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供應鏈整合與網路敏捷度對企業績效的影響

The Effects of Supply Chain Integration and Network Agility on Firm Performance

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To my parents

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供應鏈整合與網路敏捷度對企業績效的影響

摘要

供應鏈整合被視爲是改善企業績效重要的因素之一，合作的供應鏈增進了公司獲取改善企業績效的機會。另一方面，當供應鏈系統面臨劇烈的競爭時，網路敏捷度就被視爲促進供應鏈成功的重要手法。本論文分成三個研究，首先，藉由個案研究法建立了一個概念性的模型，藉由這個模型可以解釋網路敏捷度如何影響企業績效，同時，解釋網路敏捷度對於供應鏈合作策略的影響。在第二研究中，提出了一個包含供應鏈整合和企業績效等六個構面的整合模型，並利用結構方程模式方法檢驗這個模型。第三，提出一個概念性模型，檢驗顧客敏捷度對於供應鏈整合與企業績效間的關係是否具有中介效果；此外，檢驗供應鏈整合分散程度對於供應鏈整合與企業績效間的關係是否具有調合效果。研究結果顯示，顧客敏捷度對於供應鏈整合與企業績效間的中介效果成立，且供應鏈整合分散程度對於供應鏈整合與企業績效間的調合效果成立。

關鍵字：企業績效、供應鏈整合、供應鏈整合分散程度、網路敏捷度、顧客敏捷度

The Effects of Supply Chain Integration and Network Agility on Firm Performance

ABSTRACT

Supply chain integration (SCI) is considered one of the major factors in performance improvement. Collaborative supply chain enhances a firm's ability to find and seize opportunities to improve firm performance. Meanwhile, as channel systems face fierce competition, network agility is regarded as an imperative for channel success. The dissertation, hoping to better understand the relationship between network agility and operational performance, composed of three parts. First, it builds a conceptual model through a case study to explain the influence of network agility on firm performance and on channel strategies between supply chain partners. Second, it proposes and tests a model of direct and indirect relationship between SCI and firm performance. Third, it tests the mediating effect of customer agility and the moderating effect of integration diversity on the relationship between SCI and firm performance. The research results assert the significance of both effects.

Keywords: Customer agility, diversity of integration, firm performance, network agility, supply chain integration

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1. INTRODUCTION

1.1. Motivation

In a dramatically changed business environment surrounded by channel competitors, most companies are compelled to develop channel cooperative strategies for survival. A collaborative supply chain is where chain members cooperate to achieve competitive advantage through information sharing, joint decision-making, and benefit sharing, which is a result of profitability increased by value delivered to end customers (Simatupang & Sridharan, 2002). Supply chain integration is defined as the collaborative relationship among supply chain partners working for common performance goals. The goals may be reduction of supply chain length, which involves the overall supply chain networks, or decrease in production costs, enjoyed by individual companies. Collaborative relationships between supply chain members enable the adoption of supply chain integration (SCI), which in turn enhances firm performance. Previous research has argued that SCI has positive impact on firm performance (i.e. Devaraj, Krajewski, & Wei, 2007; Frohlich & Westbrook, 2001). However, Vickery, Jayaram, Droge, and Calantone (2003) failed to find a significant direct relationship between SCI and financial performance. It may be too simplistic to assert the relationship between SCI and a firm's financial performance, if the extent of integration is only measured by one or a small number of its relationships.

As channel systems face fierce competition, network agility is regarded as an imperative for channel success. Companies can employ agility to spot and exploit

changes in the market. Agility comprises three interrelated capabilities, i.e., customer agility, partnering agility, and operational agility (Sambamurthy, Bharadwaj, & Grover, 2003). Moreover, building network agility is a source for competitive actions (Sambamurthy et al., 2003). Furthermore, some empirical evidence shows that a firm's agility has a positive influence on its performance (Ettlie, 1998; Swafford, Chosh, & Murthy, 2006).

As presented previously, the studies are limited in that, however sophisticated their research techniques may be, they only assert the relationship between SCI and firm performance. Moreover, there are only few analyses on how SCI impacts on firm performance through network agility, which is a firm's capability to sense changes and respond rapidly. A high level of network agility enhances firm performance; meanwhile, SCI enables manufacturers to synchronize all supply chain participants' core competencies and capabilities to jointly reach a higher service level.

On the other hand, to better incorporate innovative modules into product concepts or information integration for higher supply chain visibility, contract manufacturers (CMs) have to cope with upstream directives, imposed by original equipment manufacturers (OEMs). However, only very few studies have probed into CMs' competitive strategy, and the thrust of supply chain research has been focused on strategy issues faced by OEMs probably because most of the western companies play the role as OEMs.

1.2. Research objectives and scopes

The overall concern of this dissertation is to find for manufacturers antecedents of

firm performance with regard to supply chain networks. It consists of three studies: a case study and two empirical studies.

First of all, the research purpose of conducting a qualitative case study was to broaden understanding about the strategic role of a mixed channel strategy and about the influence of network agility. With regard to its research scope, it is a close study of a manufacturer from Taiwan, chosen out of more than twenty companies which had implemented various supply chain cooperation projects under the support of the Taiwan government.

The first empirical study proposes to discover, by conducting a questionnaire, antecedents of firm performance for manufacturers. It investigates how SCI influences firm performance through customer agility. The second empirical study aims to examine the effect of integration diversity by investigating a variety of supply chain integration. Data for the two studies have been collected from three areas: Hong Kong, China, and Taiwan.

1.3. Research framework

The research framework of the dissertation is illustrated in Figure 1. First, there is an explorative research (research I) which seeks to find the relationship between network agility and a manufacturing firm's performance, established through information system (IS) integration. Moreover, this case study identifies the importance of inter-organizational collaborative practices in bringing supply chain partners a win-win situation. Several findings derived from the case study can be further compared with the

results of the two empirical researches. Second, the empirical studies (research II and III) are made on the Greater China and provide a comprehensive survey and valuable suggestions for the industry. Examining antecedents and consequences of supply chain integration, they provide insights that help firms in Taiwan develop core capabilities as a manufacturer.

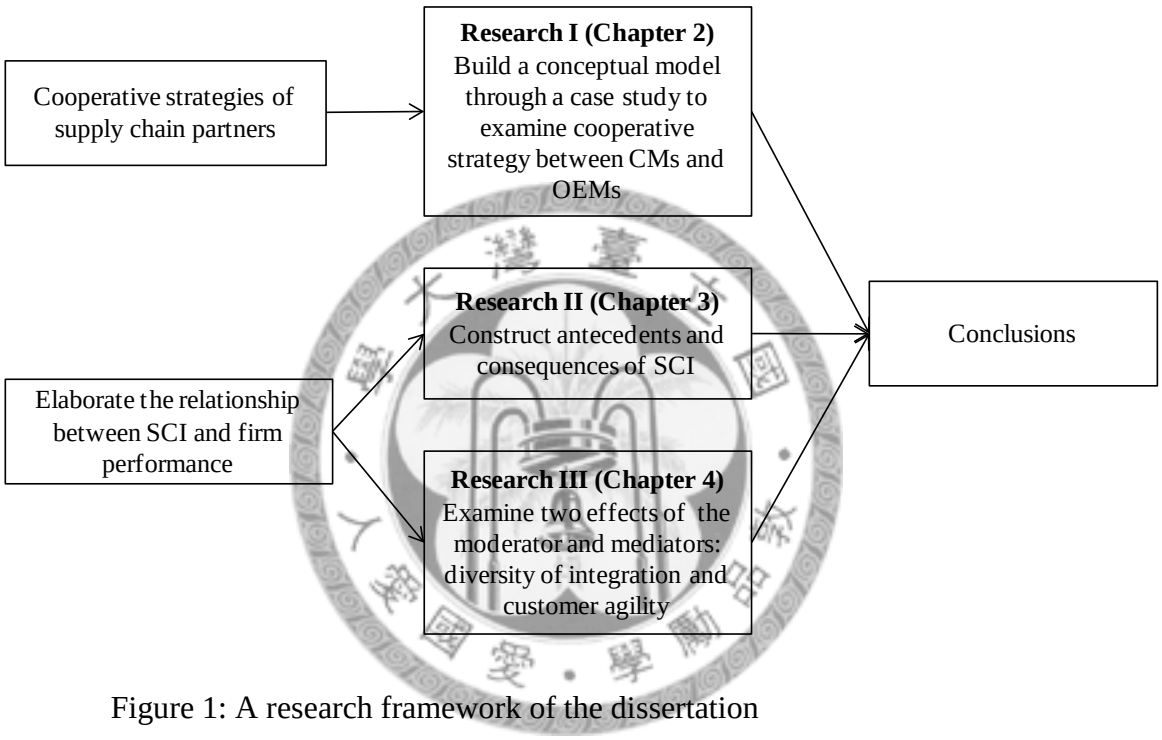


Figure 1: A research framework of the dissertation

1.3.1. Overview of research

The research I is briefly introduced as follows. Original equipment manufacturers (OEMs) can reduce labor costs, free up capital investment and enhance firm's agility by full outsourcing of product manufacturing. OEMs can then focus on the most valuable processes, e.g. R&D and marketing. However, contract manufacturers (CMs) may decide to foster their own brand and forge their own relationships with retailers or distribution channels. The conflicts of interest between OEMs and CMs can be reduced

by implementing a mixed channel strategy. Label licensing, the most essential component in the implementation, enhances the marketing capability of a CM and allows it to move up the value chain. In this research, a case study involving a supply chain network in the optical storage media industry is used to develop a conceptual model to explain how a mixed channel strategy and superior network agility enhance firm performance. This study argues that information system integration influences firm performance through network agility, and that the mixed channel strategy boosts financial performance. Moreover, the result proposes that network agility is associated with a moderating effect on the relationship between the mixed channel strategy and financial performance.

The research II is briefly introduced as follows. Facing uncertainty, the defining characteristic of business competition, and upstream directives imposed by their cooperative partners, manufacturers can use customer agility to sense changes and respond rapidly. This study proposes a conceptual model to examine, through customer agility, antecedents to better firm performance. The conceptual model was empirically tested using data collected from 809 manufacturing companies in China, Hong Kong, and Taiwan. The results show that customer agility fully mediates the relationship between SCI and firm performance. Moreover, internal process integration and technology uncertainty has been found to partially impact on the proposed model. Also, information sharing has significant impact on business process integration.

The research III is briefly introduced as follows. It may be too simplistic to assert the relationship between SCI and a firm's performance, if the extent of integration is only measured on one or a small number of its relationships. This study proposes a

conceptual model to examine whether the construct of customer agility has the mediating effect to influence the relationship between SCI and firm performance. Besides, the moderating effect of integration diversity between SCI and firm performance was also tested. Data used for testing the conceptual model were obtained from 818 manufactures in China, Hong Kong, and Taiwan. The result shows that customer agility mediates the relationship between SCI and firm performance. In addition, integration diversity moderates the influence of SCI on operational performance, such that the influence of SCI becomes less positive as diversity of integration becomes more positive.

1.4. Organization of the dissertation

This dissertation consists of 5 chapters. The remainder is organized as follows. Chapter 2 provides a case study which shows that network agility is a trigger for enhanced firm performance. Chapter 3 is an empirical study that shows how customer agility influences information integration and firm performance. Chapter 4 presents the discovery that integration diversity is a mediator between supply chain integration and firm performance. Finally, conclusions and future research suggestions are provided in Chapter 5.

2. NETWORK AGILITY AS A TRIGGER FOR ENHANCING FIRM PERFORMANCE

2.1. Introduction

A marketing channel system involves competition with other channel systems rather than horizontal competition in contemporary firms (Gupta & Woodside, 2006). Facing increasingly intense competition, firms no longer compete at a single-firm level, but rather at a level of networks of firms. As channel systems face fierce competition, network agility is regarded as an imperative for channel success. Agility comprises three interrelated capabilities, i.e., customer agility, partnering agility, and operational agility (Sambamurthy, Bharadwaj, & Grover, 2003; Treacy & Wiersema, 1993). For the past several decades, original equipment manufacturer (OEM) business has been adopted as a popular production strategy as global enterprises search for cheap manufacturing services. In recent years, the competition has intensified to such a level that those high-tech contract manufacturers (CMs) no longer enjoy profit margins as high as in the past. Profits from implementing contract manufacturing fell to as low as 4.1% in 2005, according to the annual report of the Ministry of Science and Technology in China. Dissatisfied with low manufacturing profit margins, some CMs try to move up the value chain by developing their own brands. According to the smiling (U-shaped) curve concept proposed by Stan Shih, the founder of the Acer Group, it is critical for CMs to discover the best strategy of accessing the more profitable business processes in the value chain, such as product design and marketing services. A strategy adopted by several leading high-technology companies in Taiwan involves dividing their firms into

two separate entities, one dealing with original brand manufacturer (OBM) business and the other focusing solely on OEM service provision so as to resolve conflicts of interest with its OEMs. Acer, D-link, and Asus are notable cases that have spun off their own contract manufacturing businesses. Because of a lack of marketing capabilities, these new entrants to commodity industries creating their own brands may be unable to compete with well-known brands, although the entrants can avoid big losses resulting from the withdrawal of contracts from their major OEMs.

On the other hand, OEMs are also considering how to transform their current business models to improve profitability while maintaining low costs, and how to simultaneously enhance network agility to increase competitiveness. Some OEMs try to increase profit by revamping their channel strategy. For example, Hewlett-Packard (HP) has changed its channel strategy to permit its customers to request products shipped directly from its factories (Leung, 2004). A collaborative strategy for inter-organizations provides a win-win situation. OEMs authorize their intimate partners to manufacture their brands by charging a licensing fee, a strategy known as label licensing. This practice enables OEMs and CMs to develop new business processes, and involves an innovative rethinking of firm strategies and operations.

The adoption of a mixed channel strategy can accelerate sales channel diversification between manufacturers and retailer customers. The subject of this investigation concerns three types of distribution channels, direct sales, indirect sales, and quasi-direct sales (label licensing practice), constituting the mixed channel strategy. From the perspective of CMs, the direct sales is to retail to customers directly and the indirect sales is to OEMs. Among CMs, some companies have gone beyond assembly to target

customers directly. An example is given later. The market share of Acer and Asus were ranked respectively as the 3rd and the 4th in the global laptop market in 2008 although both companies were originally CMs for laptops. Only very few studies probe into CMs' competitive strategy, and the thrust of supply chain research has been focused on strategy issues faced by OEMs probably because most of the western companies play the role as OEMs. This study tries to explore the effects of the channel system cooperation on enhancing CMs' operational performance and then on their financial performance.

Some research has argued that information technology (IT) systems positively impact on a firm's agility (Overby, Bharadwaj, & Sambamurthy, 2006; Sambamurthy et al., 2003). However, previous research left an open question about how a firm's agility influences its mixed channel strategy. This investigation fills the gap by examining the links between the effects of the mixed channel strategy and network agility. Besides, it is important to know whether network agility is influenced by information system (IS) integration. It is also interesting to investigate whether network agility and a mixed channel strategy strengthen firm performance. The purpose of this research was to broaden understanding about the strategic role of a mixed channel strategy and about the influence of network agility by conducting a qualitative case study involving channel systems in the optical storage media industry. A conceptual model is derived from the case study to explain firm performance associated with the implementation of a mixed channel strategy and network agility. This study argues that IS integration may influence firm performance through network agility. It also proposes that network agility is associated with a great moderating effect on the relationship between the mixed channel strategy and financial performance.

The remainder of this chapter is organized as follows. Related literature is reviewed in Section 2.2. The research methodology is provided in Section 2.3. Section 2.4 presents the mixed channel strategy adopted by CMC in detail. A conceptual model for assessing the mixed channel strategy and network agility is presented in Section 2.5. In the final section, discussions and conclusions are presented.

2.2. Literature review

This study briefly reviewed collaboration between OEMs and CMs, strategic roles of IT, and network agility respectively. The literature review on collaboration between OEMs and CMs provides the background to the competitive and cooperative relationship between OEMs and CMs. On the other hand, literature on IT's strategic roles and network agility reveals that both of them play an important role in enhancing firm performance.

2.2.1. Collaboration between OEMs and CMs

Because local firms usually regard their survival as the first priority, some of them pursue manufacturing contracts from global brand marketers rather than directly accessing the end market. These CMs can then focus on business processes that enhance firm performance the most, such as being a dedicated manufacturing service provider. Yu (2005) argued that rather than moving into the OBM business, which involves high business risk and brand development costs, some imitative firms have chosen to become manufacturing specialists serving product developers. Besides, CMs have begun to

shoulder functions, such as coordinating cross-border supply chains, as part of their role as integrated service providers, thus becoming an essential node in the global value chain (Chen, 2002; Wu & Hsu, 2001). Cheng, Blankson, Wu, and Chen (2005) proposed a stage model of international brand development, where CMs sell products with OEM brands to expand international markets. Arruñada and Vãzquez (2006) further pointed out that the creation of new companies, the creation of new brands, and movement up the value chain are possible strategies adopted by CMs that encounter intensified competition in certain industries. As reviewed earlier, several investigations have been proposed to explain how CMs enhance their competitive advantage in an intensely competitive environment. However, only a limited number of studies consider how CMs can avoid business risk and resolve conflicts of interest with their OEMs while they move up the value chain, especially when entering the end markets.

Teece (1986) asserted that "once the product design stabilizes there is likely to be surge of process innovation as producers attempt to lower production costs for new products." Thus, OEMs are commencing to deploy new strategies related to service innovation that lowers product costs. Innovative channel strategies enable firms to combine resources in new ways, which allows them to adapt to rapidly changing business environments. Some developments in business environments have sped up the diversification of sales channels between manufacturers and consumers (Tsay & Agrawal, 2004). Dynamic capabilities are also identified to enhance channel transformation (Wilson & Daniel, 2007). Also, Fingleton (1997) argued that many manufacturers turn from their distribution channels middlemen to direct selling. Furthermore, a direct channel is helpful in boosting a manufacturer's profit (Chiang, Chhajed, & Hess, 2003). A number of manufactures are entering into the retail market

to raise competition with OEMs and retailers. However, CMs will face high business risk if they rush into the retail market. Therefore, developing innovative channel strategies through channel coordination may reduce business risk and boost firm performance.

2.2.2. Strategic Roles of IT

Firms have traditionally established their value chains and interorganizational relationships through bundling IT systems, products, and services into an integrated structure to achieve a sustainable business (Evans & Wurster, 2000; Kettinger, Grover, Segars, & Guha, 1994; Wheeler, 2002). IT competence is usually treated as an antecedent to firm-level competitiveness (Sambamurthy et al., 2003). The quality of IT capability has been demonstrated to significantly and positively impact firm performance (Bharadwaj, 2000; Tanriverdi, 2005). Firms in the Italian insurance sector increase their productivity through IT applications (Neirotti & Paolucci, 2007). The shared knowledge between IT and customer service executives positively improves customer service processes (Ray, Muhanna, & Barney, 2005). These conceptual frameworks or empirical studies regarding competitive actions of IT systems help researchers clarify the role of IT in firm performance. Contemporary firms thus increasingly rely on IT, including process, knowledge, and communication technologies, to improve their agility and value chain collaborations, which are difficult for competitors to duplicate.

Several investigations have assessed the impact of closer manufacturer-retailer relationships on performance (Heide & John, 1988; Lusch & Brown, 1996).

Collaborative planning forecasting and replenishment (CPFR) and efficient consumer response (ECR) are two powerful systems for coordinating supply chain networks. Recently, impressive results, such as higher sales volumes and lower inventories, have been achieved by successful CPFR programs of firms, including Wal-Mart (Hill, 1999; Parks, 1999, 2001; Songini, 2001), Nabisco & Wegmans (Parks, 1999), Procter & Gamble (Schachtman, 2000), and Kmart (Songini, 2001). Manufacturers have experienced similar benefits as well as faster cycle times and reduced capacity requirements (Hill, 1999; Ireland & Bruce, 2000; Schachtman, 2000). On the other hand, other studies have examined the impacts of adopting specific aspects of ECR (Dhar, Hoch, & Kumar, 2001; Gruen & Shah, 2000; Stank, Crum, & Arango, 1999). Kurnia and Johnston (2003) asserted that IT systems, such as ECR, are designed to make the e-commerce enabled grocery industry more efficient and responsive.

2.2.3. Network agility

From the viewpoint of supply chain networks, customer sensitivity, virtual integration, process integration, and network integration are identified as four dimensions of agile supply chain practices (Hoek, Harrison, & Christopher, 2001). Besides, Sambamurthy et al. (2003) argued that “agility encompasses a firm’s capabilities which are related to interactions with customers, orchestration of internal operations, and utilization of its ecosystem of external business partners” Thus, agility comprises three interrelated capabilities: customer agility, partnering agility, and operational agility (Sambamurthy et al, 2003). From their viewpoint, customer agility represents ability to co-opting customers in the exploration and exploitation of opportunities for competitive actions. Partnering agility indicates ability to leverage

assets, knowledge, and competencies of suppliers, distributors, contract manufacturers and logistics providers in the exploration and exploitation of opportunities for competitive actions. Operational agility shows ability to accomplish speed, accuracy, and the cost in the exploitation of opportunities for competitive actions.

Although Hoek et al. (2001) introduced practices for creating an agile supply chain, Sambamurthy et al. (2003) provided a definition to deal with how agility is measured through the three interrelated capabilities. This study has adopted and applied the definition of Sambamurthy et al. (2003) for its purpose. Therefore, renaming agility in the context of supply chain, this study defined network agility as a firm's ability to sense the change and respond rapidly in supply chain networks in an intensive competitive environment. Network agility comprises three interrelated capability: customer agility, partnering agility, and operational agility.

One antecedent of network agility is from IS integration among network partners. IS integration enables clearer visibility of downstream demand and upstream manufacturing schedule. IS integration is not just the exchange of information on demand and inventory levels, but multiple, collaborative working relationships across the organizations at all levels. Therefore, IS integration plays an important role in strengthening network agility (Christopher, 2000; Lewis, Hornyak, & Patnayakuni, 2008; Overby et al., 2006). Furthermore, some empirical evidence shows that a firm's agility has a positive influence on its performance (Ettlie, 1998; Swafford, Chosh, & Murthy, 2006) and competitive actions (Sambamurthy et al, 2003).

2.3. Case methodology and case selection

2.3.1. Case methodology

Barnes (2001) argued that the case study approach is likely to be the favored research strategy for empirical investigations into the formation process of operation strategies. Five possible methodologies can be used in such case studies: ethnography, interviews, strategy charting, questionnaires, and documentation. Eisenhardt (1989) argued that the case study leads researchers to identify new theoretical relationships and question old ones. Moreover, a case study can employ an embedded design, that is, multiple levels of analysis within a single study (Yin, 2009). This research employs a qualitative research design involving multiple levels of analysis within a single company. A single case study with multiple levels, involving four business models within a CM, provides important insight into the relationship between the mixed channel strategy and firm performance, and between IS integration and network agility.

2.3.2. Case selection

This study chose the CMC Group, one of the largest optical storage manufacturing firms in the world, as its focal firm. It was chosen out of more than twenty companies which have implemented various supply chain cooperation projects under the support of the Taiwan government.

For the past few decades, the Taiwan government has allocated a large amount of budget in implementing a supply chain cooperation project so as to improve local firms' competitive advantage. These projects typically received a monetary support ranging

from half million to 2 million USD. They can be classified into five programs (named as Programs A, B, C, D, and E sequentially over a six-year span). Program A represents OEMs and CMs as channel parties who establish electronic supply chain networks. Among the firms implementing program A are IBM, Compaq and HP. Program B shows that CMs and their up-stream suppliers build channel linkages. Implementing program B are 15 large Taiwan firms, such as Acer, Inventec, and Asus. Program C and program D are respectively electronic cash flow mechanisms and electronic logistics mechanisms among companies which implement e-commerce systems. Program E indicates implementing collaborative design mechanisms between OEMs and CMs. Implementing program D are 10 international and Taiwanese firms, such as HP, Asus, and CMC. Program E is also implemented by several international and Taiwanese firms, such as HP, CMC, and Amtran. Representative firms implementing programs A, B, and E indicate different levels of the collaborative relations with network parties (see Table 1).

Table 1: Taiwan government implements collaborative programs of supply chain networks to improve overall performance of a channel system

Program Nam	Objectives	CM	OEM	Supplier	Retailer
Program A	HP establishes a global e-procurement system to enhance information visibility of supply chain networks	Acer, Asus, and Inventec, etc.	HP	--	--
Program B	Acer establishes a e-procurement system to link its upstream suppliers	Acer	--	Local upstream suppliers	--
Program E	CMC establishes various IS integration with OEMs and retailers due to various collaborative relations	CMC	HP, Philips, Wal-Mart	--	Wal-Mart, Best Buy, Staples

CMC offers a comprehensive range of storage devices including floppy diskettes, CDs, DVDs, etc. To approach global markets, CMC has established a worldwide

business network and possesses various sales channels to sell products in Britain, China, Hong Kong, Mexico, Taiwan, and the United States. CMC supplied 12.9% of the global CD-R market in 2007 and achieved a 17.9% share of the DVD-R market. For its collaboration project, CMC has established several network cooperative relations with its international brand customers and office supply retailers. CMC employs a mixed channel strategy to obtain customer segmentation so as to identify unmet customer needs. Besides, a variety of IT systems are implemented by CMC and its partners to boost collaborative relationships among channel partners. This focal firm provides us with observations and evidence that the level of network agility may influence firm performance. Also, it can be analyzed to know how a mixed channel strategy impacts on firm performance.

2.3.3. Measurements of constructs and data sources

The research model in this study contains several constructs. First, the degree of integration of network partners' information system, called IS integration, is a proxy for inter-organization cooperation. IS integration is to find the link between strategic ideas and the application of information technology among partners. The subject of this investigation experiences several types of IS integration, which varies according to its business strategies. Second, a viewpoint of a firm's capabilities provides measures of network agility which comprises three interrelated capabilities: customer agility, partnering agility, and operational agility (Sambamurthy et al., 2003; Treacy & Wiersema, 1993). Third, firm performance consists of two parts: operational performance and financial performance. This investigation provides several KPIs to measure operational performance enhanced by network agilities from the viewpoint of

manufacturing and service performance. Also, the study measures a firm's financial performance in terms of its sales margin and return of investment (ROI). Finally, the constructs related to the mixed channel strategy and reciprocal investments in IT use qualitative evidence from interviews and observations to illustrate the research concepts.

The investigation was sponsored by the Ministry of Economic Affairs in Taiwan. One of the authors was a committee member who monitored the progress of project implementation. All data were gathered from interviews and company visits during the period from 2005 to 2007. This study combines quantitative data from the subject's financial performance and key performance indicators (KPIs) with qualitative evidence from interviews and observations. Data analysis was both a whole case and cross level to demonstrate financial performance gained after the mixed channel strategy was implemented and operational performance enhanced by network agility.

There are several data sources for the research: (1) extensive archives, including business publications and corporate materials, (2) interviews with project executives and high-level managers in the focal firm, and (3) site-visits. The primary interviews for this study were conducted quarterly at the focal firm. During the 24-month period, 2-hour interviews were conducted with two to five informants, such as an executive vice president, managers of the marketing department, and managers of the e-commerce department. The data were collected in 8 waves over 24 months. If deemed necessary, further data and site-visits were requested to verify the real progress. Such a process enables collection of both real-time and longitudinal data.

The interview guide of the focal firm was divided into three sections. First, we asked

questions about the focal firm's business and channel strategy. Second, we asked the informants to describe the major events related to implementing IS systems with its partners, and to delineate the evolution of these IS systems. We used open-end questions such as how the benefit was obtained and what difficulty was encountered. Also, failed cooperative relationships were tracked. Furthermore, we asked questions related to how various business models were involved to create the focal firm's niches. Third, we asked closed-ended questions, including a quantitative evaluation of each business model regarding its KPI achievements and financial performance.

2.4. Mixed channel strategy

2.4.1. Business model profiles

CMC pursues four business models for the mixed channel strategy, including being a "white label CM" for retailers such as Wal-Mart and Staples, a "global brand CM" for Philips, a "label licensing CM" for HP and a "subsidiary OBM" for its own brand (Hyper-K). These four business models involve different collaborative activities with their supply chain partners (see Table 2). We can find that a variety of collaborative activities with supply chain partners are conducted, depending on the business model adopted.

Table 2: A profile of CMC business models

Business model	Subsidiary OBM	White label CM	Global brand CM	Label licensing CM
Representative brand name	Hyper-K	Wal-Mart	Philips	Hewlett-Packard

Channel description	A CMC subsidiary for developing its own brand	OEMs are retailers Retailers sell product in own stores	OEMs are international brand owners OEMs highly control distribution channels	OEMs are international brand owners OEMs highly control distribution channels
Value-added activities	Design, procurement, manufacturing, logistics, sales, and post-services	Procurement, and manufacturing	Procurement, manufacturing, and logistics	Procurement, manufacturing, logistics, and post-services
Relationship with downstream firms	Weak relationships with retailers	Weak relationships with retailer OEMs	Maintain a close relationship with OEMs	Maintain a close relationship with OEMs and retailers
Price and margins				
Final product price	Medium	Low	High	High
Sales margin	Medium	The lowest	High	The highest
Sales volume	Low	High	High	High
IS integration with partners[a]	CPFR and CTM	Partial data sharing	CPFR and CTM	CPFR, CTM and CCRM
Network agility[b]				
Operational agility	High	Medium[c]	High	High
Partnering agility	High	Low	High	High
Customer agility	Low	Low	Low	High

Note: [a]Our focal firm applied three IT systems to integrate their partners. For details of the IT systems, refer to Table 3.
[b]Network agility consists of three types of agility: operational, partnering, and customer agility. The relationships between network agility and IS integration comprise: (a) CPFR to enhance operational agility, (b) CTM to enhance partnering agility, and (c) CCRM to enhance customer agility.
[c]Medium level of operational agility results from reciprocal investments in IT from Wal-Mart.

In the subsidiary OBM model, Hyper-K oversees the complete supply chain network and has a medium level of collaborative activities with partners. However, Hyper-K is a local North American brand currently lacking sufficient marketing capability, resulting in a mid-level brand image, low price, and low sales margin. Thus, coordinating with retailer channels is crucial for improving its performance.

In the white label CM model, OEMs are large retailers with wholesalers in charge of commodity procurement. Final product price and sales margin highly depend on retailer marketing strategies. CMC is only responsible for manufacturing activities; however it needs to enhance its manufacturing capability to boost firm performance. Moreover, this

business model implements a low level of collaborative activities with partners, especially with large-scale retailers. For example, Wal-Mart sells products at low prices, at low sales margins, and of low quality since it pursues a low price strategy.

In the global brand CM model, OEMs are international brand owners, and CMC takes charge of manufacturing and logistics in supply chain processes. OEMs, such as Philips, hold strong bargaining power to negotiate with distributors and retailers, own a good brand image, and have high quality standards for products; therefore, their products sell at relatively high prices and sales margins. Furthermore, this business model deploys a medium level of collaborative activities with partners.

This study classified the four business models as three types of distribution channels (see Figure 2): direct sales, indirect sales, and quasi-direct sales, composing the mixed channel strategy. A CM sells products with its own brand to retailers in direct sales; sells products to OEMs in indirect sales. In quasi-direct sales, a CM directly sells products with its OEM's brand to retailers (label licensing). CMC sells its own brand, Hyper-K, for the direct sales or makes an OEM contract with buyers for the indirect sales. A long-term manufacturing contract guarantees stable profits and diminishes doubts on an unknown company. Contract manufacturing helps OEMs understand CMC's manufacturing capability and enables CMC to seize opportunities for absorbing their marketing ability.

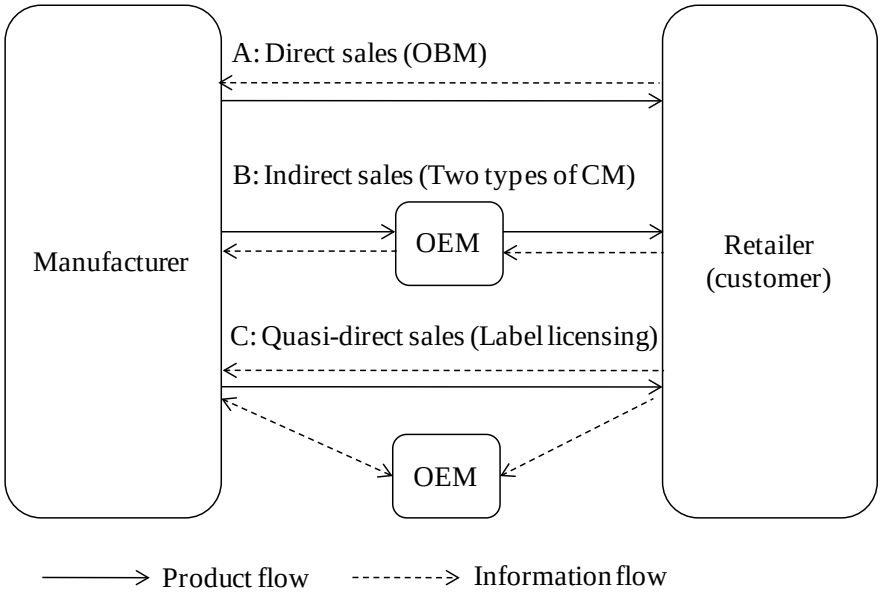


Figure 2: Three types of distribution channels: direct sales, indirect sales, and quasi-direct sales. The four business models are indicated in parentheses.

2.4.2. Determinants of implementing the label licensing

Superior network agility allows a CM and its OEM to recognize opportunities for implementing label licensing. This investigation concludes that several antecedents would influence successful implementation of label licensing: a long-term cooperative relationship, network agility of a CM, and characteristics of the licensed product.

First of all, excellent manufacturing capability and previous collaborative experience wins higher trust and reliability, resulting in a long-term cooperative relationship and manufacturing contracts. Second, impacted by superior network agility, HP and CMC deployed label licensing to increase service level and then enhanced customer satisfaction. HP provided CMC with the right to use its label on products by charging a licensing fee. HP only monitors the sales and post-sales service rather than being directly responsible for them (see Figure 2). This practice has enabled OEMs to simplify

their participation in business activities in the channel system. The cost of contract manufacturing has been transformed from expenditure to revenue through label licensing because OEMs receive a licensing fee rather than manufacturing cost. The design of new products is the process whereby OEMs provide value in the entire channel system. On the other hand, CMC crosses its organizational boundary and manages key network business processes, including sales and post-sales service. Thus, implementing label licensing can reduce the threat of OEM contract withdrawal in international branding expansion. Furthermore, accumulating marketing capabilities and boosting the relationship with retailers will help CMC develop international brand names in the future.

Finally, peripheral products in an OEM's whole product lines characterize the licensed commodity. In this study, HP's financial report shows its major revenue source does not originate from peripherals, such as CD/DVD products. A manager of HP noted "We will consider deploying the label licensing practice with CMC because this tactic allows the company free up operation cost for manufacturing activities. Furthermore, the inclusion of CD/DVD products completes our product range." For a contrast example, TDK and Memorex are also partners of CMC but they do not establish a cooperative strategy as deeply as to license their label to CMC because CD/DVD is one of their main products.

2.5. Conceptual model for assessing the mixed channel strategy and network agility

A conceptual model is suggested as shown in Figure 3. Also, several findings are proposed from the viewpoint of IS integration, network agility, reciprocal investments

in IT, and the mixed channel strategy.

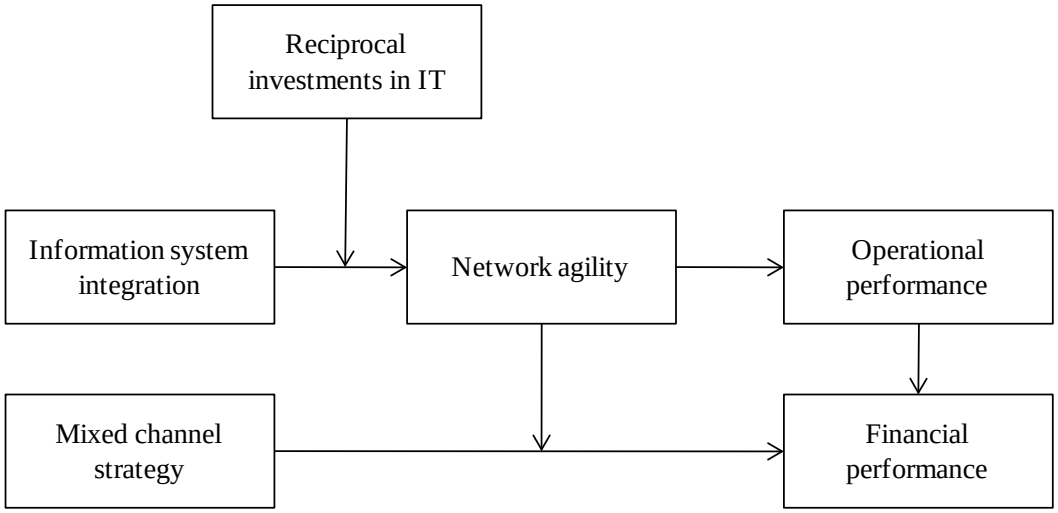


Figure 3: A conceptual model for enhancing network agility and implementing the mixed channel strategy

2.5.1. IS integration and network agility

It is critical to have efficient and effective IT systems so as to maintain close relationships among retailers, OEMs and CMs. IT systems can reduce coordination costs and operations risk (Clemons, Reddi, & Row, 1993). Coase (1937) demonstrated a transaction cost approach to the firm theory, namely, a transaction cost being the cost of providing some service or goods through markets rather than having it provided from within the firm. All costs of running the exchanges system can be referred to as transaction costs, including developing and maintaining an exchange relationship, examining transaction behavior, and avoiding opportunistic transactions (Pilling, Crosby, & Jackson, 1994). With transaction costs in their minds, firms attempt to minimize their total costs by choosing the best organizational governance structure. Furthermore, vertical integration indicates a closer relationship between the upstream and the downstream, resulting in lower transaction costs (Gummesson, 1996; Heide,

1994). Hence, it can reduce the transaction cost when a CM implements IS integration to integrate strategic ideas, operations, and data among network partners.

Various IT systems deployed for achieving network agility enhance performance of value chain activities (see Table 3). First, CMC deployed a CPFR system linking their business information together with logistics service providers and OEMs to increase vertical coordination and then boost operational agility. Second, to boost coordination with retailers and forwarders, CMC augmented the function of the CPFR system, including collaborative transportation management (CTM) and collaborative customer relationship management (CCRM), developing a so-called ECR system. CCRM enhanced customer agility as it provided a platform enabling retailers to share marketing information with CMC when retailers forecasted customer demands and planned marketing activities. CTM improved partnering agility by offering a total solution to collaborative logistics planning, which involved transportation schedule planning based on customer regular and promotion orders. In conclusion, ECR enabled CMC to achieve a more precise replenishment forecast and delivery schedule, reduce production cycle time, reduce network inventory, and boost network agility.

Table 3: IT system deployment and network agility

Value chain activities	Production	Logistics	Customer service
Goal	Operational agility	Partnering agility	Customer agility
Strategy	Enhance demand forecasts and manufacturing visibility to boost customer service	Real-time shipment forecasts	Enhance marketing information sharing among retailers, logistics, and manufacturers
Tactic	Collaborative forecasts and real-time manufacturing information sharing among partners	(a) Transportation schedule planning based on customer regular and promotion forecast orders (b) Integrate CMC's and OEMs' logistics by integrating CPFR and	Share retailer sales information with the manufacturer and logistics service providers including sales data, promotion activities, and replenishment forecasts

		CCRM systems	
IT system	CPFR	CTM	CCRM

IS integration, such as ECR, provides the firm with a useful tool to obtain more efficient communication with its partners. The relationships between network agility and IS integration comprise: (a) CPFR to enhance operational agility, (b) CTM to enhance partnering agility, and (c) CCRM to enhance customer agility. Therefore, IS integration plays an important role in enabling the sensing and responding capability of a firm. Accordingly, Finding 1 is proposed as follows.

Finding 1 *IS integration of a channel system strengthens network agility.*

2.5.2. Reciprocal investments in IT

IS integration between two companies is subjected to the depth of collaborative activities between channel partners. Retailers have more motivation to allow their IT systems to be accessed by inter-organizational IT systems when the products in question are either the main products in the shops or when they come in large volume. Retailer channels in our study can be classified into three sub-type channels according to the retailer's characteristics: (1) office supply stores, e.g., Staples, (2) consumer electronics product stores, e.g., Best Buy, and (3) discount stores, e.g., Wal-Mart. In our investigation, Staples cooperatively established an IT system with CMC. However, Wal-Mart initially failed to integrate with CMC by directly implementing IT systems due to limited benefit.

Wal-Mart and CMC implemented low IS integration. First, from the viewpoint of collaborative activities, CMC just manufactures products for War-Mart, but services provided by CMC do not involve other value-added processes for Wal-Mart. Second, for economic reasons, the products only accounts for a small proportion of Wal-Mart's total sales. An alternative example may provide evidence to illustrate that Wal-Mart decides to establish high IS integration with its partners due to economic reasons. Procter & Gamble (P&G) is the most important partners of Wal-Mart. Their joint businesses have grown from $375 million in 1988 to over $4 billion recently. P&G and Wal-Mart jointly developed a high level of IS integration and a data highway which linked P&G data to Wal-Mart data to meet the needs of customers.

Reciprocal investments are transaction-specific investments made by a firm which tends to promote a long-term or stable relationship with its value chain partners in an exchange relationship where the promotion increases the level of cooperation. Bensaou (1997) argued that in the Japanese automobile industry, cooperation between automakers and their suppliers is positively associated with the level of IT application usage between trading partners. The cooperation in the customer-supplier relationship is positively correlated with electronic data interchange (EDI) usage (Son, Narasimhan, & Riggins, 2005). Based on social exchange theory, all organizational relationships are formed by the use of a subjective cost-benefit analysis and the comparison of alternatives. Considering the nature of the exchange relationship, a retailer may provide ECR-related support to CMC even though transaction costs are relatively high in the short-term. As a manager of Wal-Mart commented, "We do not want to directly connect our sale system with CMC because DVD/CD represents only a small proportion of our total sales not our main commodity. However, we should promote a long-term

relationship with our close partners and let our IT systems appropriately link with IT systems of CMC."

When CMC in an exchange relationship makes reciprocal investments in IT, its customer (retailer) in exchange may expect more stable and on-time supply from CMC, resulting in more willingness to cooperate to a greater degree with CMC. To boost efficiency and effectiveness of replenishment, CMC is allowed to download the sales information from Wal-Mart's IT system. Effective increases in cooperation lowers Wal-Mart's inventory. Based on the reasoning of social exchange theory and on the interviews, this study proposes:

Finding 2 *The relationship between IS integration and network agility will be more positively related when the retailer provides reciprocal investments related to IT systems.*

2.5.3. Operational and financial performance

Operational performance is improved by superior network agility through boosted IS integration (see Table 4). In respect of operational agility, KPIs for demand forecasting and planning, such as on time delivery rate, forecast accuracy rate, and order fulfillment rate, ranged from 90% to 99%. Moreover, order cycle time was reduced to 30-40 days. As for partnering agility, cargo tracking cycle time was reduced from 24-36 hours to 2 minutes. Besides, the percentage of choosing and controlling forwarders increases noticeably. Regarding customer agility, numerous KPIs also have significant improvement. Manufacturers integrate retailer channels, creating an effective supply

chain network by using a CCRM system. Improvement through CCRM includes faster collection of sales data, more efficient collaborative marketing promotion between retailers and manufacturers, and lower inventory for both sides, etc. The increased synchronization of demand forecast and replenishment further reduces inventory costs for both manufacturers and retailers. Therefore, evidence is provided to support the argument that network agility positively influences operational performance.

Table 4: Boosting operational performance through network agility

Network agility	IT systems (Sub IT systems)		Indicators of operational performance	KPI (Before)[a]	KPI (After)[b]
Operational agility	CPFR		(a) On time delivery (b) Forecast accuracy rate (c) Order fulfillment (d) Order cycle time	70% 88% 70% 30-60 days (low season) 90-120 days (high season)	90% 95% 99% 30 -40 days
Partnering agility	CTM		(a) Choosing and controlling forwarders (b) Cargo tracking cycle time	20% 24-36 hours	100% 2 minutes
Customer agility	CCRM	Collaborative POS management system	(a) Time to collect all sales data from retailers (b) POS data analysis time (c) Exceptional alert	14-21 days 7 days None	2-3 days 2-3 days Real time
		Collaborative marketing promotion system	(a) Promotion planning cycle time (b) Planning analysis time (c) Exceptional alert	3 months 7 days None	1 month 1 hour Real time
		Auto replenishment system	Real-time inventory planning	No real-time	Real-time

Note: [a]KPI (before) is the original KPI before CMC implemented particular IT systems.
[b]KPI (after) is KPI improvement after CMC deployed particular IT systems.

To examine the relationship between sales margin and network agility, this study analyzes the effect of different business models on a strategy trajectory of sales margin and the level of network agility (see Figure 4). Paired comparisons are applied as a method to evaluate the level of network agility for four business models. The four positions indicate various business models: position H, denoting the label licensing practice; position P, global brand CM; position K, subsidiary OBM and position W,

white label CM. In Figure 4, positions H, P, and K lie in the first and fourth quadrant, representing higher network agility, while position W lies in the third quadrant, the area of lower sales margin and network agility. In paired comparison analyses, position H has a higher level of customer agility than position P, resulting from greater integration with retailers and rapid response to customer needs. Similarly, position K has greater partnering agility and operational agility than position W in that position K leverages more assets, knowledge, and competencies of suppliers, distributors, logistics providers, and a brand owner. In fact, the sales margin of position K is greater than that of position W because of greater network agility. For positions P and K, although the two positions have the same level of network agility, the well-known brand image of firm P might be a possible reason driving the sales margin higher. Thus, Finding 3 is proposed as follows.

Finding 3 *Building network agility is a source for boosting operational performance, and then it enhances financial performance.*

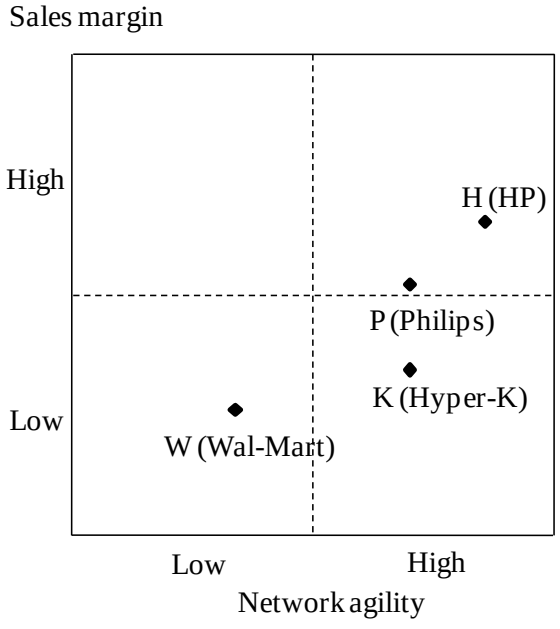


Figure 4: Effect of four business models on a trajectory of sales margin and network agility

Our focal firm is driven by two factors to enhance its financial performance while implementing the mixed channel strategy: creating customer segmentation and carving a useful niche. First, CMC leverages the mixed channel strategy to increase customer segmentation and then creates sales margins. A variety of channels is used to sell products of different qualities. By fitting its channel strategy for manufacturing capabilities, our focal firm can satisfy the needs of various customers and thus increases its financial performance.

Second, the mixed channel strategy carves a useful niche to obtain premium sales margins. Brand equity and marketing capabilities are difficult-to-trade knowledge assets, complementary to CMC's capabilities. Therefore, label licensing is considered to be deep inter-organizational cooperation, which then enhances CMC's capabilities, allowing firms to more successfully build their own marketing capabilities in the future. Philips, following HP, also implemented label licensing with CMC during the periods of this study. Both HP and Philips have similar abilities to access retailer channels and both of them enjoy well known brand images. Under the observations, such practice with Philips has increased CMC' sales margin by up to 5% compared with the original business practice (i.e. the global-brand-CM business model). Manufacturing skills do not guarantee CM to maintain long-term contracts with OEMs. CMC is competing against every potential contract manufacturer in the optical storage media industry; however, label licensing carves a useful niche in strengthening cooperative relationship with OEMs. Based on the deduction from our case study, Finding 4 is proposed as

follows.

Finding 4 *Under the condition that channel conflicts are handled well, a mixed channel strategy enhances financial performance of a firm.*

2.5.4. Mixed channel strategy and network agility

Superior network agility can influence the relationship between the mixed channel strategy and the focal firm's financial performance. First, CMC and its OEMs recognized opportunities for label licensing, which have increased the level of the mixed channel strategy, when superior network agility existed among network partners. Overall CMC's sales margin increased by up to 2% following the implementation of label licensing, after which the collaborative supply chain network with partners was enhanced, particularly with retailers and OEMs. Moreover, ROI for collaborative marketing promotion (i.e. the proportion of net sales margin to that of total promotion costs) increased from 0.6 to 0.9.

Second, the focal firm's financial performance has risen because the efficiency of overall channel is enhanced by superior network agility. Under superior network agility, responsiveness (time to collaborative marketing promotion or replenishment) has been reduced from thirty days to just seven days. The reliability of dealing with product returns has increased from 70% to 90%. Due to improved channel efficiency, such as better responsiveness and reliability, total revenue has risen to 34%. Hence, network agility has a moderating effect on the relationship between the mixed channel strategy and financial performance. Then, Finding 5 is proposed, as follows.

Finding 5 *Under the condition that channel conflicts are handled well, the relationship between the mixed channel strategy and financial performance increases with network agility.*

2.6. Discussions and conclusions

This investigation demonstrates how network agility and a mixed channel strategy enhance firm performance. Research has argued that IT systems have a positive impact on a firm's agility (Overby et al., 2006; Sambamurthy et al., 2003); however, relevant analyses are limited for how network agility has impacts on the mixed channel strategy and for how the mixed channel strategy boosts firm performance. Addressing the gap, this study explores longitudinal data to examine how the focal firm creates its niche to improve the performance through superior network agility. Companies can use network agility to sense and respond to changes in the market, and they can also rely on their channel strategy to cooperate with their partner to get niches.

2.6.1. Network agility for sensing and responding changes

The first finding indicates that IS integration is associated with a firm's operational performance through network agility. IS integration is an enabler that binds network partners together. Also, IS integration provides a firm with a useful tool to have more efficient communication with its partners. Thus, IS integration plays an important role in enabling a firm to sense the change and respond rapidly. Given the increase in competition among marketing channel systems and in cooperation among all involved

channel parties, understanding the effects of IS integration is an important objective. This investigation examines the links between the effects of IS integration and network agility. Firms require management tools for identifying profit opportunities, building complex and fluid channel networks, and evaluating risk. IT systems enable these management tools to be more powerful. Although IS integration has transformed business organization, it needs to be placed in the service of business, not the other way around.

IS integration between two companies is subjected to the depth of their collaborative activities. If a firm's partner in the channel system creates limited benefit through IS integration, it shows that the firm may be considered a minor partner. The situation was extended in our model by using reciprocal investment in IT systems as a moderator. As Finding 2 indicates, the relationship between IS integration and network agility will be more positively related when the retailer provides reciprocal investments related to IT systems. The finding shows that IT systems can be implemented based on reciprocal relations despite a relationship of low collaboration between network partners

Finding 3 is that network agility has positive impact on firm performance. In intensified competition, companies establish deep collaborative relationships with their partners in committing to closer and more agile channel networks. Superior network agility enables firms to build abilities to detect and seize market opportunities. In a time of low profit margin, CMs with superior network agility can enhance their capabilities to improve operational performance. For example, CMs can reduce production lead time and increase service level of customers through superior network agility. Furthermore, OEMs also seek CMs of higher agility to build efficient supply chain

networks so agile CMs have more opportunities to obtain manufacturing contracts from OEMs.

2.6.2. Mixed channel strategy for getting the niches

Dramatically changing business environment and channel competitors force most companies to develop their channel cooperative strategies for survival. Beside, superior network agility allows a CM and its OEM to recognize opportunities for implementing label licensing, which expands the level of the mixed channel strategy. As Finding 5 indicates, network agility has a moderating effect on relationship between the mixed channel strategy and financial performance.

Finding 4 is that a firm implements the mixed channel strategy to enhance its financial performance because this strategy creates customer segmentation and carves useful niches. First, the mixed channel strategy enables a CM to increase customer segmentation so as to identify unmet customer needs in creating sales margin. Second, label licensing helps a CM find its niches through deep collaboration among channel partners. The complementary resources of CMs, such as marketing and technological innovations typically exist in downstream companies. Individual firms usually rely on crucial resources controlled by other firms; to access the resources, they have to interact closely with the other firms that control them (Pfeffer & Salancik, 1978; Teece, Pisano, & Shuen, 1997). Therefore, implementing label licensing is considered a vehicle for increasing inter-organizational cooperation, which then helps CMs find their niches.

An insight is that the mixed channel strategy can be a successful strategy when CMs

intend to develop international brands. It is a dilemma for a firm to choose between being a dedicated CM and developing a brand when it thinks over ways to enter overseas markets. However, for commodity products, directly developing an international brand could be extremely risky if CMs lack marketing capability. Label licensing may provide CMs with migrating strategies while CMs develop their brands. Most importantly, maintaining stable manufacturing contracts are required for providing CMs with financial support, while CMs simultaneously build their own brand through global market expansion. Therefore, the mixed channel strategy can strengthen two separate capabilities of CMs: dedicated manufacturing and brand marketing.

2.6.3. Limitations

The main contribution of this study is to provide findings to support that IS integration is an enabler to establish superior network agility, which then enhances firm performance. Moreover, the mixed channel strategy has a positive relation with financial performance. However, this investigation has several limitations. First of all, the findings are carried out by a single-case study with multiple levels. Although the aforementioned findings may be case specific, we believe that they should be able to provide valuable insights for companies who face a context similar to that of our subject company. These findings will require further investigations with more case studies so as to propose a more general theoretic framework. Second, two moderating effects should be investigated more elaborately. Finding 2, which is related to the moderating effect of reciprocal investments in IT, needs further investigation since it is derived from previous research results and qualitative evidence from interviews and observations. Finding 5, which is related to the moderating effect of network agility, also needs more

evidence to support the relationship because simply it is hard to verify the interaction effect clearly by using merely our quantitative data.

3. ENHANCING OPERATIONAL PERFORMANCE USING CHANNEL INTEGRATION THROUGH CUSTOMER AGILITY: EMPIRICAL EVIDENCE FROM CHINA, HONG KONG, AND TAIWAN

3.1. Introduction

A supply chain system involves competition with other channel systems rather than horizontal competition in contemporary firms (Gupta & Woodside, 2006). Facing increasingly intense competition, firms no longer compete at a single-firm level, but rather at a level of networks of firms. Moreover, uncertainty is the defining characteristic of business competition today. As a manufacturer faces fierce competition and pressure from downstream partners, the customer agility is regarded as an imperative for surviving and obtaining niche compared to horizontal competitors. Companies can apply customer agility to sense the changes and respond rapidly in the market (Overby, Bharadwaj, & Sambamurthy, 2006) and then enhance operational performance.

The primary concern of this research is to find the relationship between business process integration among partners and operational performance through customer agility. It is also interesting to investigate whether technology uncertainty and internal process integration partially influence the proposed model. Also, the question remains whether the overall industry's structure of a country that is, the degree of overall industry's integration, influences the relationship between business process integration

and customer agility. The main purpose of this research was to discover, by conducting a questionnaire, antecedents of firm performance for manufacturers. This study collected data from manufacturers in the three countries including China, Hong Kong, and Taiwan. Also, the investigation developed a conceptual model related to information sharing, internal process integration, manufacturer-customer business process integration, customer agility, operational performance, and technology uncertainty.

The results showed that manufacturer-customer business process integration is critical while a manufacturer faces upstream directives from its original equipment manufacturers (OEMs) or retailers, who suffer a high level of horizontal competition. Second, customer agility had mediating effect on the relationship between business process integration and customer agility. Third, technology uncertainty and internal process integration partially influence our proposed model. Moreover, the overall industry's structure of a country acts as a moderator, and further enhances the influence the relationship between business process integration and customer agility. These results could provide valuable suggestions for both nations and firms to identify the antecedents and outcomes related to develop core capabilities of manufacturers in the Greater China area.

The remainder of this chapter is organized as follows. Section 3.2 reviews the literature and develops our hypotheses about how constructs are related. Section 3.3 shows our sample's profiles. Section 3.4 presents the analysis strategy and measures related to constructs used in this study. Section 3.5 summarizes the results. Section 3.6 discusses the implications for theory and managerial practices.

3.2. Hypotheses development

This investigation reviews the multi-disciplinary related to information sharing, internal process integration, manufacturer-customer business process integration, customer agility, operational performance, and technology uncertainty, developing the conceptual model shown in Figure 5. In the following parts, this study discusses each of its components and develops hypotheses about how they are related.

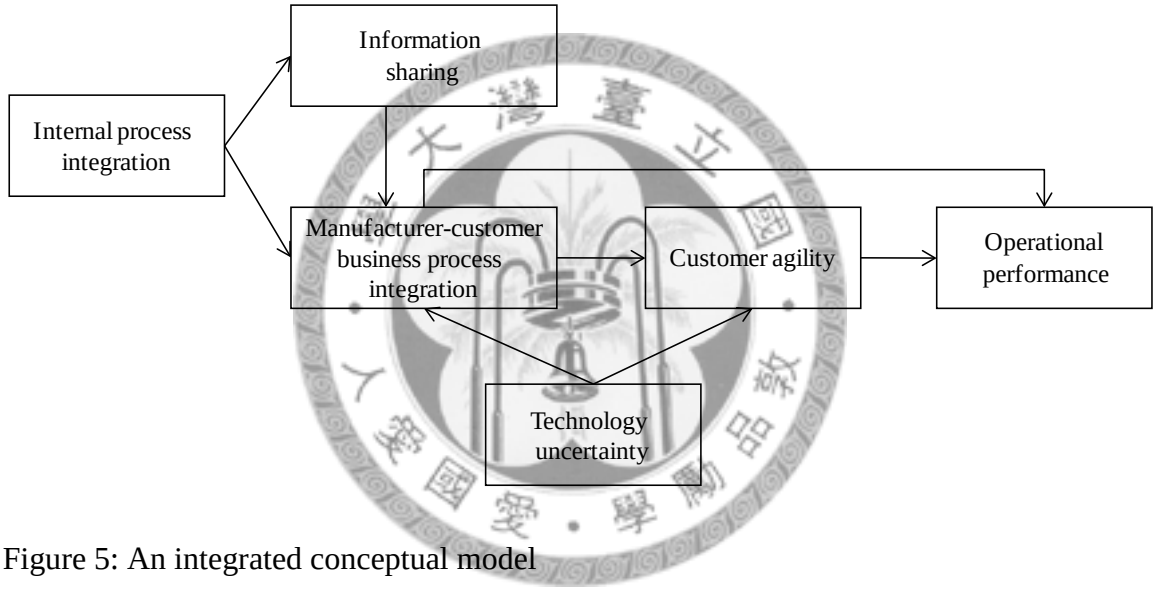


Figure 5: An integrated conceptual model

3.2.1. Information sharing and manufacturer-customer business process integration

Information technology (IT) enhances inter-organization information sharing and then achieves performance goals of a supply chain network while a manufacturer's downstream partners impose directives, related to deduction of production cost or improvement visibility of supply chain, on the manufacturer. Prior research also demonstrated that IT investments had considerable beneficial impacts on a firm's performance (i.e. Bharadwaj, Bharadwaj, & Konsynski, 1999). Moreover, many

contract manufacturers (CMs) belong to small and medium sized enterprises and they are only a minority of suppliers of their OEMs. OEMs implement information sharing with their CMs because they need cost reduction and supply chain visibility when both OEMs and CMs are in the situation of highly intensified business environment. Thus, information sharing is fundamental before supply chain partners cooperate together and then improve cross-functional integration of partners. Furthermore, companies restructure the way they do work by information sharing, and radically reducing the cost resulting from their future business integration.

The degree of sharing of network partners' information system is a proxy of inter-organization cooperation. Information sharing is to find the link between strategic ideas and the application of IT among partners. Contemporary firms thus increasingly rely on IT, including process, knowledge, and communication technologies, to improve their agility and value chain collaborations, difficult for competitors to duplicate. A well-known managerial principle asserts that "the information resources of a firm must be driven by business strategy and integrated into the product and process dimensions of enterprise" (Kettinger, Grover, Segars, & Guha, 1994). Moreover, firms have traditionally established their value chains and interorganizational relationships through bundling IT systems, products, and services into an integrated structure to achieve a sustainable business (Evans & Wurster, 2000; Kettinger et al., 1994; Wheeler, 2002). Thus, customer-manufacturer business process integration is influenced by the effect of information sharing. Information sharing is not just the exchange of information on demand and inventory levels, but multiple, collaborative working relationships across the organizations at all levels while IT can further integrate business processes of each other. Therefore, this study hypothesizes:

Hypothesis 1: The degree of information sharing between a manufacturer and its major customer will be positively related to their business process integration.

3.2.2. Customer agility

Sambamurthy, Bharadwaj, and Grover (2003) argued that "agility encompassed a firm's capabilities which were related to interactions with customers, orchestration of internal operations, and utilization of its ecosystem of external business partners." Agility comprised three interrelated capabilities, namely, customer agility, partnering agility, and operational agility (Sambamurthy et al., 2003). Customer agility means that the capabilities of a firm cooperating with customers in the exploration and exploitation of opportunities. Swafford, Ghosh, and Murthy (2006) also proposed that a firm's supply chain agility had mainly dealt with the capability of the firm to response to key performance of supply chain, rather than how effectively the goals had achieved. Moreover, one of antecedents of customer agility is a high level of manufacturer-customer business process integration because business process integration facilitates the achievement of sensing business environment and responding rapidly. That is, customer agility enhances the capabilities of enterprises to respond and perform well in rapidly changing business environment by integration. In particular, the business process integration among partners enhances visibility of downstream demand and upstream material. Therefore, manufacturer-customer business process integration played an important role in strengthening the customer agility (Chen & Chiang, 2011; Christopher, 2000; Lewis, Hornyak, & Patnayakuni, 2008; Overby et al., 2006), leading to a firm's performance (Chen & Chiang, 2011; Sambamurthy et al., 2003).

Although manufacturer-customer business process integration (MC-BPI) strengthens customer agility, the relationship will be influenced by overall industry's structure of a country. A company can enhance operational performance through assessing the underlying structural potential for globalization (Bartlett, 1987; Stopford, 1993). Three possible structure potentials consist of: more globally integrated, integrated to an equivalent extent, and less globally integrated. The three possible structure potential has different effects in business performance. Birkinshaw, Morrison, and Hulland (1995) proposed that the performance-integration plot in suitably global industries would be horizontal, whereas the under-integration and over-integration industries had upward and downward sloping plots respectively. That is, while a firm underlies an under-integration industry, the firm can easily get niches or obtain superior performance compared to other two structures.

As mentioned previously, customer agility is regarded as a capability, which enhances the ability of reacting rapidly to key chain outcomes. We considered customer agility to be a dynamic capability related to enhancing supply chain performance. The plot of MC-BPI and customer agility in optimally integrated industries is predicted to be horizontal, whereas the under-integration and over-integration industries are upward and downward sloping plots respectively (see Figure 6). Therefore, this research hypothesizes:

Hypothesis 2a: In countries whose overall industry's structure has under integrated, customer-manufacturer business process integration is positively associated with customer agility.

Hypothesis 2b: In countries whose overall industry's structure has optimally integrated, no relationship exists between customer-manufacturer business process integration and customer agility.

Hypothesis 2c: In countries whose overall industry's structure has over integrated, customer-manufacturer business process integration is negatively associated with customer agility.

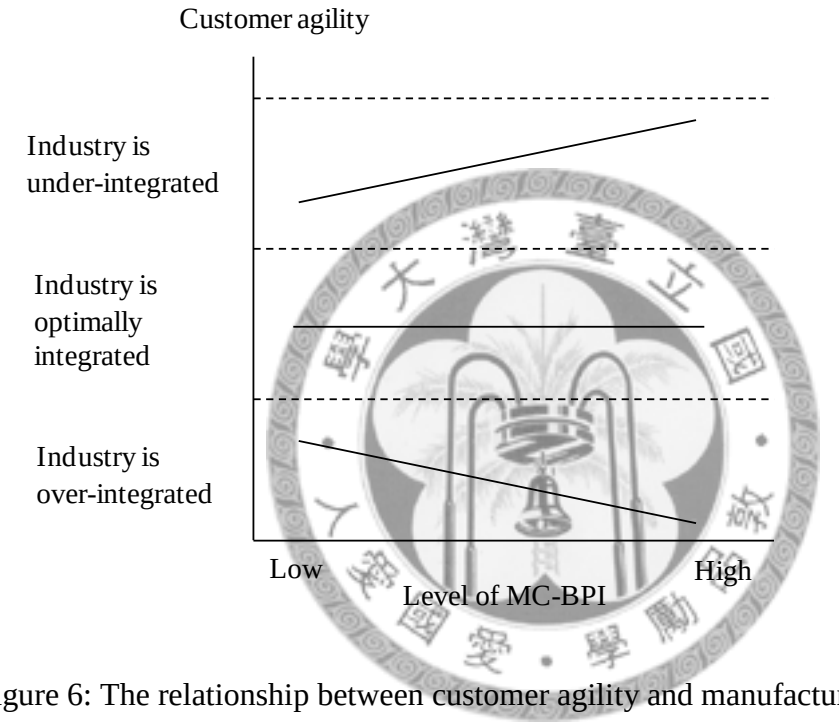


Figure 6: The relationship between customer agility and manufacturer-customer business process integration (MC-BPI)

3.2.3. Operational performance

As mentioned previously, customer agility is regarded as a capability, which enhances the ability of reacting rapidly to key chain outcomes. We considered customer agility to be a dynamic capability related to enhancing supply chain performance. Some empirical evidence also showed that a firm's agility has a positive influence on its performance (Ettlie, 1998; Swafford et al., 2006) and competitive actions

(Sambamurthy et al, 2003). Thus, operational performance can be enhanced by superior customer agility resulted from the cooperative supply chain. Therefore, this investigation hypothesizes:

Hypothesis 3: Building customer agility is a source for boosting operational performance.

As mentioned previously, collaborative supply chain achieves its performance goals through business process integration. A high level of manufacturer-customer business process integration enhances customer agility. An agile enterprise characterizes a fast moving, adaptable and robust organization so the agile firm is capable of enhancing operational performance in a dynamic and uncertain business environment. Moreover, facing fierce competition, a firm no longer competes at a single-firm level, but rather at a level of networks of firms. To satisfy needs of customers, manufacturers regard customer agility as their first priory. Without the increase of customer agility, business process integration may not result in boosting operational performance. Thus, this study hypothesizes:

Hypothesis 4: Customer agility fully mediates the relationship between the manufacturer-customer business process integration and operational performance.

3.2.4. Control constructs

Two constructs, internal process integration and technology uncertainty, are considered to be control constructs, which influences the proposed model. Internal

process integration is regarded as an internal trigger that influences information sharing and business process integration. Technology uncertainty, regarded as an external trigger, impacts on business process integration and customer agility.

Internal process integration refers to the competency of linking internally performed work into a seamless process to support customer, supplier, and intra-organizational unit requirements (Stank, Keller, & Closs, 2001). Linking internal work processes with external entities (i.e. OEMs or logistics) is positive influence on achieving a firm's goal. For example, when an order is delayed, customers do not care which function caused this delay; they want to know whether this delay can be fixed and the order can be fulfilled. Hence, internal process integration strengthens business process integration among partners.

Information sharing is supported by of a firm's internal process integration. Information sharing among organizations needs joint planning of intra-organization and working together of cross-functional teams for a manufacturer. When a manufacturer structures its own organizational strategies, practices, and process into collaborative processes, its customers' requirements is fulfilled (Cespedes, 1996; Kahn and Mentzer, 1996; Kingman-Brundage, George, & Bowen, 1995). Thus, internal process integration is an enabler to increase efficiency and effectiveness of implementing mechanisms of information sharing. Therefore, this research hypothesizes:

Hypothesis 5a: The degree of internal process integration is positively associated with information sharing.

Hypothesis 5b: The degree of internal process integration is positively associated with

manufacturer-customer business process integration.

Business environment measures a company's environment uncertainty, including supply uncertainty, demand uncertainty, and technology uncertainty (Chen & Paulraj, 2004). Technology uncertainty measures the extent of technological changes evident within the industry. Rapidly changing technological environment drives a manufacturer's needs for the development and design of innovative products and services. Building customer agility is unlikely to be needed in relatively stable technological environments because it may waste a company's resource. Moreover, technology uncertainty enhances business process integration among partners because integration can help firms detect new products or services firm customers to provide opportunities for success. Therefore, this research hypothesizes:

Hypothesis 6a: Technology uncertainty is positively associated with manufacturer-customer business process integration.

Hypothesis 6b: Technology uncertainty is positively associated with customer agility.

3.3. Sample and respondent profile

This study analyzes data at a firm level. Both samples and variables used in this analysis come from a questionnaire, which mainly used existing scales from previous research. The questionnaire developed from a cooperative, cross-functional research project sponsored by Chinese University of Hong Kong (Hong Kong), Xi'an Jiaotong University (Mainland China), and Chang Gung University (Taiwan). This investigation extracts above questionnaires as the large scale survey of major manufacturers in the

three countries.

Our sample is representative of the population of manufacturing firms including Taiwan, Hong Kong, and China (i.e. the Greater China region). A profile of the respondents is presented in Table 5, indicating that they represent a variety of ownership types, management cultures, and firm sizes. We obtained a total of 809 respondents, including 196 (24%) from Hong Kong, 405 (50%) from China, and 208 (26%) from Taiwan. With regard to ownership, 11% was listed companies or over the counter (OTC) companies, and 89% was not listed or OTC companies. For dominant management culture, 3 % was western management culture, which included American, European, and Latin American, and 94% was eastern management culture associated with Japanese, Hong Kong, China, and Taiwan. For total number of employees, 35% was less than 50 employees, 51% was 50-499 employees, and 14% was more than 500 employees.

Table 5: Descriptive statics of analysis dataset

	All areas (n=809)	China (n=196)	Hong Kong (n=405)	Taiwan (n=208)
Ownership				
Listed companies or OTC companies[a]	11.25	3.66	7.00	30.29
Not listed or OTC companies	88.75	96.34	93.00	69.71
Dominant management culture				
American	1.47	1.22	0.50	2.88
European	0.98	1.22	0.00	1.44
Hong Kong	19.56	1.71	75.50	0.96
Japanese	2.44	0.98	0.00	7.69
Latin American	0.12	0.24	0.00	0.00
Mainland Chinese	48.53	88.29	17.50	0.00
Taiwanese	23.72	2.68	1.00	87.02
Others	1.83	1.71	4.00	0.00
Missing value	1.34	1.95	1.50	0.00
Total number of employees				
<50	35.09	36.59	26.00	40.87
50-99	18.70	19.27	21.00	15.38
100-199	18.46	20.49	25.00	8.17
200-499	13.81	15.61	17.00	7.21
500-999	6.23	3.90	8.00	9.13

1000-4999	4.52	2.93	2.50	9.62
5000 or more	3.18	1.22	0.50	9.62

Note: N=809. All figures are the percentage of respondents (%). [a]OTC companies are over the counter companies.

3.4. Analysis strategy and Measures

3.4.1. Analysis strategy

Exploratory factor analysis (EFA) was applied to investigate the relationship between proposed measures and competence dimensions. Then confirmatory factor analysis (CFA) was applied to verify reliability and validity. While EFA is useful in exploring the potential latent factors, EFA assumes that errors of measurement items are uncorrelated and it cannot test whether all these dimensions together form second order factors. In contrast, CFA takes item error correlations into consideration and thus may reveal more complex relationships embedded in the items. Therefore, we applied CFA after EFA to develop our instruments. Furthermore, EFA was used to develop the constructs and CFA to confirm their properties.

SEM approaches were applied to examine the proposed model while the LISREL 8.53 program was used to estimate the relevant paths. The root-mean-square error of approximation (RMSEA) was reported, known as the most sensitive index to models with misspecified factor loadings (Hu & Bentler, 1998). Values of RMSEA less than 0.05 are considered to indicate a close fit; values in the range of 0.05 - 0.08 indicate a fairly good fit; values in the range of 0.08 - 0.1 indicate a mediocre fit; and values greater than 0.1 indicate a poor fit (Hu & Bentler, 1998; Browne & Cudeck, 1993; MacCallum, Browne, & Sugawara, 1996). The standardized root-mean-square residual (SRMR) was also reported, known as the most sensitive index to models with

misspecified factor covariance(s). As Hu and Bentler (1998) suggested, values of SRMR smaller than 0.05 are as indicative of a close fit. We evaluated a goodness-of-fit index (GFI), an adjusted goodness-of-fit index (AGFI), a non-normed fit index (NNFI), and a comparative fit index (CFI). Any model with a fit index above 0.9 is considered acceptable (Bentler & Bonett, 1980; Hu & Bentler, 1998).

Figure 7 describes the relationship between measures and latent variables of the proposed model. To determine the interrelationships in the proposed conceptual model, 28 directly observed measures and 6 constructs were included in the study. The sample consisted of 809 companies from the three countries. In order to make comparisons across populations, we examined measurement invariance by using CFA analyses. If the model passes measurement invariance test, the data will be considered to be a sample, or the data will be divided into three parts -Hong Kong, China, and Taiwan. Moreover, the logic for testing mediation effects is based on Baron and Kenny (1986) and Holye and Smith (1994). The mediation effects were tested by the chi-square difference between the full model and mediation model.

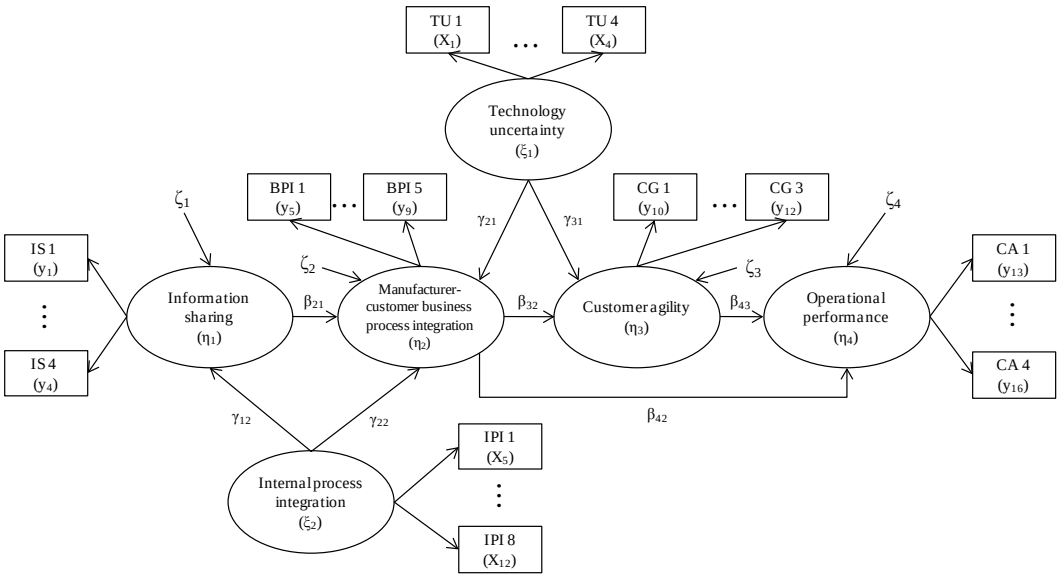


Figure 7: Structure equation model of supply chain integration

3.4.2. Measures

Respondents were asked to indicate the extent of their agreement with statements of our survey using a Likert 7-point where 1 indicates strongly disagree and 7 indicates strongly agree. The complete scale and factor ladings are listed in Appendix.

3.4.2.1. Information sharing

The 4-item Information Sharing (IS) Scale is extracted from existing scales to measure the degree of information sharing between a manufacturer and its major customer (Stank et al., 2001). The firms are asked to answer in reference to their firms' IS integration with the major customer using a 7-point scale. An example item is "Our major customer share POS information with us." An EFA of the items measuring IS revealed a single factor solution with factor loadings in excess of 0.73 for each item. Moreover, Cronbach's alpha for the reliability of the scale was 0.88.

3.4.2.2. Manufacturer-customer business process integration

We surveyed the literature to identify valid measures for related constructs and extracted from existing scales to measure Manufacturer-customer Business Process Integration (MC-BPI) (Narasimhan & Kim, 2002; Morash & Clinton, 1998). The 5-item scale measures the degree of integration between a manufacturer and its major customer using a 7-point scale. An example item is "We restructure logistics activities with our major customer." An EFA of the items measuring MC-BPI revealed a single factor

solution with factor loadings in excess of 0.66 for each item. Moreover, Cronbach's alpha for the reliability of the scale was 0.87.

3.4.2.3. Customer agility

We surveyed the literature to identify valid measures for related constructs (Cao, & Dowlatshahi, 2005) and extracted from the Supply Chain Agility Scale (Swafford et al., 2006) to measure customer agility (CA). The 3-item CA scale measures a firm's capability about sensing the change and responding rapidly using a 7-point scale. An example item is "Our supply chain has the ability to quickly modify products to meet customers' requirements." An EFA of the items measuring CA revealed a single factor solution with factor loadings in excess of 0.72 for each item. Moreover, Cronbach's alpha for the reliability of the scale was 0.74.

3.4.2.4. Operational performance

Operational Performance (OP) Scale is adopted from the 6-item Operational Performance Scale (Flynn, Huo & Zhao, 2010). We deleted 3 items from the original construct because the deleted items were considered to measure a firm's capability rather than a level of performance. Besides, an item "Our company has an outstanding record of reliable delivery to our customers" was added in our scale. An EFA of the items measuring OP revealed a single factor solution with factor loadings in excess of 0.63 for each item. Most of the items are greater than 0.70. Moreover, Cronbach's alpha for the reliability of the scale was 0.78. Thus, the firms were asked to answer in reference to their operational performance using a 4-item scale.

3.4.2.5. Technology uncertainty

We used the 4-items Technology Uncertainty (TU) Scale (Chen & Paulraj, 2004) to measure the technology uncertainty faced by a firm. The firms are asked to answer in reference to their firms' environment uncertainty about technology using a 7-point scale. An example item is "Our industry is characterized by rapidly changing technology." An EFA of the items measuring TU revealed a single factor solution with factor loadings in excess of 0.72 for each item. Moreover, Cronbach's alpha for the reliability of the scale was 0.79.

3.4.2.6. Internal process integration

The 8-item scale employed in the construct for Internal Process Integration (IPI) are extracted from existing scales to measure cross-functional integration of a firm (Morash & Clinton, 1998 ; Flynn, Huo, & Zhao, 2010). Four items were added that included strategic partnership among different internal functions, jointly developing strategic plans, monitoring business processing together, and jointly developing measurement systems. The 8-items scale can measure not only functional integration but also strategic planning integration. The firms are asked to answer in reference to their firms' internal process integration using a 7-point scale. An example item is "The use of periodic interdepartmental meetings among internal functions." An EFA of the items measuring IPI revealed a single factor solution with factor loadings in excess of 0.68 for each item. Moreover, Cronbach's alpha for the reliability of the scale was 0.92.

3.5. Results

The result reports were divided into two parts, including the full sample and subgroup samples. These reports were used to examine whether the results support our research hypotheses.

3.5.1. Overall model

Table 6 summarizes the descriptive statistics of the study variables. All correlations are significant at the 0.001 alpha. Moreover, composite reliabilities were in italics in the diagonal. The scales were all reliable with composite reliabilities ranging from 0.75 to 0.92.

Table 6: Descriptive statistics and correlations

Variables	Mean	SD	1	2	3	4	5	6
1. Operational performance (OP)	5.69	0.83	*0.82*					
2. Customer agility (CA)	5.27	0.89	0.55	*0.75*				
3. Technology uncertainty (TU)	4.66	1.09	0.14	0.24	*0.79*			
4. Information sharing (IS)	4.12	1.32	0.17	0.26	0.24	*0.88*		
5. Manufacturer-customer business process integration (MC-BPI)	4.24	1.27	0.15	0.30	0.36	0.77	*0.87*	
6. Internal process integration (IPI)	4.72	1.12	0.38	0.34	0.16	0.53	0.50	*0.92*

Note: N=809. All correlations are significant at the 0.001 alpha. Reliabilities of the scale as assessed by Cronbach's alpha are in italics on the diagonal.

The measurement model in Table 7 presents the standardized factor loadings of the measured variables on the latent factors. These loadings, or lambdas, may be interpreted as validity coefficients reflecting the degree to which the observed variables adequately measure the specified underlying construct. Most of parameters (lambdas) were similar

and ranged from 0.68 to 0.86, a range that indicates acceptable construct validity (Bentler & Speckart, 1979). Only item C3 and T2 were smaller than 0.7 (0.54 and 0.53, respectively). Squared multiple correlation is a measure of the strength of a liner relationship. Most of the squared multiple correlation are greater than 0.5 (except two measurements) showing at the acceptable level. We also used a CFA to test our measurement model. The fit indices of this CFA were: $\chi^2 = 1391$ (df = 335; $p<0.01$); NNFI = 0.96, CFI = 0.97; AGFI = 0.86, SRMR = 0.04; RMSEA = 0.07. Thus, the model was acceptable, indicating convergent validity (O'Leary-Kelly & Vokurka, 1998).

Table 7: Measurement model parameters for the full sample

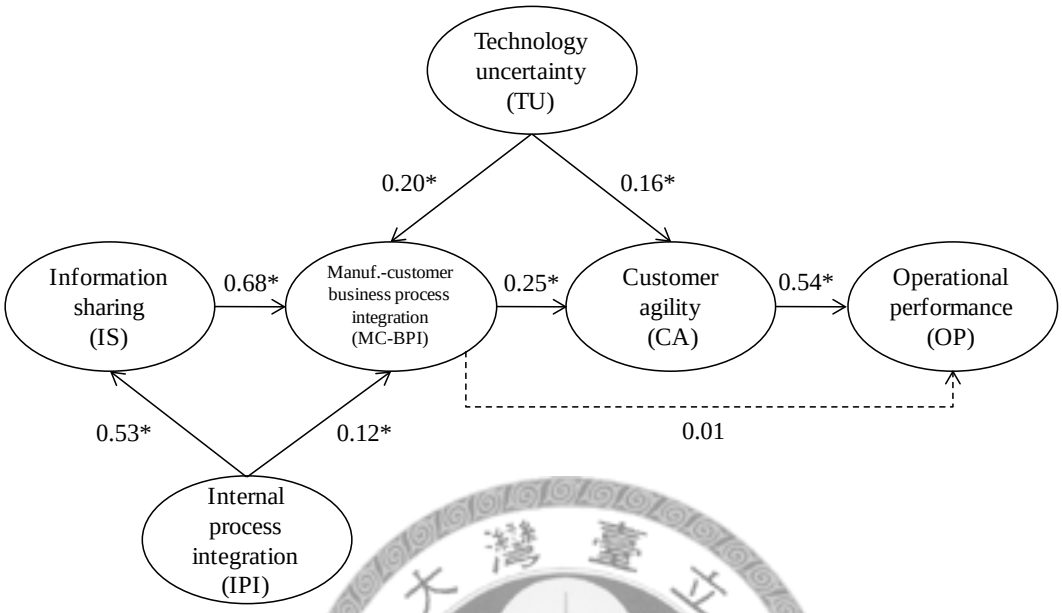
Factors and measurement items	Factor loadings	Squared multiple correlation	Estimate errors
Information Sharing(IS)			
(IS1)Our major customer share POS information with us	0.76	0.58	0.42
(IS2)Our major customer shares demand forecast with us	0.82	0.67	0.34
(IS3)We share our inventory availability with our major customer	0.84	0.71	0.29
(IS4)We share our production planning with our major customer	0.81	0.66	0.34
Manufacturer-customer Business process integration(MC-BPI)			
(B1)We restructure logistics activities with our major customer	0.74	0.55	0.44
(B2)We jointly create new products with our major customer	0.68	0.47	0.53
(B3)We jointly pursue mass customization with our major customer (to meet the customized requirements with low costs)	0.68	0.46	0.53
(B4)We monitor business processes together with our major customer	0.86	0.73	0.26
(B5)We jointly develop and maintain measurement systems with our major customer	0.81	0.66	0.34
Customer agility(CA)			
(C1)Our supply chain has the ability to quickly modify products to meet customers' requirements	0.76	0.58	0.42
(C2)Our supply chain allows us to quickly introduce new products into the market	0.80	0.64	0.37
(C3)The length of our supply chain is getting shorter	0.54	0.29	0.70
Operational performance(OP)			

(O1)Our company has an outstanding record of on-time delivery to our customers	0.80	0.64	0.37
(O2)Our company has an outstanding record of reliable delivery to our customers	0.78	0.61	0.39
(O3)The lead time for fulfilling customer orders is short	0.66	0.44	0.56
(O4)Our company provides a high level of customer service to our customers	0.68	0.46	0.54
Technology Uncertainty(TU)			
(T1)Our industry is characterized by rapidly changing technology	0.68	0.46	0.55
(T2)If we don't keep up with changes in technology, it will be difficult for us to remain competitive	0.53	0.28	0.73
(T3)Our production technology changes frequently	0.80	0.65	0.36
(T4)The rate of technology obsolescence in our industry is high	0.74	0.55	0.44
Internal process integration(IPI)			
(I1)The use of periodic interdepartmental meetings among internal functions	0.72	0.51	0.49
(I2)The use cross functional teams in process innovation	0.73	0.54	0.47
(I3)The use of cross functional teams in new product development	0.74	0.54	0.46
(I4)Real-time integration and connection among internal functions from raw material management through production, shipping, and sales	0.72	0.52	0.47
(I5)The extent of strategic partnership among different internal functions	0.81	0.65	0.35
(I6)Different internal functions jointly develop strategic plans in collaboration with each other	0.83	0.69	0.31
(I7)Different internal functions monitor business processes together	0.82	0.67	0.34
(I8)Different internal functions jointly develop and maintain measurement systems	0.78	0.61	0.39

Note: All factor loadings are significant at 0.05 alpha.
All factor loadings are completely standardized solution.

Figure 8 presents the LISREL estimates for the proposed model. First, customer agility fully mediated the relationship between manufacturer-customer business process integration and operational performance ($\beta_{OP,\ MC\text{-}BPI} = 0.01$). Second, information integration is the antecedent of MC-BPI ($\gamma_{MC\text{-}BPI,\ IS} = 0.68$). Third, internal process integration is regarded as control constructs of IS integration and MC-BPI ($\gamma_{IS,\ IPI} = 0.53$; $\gamma_{MC\text{-}BPI,\ IPI} = 0.12$). Finally, technology uncertainty also is regarded as control constructs of MC-BPI and CA ($\gamma_{MC\text{-}BPI,\ TU} = 0.20$; $\gamma_{CA,\ TU} = 0.16$). The fit indices for our proposed

model were: χ^2 = 1490 (df = 341; p<0.01); NNFI = 0.96, CFI = 0.96; AGFI = 0.85, SRMR = 0.07; RMSEA = 0.07. These results suggest that the data fit our model well.



Note: *p<0.05.
All paths are completely standardized estimates.
The dashed line represents the non-significant path.

Figure 8: The structure equation model for the full sample

3.5.2. Cross region analysis

Table 8 shows the fit indices of each region are appropriate for the CFA analysis (see Stage I). Model M0 represents the overall measurement model, including the three countries. Model M1a, M2a, and M3a show the measurement models related to Hong Kong, China, and Taiwan, respectively. M1a held superior fit indices in the three models. Moreover, based on these fit indices of M1a, M2a, and M3a, our proposed model is supported in all subgroups. These findings reveal that the three countries show the same factor structure.

Measurement invariance addresses the situation whether the same model holds across

different populations (i.e. cultures or countries). As illustrated in Stage II of Table 8, this study tested for Measurement invariance across the three countries following the method suggested by Myers, Calantone, Page, & Taylor (2000). A test of configural variance (Model C1 in Table 8) produced $\chi^2 = 2361.42$ with 1005 degrees of freedom. To test whether or not the factor loadings are equal across the three countries, we examined the difference between Model C2 and C1. The model fit of Model C2 produced $\chi^2 = 2596.07$, df = 1061. Accordingly, there was a significant difference in chi-square value between the constrained Model C2 and the unconstrained Model C1 ($\Delta\chi^2 = 234.65$, $\Delta df = 56$, $p < 0.05$). Moreover, Model C3 is both the factor loadings and estimates errors of measurement items were constrained to be equal. The difference between Models C3 and C2 was also significant ($\Delta\chi^2 = 234.18$, $\Delta df = 56$, $p < 0.05$). Finally, we set the factor loadings, estimates errors of measurement items, and factor covariance were constrained to be equal in Model C4. The difference between C4 and C3 was also significant ($\Delta\chi^2 = 136.97$, $\Delta df = 30$, $p < 0.05$). Therefore, the three regions have different measurement models.

Table 8: Fit indices of measurement model for the full sample and the subsamples

Model	χ^2	DF	NCP	SRMR	RMSEA	CFI	GFI	NNFI
Stage I								
Overall (M0)	1391.04	335	1156.850	0.045	0.065	0.970	0.880	0.960
Hong Kong (M1a)	571.32	335	217.180	0.069	0.058	0.960	0.830	0.960
China (M2a)	996.03	335	797.980	0.055	0.077	0.955	0.833	0.949
Taiwan (M3a)	794.07	335	443.620	0.057	0.080	0.955	0.788	0.949
Stage II[a]								
C1[b]	2361.42	1005	1458.770	0.069	0.074	0.957	0.832	0.951
C2(Λ)[c]	2596.07	1061	1664.010	0.100	0.076	0.951	0.809	0.948
C3(ΛΘ)[d]	2830.25	1117	1862.250	0.099	0.079	0.945	0.791	0.944
C4(ΛΘΦ)[e]	2967.22	1147	1984.750	0.145	0.080	0.942	0.775	0.943

Note: [a]Measurement invariance tests through a CFA constrained at several level. [b]C1 is the basicline model that shows three subsamples simultaneously were analyzed using a CFA. [c]All factor loadings (Lambda) of three subsamples are set to be equal. [d]Estimate errors of measurement items (Theta) and factor loadings of three subsamples are set to be equal. [e]Factor covariance (Phi), factor loadings, and estimate errors are set to be equal.

Due to the different measurement model of the three countries, we examine the factor

loadings of each country as Table 9. We can observe the three regions have significant difference in these six factors. In general, the sample from Taiwan has the highest factor loadings, whereas the sample from China has the lowest factor loadings. For example, for the item 1 of factor IS - our major customer share POS information with us, the sample from Hong Kong had the highest factor loadings.

Table 9: Measurement model parameters for the three regions

Factor	Item	Hong Kong		China		Taiwan	
		Factor loadings	Estimate errors	Factor loadings	Estimate errors	Factor loadings	Estimate errors
IS	IS1	0.80	0.36	0.71	0.50	0.78	0.39
	IS2	0.86	0.26	0.79	0.37	0.81	0.34
	IS3	0.89	0.21	0.74	0.45	0.91	0.18
	IS4	0.80	0.36	0.72	0.48	0.91	0.17
MC-BPI	B1	0.68	0.54	0.71	0.50	0.80	0.36
	B2	0.67	0.55	0.64	0.59	0.75	0.44
	B3	0.71	0.50	0.63	0.61	0.74	0.45
	B4	0.88	0.23	0.83	0.31	0.88	0.23
	B5	0.83	0.31	0.74	0.45	0.88	0.24
CA	C1	0.78	0.39	0.65	0.58	0.84	0.30
	C2	0.94	0.11	0.69	0.53	0.84	0.30
	C3	0.40	0.84	0.59	0.65	0.64	0.59
OP	O1	0.82	0.33	0.76	0.42	0.83	0.31
	O2	0.76	0.43	0.78	0.39	0.80	0.36
	O3	0.53	0.72	0.73	0.47	0.63	0.61
	O4	0.65	0.57	0.67	0.55	0.72	0.48
TU	T1	0.73	0.46	0.80	0.36	0.48	0.77
	T2	0.75	0.44	0.54	0.71	0.49	0.76
	T3	0.81	0.35	0.75	0.44	0.83	0.31
	T4	0.80	0.35	0.63	0.60	0.83	0.31
IPI	I1	0.61	0.63	0.69	0.53	0.81	0.35
	I2	0.66	0.57	0.69	0.53	0.82	0.33
	I3	0.66	0.56	0.68	0.54	0.84	0.29
	I4	0.74	0.46	0.65	0.58	0.82	0.33
	I5	0.79	0.38	0.77	0.40	0.88	0.22
	I6	0.83	0.31	0.80	0.37	0.90	0.19
	I7	0.84	0.29	0.82	0.33	0.78	0.39
	I8	0.81	0.35	0.78	0.40	0.77	0.40

Note: The factor loadings are the completely standardized solution.

Table 10 showed the path estimates of the structure equation model related to the three countries respectively. Hypothesis 1 predicts that IS is positively related to MC-BPI. The results reveal IS significantly predicted MC-BPI in the three countries. For

example, the path estimates from IS to MC-BPI in the sample from Hong Kong was 0.55 with p-value less than 0.05, showing this path being significant. Therefore, the results supported Hypothesis 1.

Hypothesis 2a, 2b, and 2c proposes that MC-BPI is positively (negatively) related to CA if the country has under globalized (over globalized), whereas MC-BPI has no relationship with CA if the country has optimally globalized. For Chinese and Taiwanese companies, the path between MC-BPI and CA was significant, providing support to Hypothesis 2a. Furthermore, for firms of Hong Kong, Hypothesis 2b was supported because MC-BPI was not significant related to CA ($\beta_{CA,\ MC\text{-}BPI} = 0.02$, $p > 0.05$). In addition, Hypothesis 3 proposes that CA is positively related to OP. We found that the path ($\beta_{OP,\ CA}$) was significant in the three countries. Therefore, Hypothesis 3 is supported.

Table 10: The path estimates of structure equation model for the three regions

Path estimates and model fit	Hong Kong		China		Taiwan	
	M1b	M1c	M2b	M2c	M3b	M3c
Path						
IS→MC-BPI	0.55*	0.55*	0.61*	0.61*	0.78*	0.78*
MC-BPI→CA	0.02	0.02	0.31*	0.30*	0.39*	0.40*
MC-BPI→OP	-0.08	--	-0.03	--	0.07	--
CA→OP	0.41*	0.41*	0.65*	0.64*	0.50*	0.53*
TU→MC-BPI	0.20*	0.20*	0.16*	0.16*	0.17*	0.17*
TU→CA	0.04	0.04	0.31*	0.31*	0.03	0.03
IPI→IS	0.62*	0.62*	0.54*	0.54*	0.51*	0.51*
IPI→MC-BPI	0.22*	0.22*	0.19*	0.19*	0.06	0.06
Model fit						
χ^2/d.f.	577.14/341	578.10/342	1141.68/341	1141.89/342	817.72/341	818.61/342
SRMR	0.07	0.08	0.10	0.10	0.08	0.08
RMSEA	0.06	0.06	0.08	0.08	0.08	0.08
GFI	0.83	0.83	0.82	0.82	0.78	0.78
NNFI	0.96	0.96	0.94	0.94	0.95	0.95

Note: The path estimates are the completely standardized solution.
*p<0.05.

Hypothesis 4 proposes that CA fully mediates the relationship between MC-BPI and

OP. For China and Taiwan, the path from MC-BPI and CA was significant ($p < 0.05$), as was the path from CA to OP ($p < 0.05$). However, the direct path from MC-BPI to OP was not significant when CA was included in the model. These results met a criterion for a mediation model to hold (Baron & Kenny, 1986; Hoyle & Smith, 1994). For the sample from Hong Kong, the path from MC-BPI and CA was not significant ($p > 0.05$). Therefore, the results partially supported Hypothesis 4. For the groups of China and Taiwan, CA is a mediator of the relationship between MC-BPI and OP; however, for the group of Hong Kong, CA is not a mediator of the relationship between MC-BPI and OP. The second statistic to test the mediation model was the chi-square difference test ($\Delta\chi^2$). Model M1c shows a mediation model for the sample from Hong Kong, Model M2c represents a mediation model for the sample from China, and M3c is a mediation model for the sample from Taiwan. Besides, M1c, M2c, and M3c do not include the direct path from MC-BPI to CA. M1b, M2b, and M3b are full models for the samples from Hong Kong, China, and Taiwan, respectively. The result of the chi-square difference test - the comparison between M2b and M2c- was not significant ($\Delta\chi^2 = 0.21$, $\Delta df = 1$, $p > 0.05$). Moreover, the comparison between M3b and M3c was not significant, either ($\Delta\chi^2 = 0.89$, $\Delta df = 1$, $p > 0.05$). These chi-square difference tests provide additional evidence that the full model (M2b and M3b) did not improve the fit from the mediation model (M2c and M3c).

Hypothesis 5 proposes that IPI is regarded as a control construct of IS and MC-BPI. For the sample from Hong Kong, IPI significantly predicted IS ($\gamma_{IS, IPI} = 0.62$, $p < 0.05$) and MC-BPI ($\gamma_{MC\text{-}BPI, IPI} = 0.22$, $p < 0.05$). For China, IPI also significantly predicted IS ($\gamma_{IS, IPI} = 0.54$, $p < 0.05$) and MC-BPI ($\gamma_{MC\text{-}BPI, IPI} = 0.19$, $p < 0.05$). However, for Taiwan, IPI only significantly predicted IS ($\gamma_{MC\text{-}BPI, IS} = 0.51$, $p < 0.05$). Thus, the

results fully support for Hypothesis 5a; however, the results provide partial support for Hypothesis 5b.

We followed a similar procedure in testing Hypothesis 6, which predicts that technology uncertainty is regarded as a control construct of MC-BPI and CA. For the sample from Hong Kong, TU significantly predicted MC-BPI ($\gamma_{\text{MC-BPI, TU}} = 0.16$, $p < 0.05$) and CA ($\gamma_{\text{CA, TU}} = 0.31$, $p < 0.05$). For the samples from Hong Kong and Taiwan, TU only significantly predicted MC-BPI ($\gamma_{\text{MC-BPI, TU}} = 0.20$, $p < 0.05$; $\gamma_{\text{MC-BPI, TU}} = 0.17$, $p < 0.05$). Thus, the results fully support for Hypothesis 6a; however, the results provide partial support for Hypothesis 6b.

3.6. Discussions

Our study demonstrates how information sharing, business process integration among partners, and customer agility influence operational performance. That is, this study is aimed to conduct empirical work designed to test the antecedents and consequences of customer agility. We found that our hypotheses were either supported or partially supported.

First, evidence supported that information sharing was positively related to business process integration in all three countries. Although information sharing was not directly related to operational performance, it can facilitate collaborative supply chain, and then activate customer agility. Moreover, in the intensified competition environment, OEMs impose upstream directives on CMs to enhance visibility of supply chain and reduce supply fluctuation. Information sharing is regarded as an imperative for supply chain

visibility. For example, point of sale (POS), supply chain systems, and other technologies have enabled partners to retrieve the same data (i.e., real demands and production schedules). Shared information between supply chain partners can further enhance business process integration, which means collaborative working between manufacturers and their downstream partners. This form of cooperation in the supply chain network is becoming more prevalent when firms focus only on their core competencies and outsource all other activities. Hence, our first contribution is that, consistent with Sambamurthy et al. (2003) as well as Overby et al. (2006), we found information sharing is positively related to business process integration in a large manufacturing sample.

The second finding of our study was the degree to which customer agility was a mediator on the relationship between business process integration and operational performance. Under intensified competition, companies should coordinate the relationships with their partners in committed to closer and more agile relationships with their customer. Leveraging the competencies of network partners achieves customer agility, which in turn enhances firm performance. Therefore, the link between manufacturer-customer business process integration and operational performance is built while customer agility exists to achieve greater responsiveness and market needs. We provide the evidence to support this mediating effect from two regions, China and Taiwan. This empirical finding also makes contributions to the literature. The finding is consistent with the study that agility mediates the effect of process and knowledge reach/richness and competitive actions (Sambamurthy et al., 2003). For Hong Kong, the mediating effect was not supported because the link between manufacturer-customer business process integration and customer agility does not seem to exist.

Third, the relationship between business process integration and customer agility was shown to be influenced by overall industry's structure of a country, as predicted. That is, the nature of the relationship between business process integration and customer agility may vary substantially from one country to another. There were two countries, China and Taiwan, for which the relationship between business process integration and customer agility was found to be positive. Hence, China and Taiwan whose overall industry's structure has under integrated through the observation that the strong manufacturer-customer business process integration is related to those with superior customer agility. The two emerging markets allow supply chain partners to enhance integration among them in order to increase customer agility. However, Hong Kong is recognized to have an optimally integrated for overall industry. Companies from Hong Kong may most have a high level of manufacturer-customer integration; therefore, there might be other antecedents influencing customer agility. For example, reducing complexity of supply chain network can enhance customer agility because it is a great benefit to working together of network partners (Christopher, 2000). Moreover, this conclusion that industries are either under integrated or optimally integrated is consistent with the study that performance-integration plots are upward, horizontal, or downward sloping (Birkinshaw et al., 1995).

Fourth, this study was partially supported that technology uncertainty influences business process integration and customer agility. Lee (1998) proposed that uncertainty could be decomposed into three components: adequacy of available information, predictability of consequences, and confidence about outcomes. Following Lee's argument (1998), while firms face technology uncertainty, they integrate business

processes between partners to reduce impacts from uncertainty. Business process integration can help firms retrieve sufficient information, have high predictability of the consequences, and more confidence about the outcomes. Based on the results, the samples from the three regions supported the relationship between technology uncertainty and business process integration. However, the relationship between technology uncertainty and customer agility was supported by the sample from China, but it was not supported by the samples from Hong Kong and Taiwan. It may be because customer agility does not allow companies to reduce technology uncertainty in these two countries. We can consider the firms from Hong Kong and Taiwan to have better overall customer agility than from China. Nevertheless, while the firms from China face the technology uncertainty, they tend to accelerate their growth of capabilities, such the length of R&D. Enhancing their capabilities reflect that the firms have better customer agility, which is stemmed from suffering technology uncertainty.

Finally, this research was partially supported that internal process integration influences information sharing and business process integration. Internal process integration recognizes that different departments and functional area within a company should operate as part of an integrated process with their partner's business processes. Hence, internal business process integration enhances the business process integration between partners, as we predicted. However, the sample from Taiwan did not support this hypothesis; it may be because the sample from listed companies or OTC companies is approximately 30% compared to other countries, just 4% and 7% related to China and Hong Kong, internal process integration requires more expenditure for these listed or OTC companies through cost-benefit analysis. Listed companies may have rigid organization and resist the change. Nevertheless, this argument related to organization

rigidity needs to be further verified in the future. Moreover, internal process integration is positively related to information sharing, as supported by the samples from the three countries. Companies should integrate their business process to facilitate information sharing with partners. For example, the capability of accurate production planning may result from across-department cooperation.

4. THE IMPACT OF DIVERSITY OF INTEGRATION ON THE RELATIONSHIP BETWEEN SUPPLY CHAIN INTEGRATION AND FIRM PERFORMANCE

4.1. Introduction

Previous research has argued that supply chain integration (SCI) has positive impact on firm performance (i.e. Devaraj, Krajewski, & Wei, 2007; Frohlich & Westbrook, 2001). However, Vickery, Jayaram, Droge, and Calantone (2003) failed to find a significant direct relationship between SCI and financial performance. It may be too simplistic to assert the relationship between SCI and a firm's financial performance, if the extent of integration is only measured by one or a small number of its relationships. On the other hand, uncertainty is the defining characteristic of business competition today, and companies can use agility to spot and exploit changes in the market (Sull, 2009). According to Vickery et al. (2003), customer service has a mediating effect on the relationship between SCI and financial performance. Thus, agility could be an antecedent that explains high firm performance in the supply chain context.

Flynn, Huo, and Zhao (2010) proposed three SCI dimensions: customer, supplier, and internal process integration. Besides, Frohlich and Westbrook (2001) proposed that the widest degree of arc of integration among supply chain partners had the strongest association with performance improvement. Although several studies indicated that manufacturers may not place equal emphasis on every dimension of SCI (i.e. Frohlich & Westbrook, 2001), previous literature leaves the question open about whether higher

integration balance has positively impact on the relationship between SCI and firm performance.

The primary concern of this research is to investigate whether customer agility mediates the relationship between SCI and firm performance. It is also interesting to know whether diversity of integration moderates the influence of SCI on firm performance. This study aims to examine the effects of customer agility and integration diversity by investigating a variety of supply chain integration in three dimensions: customer, supplier, and internal process integration.

Focusing on manufacturers, the study has collected data from the Greater China area including Hong Kong, China, and Taiwan, an area famous for its manufacturing industry. Manufacturers here require a high level of SCI to rapidly respond to customers' needs, such as new product development and reduction of production lead-time. The results show that the relationship between SCI and firm performance is mediated by customer agility. In addition, diversity of integration moderates the relationship between customer integration and firm performance, and between internal process integration and firm performance.

The remainder of this chapter is organized as follows. Section 4.2 reviews the literature and develops our hypotheses about how constructs are related. Section 4.3 shows our sample's profiles. Section 4.4 presents the construct measurements. Section 4.5 summarizes the results. Section 4.6 discusses the implications for theory and managerial practices.

4.2. Hypotheses development

This investigation reviews the multi-disciplinary related to SCI, customer agility, firm performance and diversity of integration, developing the conceptual framework shown in Figure 9. In the following parts, this study discusses each of its components and develops hypotheses about how they are related.

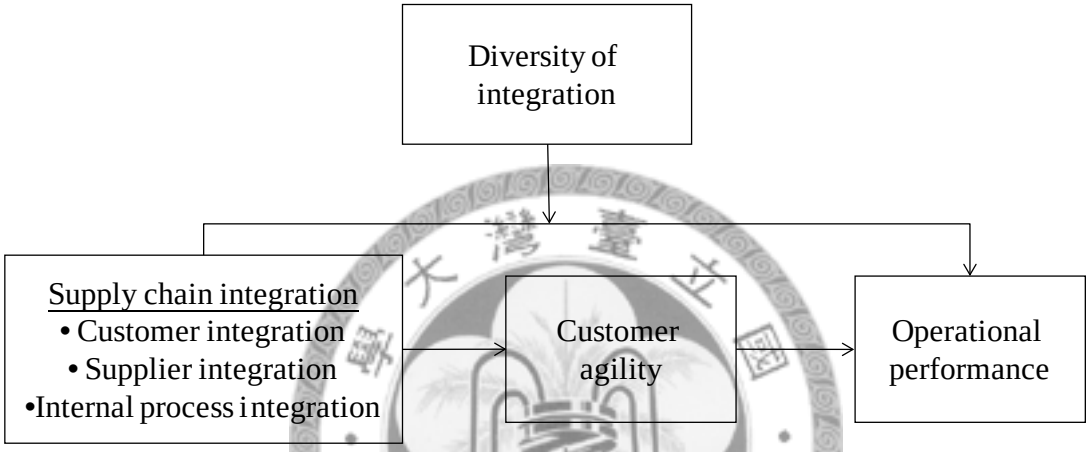


Figure 9: An integrated proposed model of supply chain integration, customer agility, firm performance, and diversity of integration

4.2.1. Effects of supply chain integration

Supply chain integration is defined as the collaborative relationship among supply chain partners achieving performance goals. The performance goals involve performance of supply chain networks, such as reducing the length of supply chain, or performance of individual companies including diminishing production cost, and inventory cost.

There are numerous types of collaborative supply chain integration, including

strategic, internal, customer, supplier technology and planning, measurement, and relationship integration (Stank, Keller, & Closs, 2001); however, there is a great deal of overlap between these constructs. Customer integration and internal integration has been found to be the most important type of collaborative supply chain integration in influencing competitive performance (Stank et al., 2001). Besides, Frohlich and Westbrook (2001) argued that manufacturers integrate their organizations with customers and suppliers in supply chain strategies. Customer and supplier integration allows manufacturers to synchronize the core competencies and capabilities of all supply chain participants to jointly achieve improved service level. Moreover, Flynn et al. (2010) further divided supply chain integration into three dimensions: customer integration, supplier integration, and internal process integration. Therefore, this research has adopted and applied the viewpoints of Flynn et al. (2010) for its purpose.

4.2.1.1. Supply chain integration and customer agility

Sambamurthy, Bharadwaj, and Grover (2003) argued that “agility encompassed a firm’s capabilities which were related to interactions with customers, orchestration of internal operations, and utilization of its ecosystem of external business partners.” Agility comprised three interrelated capabilities, namely, customer agility, partnering agility, and operational agility (Sambamurthy et al., 2003). Because research subjects of this study are construct manufacturers, which have to cope with upstream directives imposed by original equipment manufacturers, customer agility is extremely important to these construct manufacturers. Therefore, this study focuses on customer agility, which means that the capabilities of a firm cooperating with customers in the exploration and exploitation of opportunities. That is, customer agility enhances the

capabilities of enterprises to sense the change and respond and perform well in rapidly changing business environment.

SCI can improve value chain flexibility, which enhances a firm's supply chain agility (Swafford, Ghosh, & Murthy, 2006). For example, SCI enhances visibility of downstream demand and upstream components delivery schedule. Prior research has argued that various supplier and customer integration strategies on a variety of intermediate and final performance (i.e. Frohlich & Westbrook, 2001; Vickery et al., 2003). Their results indicated that firms with customer integration and supplier integration enhance firm performance through intermediate performance outcomes, such as customer service, on-time delivery, and lead-time to new product development. Besides, internal process integration is the core competence to best support customer requirements by lowing total system cost, such as logistics and communication cost (Stank et al, 2001).

Customer agility mainly deals with the capability of the firm to response to key performance of supply chain, rather than how effectively the goals had achieved. This investigation applied customer agility to the proposed model, and considered customer agility to be an intermediate construct rather than intermediate performance outcomes. The high level of customer agility enables companies to obtain high level of operational performance. Thus, this study proposes:

Hypothesis 7a: The degree of integration between a manufacturer and its customer is positively related to its customer agility.

Hypothesis 7b: The degree of integration between a manufacturer and its supplier is

positively related to its customer agility.

Hypothesis 7c: The degree of a manufacturer's internal process integration is positively related to its customer agility

4.2.1.2. Supply chain integration and operational performance

Transaction cost theory provides a useful lens for understanding supply chain integration. Coase (1937) demonstrates a transaction cost approach to the firm theory, namely, a transaction cost being the cost of providing for some service or goods through markets rather than having it provided from within the firm. Furthermore, vertical integration indicates a closer relationship between the upstream and downstream, resulting in lower transaction costs (Gummesson, 1996; Heide, 1994). With transaction costs in their minds, firms attempt to minimize their total costs by choosing the best organizational governance structure. Thus, it can reduce the transaction cost when a manufacturer strategically collaborates with its supply chain partners and collaboratively manages intra-organizational and inter-organizational processes.

Empirical evidence shows that SCI is considered one of the major factors in improving performance (i.e. Devaraj et al., 2007; Frohlich and Westbrook, 2001). Stank et al. (2001) proposed that customer integration and internal integration has been found to be the most important type of collaborative supply chain integration in influencing competitive performance. Furthermore, some research has argued that supplier integration has positively impact on firm performance (i.e. Narasimhan & Kim, 2002). Thus, this research hypothesizes:

Hypothesis 8a: Customer integration is positively related to operational performance.

Hypothesis 8b: Supplier integration is positively related to operational performance.

Hypothesis 8c: Internal process integration is positively related to operational performance.

4.2.2. Customer agility and operational performance

As mentioned previously, customer agility is regarded as a capability, which enhances the ability of reacting rapidly to key chain outcomes. We considered customer agility to be a dynamic capability related to enhancing supply chain performance. Some empirical evidence also showed that a firm's agility has a positive influence on its performance (Ettlie, 1998; Swafford et al., 2006) and competitive actions (Sambamurthy et al, 2003). Thus, this study hypothesizes:

Hypothesis 9: Building customer agility is a source for operational performance.

4.2.3. Mediation and moderation effect

4.2.3.1. Mediation effect between SCI and operational performance

A company in a supply chain network achieves its performance goals through SCI, as predicted by Hypothesis 8a, 8b, and 8c. However, Vickery et al. (2003) failed to find a significant direct relationship between SCI and firm performance. Besides, Hypothesis 7a, 7b and 7c proposed that the high level of SCI enhances customer agility. An agile enterprise characterizes a fast moving, adaptable and robust organization to satisfy

customers' need so the agile firm is capable of achieving firm performance. A company can enhance firm performance through customer agility. Thus, this study hypothesizes:

Hypothesis 10a: Customer agility mediates the relationship between the customer integration and operational performance.

Hypothesis 10b: Customer agility mediates the relationship between the supplier integration and operational performance.

Hypothesis 10c: Customer agility mediates the relationship between the internal process integration and operational performance.

4.2.3.2. Integration configuration

Since different companies may place differing degrees of emphasis on the individual dimensions of SCI, a variety of configurations of SCI exist in organizations. The configuration can be described in terms of their SCI strength and balance (Flynn et al., 2010). SCI strength is the level to which SCI activities are carried out, whereas SCI balance is the extent to which a company pays equal attention to all three dimensions of SCI. For SCI strength, previous research has suggested that the higher level of integration with a firm's supplier and/or customer has positive association with its firm performance (i.e. Benton & Maloni, 2005; Duffy & Fearne, 2004). For SCI balance, unbalance integration with customers or suppliers had lower performance improvement rates than the maximum performance that can be achieved (Frohlich & Westbrook, 2001). Thus, the association between SCI and firm performance may be influenced by SCI balance. In this study, we used diversity of integration (DOI) to represent SCI balance; that is, the more positive DOI shows the lower level of SCI balance. Therefore,

this research hypothesizes:

Hypothesis 11a: DOI moderates the influence of the customer integration on operational performance, such that the influence of customer integration becomes less positive as DOI becomes more positive.

Hypothesis 11b: DOI moderates the influence of the supplier integration on operational performance, such that the influence of supplier integration becomes less positive as DOI becomes more positive.

Hypothesis 11c: DOI moderates the influence of the internal process integration on operational performance, such that the influence of internal process integration becomes less positive as DOI becomes more positive.

4.3. Sample and respondent profile

The data analyzed in this study were collected from a firm level. Both samples and variables came from a questionnaire, which mainly used existing scales from previous research. The questionnaire was entitled “cross-cultural supply chain management,” which was developed from a cooperative research project sponsored by Chinese University of Hong Kong (Hong Kong), Xi'an Jiaotong University (Mainland China), and Chang Gung University (Taiwan). This investigation extracted the questionnaire as the large scale survey of major manufacturers in the three countries consisting of Hong Kong, China, and Taiwan.

The research unit was the manufacturing company and its supply chain. A total of 818 companies consisting of 14 industries among the three countries returned completed

surveys. Most of the respondents have been in their position for more than 3 years; thus, they should be knowledgeable about the information requested. Table 11 shows the basic information of our analyzed dataset, a variety of industries, and firm sizes. The three countries included 410 (50%) from China, 200 (25%) from Hong Kong, and 208 (25%) from Taiwan. The sample presents a variety of industries and its distribution is representative of the concentration of industries in the countries studied. For total number of employees, 35% is less than 50 employees, 51% is 50-499 employees, and 14% is more than 500 employees. For total sales of company, 28% is less than HK$ 5 millions, 51% is HK$5-100 millions, and 21% is more than HK$ 100 millions.

Table 11: Profiles of responding companies

	Greater China (n=818)	China (n=410)	Hong Kong (n=200)	Taiwan (n=208)
Industry type				
Arts & Crafts	0.6%	1%	0.5%	0%
Building Materials	4.4	7.1	1.5	1.9
Chemicals & Petrochemicals	6.8	9.3	1.5	7.2
Electronics & Electrical	19.1	14.4	16.5	30.8
Food, Beverage, Alcohol & Cigarettes	3.3	4.6	3.5	0.5
Jewelry	0.6	0.2	2	0
Metal, Mechanical & Engineering	26.9	35.6	13.5	22.6
Pharmaceutical & Medicals	2	1	0.5	5.3
Publishing & Printing	3.2	5.4	1	1
Rubber & Plastics	8.2	6.6	6.5	13
Textiles & Apparel	14.2	8.3	38.5	2.4
Toys	1.8	4.4	5.5	1.9
Wood & Furniture	2.8	0	1	1.4
Others	6.1	2.2	8	12
Total number of employees				
<50	35.1%	36.6%	26%	40.9%
50-99	18.7	19.3	21	15.4
100-199	18.5	20.5	25	8.2
200-499	13.8	15.6	17	7.2
500-999	6.2	3.9	8	9.1
1000-4999	4.5	2.9	2.5	9.6
5000 or more	3.2	1.2	0.5	9.6
Total sales of the company (2007)				
< HK$ 5M	27.8%	41%	12.5%	16.3%
HK$ 5-10M	15.6	17.3	19.5	8.7
HK$ 10-20M	12.8	11.2	19	10.1
HK$ 20-50M	12.5	12	14	12
HK$ 50-100M	10.4	7.1	13	14.4
HK$ 100 or more	20.5	11.5	20.5	38.5
missing	0.4	0	1.5	0

4.4. Measures

The questionnaire applied a 7-point Likert scale (1 = strongly disagree, 7 = strongly agree) to measure the constructs related to supply chain management. This investigation extracted and adapted these scales to measure the constructs of this study based on previous literature. The higher values indicated stronger integration, superior customer agility or better performance. The complete scale and factor ladings used in this study were listed in Appendix.

4.4.1. Internal process integration

The scale to measure internal process integration was adapted existing scales from previous literature (Narasimhan & Kim, 2002). Internal process integration was measured with the 13-item multidimensional Internal Process Integration Scale that showed the two dimensions of this scale (internal information integration and intra-organization integration). The firms respond to a 7-point scale on the basis of their observation on aspects such as “the use of periodic interdepartmental meetings among internal functions.” In a confirmatory factor analysis (CFA), the two factors of the scale loaded on a second-order factor, χ^2 (58) =298.03, comparative fit index (CFI) = 0.99, nonnormed fit index (NNFI) = 0.98, root-mean-square error of approximation (RMSEA) = 0.07. The two dimensions of Internal Process Integration Scale loaded on a second-factor could be used to measure overall internal process integration. Thus, we aggregated all items to measure overall customer integration.

4.4.2. Customer integration

The scale to measure customer integration was adapted existing scales from previous literature (Narasimhan & Kim, 2002; Morash & Clinton, 1998). Customer integration was measured with the 12-item multidimensional Customer Integration Scale that showed the three dimensions of this scale (customer communication, information sharing, and business process integration). The firms were asked to answer in reference to their firms' integration related to customer. An example item is "Our level of communication with our major customer." In a CFA, the three factors of the scale loaded on a second-order factor, χ^2 (49) = 231.97, CFI = 0.99, NNFI = 0.98, RMSEA = 0.06. The three dimensions of Customer Integration Scale loaded on a second-factor could be used to measure overall customer integration. Thus, we aggregated all items to measure overall customer integration.

4.4.3. Supplier integration

The scale to measure supplier integration was adapted existing scales from previous literature (Narasimhan & Kim, 2002). Supplier integration was measured with the 17-item multidimensional Supplier Integration Scale that showed the three dimensions of this scale (information linking, information sharing, and business process integration). The firms were asked to answer in reference to their firms' integration related to supplier. An example item is "the extent of our strategic partnership with our major supplier." In a CFA, the three factors of the scale loaded on a second-order factor, χ^2 (113) = 544.14, CFI = 0.99, NNFI = 0.99, RMSEA = 0.07. The three dimensions of Supplier Integration Scale loaded on a second-factor could be used to measure overall supplier integration. Thus, we aggregated all items to measure overall customer

integration.

4.4.4. Customer agility

Firms reported their level of customer agility using the 3-item measure developed by Swafford et al. (2006). The firms were asked to answer in reference to their firms' customer agility. An example item is "Our supply chain has the ability to quickly modify products to meet customers' requirements." Moreover, this study aggregated all items to measure overall customer agility.

4.4.5. Operational performance

Operational Performance Scale is adopted from the 6-item Operational Performance Scale (Flynn et al., 2010). We deleted 3 items from the original construct because the deleted items were considered to measure a firm's capability rather than a performance level. Besides, an item "Our company has an outstanding record of reliable delivery to our customers" was added in our scale. Thus, the firms were asked to answer in reference to their operational performance using a 4-item scale. Moreover, this study aggregated all items to measure overall operational performance.

4.4.6. Diversity of integration

To examine the integration diversity of SCI, we used a standard deviation of an individual firm's internal integration, customer integration, and supplier integration to form the variable of diversity of integration (DOI).

4.4.7. Control variables

We controlled for several variables to rule out alternative explanations. We controlled for a firm's operating region by two dummy variables. Where, the dummy variable Region_1 equaling one represents companies from Taiwan. The variable Region_2 equaling one represents companies from China. Moreover, both dummy variables equals zero represent companies from Hong Kong. Two measures of firm size were included for control purposes consisting of: Employee and Sales. Employee is assessed by means of the logarithmic transformation of the total number of employees, and Sales is evaluated by means of the logarithmic transformation of the total sales for financial year 2007. In addition, we controlled for the type of the major customer faced by respondents. Thus, three indicator variables were used to depict the major customer classification consisting of the manufacturer, distributor, and retailer. The type of major supplier faced by respondents were also controlled by three indicator variables, which respectively shows manufacturer, raw material supplier, and retailer. Finally, a percentage of sales contributed by a major customers and a percentage of a firm's purchased supplies from a major supplier were also included in the model for control purposes.

4.5. Results

The descriptive statistics, internal consistency reliabilities, and intercorrelations of all study variables are presented in Table 12.

Table 12: Means, standard deviations, and correlations

Variables	Mean	SD	1	2	3	4	5	6
1. Customer integration (CI)	4.531	1.017	*.907*					
2. Supplier integration (SI)	4.067	1.250	.652**	*.960*				
3. Internal process integration (IPI)	4.751	1.020	.560**	.493**	*.925*			
4. Diversity of integration (DOI)	0.659	0.469	-.201**	-.564**	.036	--		
5. Customer agility (CA)	5.262	0.898	.301**	.264**	.295**	-.013	*.735*	
6. Operational performance (OP)	5.694	0.831	.235**	.152**	.319**	.120**	.473**	*.812*

Note: *p<0.05; **p<0.01
N=818.
Cronbach's alphas are in italics on the diagonal.

Before we tested our hypotheses, the convergent validity of our measures was examined. We conducted a CFA specifying separate factors for internal process integration, customer integration, supplier integration, customer agility, and operational performance. The results indicated that this factor structure fit the data well, χ^2 (1091) = 4925.335, CFI = 0.969, NNFI = 0.966, RMSEA = 0.076 and SRMR = 0.049. Thus, the model was acceptable, indicating convergent validity (O'Leary-Kelly & Vokurka, 1998). Furthermore, all factor loadings were greater than 0.50 and the t-values were all greater than 2.0, further demonstrating convergent validity.

We present the results testing the effects of SCI on operational performance in Table 13. Multivariate regressions were applied to test Hypotheses 7, 8, 9, 10. In each analysis the control variables were entered into the models. Hypothesis 7a predicts that customer integration is positively related to customer agility. The results in Model 1A reveal that customer integration significant predicted customer agility ($\beta^{\wedge}$ = 0.26, p < 0.001). Thus, hypothesis 7a was supported. Also, the results in Model 2A also showed supplier integration significant predicting customer agility ($\beta^{\wedge}$ = 0.184, p < 0.001), and internal process integration significant predicting customer agility ($\beta^{\wedge}$ = 0.291, p < 0.001) in

Model 3A. Therefore, hypotheses 7b and 7c were supported.

Table 13: Effects of supply chain integration (SCI) on operational performance

Variables	Customer agility			Operational performance					
	Model 1A	Model 2A	Model 3A	Model 1B	Model 2B	Model 3B	Model 1C	Model 2C	Model 3C
Customer integration	0.26 (0.03)***			0.183 (0.028)***			0.081 (0.027)**		
Supplier integration		0.184 (0.025)***			0.094 (0.023)***			0.018 (0.022)	
Internal process integration			0.291 (0.03)***			0.283 (0.028)***			0.177 (0.027)***
Customer agility							0.389 (0.03)***	0.414 (0.03)***	0.364 (0.03)***
Intercept	5.333 (0.306)***	4.824 (0.394)***	5.513 (0.263)***	5.265 (0.285)***	5.08 (0.367)***	5.656 (0.242)***	3.189 (0.304)***	3.084 (0.359)***	3.649 (0.276)***
Employee (log)	0.088 (0.061)	0.081 (0.062)	0.104 (0.059)	0.018 (0.057)	0.051 (0.058)	0.014 (0.054)	-0.016 (0.051)	0.018 (0.052)	-0.023 (0.05)
Sales (log)	-0.051 (0.078)	-0.052 (0.079)	-0.174 (0.077)*	0.053 (0.072)	0.017 (0.074)	-0.064 (0.07)	0.073 (0.066)	0.039 (0.066)	-0.001 (0.065)
Region_1[a] (Taiwan)	0.164 (0.078)*	0.162 (0.079)*	0.321 (0.075)***	0.171 (0.072)*	0.126 (0.074)	0.327 (0.069)***	0.107 (0.066)	0.059 (0.066)	0.21 (0.064)**
Region_2[a] (China)	0.192 (0.09)*	0.238 (0.088)**	0.278 (0.084)**	0.317 (0.084)***	0.353 (0.082)***	0.414 (0.077)***	0.242 (0.076)**	0.254 (0.074)**	0.313 (0.071)***
Type of a major customer									
Cus_Manuf.	-0.066 (0.124)			-0.037 (0.116)			-0.011 (0.105)		
Cus_Distribu-tor	-0.148 (0.126)			-0.171 (0.117)			-0.113 (0.107)		
Cus_Retailer	-0.029 (0.171)			0.128 (0.159)			0.139 (0.144)		
% of sales (major cus.)	-0.132 (0.132)			0.196 (0.123)			0.247 (0.112)*		
Type of a major supplier									
Sup_Manuf.		0.41 (0.293)			0.01 (0.273)			-0.16 (0.245)	
Sup_Raw material supplier		0.305 (0.29)			-0.02 (0.27)			-0.146 (0.242)	
Sup_Retailer		0.456 (0.314)			0.152 (0.293)			-0.036 (0.263)	
% of purchase (major sup.)		-0.005 (0.136)			0.546 (0.127)***			0.548 (0.114)***	
Adj R^2	0.1	0.077	0.114	0.086	0.064	0.135	0.245	0.248	0.27

Note: [a]The data come from Hong Kong if both Region 1 and Region 2 are equal to zero.
N=818 individual firms
*p<0.05; **p<0.01; ***p<0.001.
The first value is the parameter estimate and the value within parenthesis is the standard error.
The variables including CI, SI, and IPI are centered by the mean value.

Hypothesis 8a predicts that customer integration is positively related to operational performance. The results in Model 1B reveal that customer integration significantly

predicted operational performance ($\hat{\beta}$ = 0.183, p < 0.001). Thus, hypothesis 8a was supported. Also, the results in Model 2B also showed that supplier integration significant predicted operational performance ($\hat{\beta}$ = 0.094, $p < 0.001$), and internal process integration significant predicted operational performance ($\hat{\beta}$ = 0.283, $p < 0.001$) in Model 3B. Therefore, hypotheses 8b and 8c were supported.

Hypothesis 9 proposes that customer agility is positively related to operational performance. We found that the paths ($\hat{\beta}_{CA,OP}$) were all significant in the three conditions, which respectively regard customer integration, supplier integration, and internal process integration as control variables in Model 1C, 2C, and 3C. Therefore, Hypothesis 9 was supported.

Hypothesis 10a proposes that customer agility mediates the relationship between the customer integration and operational performance. This study follows the four step test procedures for mediation described in Kenny, Kashy, and Bolger (1998). In the first step, we found that customer integration was significantly related to operational performance ($\hat{\beta}$ = 0.183, $p < 0.001$; Model 1B), thus meeting the first requirement, that customer integration needs to be related to operational performance. In the second step, customer integration needs to be related to customer agility, which was supported in our testing of Hypothesis 7a above. In testing steps 3 and 4, we included both customer integration and the mediator in the regression. We found that customer agility was significantly related to operational performance ($\hat{\beta}$ = 0.389, $p < 0.001$; Model 1C), and that the effect of customer integration remained significant but was reduced in magnitude ($\hat{\beta}$ = 0.081, $p < 0.01$; Model 1C) compared with the effect in step 1. Therefore, customer agility partially mediated the effect of customer integration on

operational performance, providing support to Hypothesis 10a; a Sobel (1982) test confirmed that the indirect effect between customer integration and operational performance was significant ($z = 7.281$, $p < 0.001$).

We followed a similar procedure in testing Hypothesis 10b, which predicts that customer agility mediates the relationship between the supplier integration and operational performance. In Step 1, we found that supplier integration was significantly related to operational performance (Model 2B). In Step 2, supplier integration was related to customer agility, which was supported in our testing of Hypothesis 7b above (Model 2A). In Step 3 and 4, we found that customer agility was significantly related to operational performance ($\hat{\beta} = 0.414$, $p < 0.001$; Model 2C), and that the effect of supplier integration was not significant ($\hat{\beta} = 0.018$, $p > 0.05$; Model 2C). Therefore, customer agility perfectly mediated the effect of supplier integration on operational performance, providing support to Hypothesis 10b; a Sobel (1982) test confirmed that the indirect effect between supplier integration and operational performance was significant ($z = 6.494$, $p < 0.001$).

Hypothesis 10c, which predicts that customer agility mediates the relationship between the internal process integration and operational performance. In Step 1 and 2, internal process integration was related to operational performance (Model 3B), and internal process integration was related to customer agility (Model 3A). In Step 3 and 4, we found that customer agility was significantly related to operational performance ($\hat{\beta} = 0.364$, $p < 0.001$; Model 3C), and that the effect of internal process integration was significant but was reduced in magnitude ($\hat{\beta} = 0.177$, $p < 0.001$; Model 3C) compared with the effect in step 1. Therefore, customer agility partially mediated the effect of

internal process integration on operational performance, providing support to Hypothesis 10c; a Sobel (1982) test confirmed that the indirect effect between internal process integration and operational performance was significant ($z = 7.576$, $p < 0.001$).

Table 14 presents multivariate regression results testing the moderating effects of DOI on the relationship between SCI and operational performance.

Table 14: Effects of diversity of integration (DOI) on operational performance

Variables	Operational performance		
	Model 4	Model 5	Model 6
Intercept	5.682(0.028)***	5.694(0.031)***	5.697(0.027)***
Customer integration(CI)	0.115(0.042)**	0.076(0.039)	0.056(0.039)
Supplier integration(SI)	0.043(0.039)	0.057(0.042)	0.027(0.04)
Internal process integration(IPI)	0.151(0.038)***	0.177(0.038)***	0.219(0.038)***
Diversity of integration (DOI)	0.303(0.079)***	0.316(0.081)***	0.295(0.079)***
CI*DOI	-0.129(0.057)*		
SI*DOI		-0.002(0.047)	
IPI*DOI			-0.162(0.06)**
Adj R^2	0.126	0.12	0.128

Note: N=818.
*p<0.05; **p<0.01; ***p<0.001.
The first value is the parameter estimate and the value within parenthesis is the standard error.
The variables including CI, SI, IPI, and DOI are centered by the mean value.

Hypothesis 11a states that DOI would moderate the relationship between customer integration and operational performance, such that the relationship would be weaker when DOI is higher. As indicated in Table 14, DOI was significant related to the customer integration-operational performance slope in the expected direction ($\hat{\beta} = -0.129$, $p < 0.05$; Model 4). We plotted the significant interaction following the procedure illustrated by Cohen, Cohen, West, and Aiken (2003). The multiple regression equation was plotted at conditional values of DOI (1 standard deviation above and below the mean). In Figure 10, as stated by Hypothesis 11a, the relationship between customer integration and operational performance was more positive at lower level of DOI rather than a higher level of that, and operational performance remained

high when DOI was high irrespective of levels of customer integration. Therefore, Hypothesis 11a was supported.

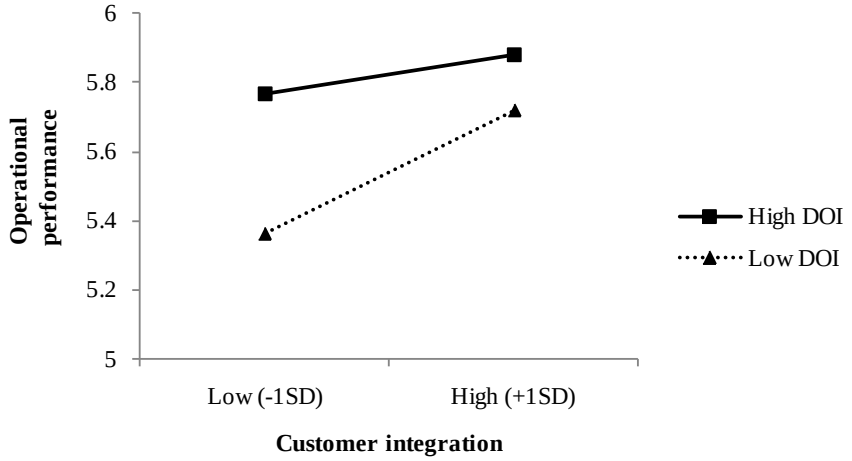


Figure 10: Diversity of integration (DOI) as a moderator of the relationship between customer integration and operational performance

Hypothesis 11c states that DOI would moderate the relationship between internal process integration and operational performance, such that the relationship would be weaker when DOI is higher. In Table 14, DOI was also significant related to the internal process integration-operational performance slope in the expected direction ($\hat{\beta}$ = -0.162, $p < 0.01$; Model 6). As shown in Figure 11, the relationship between internal process integration and operational performance was more positive at a lower level of DOI rather than a higher level of that. Therefore, Hypothesis 11c was supported.

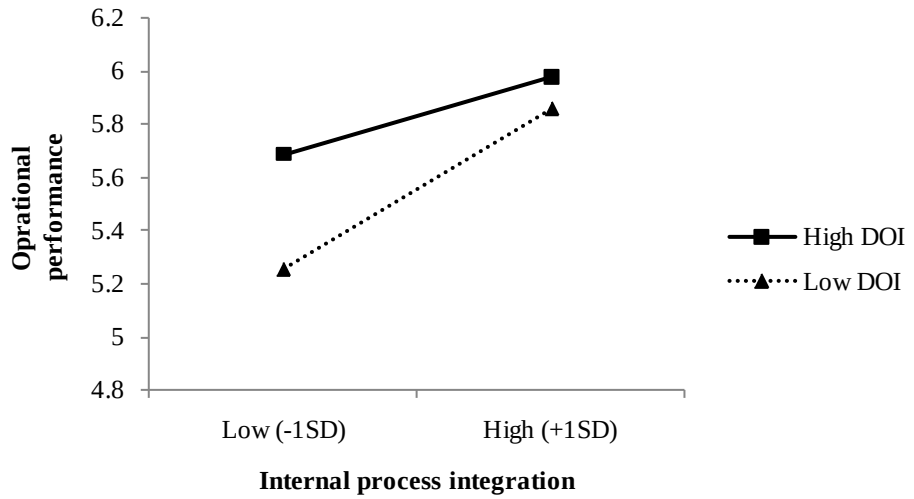


Figure 11: Diversity of integration (DOI) as a moderator of the relationship between internal process integration and operational performance

Finally, we found that DOI was not significant related to the supplier integration-operational performance slope ($\hat{\beta}$ = -0.002, $p > 0.05$; Model 5). Therefore, Hypothesis 11b was not supported.

4.6. Discussion

This research proposed and tested a model of direct and indirect relationships involving three constructs: SCI, customer agility, operational performance. Overall, there constructs were related to each other in the sequential order specified by the research model. Moreover, the moderating effect of diversity of integration was significant impact on the relationship between SCI and operational performance.

Frohlich and Westbrook (2001) proposed that the widest degree of arc of integration with both suppliers and customers had the strongest relationship with performance

improvement. However, limited analyses of their research were about whether the diversity of integration can influence firm performance. This investigation verifies that the more balance of integration resultes in the more positive association between customer integration and firm performance, so does the relationship between internal process integration and firm performance. The result implies that firms may no longer be enough to consider only the strength of integration when they improve operational performance through customer integration and internal process integration.

Flynn et al. (2010) proposed that SCI can divide into two patterns consisting of: SCI strength and SCI balance. Their results showed that SCI balance and SCI strength are equal importance for firm performance, and were consistent with the findings of this study. This investigation further verifies that SCI balance (or diversity of integration) has significant impact on the association between SCI and performance.

According to previous research, the strength of SCI is essential to improve firm performance; however, the three dimensions of SCI function jointly so the individual integration, such as customer integration, has limited extent in enhancing firm performance. Companies should synchronize their processes in order to fulfill their customer's requirements and efficiently interact with their suppliers; therefore, it is important that firms equal attention to all three dimensions of SCI.

The second finding of our study was the degree to which customer agility was a mediator on the relationship between SCI and operational performance. The finding is also consistent with the study that agility mediates the effect of process and knowledge reach/richness and competitive actions (Sambamurthy et al., 2003). Under intensified

competition, companies should coordinate the relationships with their partners in committed to closer and more agile relationships with their customer. Leveraging the competencies of network partners through SCI achieves customer agility is able to improve operational performance. Therefore, the link between SCI and operational performance is built while customer agility exists to achieve greater responsiveness and market needs.

5. CONCLUSIONS

There are three individual studies in the dissertation. First of all, a conceptual model shows how network agility influences firm performance, and it indicates that network agility influences the collaborative relationship between OEMs and CMs. Then, this dissertation proposes and tests a model of direct and indirect relationship involving 6 constructs: information sharing, manufacturer-customer business process integration, customer agility, operational performance, internal process integration, and technology uncertainty. Overall, the 6 constructs are related to each other as can be seen in the model in Chapter 3. Finally, the focus shifts to testing the mediating effect of customer agility and the moderating of integration diversity on the relationship between SCI and firm performance. Both the mediating and moderating effect are found significant in the results.

In these studies, the subjects are a variety of manufacturers in the Greater China area including China, Hong Kong, and Taiwan, an area famous for its manufacturing industry. Manufacturers here require a high level of SCI to rapidly respond to the needs of upstream OEMs or retailers, such as new product development and reduction of production lead-time. Thus, network agility, including customer agility, operational agility, and partnering agility, enables manufacturers to satisfy upstream directives imposed by their supply chain partners.

Technology serves an important role in building customer-centric organization. In the first study, it is supported that IS integration is an enabler to a robust network. Firms

require management tools for identifying profit opportunities, building complex and fluid channel networks, and evaluating risk. In fact, IS integration makes these management tools more powerful and offers customers and suppliers clear visibility of the entire supply chain network.

Like most of the previous empirical studies, this dissertation examines the effect of SCI. With the help of the conceptual models of the case study and empirical studies, the role of integration in firm performance is also clarified. For manufacturers, SCI enhances visibility of supply chain and therefore reduces production costs; for OEMs, SCI is necessary for reduction of monitoring costs. Thus, SCI is a useful tool that enables supply chain partners to share benefits. Contemporary firms thus increasingly rely on SCI, including process, knowledge, and communication technologies, to improve their agility and to establish with value chain collaborations that are difficult for competitors to duplicate.

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APPENDIX

Construct Measurements with Factor Loadings

All items were measured on a 7-point scale on which 1 was “strongly disagree” and 7 was “strongly agree”.

Table A 1 : Customer Integration Scale

Please indicate the extent of integration or information sharing between your organization and your major customer in the following areas.

Construct	Measurement items	Factor loading	Measurement model		
			Estimates	R^2	t-value
Customer communication (α=0.79; eigen value=2.31)	Our level of communication with our major customer	0.77	1.00	0.46	--
	Our follow-up with our major customer for feedback	0.82	1.34	0.70	17.76
	The frequency of our contacts with our major customer	0.81	1.21	0.52	16.91
Information sharing (α=0.88; eigen value=3.03)	Our major customer share POS information with us	0.73	1.00	0.65	--
	Our major customer shares demand forecast with us	0.77	1.03	0.73	26.28
	We share our inventory availability with our major customer	0.83	1.01	0.60	23.37
	We share our production planning with our major customer	0.78	0.97	0.54	21.74
Business process integration (α=0.87; eigen value=3.17)	We restructure logistics activities with our major customer	0.66	1.00	0.60	--
	We jointly create new products with our major customer	0.78	0.97	0.51	20.22
	We jointly pursue mass customization with our major customer (to meet the customized requirements with low costs)	0.76	0.92	0.50	20.13
	We monitor business processes together with our major customer	0.78	1.08	0.65	22.93

	We jointly develop and maintain measurement systems with our major customer	0.74	1.01	0.55	20.78

Note: All t-values are significant at $p<0.05$
Model fit: $\chi^2/df=4.73$; AGFI= 0.93; NNFI= 0.98; CFI= 0.99; RMSEA= 0.06.

Table A 2: Supplier Integration Scale

Please indicate the extent of integration or information sharing between your organization and your major supplier in the following areas.

Construct	Measurement items	Factor loading	Measurement model		
			Estimates	R^2	t-value
Information linking (α=0.89; eigen value=3.44)	Our level of information exchange with our major supplier through information network	0.82	1.00	0.60	--
	The establishment of a quick ordering system with our major supplier	0.83	1.04	0.73	24.92
	The extent of our strategic partnership with our major supplier	0.72	1.02	0.72	24.81
	Stable procurement through networking with our major supplier	0.82	0.95	0.58	28.28
Information sharing (α=0.95; eigen value=5.00)	Our major supplier shares its production planning with us	0.77	1.00	0.69	--
	Our major supplier shares its production capability with us	0.81	1.04	0.73	41.80
	Our major supplier shares its inventory availability with us	0.80	1.02	0.77	32.04
	We share our production planning with our major supplier	0.79	1.07	0.83	34.01
	We share our demand forecast with our major supplier	0.73	1.03	0.76	31.53
	We share our inventory availability with our major supplier	0.79	1.04	0.75	31.31
Business process integration (α=0.93; eigen value=4.40)	We help our major supplier to improve its process to better meet our needs	0.72	1.00	0.69	--
	We jointly develop strategic plans in collaboration with our major supplier	0.67	1.05	0.72	29.69
	We collaborate in forecasting and replenishment planning with our major supplier	0.74	0.92	0.64	27.12
	We collaborate in production planning , operating, purchasing, ordering, engineering change,	0.72	0.99	0.67	27.99

and product design with our major supplier				
We restructure logistics activities with our major supplier	0.68	0.93	0.63	26.77
We jointly pursue mass customization with our major supplier (to meet the customized requirements with low costs)	0.73	1.03	0.54	23.98
We jointly develop and maintain measurement systems with our major supplier	0.61	1.03	0.65	27.39

Note: All t-values are significant at $p<0.05$
Model fit: $\chi^2/df=4.82$; AGFI= 0.90; NNFI= 0.99; CFI= 0.99; RMSEA= 0.07.

Table A 3: Customer Agility Scale

Please indicate the degree to which you agree or disagree with the following statements concerning your supply chain (indicating your suppliers and customers).

Construct	Measurement items	Factor loading	Measurement model		
			Estimates	R^2	t-value
Customer agility (α=0.74; eigen value=1.97)	Our supply chain has the ability to quickly modify products to meet customers' requirements	0.84	0.80	0.56	19.06
	Our supply chain allows us to quickly introduce new products into the market	0.86	0.94	0.69	20.63
	The length of our supply chain is getting shorter	0.72	0.58	0.27	13.87

Note: All t-values are significant at $p<0.05$
Model fit: the Model is saturated.

Table A 4: Operational Performance Scale

Please indicate the degree to which you agree or disagree with the following statements concerning your company's performance in comparison to the average of your competitors.

Construct	Measurement items	Factor loading	Measurement model		
			Estimates	R^2	t-value
Operational performance (α=0.78; eigen value=2.44)	Our company has an outstanding record of on-time delivery to our customers	0.83	0.80	0.66	25.15
	Our company has an outstanding record of reliable delivery to our customers	0.85	0.80	0.64	24.77
	The lead time for fulfilling customer orders (the time which elapses between the receipt of a customer's order and the delivery of the goods) is short	0.79	0.74	0.41	18.57
	Our company provides a high level of customer service to our customers	0.63	0.66	0.44	19.48

Note: All t-values are significant at $p<0.05$
Model fit: $\chi^2/df=6.02$; AGFI=0.96; NNFI=0.98; CFI=0.99; RMSEA= 0.08.

Table A 5: Internal Process Integration Scale

In this section, you are asked to evaluate the degree of internal process integration in your organization. Please indicate the degree of integration in the following areas.

Construct	Measurement items	Factor loading	Measurement model		
			Estimates	R^2	t-value
Internal information integration (α=0.87; eigen value=3.56)	Data integration among internal functions	0.75	1.000	0.49	--
	Enterprise application integration among internal functions	0.77	1.149	0.59	22.796
	Integrative inventory management	0.82	1.126	0.60	18.513
	Real-time searching of the level of inventory	0.76	0.984	0.52	17.277
	Real-time searching of logistics-related operating data	0.73	1.005	0.56	17.806
Intra-organization integration (α=0.92; eigen value=4.92)	The use of periodic interdepartmental meetings among internal functions	0.68	1.00	0.53	--
	The use cross functional teams in process innovation	0.70	0.96	0.52	23.97
	The use of cross functional teams in new product development	0.75	0.99	0.54	19.96
	Real-time integration and connection among internal functions from raw material management through production, shipping, and sales	0.69	0.91	0.57	20.41
	The extent of strategic partnership among different internal functions	0.81	0.95	0.61	21.06
	Different internal functions jointly develop strategic plans in collaboration with each other	0.85	1.03	0.63	21.32
	Different internal functions monitor business processes together	0.80	1.1	0.62	21.19
	Different internal functions jointly develop and maintain measurement systems	0.76	1.02	0.56	20.13

Note: All t-values are significant at $p<0.05$
Model fit: $\chi^2/df=5.14$; AGFI= 0.92; NNFI= 0.98; CFI=0.99; RMSEA= 0.07.

Table A 6: Environment Uncertainty Scale

The following statements are about your company's environment uncertainty. Please indicate your degree of agreement that you have with each statement.

Construct	Measurement items	Factor loading	Measurement model		
			Estimates	R^2	t-value
Demand uncertainty (α=0.83; eigen value=3.30)	Our master production schedule has a high percentage of variation in demand	0.49	1	0.18	
	It has been difficult for us to procure raw materials for our major product	0.70	1.74	0.36	10.37
	Our demand fluctuates drastically from week to week	0.84	2.16	0.63	11.50
	Customer requirements for our products vary dramatically	0.79	2.07	0.64	11.51
	Our supply requirements vary drastically from week to week	0.82	2.21	0.62	11.47
	The volume of our customers' demand is difficult to predict	0.59	1.61	0.35	10.36
Technology uncertainty (α=0.79; eigen value=2.48)	Our industry is characterized by rapidly changing technology	0.72	1.00	0.48	
	If we don't keep up with changes in technology, it will be difficult for us to remain competitive	0.77	0.69	0.26	12.59
	Our production technology changes frequently	0.79	1.16	0.62	17.86
	The rate of technology obsolescence in our industry is high	0.74	1.15	0.57	17.51

Note: All t-values are significant at $p<0.05$
Model fit: $\chi 2/df=202.85/34$; AGFI=0.92; NNFI=0.96; CFI=0.97; RMSEA=0.08.