to-market of an automaker means speed-to-market of its parts suppliers. As proposed, it is expected that modularization would enhance the parts suppliers' capability of speed-to-market.

Modularization helps improve product quality (Parente, 2003). First, it stimulates a firm's autonomous innovation which can lead to better product performance and quality (Garud & Kumaraswamy, 1995; Langlois & Robertson, 1992; Pil & Cohen, 2006). Second, the tacit knowledge is isolated within the module and the module supplier who is specialized in its area. Such specialization is helpful to improving product performance and quality (Clark, et al., 1987). Third, compared to the buyer whose responsibility is the whole product system with a much larger scale and complexity, the module supplier has a lower cost of conducting adequate experimentations on module level, which is another crucial means of quality assurance (Baldwin & Clark, 2000).

Thus, based on the literature review on modularization and its impact on firms, the relation between the three dimensions of modularization and its outcomes are hypothesized as follows:

H1a: There is a positive relation between the degree of module product architecture and the market performance of automotive firms in China.

H1b: There is a positive relation between the degree of tacit knowledge isolation and the market performance of automotive firms in China.

H1c: There is a positive relation between the degree of supply chain integration and the market performance of automotive firms in China.

H2a: There is a positive relation between the degree of modular product architecture and the strategic positional advantage of automotive firms in China.

H2b: There is a positive relation between the degree of tacit knowledge isolation and the strategic positional advantage of automotive firms in China.

H2c: There is a positive relation between the degree of supply chain integration and the strategic positional advantage of automotive firms in China.

Mergers and acquisitions. Modularization not only has an impact on the inner structure of organizations, it also impacts the structure of the whole supply chain. Manufacturers are eventually moving procurement from discrete parts and components to modules, and there is an emerging trend of vertical integration in the auto parts industry (Doran, et al., 2007; Ernst & Kamrad, 2000; Kotabe, et al., 2007; Lin, et al., 2009; Sako, 2003; Veloso, 2000). Some managers even expect that only ten percent of the major parts suppliers will be left in the global market within a decade. Moreover, parts suppliers in Brazil have decreased from 550 to 250 within two years (Collins, et al., 1997).

The motivation behind such a wave of mergers and acquisitions in the auto parts industry is to internalize production and acquire needed know-how, as described by internalization, TCE and KBV theories. The ultimate goal is to minimize transaction

costs and improve strategic competitiveness by obtaining knowledge which is the most strategic asset of a firm (Coase, 1937; Kogut & Zander, 2003a; Shimizu, Hitt, Vaidyanath, & Pisano, 2004; Williamson, 1975). For some parts suppliers, it is a way of upgrading themselves and becoming qualified tier-1 module suppliers competing in the global market (Brandt & Biesebroeck, 2007).

A case study in China shows that mergers and acquisitions in the auto parts industry is greatly influenced by the buyer's leadership. This influence arises because parts suppliers in turn influence the buyer's product quality, costs and even innovation (Lockstrom, Schadel, Harrison, Moster & Malhotra, 2010). MNEs are trying to realize their OLI advantages through merger and acquisition activities in the Chinese auto parts industry. Mergers and acquisitions in the supply chain are also ways to improve operational and business performance (Flynn, Huo, & Zhao, 2010), which is crucial for all the parts suppliers who are struggling in a hard-to-survive auto industry (International Trade Administration, 2011; Veloso, 2000; Veloso & Kumar, 2002). Thus it would not be a surprise to see mergers and acquisitions as a result of modularization in the Chinese auto industry. Based on the above mentioned argument, the following hypothesis is suggested:

H3a: There is a positive relation between the degree of module product architecture and the likelihood that a merger/acquisition will take place between parts suppliers.

H3b: There is a positive relation between the degree of tacit knowledge isolation and the strategic positional advantage of automotive firms in China.

H3c: There is a positive relation between the degree of supply chain integration and the strategic positional advantage of automotive firms in China.

(3.3) Physical Proximity and Knowledge Sharing

Researchers observe that physical proximity and knowledge sharing can enhance the relation between modularization and its outcomes. Such an effect was found in the Brazilian and French auto industries (Collins, et al., 1997; Kotabe, et al., 2007; Parente, 2003; Sako, 2005).

Physical Proximity. Due to the importance of spatial dimension, physical (geographical) proximity in supply chain becomes a research topic in itself. In the economics of proximity approach and industrial cluster theory, proximity has an impact on economic interaction and performance (Boschma, 2005b; Porter, 2000). Locational advantage is one of the dimensions in the OLI model, which argues that by taking the locational advantage MNEs can augment their competitive advantage (Dunning, 2001). In modular production, benefits from physical proximity include: easier logistic management, easier JIT implementation, closer cooperation, more trust between two sides, better inter-firm relations, and more frequent contact between the automaker and supplier which leads to better knowledge exchange (Frigant & Lung, 2002). Subsequently, physical proximity helps to spark innovation and to improve performance (Boschma, 2005a).

In order to cope with the challenges in the auto industry, automakers and their suppliers have to conduct intense interactions and communications (Lockstrom, et al., 2010). In supply chains, a high degree of collaboration between the module buyer and supplier is required from the very beginning of module design, to the onsite service on the assembly line. Physical proximity makes such intimacy between buyer and supplier possible. It not only reduces uncertainties in the assembly line due to the more closed

cooperation and better mutual understanding (Salerno, 1999; Tu, et al., 2004), but also reduces the logistical costs of parts suppliers and inventories of automakers due to the locational convenience.

In reality, supplier clusters and modular consortia are increasingly being developed in many regions as a result of the competition between the automakers and the suppliers (Collins, et al., 1997; Rutherford, 2001; Sako, 2003). It has been noticed that major suppliers in global automotive market are expanding their business by following the automakers geographically, again this is an evidence of the OLI model applied by MNEs (Liu, et al., 2008).

Knowledge Sharing. Knowledge has been well recognized as a key resource, and a strategic asset contributing to a firm's competitive advantage (Kogut & Zander, 2003a, 2003b; Penrose, 1959; Richard & Devinney, 2005). Taking a further step, Grant (1996) emphasizes that knowledge integration is even more critical than knowledge itself. The moderating effect of knowledge sharing has been found between modularization and its outcomes from automakers (Cusumano & Nobeoka, 1992; Howard & Squire, 2007; Sako, 2003; Salerno, 1999, 2001; Tu, et al., 2004). Several factors can affect the effectiveness of knowledge sharing including the type of knowledge, inter-firm relations ,and communications (Sarala & Vaara, 2010).

Compared to explicit knowledge, which can be articulated codified and transferred via verbal communication and written documentation, tacit knowledge is difficult to teach and learn. It is based on the accumulation of experience and the expertise of organizational members (Ranft & Lord, 2002). An empirical study of the auto industry in Japan, Turkey and the U.S. shows that no matter how simple the

technical exchange or higher-level technology transfer, knowledge sharing between the buyer and supplier is always associated with supplier performance improvement (Kotabe, et al., 2003; Wasti & Wasti, 2008).

Network connections and knowledge-sharing routines become decisive factors for the success and failure of Japanese organizations (Collinson & Wilson, 2006). Interactions and relationships between individuals or groups are playing an important role for knowledge exchange and integration, especially for tacit knowledge (Brown & Duguid, 1991).

Toyota credits its success with JIT management to an effective knowledge sharing network with suppliers. Such effectiveness of knowledge sharing is built upon a high degree of collaboration and high quality communication. There are various ways to create and manage knowledge sharing between Toyota and its suppliers. According to media naturalness theory, as a result of Darwinian evolution, face-to-face communication is the best way for education, knowledge transfer and negotiation among human society (Kock, 2005). As a matter of fact, face-to-face communication is always highly recommended as a part of on-site philosophy of Toyota, although it is not always possible (Dyer & Nobeoka, 2000).

Thanks to modern technology, knowledge sharing can be realized through the use of e-communication. Video conference, teleconference, chatting tools, email, and all other similar tools are widely used by nowadays firms to exchange information and transfer knowledge. Nevertheless limitations exist in these e-communication tools. Media richness theory advocates the more ambiguous and uncertain a task is, the richer the

format of media is needed (Daft & Lengel, 1986). Regularly held video conferences, shared management software like ERP are largely used between Toyota and its suppliers.

Based on the literature about the moderating effect of physical proximity and knowledge sharing, the following hypotheses are suggested:

H4. The positive relation between the degree of modularization and market performance becomes stronger as physical proximity between module buyers and suppliers increases.

H5. The positive relation between the degree of modularization and strategic positional advantage becomes stronger as physical proximity between module buyers and suppliers increases.

H6. The positive relation between the degree of modularization and market performance becomes stronger as knowledge sharing between module buyers and suppliers increases.

H7. The positive relation between the degree of modularization and strategic positional advantage becomes stronger as knowledge sharing between module buyers and suppliers increases.

(4) Guanxi: The Cultural Sensitivity

Dunning regards national culture as a critical factor affecting FDI inflows, MNEs' strategy and activity (Dunning & Bansal, 1997; Hofstede, 1984; Seyoum, 2011). Culture plays an important role in the MNEs' entry mode choice (Kogut & Singh, 1988), it has an essential impact on the quality of knowledge transfer among MNEs and their subsidiaries (Bhagat, Kedia, Harveston, & Triandis.H.C., 2002; Minbaeva, Pedersen, Bjorkman, Fey, & Park, 2003; Sarala & Vaara, 2010; Simonin, 2004), which in turn would affect the performance and strategic positional advantage of MNEs (Kogut & Zander, 2003a, 2003b; Love, 1995; McFetridge, 1995). It also highly influences the variables of

Dunning's OLI model. For example, a society of high power distance shows a lower tendency to internalize, and location choice of MNE is affected by the cultural distance between home and host countries (Dunning & Bansal, 1997).

As a significant part of Chinese culture, Guanxi is described by management consultant as the informal connection which is so essential to gain access to almost everything in China, just as an old Chinese saying: "Who you know is more important than what you know" (Yeung & Tung, 1996, p. 54). Thus numerous guidebooks advocate that foreign firms should pay attention to Guanxi, otherwise they could face a dim future in the Chinese market (Tsang, 1998). Although China is not the only society where networks play an important role in social life, Guanxi is still recognized by many scholars as something special within Chinese society. It is similar to but different from the social networking in the West. Trusting relations are involved in both cases; yet Chinese business relations have a stronger personal and socio-emotional component inside, such as more interactions of gifts exchange, banquets, etc. Sometimes it can become a substitutes for formal institutional support in Chinese business (Chua, Morris, & Ingram, 2009; Xin & Pearce, 1996). Such characteristics are rooted in the Chinese Confucian society and culture of familial collectivism (Tsang, 1998; Yeung & Tung, 1996). Due to the essence and uniqueness, Guanxi as a Chinese term of social networking is directly adopted into English parlance by western researchers (Gold, Guthrie, & Wank, 2002).

Guanxi as a kind of business contact can be an important source of competitive advantage for MNEs in China (Seyoum, 2009).Although more and more managers of MNEs are aware of this, its mechanism is not yet well understood and its impact is still underestimated. Guanxi activities like gift exchange and business visit are viewed as a

waste or unnecessary by some western managers, and such an opinion has been proved to be deadly wrong when doing business in China (Chadee & Zhang, 2000). Some scholars regard Guanxi as a kind of relationship marketing in China (Wong & Chan, 1999).Managers are warned to be cautious of Guanxi's dark side, which includes reciprocal obligations and collective blindness (Gu.F.F., Hung, & Tse, 2008), yet it has been confirmed that basically Guanxi is ethical, or at least has very little to do with ethical reasoning, and it can be used as a positioning strategy in China (Leung & Wong, 2001; Su, Sirgy, & Littlefield, 2003).

Guanxi is believed to exist both at the person-to-person and firm-to-firm level. The latter is more valuable to western MNEs since most expatriate managers who build up and own personal Guanxi stay a relatively short time in China. A five stage model was created to illustrate the development of Guanxi: Initiating contact, solidifying relationships, forming Guanxi, expanding relationships and utilizing Guanxi system (Li & Wright, 2000).

Different dimensions exist in Guanxi: adaptation, dependence, favor , trust (Buttery & Wong, 1999), Ganqing (a Chinese expression for degree of closeness), credibility, face (Tsang, 1998), opportunism, dynamism, business interaction and protectionism (Leung & Wong, 2001).

The indirect and direct effect of Guanxi on firms' market performance and strategic positional advantage has been confirmed by scholars. It is found that there is a strong tie between Guanxi and trust, which is a key element to firms' success (Aulakh, Kotabe, & Sahay, 1996; Gong & Lian, 2009; Johnson, Cullen, Sakano, & Takenouchi, 1996; Kwon & Suh, 2005; Morgan & Hunt, 1994; Ritter & Gemunden, 2003). Guanxi is

important for subordinate trust in the supervisor, and among business executives. It makes a contribution to the level of trust between buyer and supplier in a supply chain. Guanxi has both positive and negative effects on trust in management; such effects are mediated by perceived procedural justice. (C. C. Chen, Chen, & Xin, 2004; Farh, Tsui, Xin, & Cheng, 1998; D. Y. Lee & Dawes, 2005).

Besides the indirect impact via trust, Guanxi can also affect many aspects of the firms' performance and strategic positional advantage directly, such as sales growth, net profits growth, long-term financial performance, competitiveness and access to resources (Park & Luo.Y., 2001; Yeung & Tung, 1996). Such impact is mediated by relationship quality and interdependence (D.-J. Lee, Pae, & Wong, 2001). As per foreign investment in China, "Guanxi has a significant and positive impact on a venture's accounting and market performance". In this case, MNEs' entry mode, country of origin and length of operation are playing a moderator role between Guanxi and firms' performance. The evidence shows that Guanxi has a profound and positive impact on firms' efficiency and growth, which are indicators of firms' strategic positional advantage (Y. Luo, 1997; Y. Luo & Chen, 1997). Firms can gain market access and growth through Guanxi networks, but this can only be realized when Guanxi is capitalized from the personal to the corporate level (Gu.F.F., et al., 2008).

Based on the literature of Guanxi's impact on business in China, the following hypotheses are suggested:

H8. The positive relation between the degree of modularization and market performance becomes stronger as Guanxi between module buyers and suppliers gets closer.

H9. The positive relation between the degree of modularization and strategic positional advantage becomes stronger as Guanxi between module buyers and suppliers gets closer.

Conclusion

From the literature review, it has been found that modularization has become an important strategy for MNEs in the computer software and hardware industry. It is a way of reconfiguring the structure of organizations, integrating or outsourcing production, obtaining or isolating knowledge. Through modularization, firms can reduce the cost of design, production, experimentation, maintenance, administration and knowledge transfer. Firms can also greatly improve the speed-to-market and flexibility in the way of mass customization, which is the essence of modularization. Due to the specialization brought by modularization, product quality will be improved as well. All these benefits generated by modularization can lead to the improvement of firms' strategic positional advantage.

Better performances are also found among firms adopting the strategy of modularization, including larger customer range, higher profit and better customer relations. The flexibility and specialization brought by modularization enables firms to win more customers. Isolated knowledge transfers value creation downstream from module buyer to supplier, which gives more profit margins to the module supplier. Modularization requires a high degree of collaboration from the beginning of product design to the end of customer service. Thus it creates a more closed and stable relationship between the module buyer and supplier.

As a purpose of integration, module suppliers try to upgrade their value chain position, obtain special knowledge, and approach new markets through mergers and acquisitions.

Such a wave has been noticed in Europe, Brazil, and Chinese automotive industries. It has also provided evidence for internalization theory, transaction cost economics, OLI model and knowledge-based view of firm.

Modularization in the auto industry has been regarded as a new milestone in organization management. Initiated by European automakers, it has been well accepted and adopted by others. Yet the degree and way of modularization differs greatly by region. Europe has the highest degree and fastest pace. Modularization in the U.S. is not so welcomed due to the opposition of union, and the culture of arm's length relationships between buyer and supplier. The Japanese auto industry is lagging behind in this aspect due to the wage gap between automakers and parts suppliers not being big enough to induce this strategy. Limited geographic space also makes it hard for physical proximity.

Despite of all the importance, no empirical study has been conducted on modularization in the Chinese auto industry, which is by now the largest auto manufacturer and consumer in the world. Thus it is an imperative and meaningful task to conduct such a research. Nine hypotheses are presented here and will be tested as described in the following chapter.

Chapter III

Methodology

Introduction

The research methodology and construct measurements to be used in the study are discussed in this chapter. The purpose of this study is to conduct empirical research on the impact of modularization on the Chinese auto industry, which, after an extensive literature search, does not appear to have been done in any other studies. Moderating factors such as physical proximity, knowledge sharing and Guanxi which are observed as pertinent in similar works conducted in other countries are also analyzed in this study.

Quantitative research is employed to examine the relation between modularization and its impact on the Chinese auto industry. Modularization's impact on the firm is measured by firm performance and strategic positional advantage, while the impact on industry is measured by the trend in mergers and acquisitions. Physical proximity, knowledge sharing and Guanxi between module buyers and suppliers are examined as moderators between modularization and its impact.

Research Design

Based on the research questions presented in Chapter I and the literature review in Chapter II, it is anticipated that there is a positive relation between modularization and auto firms' performance and positional advantage in China. Such a relation is also expected to be shown between modularization and the trend of mergers and acquisitions in the Chinese auto industry. Such a relation is expected to be enhanced by moderators including physical proximity, knowledge sharing and Guanxi. The conceptual framework of this study is depicted as follows:

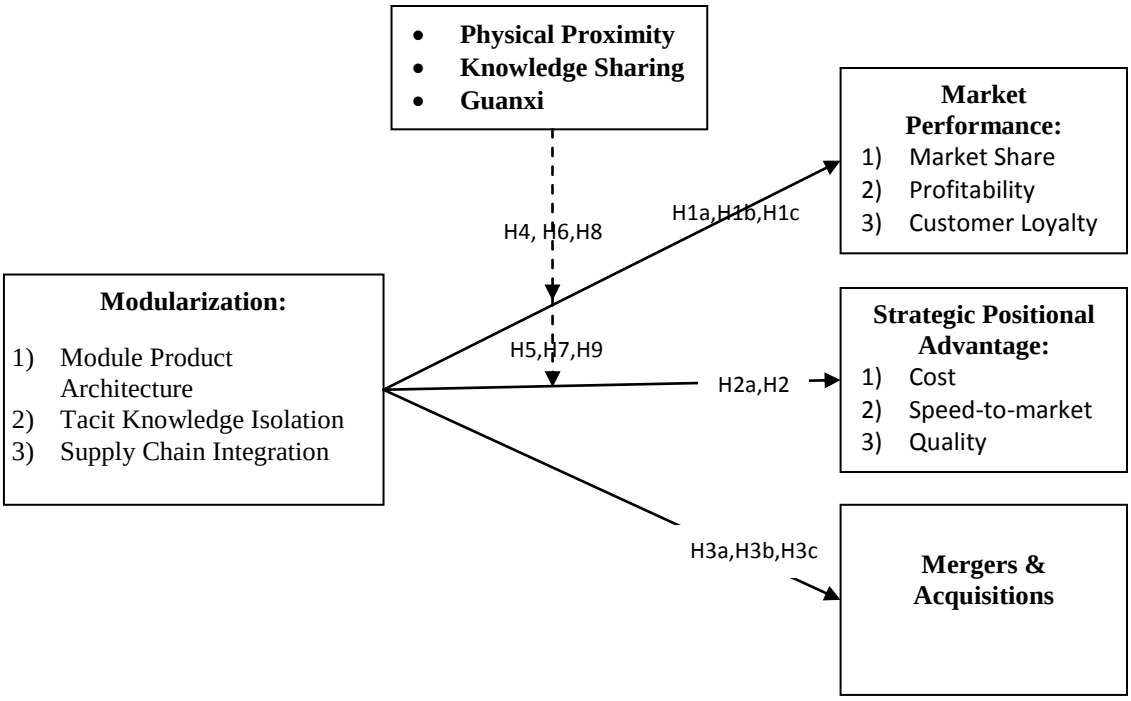


Figure 6. Conceptual Framework

Research Framework

As shown in figure 6, modularization will be examined as the **independent variable**; the impact of modularization on the Chinese auto industry will be examined as the **dependent variable**, which includes firm's performance, firm's strategic positional advantage and the trend of mergers and acquisitions in the Chinese auto industry. Physical proximity, knowledge sharing and Guanxi between module buyers and suppliers will be examined as **moderators** between modularization and its impact. The concept of modularization and its outcomes, and the moderators were discussed in literature review of Chapter II, and summarized as follows:

Independent variable:

Modularization - measured by three dimensions: modular product architecture; tacit knowledge isolation; and supply chain integration.

Dependent variables:

Market Performance - measured by three dimensions: market share; profitability and customer loyalty.

Strategic Positional Advantage – measured by three dimensions: cost; speed-to-market and quality.

Mergers and Acquisitions – measured by the occurrence of historical mergers and acquisitions in the most recent three years that data is available, and the prediction for the probability of occurrence for the three years in the future.

Moderators:

Physical proximity; knowledge sharing; and Guanxi

Hypotheses and Instruments

As listed in Chapter I, the research questions for this study are:

1. What is the impact of modularization on the automotive firms' performance in China?
2. What is the impact of modularization on the automotive firms' strategic positional advantage in China?
3. Is modularization a stimulus to the trend of mergers and acquisitions in the Chinese auto industry?
4. What kind of effect do physical proximity, knowledge sharing and Guanxi have on the relation between modularization and its impact on the Chinese auto industry?

In order to answer these research questions, the following hypotheses are suggested based on the review of literature and conceptual framework:

H1a: There is a positive relation between the degree of module product architecture and the market performance of automotive firms in China.

H1b: There is a positive relation between the degree of tacit knowledge isolation and the market performance of automotive firms in China.

H1c: There is a positive relation between the degree of supply chain integration and the market performance of automotive firms in China.

H2a: There is a positive relation between the degree of modular product architecture and the strategic positional advantage of automotive firms in China.

H2b: There is a positive relation between the degree of tacit knowledge isolation and the strategic positional advantage of automotive firms in China.

H2c: There is a positive relation between the degree of supply chain integration and the strategic positional advantage of automotive firms in China.

H3a: There is a positive relation between the degree of module product architecture and the likelihood that a merger/acquisition will take place between parts suppliers.

H3b: There is a positive relation between the degree of tacit knowledge isolation and the strategic positional advantage of automotive firms in China.

H3c: There is a positive relation between the degree of supply chain integration and the strategic positional advantage of automotive firms in China.

H4. The positive relation between the degree of modularization and market performance becomes stronger as physical proximity between module buyers and suppliers increases.

H5. The positive relation between the degree of modularization and strategic positional advantage becomes stronger as physical proximity between module buyers and suppliers increases.

H6. The positive relation between the degree of modularization and market performance becomes stronger as knowledge sharing between module buyers and suppliers increases.

H7. The positive relation between the degree of modularization and strategic positional advantage becomes stronger as knowledge sharing between module buyers and suppliers increases.

H8. The positive relation between the degree of modularization and market performance becomes stronger as Guanxi between module buyers and suppliers gets closer.

H9. The positive relation between the degree of modularization and strategic positional advantage becomes stronger as Guanxi between module buyers and suppliers gets closer.

A summary of the hypotheses and the ways of testing them is depicted as follows:

Table 1

Summary of Hypotheses: MP- Market Performance, SPA – Strategic Positional Advantage; M&A- Mergers & Acquisitions, PP – Physical Proximity, KS – Knowledge Sharing, GX – Guanxi

H	Independent Variable	Moderator	Dependent Variable	Analysis
H1a	Module Product Architecture		MP	Correlation
H1b	Tacit Knowledge Isolation		MP	Correlation
H1c	Supply Chain Integration		MP	Correlation
H2a	Module Product Architecture		SPA	Correlation
H2b	Tacit Knowledge Isolation		SPA	Correlation
H2c	Supply Chain Integration		SPA	Correlation
H3a	Module Product Architecture		M&A	Correlation
H3b	Tacit Knowledge Isolation		M&A	Correlation
H3c	Supply Chain Integration		M&A	Correlation
H4	Modularization	PP	MP	Regression
H5	Modularization	PP	SPA	Regression
H6	Modularization	KS	MP	Regression
H7	Modularization	KS	SPA	Regression
H8	Modularization	GX	MP	Regression
H9	Modularization	GX	SPA	Regression

Measures:

Except for the measure of mergers and acquisitions, fifty nine survey questions were adapted from existing research which have been tested and validated as the

instrument for this study. Each statement of the questionnaire contains a 5-point scale to measure the degree of a certain dimension. Scales of Question 1- 17, 22-24 and 41-63 range from strongly disagree (1) to strongly agree (5); scales of question 25-39 range from much lower (1) to much higher (5).

There are seven measures for this study:

Independent variable: (1) modularization;

Dependent variables: (2) firm's performance, (3) positional strategic advantages and (4) mergers and acquisitions

Moderators: (5) physical proximity; (6) knowledge sharing and (7) Guanxi

(1) Modularization (MD): Most of the researchers in this field operationalize MD by measuring it with three dimensions: modular product architecture, tacit knowledge isolation and supply chain integration. The questionnaire was adapted from the study of modularization in Brazil by Parente (2003). This study reported an internal reliability coefficient of 0.83 for modular product architecture, .80 for tacit knowledge isolation and .88 for supply chain integration (Lau, Yam, & Tang, 2010; Parente, 2003; Tu, et al., 2004; Worren, et al., 2002).

Questions 1 to 5 in the questionnaire were about the degree of module product architecture. Some essential attributes of a module product were reflected in these questions: internal complexity and external exchangeability; component separability and component combinability (Parente, 2003). Questions 6 to 10 were utilized to ask respondents about the tacit knowledge isolation within a module and module supplier, which is another essence of modularization: the boundary of a module product and module producer was determined by the isolation of tacit knowledge between the module

buyer and supplier. Questions 11 to 17 were to measure the degree of supply chain integration as the third dimension of modularization. Degree of supply chain integration was reflected by questions about the degree of cooperation and collaboration between the module buyer and supplier.

(2) Market Performance (MP): This scale measured firm's market performance, including financial and non-financial performance. It was measured by the average score of market share, profitability, and customer loyalty (Day & Wensley, 1988; Lanctot & Swan, 2000). The purpose of questions 18 was to capture this scale; an internal reliability coefficient was reported as 0.80 by Lanctot and Swan (2000).

(3) Strategic Positional Advantage (SPA): This scale was measured by the average score of three dimensions: low cost; speed-to-market and high quality. This item consists of questions 23 to 37, trying to capture the improvement of firm's strategic positional advantage. An internal reliability coefficient of 0.85 was reported (Lanctot & Swan, 2000).

(4) Mergers and acquisitions (M&A): The statement of question 38 was scored as 5 if the answer was yes, and scored as 1 if the answer was no. The statement of question 39 was based on a personal judgment on the probability of the future event.

(5) Physical Proximity (PP): Questions 40 to 44 were adapted to measure the importance of locational closeness between module buyer and supplier, as a moderator for the impact of MD. An internal reliability coefficient of .76 was reported by Parente (2003).

(6) Knowledge Sharing (KS): through question 45 to 55, respondents were asked about the degree of knowledge sharing within their firms and between module buyers and

suppliers. Various ways of knowledge sharing were included: face to face communication, audio conference, video conference, website and electronic information sharing. An internal reliability coefficient of 0.88 was reported by Parente (2003).

(7) Guanxi (GX): Measures of Guanxi as another moderator were derived from the work of Chen et al (2011), which is focused on the Guanxi between buyer and supplier in manufacturer industry. Questions 58 to 61 were adapted to ask respondents about the utilization of Guanxi in their firms. Guanxi's impact was measured by the degree of friendship, value of *face*, frequency of gift exchange and reciprocal help between two sides. An internal reliability coefficient of 0.798 was reported.

Sample and Data Collection

As described in Chapter I, the research scope of this study is auto industry in China. Thus samples were collected from automotive manufacturers in China, including automakers and parts suppliers.

Approval from International Review Board was obtained before conducting such a survey and the data collection.

A doctoral student from Nova Southeastern University in the U.S. and a professor from Chang An University in China were asked to review the Chinese questionnaire which was translated from the original English version, which was then revised and subject to a back-translation procedure to ensure validity in a cross-cultural context.

The purchasing departments of three major automakers in Chinese market were used as the channels to distribute the questionnaire to 250 auto parts suppliers: FAW Group, FAW Jilin Auto LTD, and Daihatsu (Shanghai) Co. Ltd. Business managers with full information of the firms were asked to answer these questions. Questionnaires were

sent electronically to the purchasing department of three automakers, and then distributed to auto parts suppliers electronically. Answers from auto parts suppliers were collected by the purchasing department of the three automakers via email, and then forwarded to the researcher.

Listed as a Fortune 200 global firm, FAW Group is China's oldest and largest vehicle manufacturer with an annual output of 2.5 million units of vehicles and with a sales income of 45 billion US dollars in year 2010. There are approximately 1000 auto parts suppliers (OEM) supplying to the FAW Group in China. The purchasing department of FAW Group mainly deals with the parts suppliers for passenger cars and heavy duty trucks, which are the major product series in the FAW Group (FAW, 2012).

FAW Jilin Auto Ltd is a subsidiary company of FAW Group, specializing in minivan and compact cars with annual sales of 120,000 units in year 2011. Although it is under the umbrella of FAW Group, there is an independent purchasing department in FAW Jilin Auto Ltd due to the different product lines from the other subsidiaries (Auto333, 2012).

Daihatsu (Shanghai) Co. Ltd. is a branch company of Daihatsu Motor Co. Ltd, which in turn is a subsidiary of Toyota Motor Co. Ltd. Daihatsu Motor Co. Ltd specializes in compact vehicles and is one of the earliest foreign auto maker producing vehicles in China. As a part of its globalization strategy, Daihatsu set up a company in Shanghai for the purpose of outsourcing auto parts from China (Daihatsu, 2012).

In order to reduce common method bias and same resource bias (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003; Sims & Sun, 2012), the following techniques were adopted:

1. Respondents' answers were anonymous.

2. Respondents were informed that there was no right or wrong answers, questions should be answered as honestly as possible.

3. Questions about the status of the respondents and firms were inserted between measures of modularization and outcomes, for the purpose of generating a psychological separation between constructs.

4. Answers were based on different information resources: personal judgment and factual database (firm's status and performance)

Data Analysis and Interpretation

The questionnaire was adapted from previous research which has tested and confirmed construct validity and scale reliability; such test was conducted in this study again.

A participating rate of 80% was expected from the respondents which would yield a sample size of approximately 200 firms. Correlation and regression analysis would test the data. Hypotheses would be supported or rejected and the research questions would be answered. Interpretation would be made based upon the result of data analysis.

Summary

The purpose of this research is to conduct a study on modularization in the Chinese auto market, and to discuss it in light of the theory of the MNE. Through the analysis on the collected data and discussion on the result in Chapter IV, a new regional study in IB is explored and the value is added to the research in this direction. Conclusions and implications derived from the analysis on the data are presented in Chapter V.

Chapter IV

Data Analysis

Introduction

This chapter describes the data analysis used to test the hypotheses illustrated in the previous chapter and consists of three sections: the first section describes the sample and demonstrates the characteristics of the respondents. The second section analyzes the data based on the framework of the hypotheses, and discusses the results of the data analysis. The final section is a summary of the findings. The functional forms to be tested in this dissertation are reported as following:

(1) Modularization (MD) = f (Modular Product Architecture, Tacit Knowledge Isolation, Supply Chain Integration)

(2) Market Performance (MP) = f (MD)

(3) Strategic Positional Advantage (SPA) = f (MD)

(4) Moderating and mediating effects of Physical Proximity (PP), Knowledge Sharing (KS), and Guanxi (GX) on the strength of the relationship given in (2) and (3)

Sample Response Rate

A questionnaire consisting of 57 items was distributed via email to managers or engineers of 350 auto parts manufacturers in China. The questionnaire was adapted from previous studies of Parente (2003); Day and Wensley (1988); Lanctot and Swan (2000); and Chen et al. (2011). Emails were sent through managers of three major auto makers purchasing departments in China: FAW Group, FAW Jilin Auto LTD, and Daihatsu (Shanghai) Co. LTD. Respondents emailed their answers to the purchasing departments' managers who then forwarded them to the researcher in a manner that allowed the

respondents to remain anonymous. Out of 350 respondents, the total number of usable surveys was 262, which represents a 75% return rate. Among the 262 usable surveys, 201 were collected through FAW Group, 36 through FAW Jilin Auto LTD, and 25 through Daihatsu (Shanghai) Co. LTD.

Descriptive Statistics

Descriptive statistics of the sample were used to display size of the firm (by number of employees) (Fig. 7), length of time in business (Fig. 8), experience with mergers and acquisitions (Figs. 9 and 10), joint venture (Fig. 11) and job rank of the respondent (Fig. 12).

Examining size of surveyed firms by number of employees, of 262 firms, 115 firms have less than 250 employees, accounting for 47.9% of the total, while 125 firms have more than 251 employees, accounting for 52.1% of the total (Fig. 7).

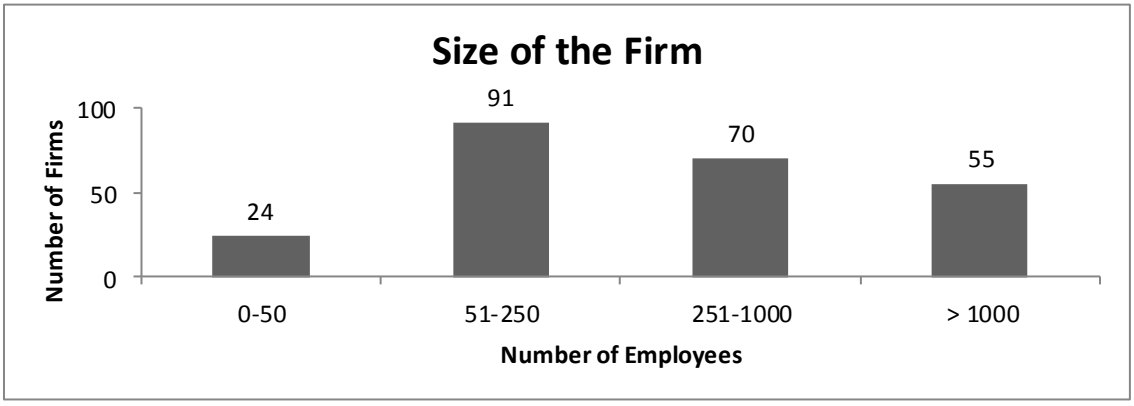


Figure 7. Size of the Firm (by Number of Employees)

Among the total 262 answers, 47 are from firms with a history of less than 10 years, accounting for 19.3% of the total; 151 are from firms 11-30 years old (61.9%); 17 are from firms 31-50 years old (7%); and 29 are from firms greater than 50 years old (11.9%) (Fig. 8).

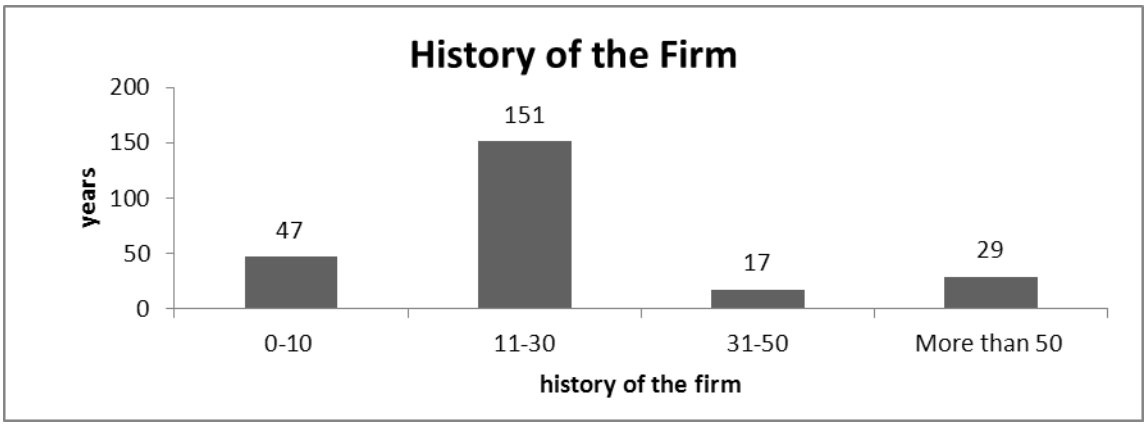


Figure 8. History of the Firm

Among the 262 responding firms, 79.4% had not experienced mergers and acquisitions in the last three years while 29.6% did (Fig. 9). Expectation for future mergers and acquisitions is displayed in Figure 10. A scale of 1 to 5 presents the degree of expectation from very low to very high. As reported, 53.1% of the respondents have very low expectation for mergers and acquisitions' activity in the future three years, and 4.6% have very high expectation.

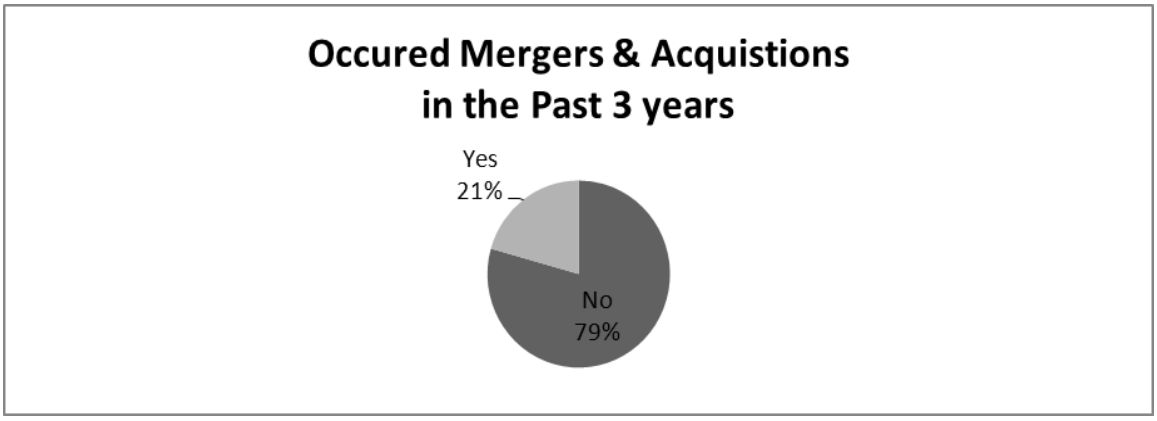


*Figure 9.*Mergers and Acquisitions Completed

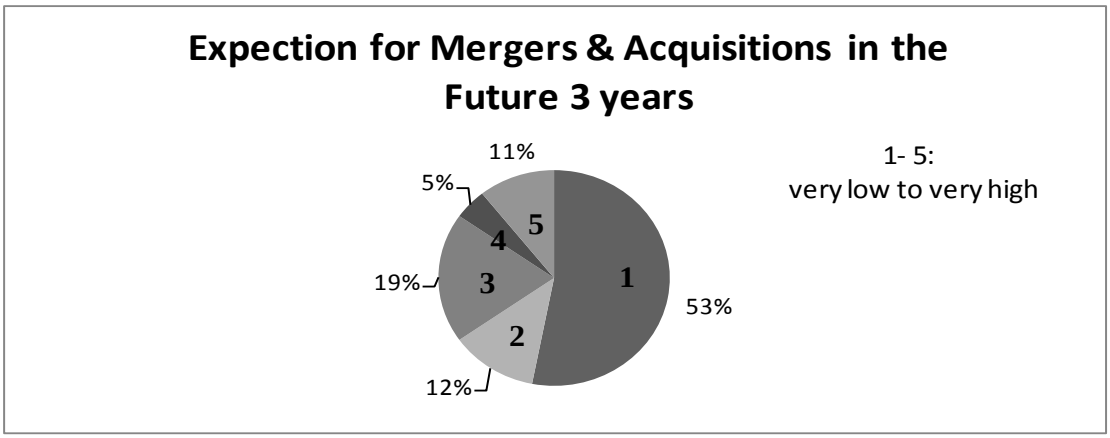


Figure 10. Expectation for the Future Mergers and Acquisitions

Attribute of the firm is categorized by joint-ventured with foreign firms or non-joint-ventured, as reported in Figure 11, 17.1% of the surveyed firms are joint-ventured with foreign firms, while 81.7% are non-joint ventured ones.

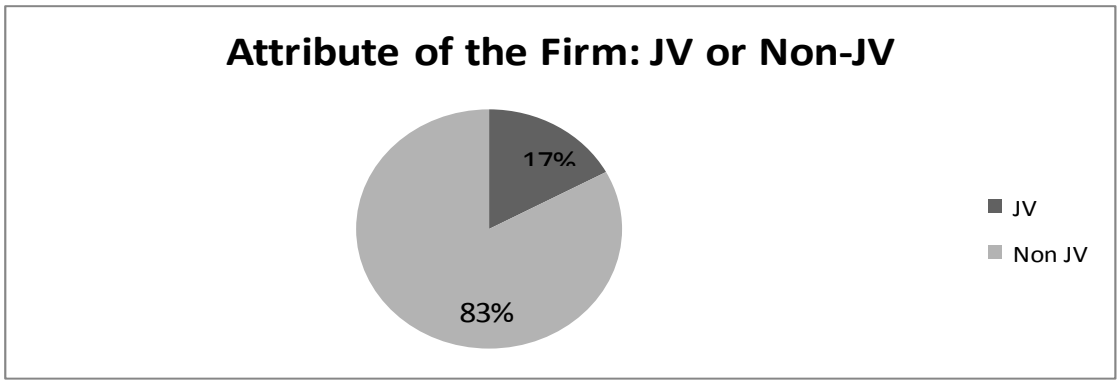


Figure 11. Attribute of the Firm

Ranks of the survey respondents in their firms are described in Figure 12. Of the total 199 answers, 32 are from senior management (16.1%), 92 are from middle management (26.2%), 50 are from technical engineers (25.1%), and 25 are from support staff (12.6%).

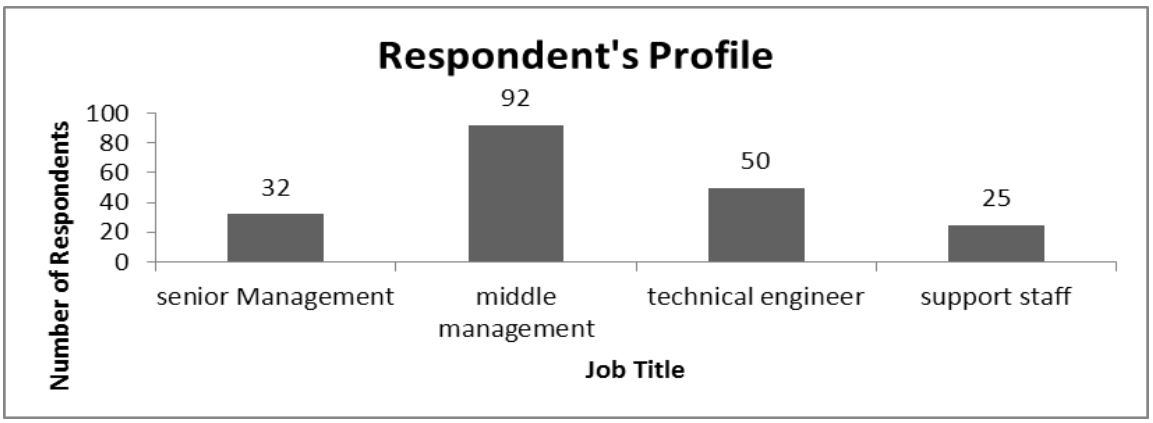


Figure 12. Respondent's Profile

Reliability and Exploratory Factor Analysis

The reliability of the survey instrument was tested by Cronbach's alpha. While coefficient alpha of at least .70 is considered acceptable for hypothesis testing (Sims, 2000), some researchers have argued that the .70 cutoff is inappropriate unless other types of information are taken into account (Parente, 2003; Schmitt, 1996). Alphas ranged from .7 for Guanxi to .86 for physical proximity (see Table 2).

Table 2

Cronbach's Alpha Reliability Scores

Questionnaire Variables		Items Included	α
Modularization	Modular Product Architecture	5	.84
	Tacit Knowledge Isolation	5	.82
	Supply Chain Integration	7	.81
Market Performance		3	.81
Strategic Positional Advantage		15	.91
Physical Proximity		5	.86
Knowledge Sharing		11	.85
Guanxi		4	.70

Modular product architecture, tacit knowledge isolation and supply chain integration as the three dimensions yield the reliability coefficients of .84, .82, and .80, which are closed to the result from previous studies as of .83, .80, and .88 (Lau, et al., 2010; Parente, 2003; Tu, et al., 2004; Worren, et al., 2002).

Market performance as a dependent variable has three items and yield a reliability coefficient of .80, which is same as the result of previous study from Lanctot and Swan (2000) .

Strategic positional advantage as another dependent variable is measured by 15 items, with a reliability coefficient of .78, which is a bit lower than the result from Lanctot and Swan (2000)'s study, but still above the acceptable level.

Physical proximity, knowledge sharing and Guanxi as three moderators, have reliability coefficients of .86, .85, and .70 respectively, which are closed to result of .76, .88, and .80 from previous studies (H. Chen, et al., 2011; Parente, 2003).

An exploratory factor analysis (EFA) was conducted on 57 variables. The principal extraction method with Varimax rotation and Kaiser normalization of component analysis was selected as suggested by Hair, Anderson, Tatham and Black (1998).

The results of Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity are displayed in Table 3. With a KMO value of .783, which is greater than 0.5, and a significance value of .000, which is less than 0.05, the factor analysis performed is acceptable (Schwarz, 2011).

Table 3

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.783
Bartlett's Test of Sphericity	Approx. Chi-Square	9292.101
	df	1485
	Sig.	.000

From the EFA output, eight factors have been created from variables with loading values greater than 0.30, which is regarded as moderately acceptable (DeCoster, 2004; Yusoff, 2011). The loading values and factors are identified in Table 4. The EFA converged in 8 iterations.

Table 4

Exploratory Factor Analysis: MPA-Module Product Architecture, TKI- Tacit Knowledge Isolation, SCI-Supply Chain Integration, MP-Market Performance, SPA-Strategic Positional Advantage, PP-Physical Proximity, KS-Knowledge Sharing, GX-Guanxi

Factors	Variables	Component					
		1	2	3	4	5	6
Factor (1)	MPA 1	.356	-.199	.136	-.002	**.464**	.306
Module Product Architecture	MPA 2	.329	-.109	.321	-.035	**.547**	.033
	MPA 3	.038	.022	.108	.056	**.753**	.180
	MPA 4	.139	-.007	.083	.045	**.719**	.137
	MPA 5	-.028	-.067	.186	.049	**.671**	.357
	TKI 1	**.627**	-.129	-.037	-.051	.323	.210
	TKI 2	**.548**	-.109	.224	-.127	.390	.010
Factor (2)	TKI 3	**.643**	-.038	-.015	-.086	.332	.235
Tacit Knowledge Isolation	TKI 4	**.611**	.080	-.143	.156	.285	.143
	TKI 5	**.570**	.003	-.013	.155	.252	-.060
Factor (3)	SCI 1	**.501**	.002	.173	.098	-.150	.074
Supply Chain Integration	SCI 2	**.678**	-.066	.142	.204	.065	.013
	SCI 3	**.747**	-.083	.127	.134	.159	-.156
	SCI 4	**.332**	.002	.059	.373	.093	.312
	SCI 5	**.758**	-.037	.003	.092	-.080	.020
	SCI 6	**.597**	-.044	.259	.028	.350	-.199
	SCI 7	**.766**	.069	.105	.096	.083	.039
Factor (4)	MP 1	.537	.045	.133	-.115	.040	**.510**
Market Performance	MP 2	.149	.028	.055	-.145	.164	**.622**
	MP 3	.569	-.021	.213	-.073	.112	**.503**

Factor (5)	SPA 1	.509	.064	.309	-.260	-.119	.115
Strategic Positional Advantage	SPA 2	.063	**.316**	-.217	.355	.070	.315
	SPA 3	-.103	.270	-.064	.369	.104	.122
	SPA 4	-.011	**.822**	-.018	.074	-.118	.117
	SPA 5	.012	**.808**	.054	.015	-.203	.011
	SPA 6	-.023	**.828**	.047	-.070	-.181	-.016
	SPA 7	.024	**.766**	.093	.193	.034	.016
	SPA 8	-.043	**.819**	-.021	.072	.143	.050
	SPA 9	.034	**.748**	.031	.050	.112	-.050
	SPA10	-.107	**.719**	.053	-.036	-.036	-.191
	SPA11	.377	.202	.040	-.064	-.185	.150
	SPA12	.277	.152	-.053	-.037	-.040	.243
	SPA13	.567	-.026	.125	-.113	-.245	.130
	SPA14	.196	.075	.051	-.109	.250	-.160
	SPA15	.045	.226	-.091	-.051	.196	.037
Factor (6)	PP1	.015	.002	-.063	**.702**	.020	-.048
Physical Proximity	PP2	.051	.116	-.128	**.777**	-.099	-.019
	PP3	.099	.041	.148	**.831**	-.007	.013
	PP4	.006	.014	.191	**.719**	.069	.175
	PP5	.139	-.046	.131	**.763**	-.057	.116
Factor (7)	KS1	.501	-.033	**.564**	-.044	-.210	.090
Knowledge Sharing	KS2	.452	-.102	**.386**	.210	.011	.143
	KS3	.262	.036	**.745**	-.043	.056	-.167
	KS4	.224	.125	**.680**	.209	.169	-.051
	KS5	.239	-.108	**.510**	.276	.051	.154
	KS6	-.032	.077	**.678**	-.094	-.032	.093
	KS7	.194	.015	**.760**	-.031	.122	.088
	KS8	-.031	.025	**.682**	-.142	.327	.021
	KS9	.195	-.041	**.517**	.095	.057	.291
	KS10	-.186	-.009	**.449**	.072	.466	-.011
	KS11	-.075	.043	**.525**	.203	.343	.202
Factor (8)	GX 1	.062	-.143	.115	.108	.092	**.643**
Guanxi	GX 2	-.030	.230	.040	.243	.041	**.624**
	GX 3	-.068	.016	.029	.167	.158	**.493**
	GX 4	.309	-.115	.124	.097	.039	**.588**

Correlation Analysis

In order to test the relation between the independent variable (modularization) and dependent variables (market performance, strategic positional advantage, and mergers and acquisitions), correlation analysis under SPSS was conducted.

Module product architecture as one of the three dimensions of modularization was calculated by the mean of the five items under it, as depicted in Table 2. Similarly, tacit knowledge isolation was calculated by the mean of the five items under it, and supply

chain integration was calculated by the mean of the seven items under it.

Market performance and strategic positional advantage as the independent variables were calculated by the means of their items. Under strategic positional advantage, items 2 through 10 were reversed coded since the scales were designed in a reversed way for these questions.

The result from correlation analysis under SPSS shows that there are different levels of correlation between the independent and dependent variables, as displayed in Table 5. Except for the correlation between module product architecture and strategic positional advantage, Pearson's r value and p value show significant correlations between the independent and dependent variables (Sims, 2000).

Market performance is found significantly positively correlated with module product architecture, with a Pearson's r of .36. Thus, Hypothesis 1a is supported:

H1a: There is a positive relation between the degree of module product architecture and market performance of the automotive firms in China.

Market performance is also significantly positively correlated with tacit knowledge isolation, with a Pearson's r of .43. Thus, Hypothesis H1b is supported:

H1b: There is a positive relation between the degree of tacit knowledge isolation and market performance of the automotive firms in China.

It is also found that a significant positive correlation exist between market performance and supply chain integration, with a Pearson's r of .44. Thus Hypothesis H1c is supported:

H1c: There is a positive relation between the degree of supply chain integration and market performance of the automotive firms in China.

The significant correlation between strategic positional advantage and module product architecture was not found in this study. In this case, Pearson's r is .10 with a p-value of .10. Thus Hypothesis H2a is rejected: No significant relation is found between the degree of modular product architecture and strategic positional advantage of the automotive firms in China.

But a significant positive correlation does exist between strategic positional advantage and tacit knowledge isolation, with Pearson's r of .26. Thus Hypothesis H2b is supported:

H2b: There is a positive relation between the degree of tacit knowledge isolation and strategic positional advantage of the automotive firms in China.

A significant positive correlation is also found between strategic positional advantage and supply chain integration, with a Pearson'r of .19. Hypothesis H2c is supported:

H2c: There is a positive relation between the degree of supply chain integration and strategic positional advantage of the automotive firms in China.

The significant correlation between mergers acquisitions and module product architecture was not found in this study. In this case, Pearson's r is .12 with a p-value of .05. Thus Hypothesis H3a is rejected: No significant relation is found between the degree of modular product architecture and mergers acquisitions in the Chinese automotive industry.

Again, the significant correlation between mergers acquisitions and tacit knowledge isolation was not found in this study. In this case, Pearson's r is -.01 with a p-value of .92. Thus Hypothesis H3b is rejected: No significant relation is found between

the degree of tacit knowledge isolation and mergers acquisitions in the Chinese automotive industry.

The significant correlation between mergers acquisitions and supply chain integration was not found as well. In this case, Pearson's r is -.001 with a p-value of .98. Thus Hypothesis H3c is rejected: No significant relation is found between the degree of supply chain integration and mergers acquisitions in the Chinese automotive industry.

Table 5

Correlation between Dependent and Independent Variables

Variable	1	2	3	Mean	SD
Modular Product Architecture				3.48	1.14
Tacit Knowledge Isolation	.44**			4.36	0.81
Supply Chain Integration	.33**	.64**		4.43	0.67
Market Performance	.36**	.43**	.44**	3.96	1.01
Strategic Positional Advantage	.10	.26**	.19**	3.27	0.60
Mergers and Acquisitions	.12	-.01	-.001	1.55	1.39

** $p < .01$

Moderating Effect

In order to test the moderating effects, the methods outlined by Aiken and West (1991) and recommended by Sims, Gong and Ruppel (2012) is adopted in this study, through which the potential multi-collinearity problems can be avoided (Hair, Anderson, Tatham, & Black, 2005). Modularization as the independent variable is mean-centered prior to testing the moderating effects of physical proximity, knowledge sharing and Guanxi on the relations between the independent variable (modularization) and the dependent variables (market performance, strategic positional advantage). Two base

models of regression analysis were constructed. Model A is to test the main effect of modularization on market performance, while Model B is to test the main effect of modularization on strategic positional advantage (see Table 6 and Table 7).

Table 6

Modularization (MD) on Market Performance (MP)

Model A	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
MD	.72	.08	.50	9.29	.00
F = 86.4, p = .00					

Table 7

Modularization (MD) on Strategic Positional Advantage (SPA)

Model B	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
MD	.17	.046	.22	3.59	.00
F = 12.9, p = .00					

To test Hypothesis 4, physical proximity and the interaction term consisting of physical proximity and modularization were added to the base model (Model A). As displayed in Table 8, the interaction term was not significant (Model A1; β= .066; p = 2.31). Hypothesis 4 was rejected, which means physical proximity doesn't have significant impact on the relation between a firm's modularization degree and its market performance.

Table 8

Regression Results Hypothesis 4
Modularization (MD) and Physical Proximity (PP) on Market Performance (MP)

Model A1	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
MD	.74	.08	.52	9.48	.00
PP	-.08	.05	-.08	-1.51	.13
MD x PP	.09	.08	.07	1.20	.23

$F = 30.00$, $p = .00$

To test Hypothesis 5, physical proximity and the interaction term consisting of physical proximity and modularization were added to the base model (Model B). As displayed in Table 9, the interaction term was significant (Model B1; $\beta = -.145$; $p \leq .05$). The results of the simple slope analysis are displayed in Fig. 13 which demonstrates the interacting effect of physical proximity and modularization on strategic positional advantage. The slope of strategic positional advantage is steeper with low physical proximity than it is with high physical proximity. This shows that the relation between modularization and strategic positional advantage is stronger under lower physical proximity. Therefore Hypothesis 5 is rejected, but null hypothesis is supported: the positive relation between the degree of modularization and strategic positional advantage becomes stronger as physical proximity between module buyers and suppliers decreases. This contradictory finding will be discussed in Chapter V.

Table 9

Regression Results Hypothesis 5
Modularization (MD) and Physical Proximity (PP) on Strategic Positional Advantage (SPA)

Model B1	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
MD	.17	.05	.22	3.6	.00
PP	-.07	.03	-.13	-2.2	.03
MD x PP	-.11	.05	-.15	-2.4	.02

F = 8.8, p = .00

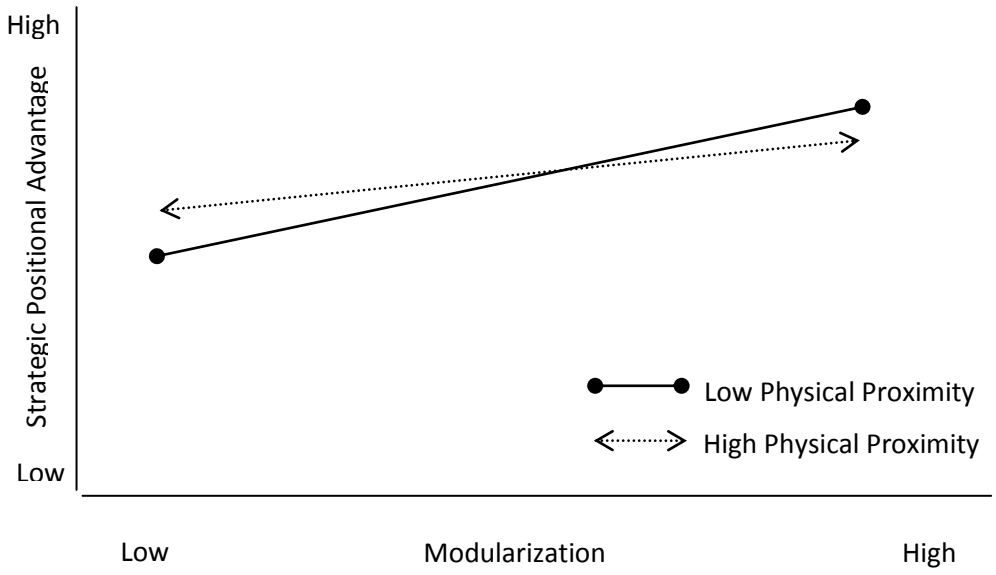


Figure 13. Moderating Effect of Physical Proximity on the Relation between MD and SPA

To test Hypothesis 6, knowledge sharing and the interaction term consisting of knowledge sharing and modularization were added to the base model A. As displayed in Table 10, the interaction term was not significant (Model A2; β= -.059; p = .290). Hypothesis 6 was rejected, which means, knowledge sharing does not have significant impact on the relation between a firm's modularization degree and its market

performance.

Table 10

Regression Results Hypothesis 6
Modularization (MD) and Knowledge Sharing (KS) on Market Performance (MP)

Model A2	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
MD	.62	.09	.43	7.07	.00
KS	.15	.08	.11	1.85	.07
MD x KS	-.10	.09	-.06	-1.06	.29

F = 30.63, p = .00

To test Hypothesis 7, knowledge sharing and the interaction term consisting of knowledge sharing and modularization were added to the base model B. As displayed in Table 11, the interaction term was not significant (Model B2; β= .071; p = .256). Hypothesis 7 was rejected, which means, knowledge sharing does not have significant impact on the relation between a firm's modularization degree and its strategic positional advantage.

Table 11

Regression Results Hypothesis 7
Modularization (MD) and Knowledge Sharing (KS) on Strategic Positional Advantage (SPA)

Model B2	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
MD	.183	.053	.240	3.445	.00
KS	-.006	.047	-.009	-.132	.90
MD x KS	.065	.057	.071	1.139	.26

F = 4.727, p = .00

To test Hypothesis 8, Guanxi and the interaction term consisting of Guanxi and modularization were added to the base model A. As displayed in Table 12, the interaction term was not significant (Model A3; β= -.103; p = .054). Hypothesis 8 was rejected, which means, Guanxi does not have significant impact on the relation between a firm's modularization degree and the firm's market performance.

Table 12

Regression Results Hypothesis 8
Modularization (MD) and Guanxi (GX) on Market Performance (MP)

Model A3	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
MD	.59	.08	.41	7.39	.00
GX	.26	.06	.23	4.14	.00
MD x GX	-.16	.08	-.10	-1.94	.054

F = 37.37, p = .00

To test Hypothesis 9, Guanxi and the interaction term consisting of knowledge sharing and modularization were added to the base model B. As displayed in table 13, the interaction term was not significant (Model B3; β= -.093; p = .133). Hypothesis 9 was rejected, that means, knowledge sharing does not have significant impact on the relation between a firm's modularization and its strategic positional advantage.

Table 13

Regression Results Hypothesis 9
Modularization (MD) and Guanxi (GX) on Strategic Positional Advantage (SPA)

Model B3	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
MD	.16	.05	.21	3.23	.00
GX	-.02	.04	-.03	-.45	.66
MD x GX	-.08	.05	-.09	-1.51	.13

F = 5.17, p = .00

The results of moderating effect analysis on market performance are summarized in Table 14, and the results of moderating effect analysis on strategic positional advantage are summarized in Table 15.

Table 14

Regression Results [a] *of Modularization (MD) and Moderators on Market Performance(MP)*

	Model A	Model A1	Model A2	Model A3
Modularization (MD)	.50	.52	.43	.41
Physical Proximity (PP)		-.08		
Knowledge Sharing (KS)			.11	
Guanxi (GX)				.23
MD x PP		.07		
MD x KS			-.06	
MD x GX				-.10
Adjusted R2	.25	.25	.25	.30
F	86.38	29.96	30.63	37.37

a. Results based on mean-centered values; standardized coefficients displayed. Dependent Variable: market performance

Table 15

Regression Results [b] of Modularization (MD) and Moderators on Strategic Positional Advantage (SPA)

	Model B	Model B1	Model B2	Model B3
Modularization (MD)	.17	.22	.24	.21
Physical Proximity (PP)		-.13		
Knowledge Sharing (KS)			-.01	
Guanxi (GX)				-.03
MD x PP		-.15*		
MD x KS			-.07	
MD x GX				-.09
Adjusted R2	.04	.08	.04	.05
F	12.89	8.79	4.73	5.17

b. Results based on mean-centered values; standardized coefficients displayed.
* P< .05
Dependent Variable: strategic positional advantage

From the abovementioned moderating effect analysis, physical proximity is the only moderator found to have an impact on the relation between a firm's modularization and strategic positional advantage. The impact of knowledge sharing is not supported, which is inconsistent with the previous study conducted in the Brazilian automotive industry (Kotabe, et al., 2007). Guanxi does not show such an effect, which is discussed in Chapter 5.

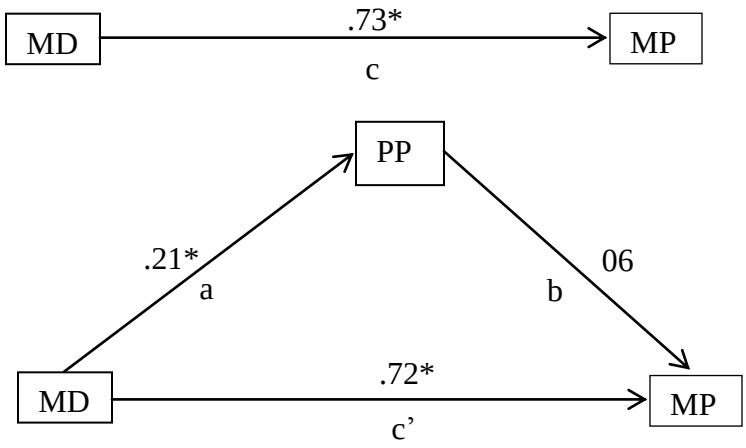
Mediating Effect

Despite the evidence from a previous study showing that physical proximity, knowledge sharing and Guanxi are important factors affecting a firm's performance and strategic positional advantage, only the physical proximity displayed a moderating effect

on the relation between modularization and a firm's strategic positional advantage in this study. Taking it a step further, the mediating effect from physical proximity, knowledge sharing, and Guanxi is analyzed as follows:

The mediating effects were tested with the bootstrapping indirect paths method created by Preacher and Hayes (2008). The bootstrapping model does not require the significant a and b paths suggested by Hair (2005) and Newsom (2012). SPSS macro were used in the analysis as suggested by Sims and Sun (2012) .

MED1: **PP on MP**. The mediation effect from physical proximity (PP) on the relation between modularization (MD) and market performance (MP) was tested. Figure 14 shows the path coefficients for the tested model, and Table 16 shows the results of the regression analysis. The results of the mediation analysis using the bootstrapping technique indicate that physical proximity partially mediates the relation between modularization and market performance. When physical proximity is included in the equation, there is a smaller direct positive relation between modularization and market performance. The results of the regression analysis indicate that 25 percent of the variance in market performance is explained by the mediated model. Therefore, the partial mediation effect is supported.



Notes: n = 262; * p < 0.05

Figure 14. Mediation paths: physical proximity (PP) on the relation between modularization (MD) and market performance (MP)

Table 16.

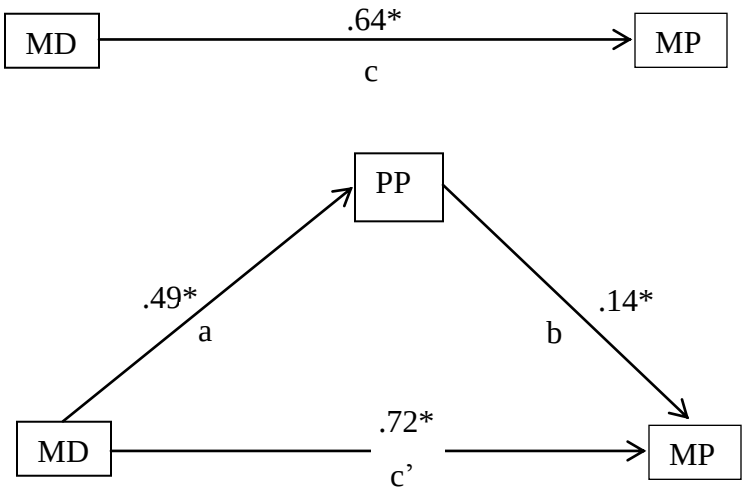
Regression Results for Modularization and Physical Proximity on Market Performance

	Market performance		
Independent variables	Beta	SE	t
Modularization	.72	.08	9.29*
Physical proximity	-.06	.05	-1.30*
R^2	.254		
Adjusted R^2	.248		
F	44.14*		
d.f.	259		

Notes: n = 262; *p < .05

MED2: **KS on MP**. The mediation effect of knowledge sharing (KS) on the relation between modularization (MD) and market performance (MP) was tested. Figure 15 shows the path coefficients for the tested model, and Table 17 shows the results of the

regression analysis. The results of the mediation analysis using the bootstrapping technique indicate that knowledge sharing does not mediate the relation between modularization and market performance. Instead, the findings indicate that modularization is directly and positively related to market performance, with 25 percent of the variance in market performance being explained by modularization. Therefore, mediation effect is rejected.



Notes: n = 262; * p < 0.05

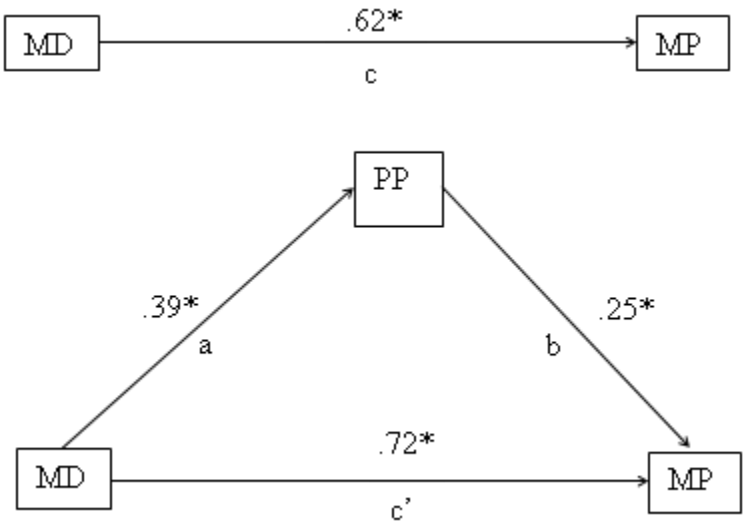
Figure 15. Mediation paths: knowledge sharing on the relation between modularization (MD) and market performance (MP)

Table 17

Regression Results of Modularization and Knowledge Sharing on Market Performance

		Market performance	
Independent variables	Beta	SE	t
Modularization	.72	.08	9.29*
Knowledge sharing	.15	.08	1.97
R^2	.26		
Adjusted R^2	.25		
F	45.36*		
d.f.	259		
Notes: n = 262; *p < .05			

MED3: GX on MP. The mediating effect of Guanxi on the relation between modularization and market performance was tested. Figure 16 shows the path coefficients for the tested model, and Table 18 shows the results of the regression analysis. The results of the mediation analysis using the bootstrapping technique indicate that Guanxi does not mediate the relation between modularization and market performance. Instead the findings indicate that modularization is directly and positively related to market performance, with 28.7 percent of the variance in market performance being explained by modularization. Therefore, mediation effect is rejected.



Notes: n = 262; * p < 0.05

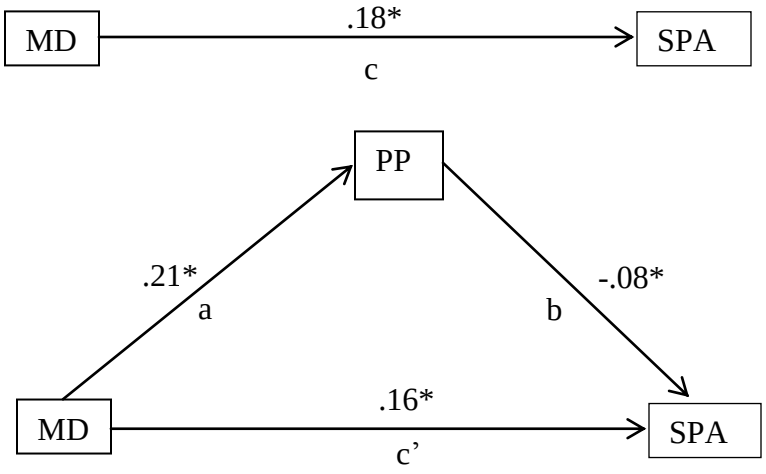
Figure 16. *Mediation paths: Guanxi (GX) on the relation between modularization (MD) and market performance (MP)*

Table 18

Regression Results of Modularization and Guanxi on Market Performance

		Market performance	
Independent variables	Beta	SE	t
Modularization	.72	.08	9.29*
Guanxi	.25	.06	4.00*
R^2	.292		
Adjusted R^2	.287		
F	53.61*		
d.f.	259		
Notes: n = 262; *p < .05			

MED4: PP on SPA. The mediation effects of physical proximity (PP) on the relation between modularization (MD) and strategic positional advantage (SPA) was tested. Figure 17 shows the path coefficients for the tested model, and Table 19 shows the results of the regression analysis. Bias corrected and calculated accelerated confidence intervals do not contain zero, as an indication that the indirect path of the mediator is significantly different from zero. The results indicate that physical proximity fully mediates the relationship between modularization and strategic positional advantage. When physical proximity is included in the equation, there is a smaller direct positive relation between modularization and strategic positional advantage. In addition, the results of the regression analysis indicate that 6.6 percent of the variance in market performance is explained by the mediated model. Therefore, the full mediation effect is supported.



Notes: n = 262; * p < 0.05

Figure 17. Mediation paths: physical proximity (PP) on the relation between modularization (MD) and strategic positional advantage (SPA)

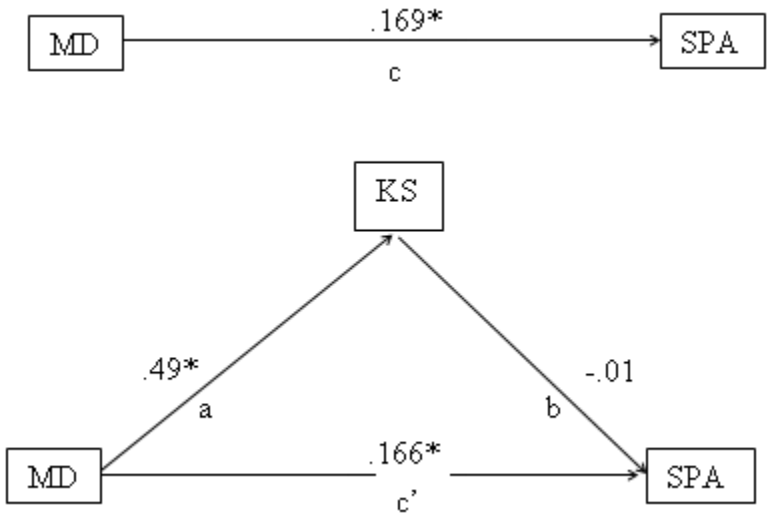
Table 19

Regression Results of Modularization and Physical Proximity on Strategic Positional Advantage

	Strategic Positional Advantage		
Independent variables	Beta	SE	t
Modularization	.16	.05	3.60*
Physical proximity	-.08	.03	-2.68*
R^2	.073		
Adjusted R^2	.066		
F	10.18*		
d.f.	259		

Notes: n = 262; *p < .05

MED5: KS on SPA. The mediation effects of knowledge sharing (KS) on the relation between modularization (MD) and strategic positional advantage (SPA) was tested. Figure 18 shows the path coefficients for the tested model, and Table 20 shows the results of the regression analysis. The results of the mediation analysis using the bootstrapping technique indicate that knowledge sharing partially mediates the relation between modularization and strategic positional advantage. When knowledge sharing is included in the equation, there is a smaller direct positive relation between modularization and strategic positional advantage. The results of the regression analysis indicate that 4 percent of the variance in strategic positional advantage is explained by the mediated model. Therefore, the partial mediation effect is supported.



Notes: n = 262; * p < 0.05

Figure 18. Mediation paths: knowledge sharing (KS) on the relation between modularization (MD) and strategic positional advantage (SPA)

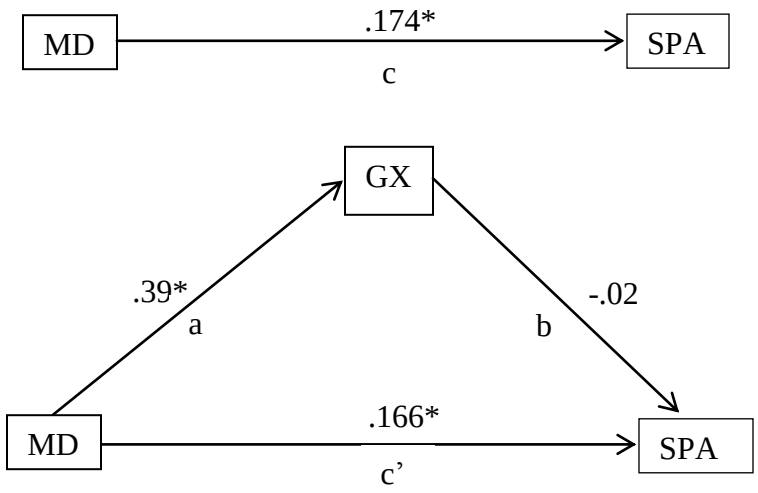
Table 20

Regression Results of Modularization and Knowledge Sharing on Strategic Positional Advantage

	Strategic positional advantage		
Independent variables	Beta	SE	t
Modularization	.166	.05	3.60*
Knowledge sharing	-.08	.05	-.16*
R^2	.05		
Adjusted R^2	.04		
F	6.43*		
d.f.	259		

Notes: n = 262; *p < .05

MED6: GX on SPA. The mediating effect of Guanxi (GX) on the relation between modularization (MD) and strategic positional advantage (SPA) was tested. Figure 19 shows the path coefficients for the tested model, and Table 21 shows the results of the regression analysis. The results of the mediation analysis using the bootstrapping technique indicate that Guanxi partially mediates the relation between modularization and strategic positional advantage. When Guanxi is included in the equation, there is a smaller direct positive relation between modularization and strategic positional advantage. The results of the regression analysis indicate that 29 percent of the variance in strategic positional advantage is explained by the mediated model. Therefore, the partial mediation effect is supported.



Notes: n = 262; * p < 0.05

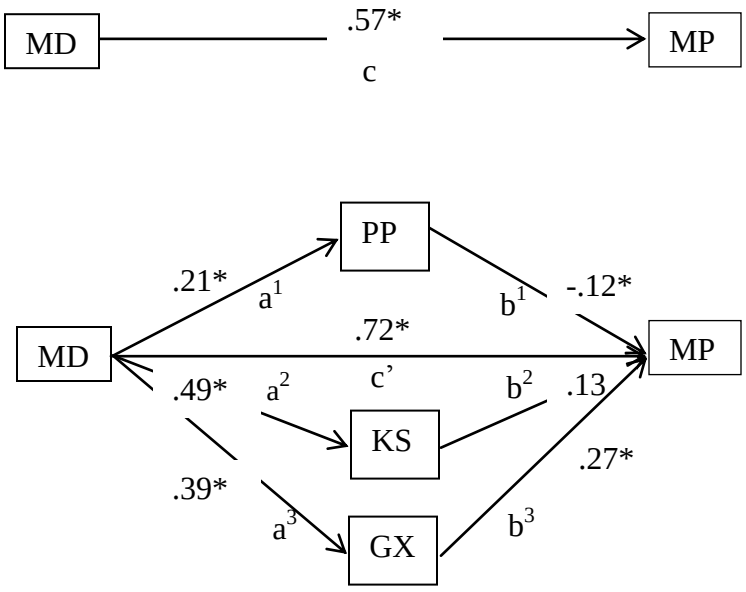
Figure 19. Mediation paths: Guanxi (GX) on the relation between modularization (MD) and strategic positional advantage (SPA)

Table 21

Regression Results of Modularization and Guanxi on Strategic Positional Advantage

	Strategic Positional Advantage		
Independent variables	Beta	SE	t
Modularization	.72	.08	9.29*
Guanxi	.25	.06	4.00*
R^2	.292		
Adjusted R^2	.287		
F	53.61*		
d.f.	259		
Notes: n = 262; *p < .05			

MED7: PP, KS and GX on MP. The mediation effect from the combination of physical proximity (PP), knowledge sharing (KS), and Guanxi (GX) on the relation between modularization and market performance was tested. Figure 20 shows the path coefficients for the tested model, and Table 22 shows the results of the regression analysis. The results of the mediation analysis using the bootstrapping technique indicate that the combination of physical proximity, knowledge sharing, and Guanxi does not mediate the relation between modularization and market performance. Instead, the findings indicate that modularization is directly and positively related to market performance, with 30 percent of the variance in market performance being explained by modularization. Therefore, mediation effect is rejected.



Notes: n = 262; * p < 0.05

Figure 20. Mediation paths: Physical Proximity (PP), Knowledge Sharing (KS) and Guanxi (GX) on the relation between modularization (MD) and market performance (MP)

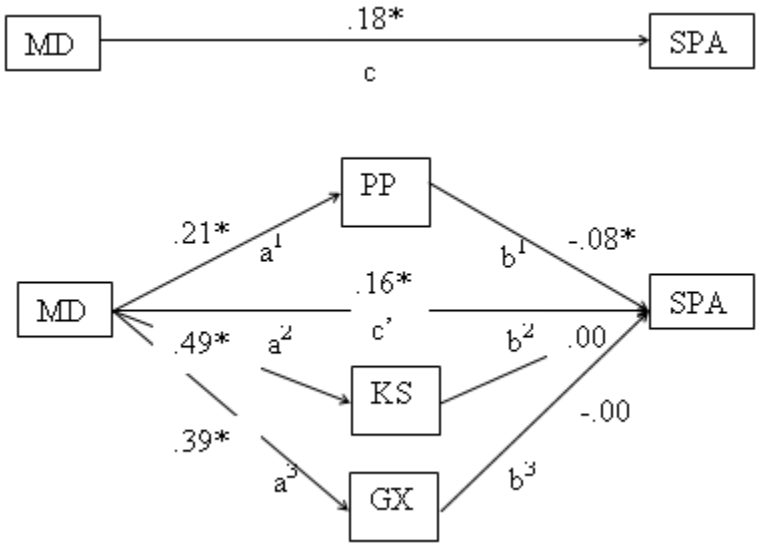
Table 22

Regression Results of Modularization and Mediators on Market Performance

	Market performance		
Independent variables	Beta	SE	t
Modularization	.72	.08	9.29*
Physical proximity	-.12	.05	-2.37*
Knowledge sharing	.13	.08	1.76
Guanxi	.27	.06	4.27*
R^2	.31		
Adjusted R^2	.30		
F	29.47*		
d.f.	257		

Notes: n = 262; *p < .05

MED8: PP, KS and GX on SPA. The mediation effect from the combination of physical proximity (PP), knowledge sharing (KS), and Guanxi (GX) on the relation between modularization and strategic positional advantage was tested. Figure 21 shows the path coefficients for the tested model, and Table 23 shows the results of the regression analysis. The results of the mediation analysis using the bootstrapping technique indicate that the combination of physical proximity, knowledge sharing, and Guanxi partially mediates the relation between modularization and strategic positional advantage. When the physical proximity, knowledge sharing, and Guanxi are combined and included in the equation, there is a smaller direct positive relation between modularization and strategic positional advantage. The results of the regression analysis indicate that 6 percent of the variance in strategic positional advantage is explained by the mediated model. Therefore, the partial mediation effect is supported.



Notes: n = 262; * p < 0.05

Figure 21. Mediation paths: Physical Proximity (PP), Knowledge Sharing (KS) and Guanxi (GX) on the relation between modularization (MD) and strategic positional advantage (SPA)

Table 23

Regression Results of Modularization and Mediators on Strategic Positional Advantage

	Strategic Positional Advantage		
Independent variables	Beta	SE	t
Modularization	.18	.05	3.42*
Physical proximity	-.08	.03	-2.60*
Knowledge sharing	.00	.05	.10
Guanxi	-.00	.04	-.02
R^2	.07		
Adjusted R^2	.06		
F	5.05*		
d.f.	257		

Notes: n = 262; *p < .05

Findings of the mediating effects are summarized as follows:

MED1: The mediating effect of physical proximity on the relation between modularization and market performance is partially supported.

MED2: The mediating effect of knowledge sharing on the relation between modularization and market performance is rejected.

MED3: The mediating effect of Guanxi on the relation between modularization and market performance is rejected.

MED4: The mediating effect of physical proximity on the relation between modularization and strategic positional advantage is fully supported.

MED5: The mediating effect of knowledge sharing on the relation between modularization and strategic positional advantage is partially supported.

MED6: The mediating effect of Guanxi on the relation between modularization and strategic positional advantage is partially supported.

MED7: The mediating effect from the combination of physical proximity, knowledge sharing and Guanxi on the relation between modularization and market performance is rejected.

MED8: The mediating effect from the combination of physical proximity, knowledge sharing and Guanxi on the relation between modularization and strategic positional advantage is partially supported.

Summary

In this chapter, the attribute of the surveyed firms and profile of the respondents were described by the descriptive statistics. The relation between the independent and dependent variables was tested by correlation analysis. The moderating effects were tested by linear regression analysis under SPSS. Additionally, mediating effects were also tested by linear regression analysis by utilizing SPSS macro provide by Preacher and Hayes (2008). The tested hypotheses are summarized in Table 24. New findings of mediating effects are summarized in Table 25. A modified research model based on the results of analysis is depicted in Figure 22.

The results of the study show that in the Chinese auto industry, a firm's market performance and strategic positional advantage are significantly correlated to modularization. Physical proximity has a mediating effect on the relation between modularization and a firm's performance. It also has both moderating and mediating effect on the relation between modularization and strategic positional advantage. Knowledge sharing and Guanxi play a mediator's role between a firm's modularization

and strategic positional advantage. Chapter V will discuss the results extensively and present the conclusions, implications and future work.

Table 24

Summary of Hypotheses Tests: MP- Market Performance, SPA – Strategic Positional Advantage; PP – Physical Proximity, KS – Knowledge Sharing, GX – Guanxi

H	IV	Moderator	DV	Tests	Results
H1a	Module Product Architecture		MP	Correlation	Supported
H1b	Tacit Knowledge Isolation		MP	Correlation	Supported
H1c	Supply Chain Integration		MP	Correlation	Supported
H2a	Module Product Architecture		SPA	Correlation	Rejected
H2b	Tacit Knowledge Isolation		SPA	Correlation	Supported
H2c	Supply Chain Integration		SPA	Correlation	Supported
H4	MD	PP	MP	Regression	Rejected
H5	MD	PP	SPA	Regression	Rejected (Negative Impact was Supported)
H6	MD	KS	MP	Regression	Rejected
H7	MD	KS	SPA	Regression	Rejected
H8	MD	GX	MP	Regression	Rejected
H9	MD	GX	SPA	Regression	Rejected

Table 25

Mediating Effects: MP- Market Performance, SPA – Strategic Positional Advantage; M&A – Mergers and Acquisitions, PP – Physical Proximity, KS – Knowledge Sharing, GX – Guanxi

Model	IV	Mediator	DV	Tests	Results
MED1	MD	PP	MP	SPSS macro	Partially supported
MED2	MD	PP	SPA	SPSS macro	Fully supported
MED3	MD	KS	MP	SPSS macro	Rejected
MED4	MD	KS	SPA	SPSS macro	Partially supported
MED5	MD	GX	MP	SPSS macro	Rejected
MED6	MD	GX	SPA	SPSS macro	Partially supported
MED7	MD	PP+KS+GX	MP	SPSS macro	Rejected
MED8	MD	PP+KS+GX	SPA	SPSS macro	Partially supported

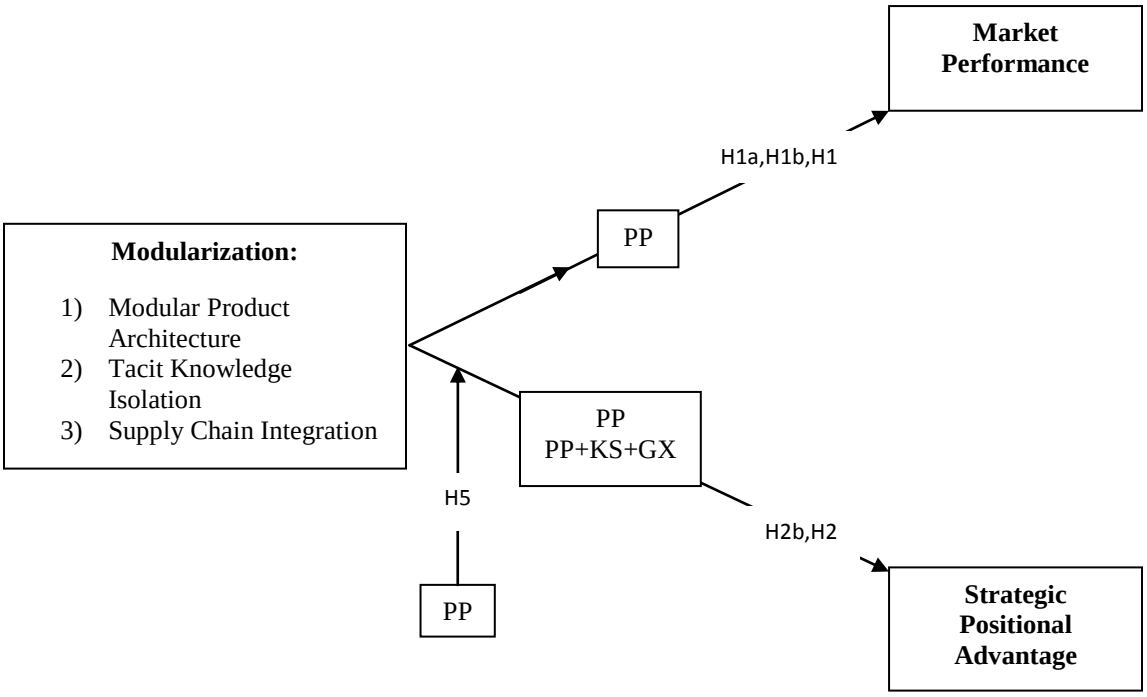


Figure 22. Modified Research Model: PP –physical proximity; KS- knowledge sharing; GX-Guanxi

Chapter V

Summary and Conclusions

Introduction

This chapter provides a summary of the findings of this study and briefly reviews its purpose, relevant literature, and research design. Conclusions are drawn from the research findings. Limitations and recommendations are also presented in this chapter.

Summary of the Research Study

Modularization has become a mainstream of research in the field of international strategy (Pine II, 1993; Pine II, et al., 1993; Ro, et al., 2007; Starr, 1965), yet very few empirical studies have been conducted because the complexity of modularization makes it hard to operationalize the concept (Fixson, 2003; Hoetker, 2006; Sako, 2003; Salvador, 2007). In the automotive industry, the technological complexity, labor intensity, and high monetary investment make modularization one of the most essential strategies to be applied (Collins, et al., 1997; Pires, 1998; Shimokawa, 2002). In contrast to the popularity of this strategy in the automotive industry, the richness of modularization-focused empirical study is far less than sufficient. This study is an extension of the pioneer works of Parente (2003) and Kotabe et al, (2007) conducted in the Brazilian automotive market. The impact of Guanxi as a part of national culture in China was included as a factor in the analysis. This study is built on the bases of internalization theory, transaction cost economics, the OLI model, and the knowledge-based view of the firm. Internalization theory and transaction cost economics paved the theoretic foundation of the firms' modularization strategy from a perspective of economics and management. The OLI model explained the rationale of modularization as an activity of

MNEs in global supply chains. Finally, the knowledge-based view gave a new insight of modularization as a way of isolating and transferring knowledge in global supply chains.

Instruments for measuring the dependent and independent variables were adapted from Chen et al, (2011), Day and Wensley (1988), Lanctot and Swan (2000) and Parente (2003). A total of 350 surveys were distributed and 262 were returned as usable data, yielding a 75% total response rate. These surveys were distributed through the purchasing departments of three major auto makers in China via email. Responses were collected by the same means. The time span between questionnaire conveyance and receipt of response was approximately two months. The high response rate and quickness should be credited to the high degree of collectivism in Chinese culture (Hofstede, 1984) and the high degree of integration at the management level in the automotive industry (Doran, et al., 2007; Takeishi & Fujimoto, 2001).

The descriptive data and profiles of the respondents were presented in Chapter IV. Regarding the size of the responding firms, most were medium or large. 80.7% of the responding firms have been in business for more than 10 years. The findings of the study have been discussed in Chapter IV by analyzing the hypotheses listed in Chapter II and Chapter III, with an additional mediating effect analysis.

Summary of the Findings

Findings of the correlation between the independent and dependent variables are displayed through a deterministic model in Figure 23, which identifies the relationship between modularization and its outcomes. Six contingency models are displayed in Figure 24, 25,26,27,28 and 29 respectively, illustrating the moderating and mediating effects on the relationship between modularization and its outcomes.

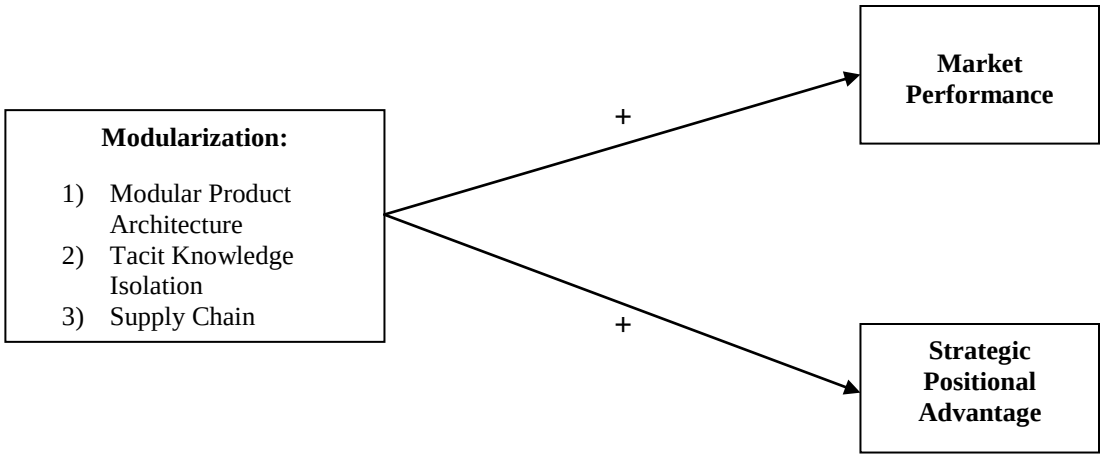


Figure 23. Deterministic Model

Market performance and modular product architecture. It was found that a firm's market performance has a significant positive correlation with modular product architecture, which is in accordance with the findings from previous works (Kotabe, et al., 2007; Parente, 2003). This hypothesis was supported.

Market performance is measured by the firm's market share, profitability, and customer loyalty (Day & Wensley, 1988; Lanctot & Swan, 2000).Functionality and compatibility as the essential attributes of a modular product are yielded and determined by the design of this product (Miller & Elgard, 1998). Thus a modular product with a well-designed architecture will be in a better position to help the module supplier to enlarge market share, maximize profit and retain customer's loyalty. In the case of FAW, the largest auto manufacturer in China, it was modularization that enabled FAW to make a smooth transformation, and upgrade its 30-year-old truck production which was introduced from the Soviet Union into a much more advanced one. Thus, modularization

and transformation have been the key factors for the survival of FAW in the Chinese truck manufacturing industry and for its maintenance of a leading position among its competitors (Chen, 2008) .

Market performance and tacit knowledge isolation. It was found that there is a significant positive correlation between market performance and tacit knowledge isolation, which is in accordance with findings from previous works (Kogut & Zander, 2003a; Kotabe, et al., 2007; Parente, 2003; Ro, et al., 2007). Therefore, this hypothesis was supported. Tacit knowledge isolation means the capability of a module supplier to isolate the tacit knowledge within the modular product and the boundary of the firm to eliminate the cost of managing such tacit knowledge from the module buyers' side. Module buyers would rather chose those suppliers who are capable of isolating tacit knowledge, instead of leaving the module related problems and headaches to the buyers. Thus, it is understandable that the capability of tacit knowledge isolation will enhance the market performance of module suppliers.

In the automotive spare parts industry, it has been reported that the capability of managing complexity (shorter design cycles and wider model ranges that are rooted in the firm's tacit knowledge) is essential to a firm's market share, which supports the positive relation between the firm's tacit knowledge isolation and market performance (Fernihough & Gyimesi, 2008). In the Chinese auto industry, auto parts suppliers with leading technologies such as Shanghai Yanfeng JC, Siemens VDO, and Arvin are playing leading roles in the market by taking most of the market share, yielding superior financial performance, and maintaining a strong relationship with the major buyers (Brandt & Biesebroeck, 2007).

Market performance and supply chain integration. It was found that there is a significant positive correlation between market performance and supply chain integration which is in agreement with previous studies (Flynn, et al., 2010; Kotabe, et al., 2007; Parente, 2003). Therefore, this hypothesis was supported. Supply chain integration is defined as the degree of the strategic collaboration between the buyers and suppliers located on a supplier chain, in order to achieve the efficiency, effectiveness of products and services, and to provide maximum value to the customers. Since tacit knowledge has been isolated within the modular products by module suppliers, a high degree of collaboration between the buyer and supplier is critical to ensure the module or modules can fit smoothly into the final product on the assembly side of the buyer, and perform well after the final product is delivered to the customer. Such a collaboration between the module buyers and suppliers as strategic partners is also vital to succeed in the face of the high degree of competition, complexity and volatility in the auto industry (Lockstrom, et al., 2010). In the Chinese auto industry, auto parts suppliers create geographic clusters surrounding the auto makers in order to increase physical integration into the supply chain, and thus enhance their market performance (Liu, et al., 2008).

Strategic positional advantage and modular product architecture. No significant correlation between strategic positional advantage and modular product architecture was found in this study, thus this hypothesis was rejected. This is inconsistent with the findings from the Brazilian market by Kotabe et al. (2007) and Parente (2003).

A firm's strategic positional advantage consists of the firm's capability to create superior value to the customers, or capability of offering the same value at a lower cost to

customers (Porter, 1991). It is measured by firm's low cost, speed to market and high product quality (Cusumano & Nobeoka, 1992; Lanctot & Swan, 2000).

China's automotive industry is quite different from the others with an extremely fragmented landscape, among which most of the firms specialized in lower-end parts. Seventy percent of the auto supply market is occupied by foreign companies or joint ventures (APCO, 2010), yet only 17% of the surveyed firms in this study are under foreign investment or joint venture. Again, the surveyed firms are auto parts manufacturers supplying to three major auto makers in China: FAW Group, FAW Jilin Auto LTD, and Daihatsu (Shanghai) Co. LTD. These three auto makers are mainly producing economic and compact cars with engine capacity of no more than 2000 cc, which means most of their suppliers are not the industrial leaders with cutting edge technology for modular design. The descriptive statistics of this study also show that among the three dimensions of modularization, the mean of modular product architecture is only 3.48 on a scale of 5, much lower than the other two dimensions of tacit knowledge isolation and supply chain integration with a mean score of 4.36 and 4.43 respectively.

Therefore, the results indicate that China's auto parts suppliers for mid-sized and compact cars are still weak regarding design of modular product architecture, and the correlation between the firm's strategic positional advantage and modular product architecture was rejected.

Strategic positional advantage and tacit knowledge isolation. It was found that there is a significant positive correlation between firm's strategic positional advantage and tacit knowledge isolation, therefore, this hypothesis was supported. These results are in agreement with findings from previous studies (Kogut & Zander, 2003a; Kotabe, et al.,

2007; Parente, 2003; Ro, et al., 2007).

The essential spirit of tacit knowledge isolation is to isolate tacit knowledge within the modular product; therefore, a product family can be produced by means of different combinations of module. Design work for the same parts within a module could be saved, a larger production scale could bring the production cost down, and lower product defect would be yielded due to a lower number of parts. Consequently, production cost would be reduced, the responding speed to the market would be improved, and less product defect will be realized. Furthermore, thanks to the interchangeability of the modular products, firm's response speed to the market could also be drastically improved.

Strategic positional advantage and supply chain integration. It was found that there is a significant positive correlation between strategic positional advantage and supply chain integration, which has also been proven in previous studies (Flynn, et al., 2010; Kotabe, et al., 2007; Parente, 2003). Therefore, this hypothesis was supported.

Through the high degree of collaboration between the module buyers and suppliers, the efficiency of the supply chain will be improved by eliminating redundancies in management and production. Consequently, the speed-to-market will be improved and cost will be cut down. A highly integrated supply chain can also enhance communication and understanding between two parties, reduce the defect rate and improve the quality of the final product. Thus, the significant correlation between strategic positional advantage and supply chain integration is proving to be true in the Chinese auto industry.

Mergers and acquisitions. Although mergers and acquisitions became a trend in

the global auto industry, no significant correlation was found between modularization and this aspect in the Chinese auto industry. Mergers and acquisitions in the Chinese auto industry mainly fall into four categories: The first is the mergers and acquisitions among parts suppliers in different regions. The second is a joint commitment effort between the auto makers and auto parts suppliers to form a geographical advantage. The third is the development of private enterprises promotes mergers and acquisitions. Finally, thanks to the full liberalization of auto parts market since China's accession to the WTO in 2001, some foreign leaders are anxious to enter China through a way of mergers and acquisitions. These industrial leaders are playing a dominating role by controlling capital, monopolizing the market, and creating technological blockade. This may make it more difficult or challenging for the domestic auto parts suppliers to compete and survive (Asia Consulting, 2012; China-Lutong, 2012). Since 70% of the surveyed firms in this study are domestic, it is reasonable that modularization did not show an intruding impact on the mergers and acquisitions among these firms.

Physical proximity. The moderating effect of physical proximity on the relation between modularization and market performance was rejected in this study, which is inconsistent with the findings from the Brazilian market by Kotabe et al. (2007) and Parente (2003). That means the relation between modularization and market performance is not affected by the degree of physical proximity. On the other hand, a mediating effect of physical proximity on the relation between modularization and market performance was partially supported in this study, as displayed in Figure 24.

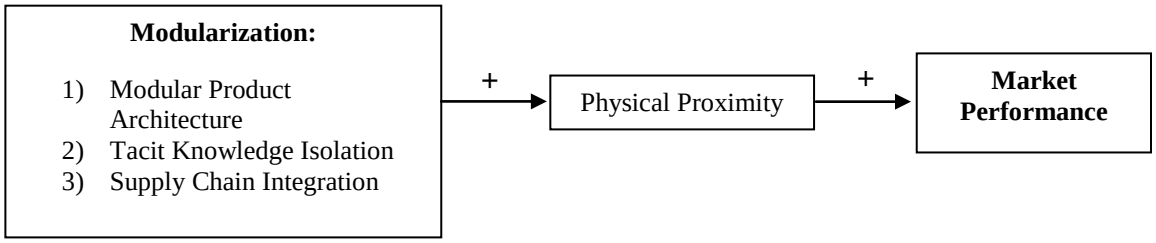


Figure 24. Contingency Model of Market Performance: Mediating Effect of Physical Proximity

In contrast to the Brazilian auto industry where the four major players VW, GM, Ford and Fiat are dominating 89.9% of the market (Havas Digital Insight, 2011), China has a much more scattered structure. It is estimated that there are more than 100 auto makers competing in the Chinese auto industry, among which 17 major players occupy 89% of the market, including both foreign and domestic brands (KPMG, 2007). Most of the auto parts and module suppliers simultaneously supply to different buyers (KPMG, 2009). Thus, in practice, it is difficult for a supplier to be in close geographic proximity to all of the buyers. The parts and module suppliers in China are geographically clustered in six major areas, and in close proximity to only a few major auto makers (Liu, et al., 2008). A firm's market performance, including market share, profitability and customer loyalty, will be enhanced by modularization, but such relation will not get stronger when physical proximity increases. Modularization is a driving force to the physical proximity of the supply chain, which in turn has a positive impact on a firm's market performance.

In this study, a negative moderating effect of physical proximity was found in the relation between modularization and a firm's strategic positional advantage, as displayed in Figure 25. That means the relation between modularization and strategic positional advantage will decrease when physical proximity increases. Meanwhile, a mediating effect of physical proximity between modularization and strategic positional advantage

was fully supported, as displayed in Figure 26. In reality, such a conclusion can be interpreted that the positive correlation between modularization and strategic positional advantage will be alleviated by the benefit of physical proximity of the supply chain. On the other hand, modularization is a driving force to make suppliers geographically follow the buyers, which in turn will improve a firm's strategic positional advantage including faster speed-to-market, lower managerial and operational cost, and better product quality.

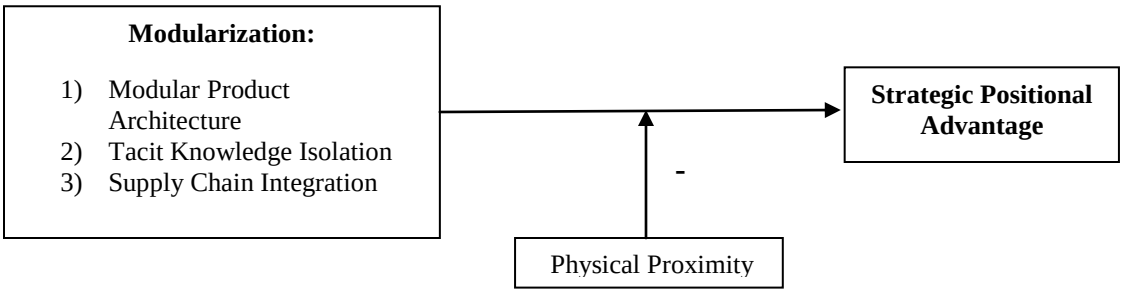


Figure 25. Contingency Model of Strategic Positional Advantage: Moderating Effect of Physical Proximity

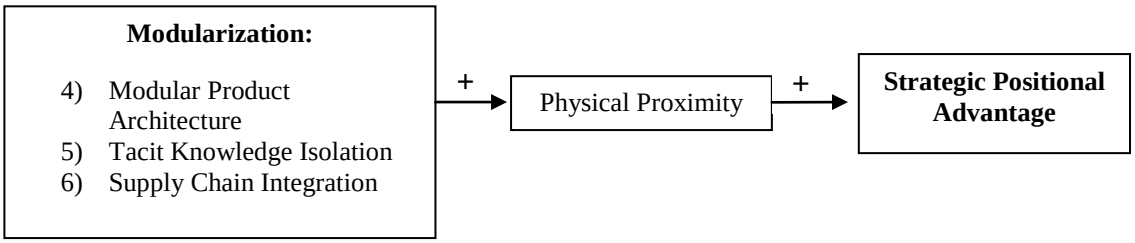


Figure 26. Contingency Model of Strategic Positional Advantage: Mediating Effect of Physical Proximity

Knowledge sharing. In this study, neither a moderating nor mediating effect was found from knowledge sharing on the relation between modularization and market performance, nor was a moderating effect found on the relation between modularization and strategic performance.

In practice, knowledge sharing between the auto makers and parts suppliers in the Chinese auto industry is still inadequate compared to developed countries. Many domestic suppliers communicate with buyers in a very old-fashioned way, which leads to the loss of essential information, as well as knowledge sharing. This problem can cost suppliers lots of business opportunities (Booz & Co., 2009). It also places buyers in a difficult situation for finding the proper suppliers. It was estimated that, in 2008, the three automakers from the U.S. had $8 billion less in components sourcing from China than their original forecast (Gao, 2008). Most of the surveyed suppliers in this study are domestic ones, with a gap both in technology and management when compared to the global industrial leaders. This could be the very reason why knowledge sharing does not show a significant moderating impact on the relation between modularization and a firm's market performance and strategic positional advantage in China.

On the other hand, a partial mediating effect of knowledge sharing was found on the relation between modularization and a firm's strategic positional advantage, as displayed in Figure 27, which indicates that modularization will force firms in the supply chain to have a more frequent and in-depth knowledge sharing. Such knowledge sharing will in turn improve a firm's strategic positional advantage by reducing managerial and operational cost, enhancing a firm's capability of speed-to-market and improving product quality.

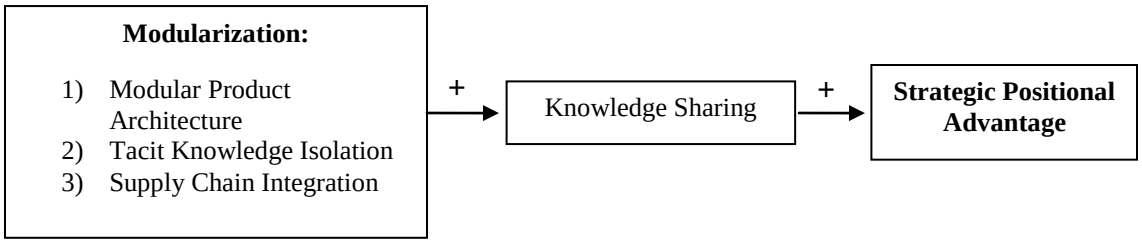


Figure 27. Contingency Model of Strategic Positional Advantage: Mediating Effect of Knowledge Sharing

Guanxi. In this study, neither a moderating nor mediating effect was found from Guanxi on the relation between modularization and market performance, nor was a moderating effect found on the relation between modularization and strategic positional advantage.

Guanxi as a way of social networking plays an importance role in Chinese society. It is rooted in the thousands-years-long Chinese history. Such activity is more prominent in less developed societies with a weak rule of law. Sometimes it plays as a complement or substitute to formal institutional support (Xin & Pearce, 1996). Thanks to the open-gate policy and market - oriented economy in recent China, industrialization and modernization has reduced the importance of the traditional form of Guanxi. The less involvement of government bureaucracy makes Guanxi less important in China's economy (Guthrie, 1998). China's auto industry is heavily dominated by auto makers from industrialized countries. The relation between buyer and supplier is a business to business relation. Thus it is understandable that Guanxi does not show a significant impact on the relation between modularization and a firm's performance and strategic positional advantage in China.

On the other hand, a partial mediating effect of Guanxi was found on the relation between modularization and a firm's strategic positional advantage, as displayed in

Figure 28. This implies that modularization can bring up a more intense Guanxi to the firms in the automotive supply chain, and such closer Guanxi will in turn reinforce a firm's strategic positional advantage. Since Guanxi is the trust, closeness, credibility and inter-dependence between business partners in China (Fan, 2002; Tsang, 1998), firms utilize Guanxi as a strategic mechanism to overcome competitive and resource disadvantages, and ultimately enhance the strategic positional advantage.(Park & Luo, 2001).

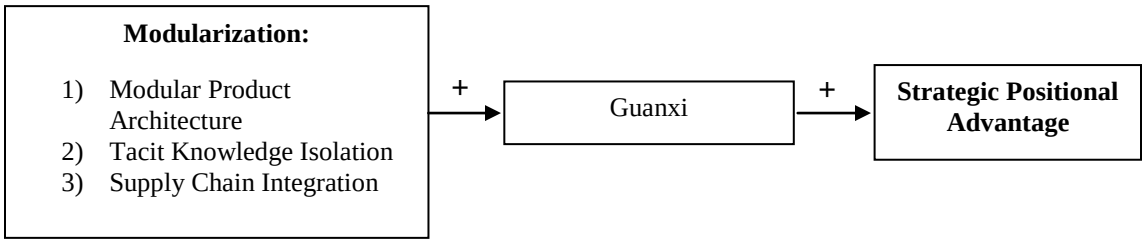


Figure 28. Contingency Model of Strategic Positional Advantage: Mediating Effect of Guanxi

Mediating effect from physical proximity, knowledge sharing and Guanxi as a combination. No significant mediating effect was found from the combination of physical proximity, knowledge sharing and Guanxi on the relation between modularization and market performance. However, a mediating effect on the relation between modularization and strategic positional advantage was partially supported as displayed in Figure 29. This indicates that relation between modularization and a firm's market performance (market share, profitability, and customer loyalty) was not significantly changed when physical proximity, knowledge sharing and Guanxi as a combination were involved together. As discussed in previous sections, this could be a result of the unique structure and characteristic of the Chinese auto industry: more than 100 auto makers co-exist in the market with poor communication between the buyers and

suppliers. But, as modularization is the driving force of physical proximity, knowledge sharing ,and Guanxi in China's automotive supply chain, these factors together will in turn help firms to strengthen their strategic positional advantage by lowering managerial and operational cost, enhancing speed-to-market capability, and improving product quality.

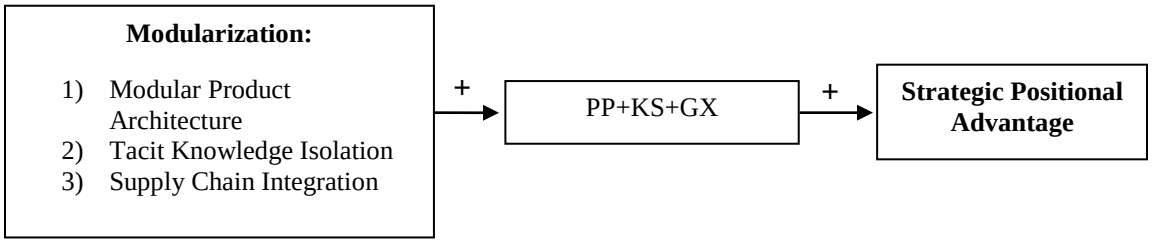


Figure 29. Contingency Model of Strategic Positional Advantage: Mediating Effect from Physical Proximity (PP), Knowledge Sharing (KS) and Guanxi (GX) as a Combination

Implication of this Study to Current Theory

Despite various studies on modularization, very few empirical studies were conducted in the domain of international strategy, especially in the auto industry. This study fills in such a gap by analyzing modularization and its impact on the Chinese auto industry. It tested and supported previous findings of the positive correlations between modularization and a firm's market performance and strategic positional advantage. The virtue of modularization as a way to internalize management and production for module suppliers, and to minimize the transaction cost of the supply chain, is reflected in the findings of this study.

Modularization consists of three dimensions: modular product architecture, tacit knowledge isolation and supply chain integration. Through the module product architecture, the responsibility of the buyer and supplier is clearly defined and designated.

Each firm can focus on its core competence and maximize its ownership, locational, and internalization (OLI) advantages. Tacit knowledge isolation is a proof and application of the knowledge-based-view of the firm. In today's auto industry, a firm's boundaries are formed based on its expertise. Once such boundaries are set up and agreed upon by the firms located on the supply chain, the tacit knowledge should be strictly enclosed and isolated within the modules and module suppliers, in other words, it is a procedure of internalization for the module suppliers. After all, a high degree of collaboration between the firms is essential to minimize the transaction cost in the supply chain. Therefore, in the process of modularization, the ownership advantage, locational advantage, and internalization advantage are realized through redesigning a firm's boundaries. As a result, knowledge of the module buyers and suppliers are isolated and utilized in a most efficient way.

In contrast to the findings of a previous study conducted in Brazil, physical proximity and knowledge sharing did not show a moderating effect on the relation between modularization and a firm's market performance in the Chinese auto industry. A negative moderating effect of physical proximity was found in the relation between modularization and strategic positional advantage. This indicates that such a moderating effect depends on the attribute and structure of a certain industrial area; it does not occur everywhere. On the other hand, a mediating effect was found from physical proximity and knowledge sharing on the relation between modularization and firm's strategic positional advantage. Such findings are value added to the study of modularization.

Guanxi has long been a main stream field in the study of Chinese culture, yet Guanxi did not show any moderating effect on the relation between modularization and

its outcomes. Its mediating effect on the relation between modularization and strategic positional advantage was partially supported. This proves that the degree of Guanxi's impact on Chinese business depends on institutional environment and industrial sectors. With the development of the Chinese economy, Guanxi's role is declining gradually, especially in the industrial areas where governmental intervention is not so strong.

Implications for the Practitioners

China recently has become the largest market and manufacturer in the global auto industry, and shows many different attribute, and characteristics compared to the rest of the world. This study again proves that modularization is an efficient and effective way of improving firm's market performance and enhancing a firm's strategic positional advantage in the Chinese auto industry. Auto makers can enjoy the benefits of modularization by means of outsourcing the modules to the suppliers. It can help the automakers be more flexible to the market demand, to lower the managerial and operational costs, to focus on their core competitive advantages, and in the long run, become a winner in the market. Meanwhile, auto parts suppliers should also consider adopting the strategy of modularization, in order to satisfy the buyers' demand. Through the different combination of modules, parts suppliers can also reduce the cost of design, production and administration, speed up its response to the market demand, and concentrate on its core competence.

In order to implement the strategy of modularization, a firm has to make a reformation through three aspects: product modularization, tacit knowledge isolation and a high degree of supply chain integration. A firm becomes modularized only when these three aspects are accomplished.

The modular product in design and production is the basis of modularization strategy. In the auto industry, a module buyer is often playing the leading role in the supply chain. This module buyer should have a very clear idea and boundary for the module products it intends to purchase, and have the capability of organizing the supply chain, giving the necessary technical and managerial support to the module suppliers which are located on the lower end of the supply chain. Meanwhile, module suppliers should maintain a strong team to design and produce the modular products.

A module supplier should have the capability to isolate the tacit knowledge within its products and the firm's boundaries, in order to supply a ready-to-use module to the buyer. Only a tacit knowledge isolated module can guarantee a clear boundary of the firm, eliminate redundant cost in production and management, and fully realize the core competence of the firms located on the supply chain. A poorly designed modular product without completely isolating the tacit knowledge inside will lose the essence of modularization. In practice, that means a tremendous amount of extra work and a lot more potential quality problems to the buyer.

Due to the high degree of tacit knowledge isolation, firms in the supply chain need intensive collaboration in order to achieve the ultimate goal of modularization. From the very beginning of module product design, technical teams from buyers and suppliers need to work closely to define and clarify the product function and responsibilities of both sides. During the process of production, the two parties have to collaborate to make sure the modular product can realize the designated function and fit perfectly into the final assembly. They should also jointly take the responsibility for after-sales service related to the modular product. Finally, the supplier should keep a

close eye on the production of the buyer, so that it can adjust its own production plan based on the demand of the buyer.

Thus, it is clear that modularization has become a driving force to the firms to reach a higher level of production and management. Through modularization, firms can have a system of lower cost, better quality, and lower response time. That is why in the long run, modularization will benefit firms with their market performance and strategic positional advantage. But this does not mean that modularization is always the right strategy to adopt, it is only one of the possible effective ways of improving a firm's market performance and competitiveness. The negative impact of modularization has been reported by researchers as described in Chapter II of this study. The final decision of when and how a firm should utilize modularization, should be based on a calculation by including other factors such as a firm's resources, knowledge, structure, political, legal and technological environment (Luthans & Doh, 2012) .

Physical proximity and knowledge sharing are always important to the automotive manufacturers, as argued by the other researchers. However, no significant moderating effect in the relation between modularization and its outcomes was found in this study. Physical proximity showed a mediating effect on the relation between modularization and both market performance and strategic positional advantage. That means, as a result of modularization in the auto industry, a firm' physical proximity can lead to better market performance and strategic advantage. Knowledge sharing showed a mediating effect on the relation between modularization and strategic positional advantage, indicating that modularization will drive a firm into a higher degree of knowledge sharing, which in turn will improve the strategic positional advantage of the firm. Although knowledge sharing

is still inadequate in the Chinese auto industry, especially for those domestic firms, it is a critical factor for the long term benefit of a firm. This is good news for managers who embrace the strategy of modularization.

Finally, Guanxi, as a very popular phenomenon in China, showed its impact in this study. Although only a partial mediating effect from Guanxi was found on the relation between modularization and strategic positional advantage, it still gives a hint to the business managers in the Chinese auto market that modularization can improve Guanxi, which in turn can benefit a firm with its competitiveness. Not like some other business areas, the supply chain in the Chinese auto industry does not heavily rely on Guanxi, especially from the perspective of modularization. Thus, managers should be fully aware of the importance of Guanxi, but need not to be overwhelmed.

Limitations of this Study

First of all, this is a single regional study based on the Chinese automotive market. Some unique characteristics of modularization were found in this region, and limitation is also embedded due to the same reason. Some factors in the Chinese market like the transition from central planning to a market oriented economy, political impact, intellectual property rights and technological environment were not included and analyzed.

Second, due to the fast-paced development of the Chinese auto market and the complexity of the auto industry itself, a qualitative study could be conducted together with the quantitative one, in order to reach a deeper understanding of modularization and its impact.

Third, the surveyed firms in this study are mainly manufacturers of economic and

compact cars with the engine capacity of no more than 2000 cc, 70% of which are domestic ones. This is a result of the convenience of sampling. Thanks to the government policy of encouraging consumers to buy more fuel efficient cars, this segment counts for 66% of the Chinese car market (Oliver, Gallagher, Tian, & Zhang, 2009). But a more accurate conclusion would be expected if more firms specialized in the other segments could be included as well.

Fourth, because of the complexity of modularization, the analyses of the driving forces of modularization in the Chinese auto industry were not included in this study. It would be a more complete and valuable one if the antecedent factors were included.

Finally, Guanxi as a very subtle and sophisticated phenomenon in China could be measured in a more comprehensive way. With economic development and merging into the global market, the way of forming, utilizing, and maintaining Guanxi in China is also changing. A more updated and comprehensive measurement could be created in order to conduct a more accurate study on Guanxi.

Recommendations for Future Study

Due to the rareness of empirical studies on modularization, and the limitations of this study itself, there is a great potential for future studies. A few directions are recommended as follows:

First of all, the sample size could be expanded by including the manufacturers of cars with larger engine capacity. Antecedents of modularization in the Chinese auto industry can be analyzed. Some other factors such as political, technological, and legal environment can be taken into account. It is also suggested that a qualitative study can be conducted together with the quantitative one, in order to reach a deeper understanding of

modularization in the Chinese auto industry.

Second, it would be helpful to enrich the measurement of Guanxi in future study. Although Guanxi did not show a strong impact in this study, it still plays an important role as it is deeply rooted in the Chinese culture and prevalent in the Chinese business world.

Third, a similar study could be conducted in regions other than Brazil and China, or a comparative study could be conducted among several regions with different characteristics. This would further reinforce the study of modularization in the auto industry.

Fourth, among the existing studies on modularization, no empirical research about the boundaries of the module was found. Sako (2003) noticed this problem and made a brief comparison between the auto industry and the computer industry in a conceptual way, but no follow up study was made after that. This could partly be explained by the complexity of modules and modularization itself.

Conclusion

Modularization as an important strategy to realize mass customization, reduce cost, and improve a firm's competitiveness has been recognized in academia and practice for decades. However, very few empirical studies have been conducted in the auto industry despite that such strategy has been highly recommended and embraced by many auto manufacturers. As discovered through the research undertaken in this dissertation, modularization is an effective way of improving a firm's market performance and enhancing a firm's strategic positional advantage in the Chinese auto industry.

Due to the uniqueness of the Chinese market, some factors like physical

proximity and knowledge sharing play different roles in the process of modularization. Thus, it is identified that differences do exist on modularization in different markets.

Guanxi, as an inevitable factor of Chinese business study, shows the impact on modularization and its outcomes. This study helps to make a deeper understanding of Guanxi through the way of analyzing its impact on the supply chain in the Chinese auto industry.

In practice, business managers in the Chinese auto market can ride on the wave of modularization, conscientiously take into consideration the other factors like geographic location, knowledge sharing, and Guanxi to manage their business in a more efficient and effective manner.

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Appendix A

Dissertation Study Survey Letter and Instruments

English Version

Aug 16, 2012

Dear Sir/Madam:

This survey is a part of my doctoral student dissertation from Nova Southeastern University located in Florida, U.S.A.

In recent times China has been recognized as the largest car market and manufacturer in the world, yet the industrial structure is quite different from leading countries in the auto industry such as the US and Japan. Modularization is praised as a revolution in the management history of the auto industry, yet so far there is no empirical study on modularization and its impact on the Chinese auto industry. This study will fill in such a gap in academia, and help managers in the auto industry make a more scientific decision of whether and how they should go into modularization

The items inside this survey ask general questions about the modularization and its impact on your firm. There is no request for any sensitive or confidential information. It will take about 20 minutes to finish the questionnaire. Please feel free to contact the researcher Mr. Yunshan Lian or the dissertation chair Dr. Belay Seyoum for any questions about the survey.

Your participation in this survey is completely voluntary. The information you provide is invaluable for us and will help scholars and managers have a better understanding on modularization and the Chinese auto industry. Your time and effort in responding to the survey is highly appreciated. Thank you very much in advance!

Best Regards

Yunshan Lian
Doctoral Student

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H.Wayne Huizenga School of Business and Entrepreneurship
Nova Southeastern University
3301 College Ave., Carl DeSantis Building
Ft Lauderdale, FL 33314, U.S.A.

A Survey on Modularization and Its Impact on Chinese Auto Industry

The following questions are about the **merger and acquisition** activities of your firm. Please answer question 1 based on historical information, and question 2 with your personal prediction.

	Yes	**No**
1. Our firm engaged in a merger or acquisition during the last 3 years (If yes, please indicate the country of origin of the partner, e.g. China or Japan)		

Degree of your agreement with each statement 1= strongly disagree; 5= strongly agree	1	2	3	4	5
2. There is a possibility that our firm will experience mergers and acquisitions within 3 years (If yes, please indicate the likely country of origin of the future partner, for example, China, Japan or Germany)					

The following questions are about the degree of modularization of your firm. Based on your personal opinion, please check the cell best describing the degree to which you agree with the following statements:

Product

Degree of your agreement with each statement: 1= strongly disagree; 5= strongly agree	1	2	3	4	5
1. We usually have a range of product models forming one or more product families					
2. Most of our products have been decomposed into separate modules that can be re-combined into new product designs to achieve higher variety and reduce development time					
3. For our main product(s), we can make changes in key components without having to redesign other components					
4. For our current main product(s), we have re-use components (carry-over) from previous product generations					
5. We have a high degree of component sharing between different products in our main product line					

Technology

Degree of your agreement with each statement: 1= strongly disagree; 5= strongly agree	1	2	3	4	5
1. During product development, we and our buyers collaborate intensively to divide component /module manufacturing responsibilities efficiently					
2. We possess all the necessary expertise and know-how for manufacturing the components /modules that go into our buyer's assembly line					
3. We retain the expertise and know-how necessary to manufacture the components or modules					
4. We deliver the components/modules that are ready to go into our buyer's assembly line without last minute adjustments					
5. We are responsible for sequenced delivery to our buyer's assembly line					

Collaboration

Degree of your agreement with each statement: 1= strongly disagree; 5= strongly agree	1	2	3	4	5
1. We can only get payment after the approval of the final assembled product from our buyer					
2. We are closely monitoring the speed and flow of our buyer's assembly line					
3. We are willing to work together closely with our buyer to bid for new sales contracts					
4. We have our personnel working inside or at a close distance to our buyer's assembly line					
5. We have the ability to adjust production accordingly to the speed of our buyer's production					
6. In the product development stage, we create cross-functional teams to cooperate with the buyer's people					
7. There's a high degree of cooperation between our engineers and the buyer's engineers when trying to solve design problems					

Please check the answer that can best describe you and your company:

1. My job rank	Senior management	Middle management	Technical engineer	Support staff
2. Number of employees in my company	0-50	51-250	251-1000	More than 1000
3. History of my company	0-10 years	11-30 years	31- 50 years	More than 50 years
4. My company is a joint venture between a local and a foreign company	Yes (if yes, please indicate the country of origin of the foreign company, e.g. Germany or Japan)		No	

The following questions are about the market performance of your firm. Based on your firm's profile, please check the cell which can best describe your firm's performance in the most recent three years:

Market Performance

Degree of your agreement with each statement: 1= strongly disagree; 5= strongly agree	1	2	3	4	5
1. The market share of our firm has increased					
2. The profitability of our firm has improved					
3. The customer loyalty to our firm has improved					

The following questions are about the strategic positional advantage of your firm. Based on your personal opinion, please compare your firm to your three major competitors in the last 12 months:

Strategic Positional Advantage

Position of your firm compared to the major competitors: 1= much lower; 5= much higher	1	2	3	4	5
1. The number of product attributes relative to price offered was …					
2. Our production cost has been …					
3. Our direct labor cost has been …					

4. Time to determine the desired product's features was …					
5. Time to determine the product's production cost was …					
6. Time to determine the desired product's sales price was …					
7. Time to determine feasibility of proposed technologies was …					
8. Time to determine plan for product development and introduction was …					
9. Time R&D and manufacturing spent on determining how to produce at a desirable price was …					
10. Time spent from commitment to manufacture and to occurrence of sales was …					
11. The overall speed to market of our products from initial idea to the occurrence of initial sales was …					
12. Product reliability (mean time to first failure) was …					
13. Product durability / product life was …					
14. Ease of product serviceability was …					
15. Freedom from product defects was …					

The followings are about the **locational relationship** between your firm and module buyers. Based on your personal opinion, please indicate the degree to which you agree with the following statements.

Degree of your agreement with each statement: 1= strongly disagree; 5= strongly agree		1	2	3	4	5
Physical Proximity	1. Physical proximity to our buyer is a key priority to us					
	2. Geographic distance to our buyer has a negative effect on performance					
	3. Our business believes having production inside our buyers' premises can positively affect our performance					
	4. Our business believes having production facilities inside buyers' factories sharing the same factory floor can positively affect our performance					
	5. Our business believes that physical proximity with buyers can have a significant positive affect on overall performance					

The followings are about the **knowledge sharing** between your firm and module buyers. Based on your personal opinion, please indicate the degree to which you agree with the following statements.

Degree of your agreement with each statement: 1= strongly disagree; 5= strongly agree		1	2	3	4	5
Knowledge Sharing	1. Our engineers/technical staff frequently visit and chat with our buyers					
	2. Our people develop different product expertise from frequently working and interacting in different projects and product areas					
	3. Face to face contact between our engineers/technical staff and					

	buyers happens quite often					
	4. We frequently send our engineers/ technical staff to visit buyers					
	5. We frequently receive visits from buyers' engineers /technical staff					
	6. There are adequate video conferences between our engineers/technical staff and buyers'					
	7. There are adequate audio conferences between our engineers/technical staff and buyers'					
	8. We publish and share information/ knowledge with buyers on the Web					
	9. Our buyers publish and share information/ knowledge with us on the Web					
	10. We maintain an electronic knowledge base used by buyers' engineers/technical staff					
	11. Buyers maintain an electronic knowledge base used by our engineers/technical staff					

The followings are about the **business relationship** between your firm and module buyers. Based on your personal opinion, please indicate the degree to which you agree with the following statements.

Degree of your agreement with each statement: 1= strongly disagree; 5= strongly agree		1	2	3	4	5
Business Relationship	1. We have great personal friendships with our buyers					
	2. Both sides highly value the concept of "face" and we try to protect each other's "face" in our business dealings					
	3. We exchange special gifts with our buyers in each holiday season to show gratitude to each other					
	4. We are willing to offer help when needed, because our buyer did the same before					

Chinese Version

2012-8-16

尊敬的先生/女士：

这份调研问卷是本人就读于美国佛罗里达州的诺瓦东南大学的博士论文中的一部分。

近年来中国已被视作全球最大的汽车消费市场和制造者，但其产业结构完全不同与其它汽车行业领先国家如美国日本等。模块化在当今的汽车工业中经常用被采用，但迄今为止还没有出现对于中国汽车产业模块化的量化分析。这个研究课题对于汽车产业界的管理者们做出更好的决策，是否以及如何利用模块化来提高自己公司业绩将会起到一定的帮助作用。

这份问卷中的问题只涉及关于模块化及其影响的一些普通性问题，不会涉及到任何敏感或保密的信息。完成该份问卷大概需要20分钟的时间。

如果有任何疑问，请随时与研究员连云杉先生或者论文指导主任教授赛雍博士联系。

对本次调研活动的参与完全取决您的自愿。您所提供的信息对于我们是非常宝贵的，也将帮助学者和管理者们对于模块化以及中国汽车工业有更好的理解。我们非常感激您花费时间和努力来回答这份问卷！

此致

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关于模块化及其对中国汽车工业影响的调研

下面是有关贵公司的兼并和收购行为的问题。请按照公司历史信息回答第一题，按照您的个人判断回答第二题 (请在空格中画叉号（X）)。

	是	否
1. 我们公司在过去3年中曾经经历过兼并和收购。 (如果回答是，请指出兼并和收购的另一方公司的国籍，比如是中国或者德国)		

您对下面表述的认可程度 1=非常不认可， 5=非常认可	1	2	3	4	5
2． 我们公司可能在未来三年会经历兼并和收购 （如果您认为可能，请指出未来进行兼并和收购的另一方公司可能的国籍，比如是中国, 德国或者日本）					

下面是有关贵公司模块化程度的问题。基于您个人观点，请在最能描述您的认可程度的空格中画叉号（X）

产品

您对下面表述的认可程度 1=非常不认可；5=非常认可	1	2	3	4	5
1．我们通常有许多产品模块，从而能够形成一个甚至多个产品系列					
2．我们的大部分产品被分解成独立的模块，这些模块可以被重新组合成新的产品，从而达到产品的多样化并缩短产品的开发周期					
3．对于我们的主打产品，我们可以更换其中的关键部件，而不需要重新设计其他部件					
4．对于我们现在的主打产品，我们沿用了前代产品中的一些部件					
5．在我们的主产品系列中，不同的产品之间有很强零部件互换性					

技术

您对下面表述的认可程度 1= 非常不认可；5= 非常认可	1	2	3	4	5
1．在产品开发过程中，我们和我们的买方密切合作，将各自的零部件/模块的生产责任非常有效地区分开来					
2．我们完全拥有生产零部件/模块所需要的专业技能和知识，这些零部件/模块将被供应到我们买方的装配线上					
3．我们保有生产零部件/模块所需的专业技能和知识					
4．我们供应到买方装配线的零部件/模块都是成品，不需要在即将供应的最后一刻进行调整					
5．我们对供应到买方装配线的交货顺序负责					

合作

您对下面表述的认可程度 1=非常不认可；5= 非常认可	1	2	3	4	5
1．我们只能在买方对最终的装配成品检验合格后才能得到付款					
2．我们密切关注买方装配线的速度和流量					
3．我们愿意和我们的买方密切合作进行一些新的投标活动					
4．我们派遣人员在买方的装配线上或者接近买方装配线的地方工作					
5．我们有能力根据买方的生产速度来调整我们自己的生产速度					
6．在产品开发阶段，我们组织跨领域的团队来与买方的人员配合					
7．当需要解决设计上的一些问题时,我方和买方的工程师之间有着密切合作					

请在最接近于您和您的公司的描述上画叉（X）

1．我的职务	高级经理	中层经理	技术工程师	服务人员
2．我公司的雇员数量	0-50	51-250	251-1000	超过1000人
3．公司历史	0-10 年	11-30 年	31-50 年	超过50 年

4．我公司是中外合资企业	是 （如果回答是，请指出合资的外方是哪一国，比如是德国或者日本）	否

下面是关于贵公司市场业绩的问题。根据贵公司的资料,
请在下面最符合公司近三年来的市场业绩的空格内画叉（X）

市场业绩

您对下面表述的认可程度 1= 非常不认可；5= 非常认可	1	2	3	4	5
1．我们公司的市场份额得到了增长					
2．我们公司的利润得到了增长					
3．客户对我们公司的忠诚度得到了提升					

下面是关于贵公司战略优势的问题。请基于您个人观点，将贵公司和贵公司的三个主要竞争对手在过去12个月中的表现进行对比

战略优势

贵公司与主要竞争对手的态势比较 1= 非常低；5= 非常高	1	2	3	4	5
1．我们产品的性能价格比 …					
2．我们产品的成本 …					
3．我们的直接人工成本 …					
4．用于决策目标产品特性所花的时间 …					
5．用于决策产品的制造成本所花的时间 …					
6．用于决策目标产品的销售价格所花的时间 …					
7．用于决策技术建议的可行性所花的时间 …					
8．用于决策产品研发和推广计划所花的时间 …					
9．研发和制造部门用于决策如何达到目标价格所花的时间 …					
10．从签订合同到生产再到实现销售的整个过程的时间长短 …					
11．我们的产品从构思到实现销售的总体市场应对速度 …					
12．产品的可靠性（第一次故障的发生时间）…					
13．产品的耐用性/产品寿命 …					
14．产品维修的容易性 …					
15．产品零故障率 …					

下面是关于贵公司与买方的地理位置关系的问题。请基于您个人观点，指出您对以下表述的认可程度,请在最能描述您的认可程度的空格中画叉号（X）：

您对以下表述的认可程度 1= 非常不认可；5= 非常认可		1	2	3	4	5
地理位置上的邻近程度	1．与买方地理位置上的邻近对我们而言非常关键					
	2．与买方地理位置上的距离越远，对我们业绩的负面影响越大					
	3．我们相信在我们买方的地盘上进行生产会对我们的业绩有促进作用					
	4．我们相信在买方的厂房内设置我们自己的生产设备会对我们的业绩有促进作用					

	5．我们相信与买方地理位置上的接近可以大幅度提高我们的业绩					

下面的问题是关于贵公司与模块产品买方的知识共享的问题。请基于您个人观点，指出您对以下表述的认可程度, 请在最能描述您的认可程度的空格中画叉号（X）

您对以下表述的认可程度 1= 非常不认可；5= 非常认可		1	2	3	4	5
知识分享	1．我们的工程技术人员经常访问我们的买方并且交流					
	2．我们人员的产品技能通过经常在不同的项目和产品领域的工作交流而得到发展					
	3．我们的工程技术人员与买方面对面的接触非常频繁					
	4．我们经常派我们的工程技术人员访问买方					
	5．我们经常接待买方的工程技术人员的访问					
	6．我们的工程技术人员经常与买方进行视频会议					
	7．我们的工程技术人员经常与买方进行电话会议					
	8．我们在互联网上向买方发布以及分享信息和知识					
	9．我们的买方在互联网上向我们发布以及分享信息和知识					
	10．我们拥有电子数据库供买方的工程技术人员使用					
	11．买方拥有电子数据库供我们的工程技术人员使用					

下面是关于贵公司和买方的商务关系的问题。请基于您个人观点，指出您对以下表述的认可程度, 请在最能描述您的认可程度的空格中画叉号（X）

您对以下表述的认可程度 1= 非常不认可；5= 非常认可		1	2	3	4	5
商务关系	1．我们与买方有很好的人际关系					
	2．双方都很重视“面子”，我们都试图在业务往来中保护好对方的“面子”					
	3．我们在各个节日期间都与买方交换礼品，以显示相互的诚意					
	4．我们愿意在买方需要的时候给与帮助，因为过去买方也曾经帮助我们					

Appendix B

IRB Approval Document

NOVA SOUTHEASTERN UNIVERSITY
Office of Grants and Contracts
Institutional Review Board

MEMORANDUM

To: **YUNSHAN LIAN** (yunshan@nova.edu)
H. Wayne Huizenga School of Business & Entrepreneurship

From: Michael J.R. Hoffman, DBA, Institutional Review Board

Date: September 13, 2012

Re: Modularization (MD) and Its Impact on the Chinese Auto Industry (**IRB#: 091204)**

I have reviewed the above-referenced research protocol at the center level. Based on the information provided, I have determined that this study is exempt from further IRB review. You may proceed with your study as described to the IRB. As principal investigator, you must adhere to the following requirements:

1) CONSENT: If recruitment procedures include consent forms these must be obtained in such a manner that they are clearly understood by the subjects and the process affords subjects the opportunity to ask questions, obtain detailed answers from those directly involved in the research, and have sufficient time to consider their participation after they have been provided this information. The subjects must be given a copy of the signed consent document, and a copy must be placed in a secure file separate from de-identified participant information. Record of informed consent must be retained for a minimum of three years from the conclusion of the study.

2) ADVERSE REACTIONS: The principal investigator is required to notify the IRB chair and me (954-262-5369 and 954-262-5154, respectively) of any adverse reactions or unanticipated events that may develop as a result of this study. Reactions or events may include, but are not limited to, injury, depression as a result of participation in the study, life-threatening situation, death, or loss of confidentiality/anonymity of subject. Approval may be withdrawn if the problem is serious.

3) AMENDMENTS: Any changes in the study (e.g., procedures, number or types of subjects, consent forms, investigators, etc.) must be approved by the IRB prior to implementation. Please be advised that changes in a study may require further review depending on the nature of the change. Please contact me with any questions regarding amendments or changes to your study.

The NSU IRB is in compliance with the requirements for the protection of human subjects prescribed in Part 46 of Title 45 of the Code of Federal Regulations (45 CFR 46) revised June 18, 1991.

Cc: Protocol File
Office of Grants and Contracts (if study is funded)

Appendix C

Exploratory Factor Analysis Variables and Output

Rotated Component Matrix

	Component					
	1	2	3	4	5	6
product1	.356	-.199	.136	-.002	.464	.306
product2	.329	-.109	.321	-.035	.547	.033
product3	.038	.022	.108	.056	.753	.180
product4	.139	-.007	.083	.045	.719	.137
product5	-.028	-.067	.186	.049	.671	.357
technology1	.627	-.129	-.037	-.051	.323	.210
technology2	.548	-.109	.224	-.127	.390	.010
technology3	.643	-.038	-.015	-.086	.332	.235
technology4	.611	.080	-.143	.156	.285	.143
technology5	.570	.003	-.013	.155	.252	-.060
collaboration1	.501	.002	.173	.098	-.150	.074
collaboration2	.678	-.066	.142	.204	.065	.013
collaboration3	.747	-.083	.127	.134	.159	-.156
collaboration4	.332	.002	.059	.373	.093	.312
collaboration5	.758	-.037	.003	.092	-.080	.020
collaboration6	.597	-.044	.259	.028	.350	-.199
collaboration7	.766	.069	.105	.096	.083	.039
MP1	.537	.045	.133	-.115	.040	.510
MP2	.149	.028	.055	-.145	.164	.622
MP3	.569	-.021	.213	-.073	.112	.503
SPA1	.509	.064	.309	-.260	-.119	.115
SPA2	.063	.316	-.217	.355	.070	.315
SPA3	-.103	.270	-.064	.369	.104	.122
SPA4	-.011	.822	-.018	.074	-.118	.117
SPA5	.012	.808	.054	.015	-.203	.011
SPA6	-.023	.828	.047	-.070	-.181	-.016
SPA7	.024	.766	.093	.193	.034	.016
SPA8	-.043	.819	-.021	.072	.143	.050
SPA9	.034	.748	.031	.050	.112	-.050
SPA10	-.107	.719	.053	-.036	-.036	-.191
SPA11	.377	.202	.040	-.064	-.185	.150
SPA12	.277	.152	-.053	-.037	-.040	.243
SPA13	.567	-.026	.125	-.113	-.245	.130
SPA14	.196	.075	.051	-.109	.250	-.160
SPA15	.045	.226	-.091	-.051	.196	.037
PP1	.015	.002	-.063	.702	.020	-.048
PP2	.051	.116	-.128	.777	-.099	-.019
PP3	.099	.041	.148	.831	-.007	.013
PP4	.006	.014	.191	.719	.069	.175
PP5	.139	-.046	.131	.763	-.057	.116
KS1	.501	-.033	.564	-.044	-.210	.090
KS2	.452	-.102	.386	.210	.011	.143
KS3	.262	.036	.745	-.043	.056	-.167
KS4	.224	.125	.680	.209	.169	-.051
KS5	.239	-.108	.510	.276	.051	.154
KS6	-.032	.077	.678	-.094	-.032	.093
KS7	.194	.015	.760	-.031	.122	.088
KS8	-.031	.025	.682	-.142	.327	.021
KS9	.195	-.041	.517	.095	.057	.291
KS10	-.186	-.009	.449	.072	.466	-.011
KS11	-.075	.043	.525	.203	.343	.202
BR1	.062	-.143	.115	.108	.092	.643
BR2	-.030	.230	.040	.243	.041	.624
BR3	-.068	.016	.029	.167	.158	.493
BR4	.309	-.115	.124	.097	.039	.588

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.
a Rotation converged in 8 iterations.

Appendix D

Correlation between Independent and Dependent Variables

		COMPUTE product = (p1 + p2 + p3 + p4 + p5) / 5 (COMPUTE)	COMPUTE tech = (t1 + t2 + t3 + t4 + t5) / 5 (COMPUTE)	COMPUTE collab = (c1 + c2 + c3 + c4 + c5 + c6 + c7) / 7 (COMPUTE)	market performance	SPA
COMPUTE product = (p1 + p2 + p3 + p4 + p5) / 5 (COMPUTE)	Pearson Correlation	1	.444(**)	.330(**)	.361(**)	.103
	Sig. (2-tailed)	.	.000	.000	.000	.097
	N	262	262	262	262	262
COMPUTE tech = (t1 + t2 + t3 + t4 + t5) / 5 (COMPUTE)	Pearson Correlation	.444(**)	1	.643(**)	.425(**)	.261(**)
	Sig. (2-tailed)	.000	.	.000	.000	.000
	N	262	262	262	262	262
COMPUTE collab = (c1 + c2 + c3 + c4 + c5 + c6 + c7) / 7 (COMPUTE)	Pearson Correlation	.330(**)	.643(**)	1	.440(**)	.192(**)
	Sig. (2-tailed)	.000	.000	.	.000	.002
	N	262	262	262	262	262
market performance	Pearson Correlation	.361(**)	.425(**)	.440(**)	1	.150(*)
	Sig. (2-tailed)	.000	.000	.000	.	.015
	N	262	262	262	262	262
SPA	Pearson Correlation	.103	.261(**)	.192(**)	.150(*)	1
	Sig. (2-tailed)	.097	.000	.002	.015	.
	N	262	262	262	262	262

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).