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The study of relationships between the collaboration for supply chain, supply chain capabilities and firm performance: A case of the Taiwan's TFT-LCD industry

Shu-Hsien Liao, Fang-I Kuo*

Department of Management Sciences, Tamkang University, No.151, Yingzhuan Rd., Tamsui Dist., New Taipei City 25137, Taiwan (R.O.C.)

*Corresponding author. Mobile: +886 933716663.
E-mail address: airenekuo@yahoo.com.tw (F.-I. Kuo)
Fax: +886 2 2629-6582

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1. Introduction

Consultants and academics have widely discussed supply chain collaboration since the mid-1990s. Examples of the discussed topics include vendor-managed inventory (VMI), collaborative forecasting planning and replenishment (CPFR), continuous replenishment (CR), and e-collaboration (EC) (Sanders, 2007; Chen et al., 2007; Rosenzweig, 2009; Chong et al., 2009). Innovation is the interaction among process dynamics, a firm, and the environment in which the firm operates. Its development depends on feedback mechanisms between external environments and technical developments (Freeman, 1987). Innovation is generated not only within organizations but also by relationship networks among firms, subcontractors, and government institutions (Cooke et al., 2000). Previous studies on supply chain management (SCM) suggest that two key factors enhance supply chain performance (SCP): strategy orientations (Kenneth et al., 2006; Demeter et al., 2006; Min et al., 2007) and innovative channel integration (Alvarado and Kotzab, 2001; Kim et al., 2006; Zhao et al., 2008). Supply chain collaboration provides a network, partnership, or mechanism for supply chain innovation.

Supply chain collaboration is a collective process that depends on numerous interactions and relationships among an organization and its external environment, including suppliers, customers, training bodies, and government agencies. Gann and Salter (2000) and Rothwell (1992) defined this type of innovation as "fifth-generation innovation," a multifactor process requiring high integration levels at both intra- and inter-organizational levels. Therefore, we consider supply chain collaboration is an example of fifth-generation innovation and as significantly influenced by the development of integration, networks, collaboration, and alliances leading to various external relationships. Supply chain channel integration generates the formation of supply chain value innovation (Lin et al., 2010).

We assert that internalization extends beyond the cost of transaction through the market to conditions that enable firms to establish, maintain, and use capabilities more efficiently than markets can (Barney, 1991). Finding methods for leveraging resources to create and sustain a competitive advantage for firms has become the central focus for marketing scholars who link various types of market-based assets (Srivastava et al., 1999) and capabilities (Day, 1994) with the ultimate financial performance of a firm (Srivastava et al., 2001). Supply chain capabilities (SCCs) include the ability of an organization to identify, use, and assimilate both internal and external resources and information to facilitate overall supply chain activities (Bharadwaj, 2000). Certain studies have found that SCCs enable firms to learn from and respond to environmental changes (Amit and Schoemaker, 1993; Teece et al., 1997). In addition, SCCs represent a high-level hierarchy of organizational capabilities (Grant,1996) and require wide collaboration. These capabilities are valuable sources of value creation within firm relationships that extend to the supply chain (Holcomb and Hitt, 2007).

SCM enhances competitive performance by closely integrating internal firm functions and effectively linking them with the external operations of suppliers, customers, and other channel members (Kim, 2009). Viewed from this perspective, the level of supply chain collaboration has significant associations with using SCM practices for intensifying competitive capabilities and firm performance. Lin et al. (2010) proposed a model for addressing innovation drivers in the channel integration of SCM. Their findings confirm that value co-creation and value constellations, which serve as innovation drivers in channel integration, are positively associated with SCP.

【Insert Fig. 1 about here】

To investigate whether supply chain collaboration, value innovation, and SCCs improve firm performance, researchers have recently begun creating value-adding innovation to use resources fully because it is related to both the supply chain process and business performance (Kim et al., 2006; Lin et al., 2010). We do not overstress the technical or management aspects of SCM issues because they are mutually complementary. Therefore, we propose a conceptual structure for establishing a theoretical model, as shown in Fig. 1.

2. Literature Review

2.1 Collaboration for supply chain value innovation

Mentzer (2000) proposed that most organizations have the same collaboration goal. Relationships should involve long periods of joint activities. Ellinger et al. (2000) suggested that a higher level of supply chain collaboration leads to greater business-partner independence. Numerous organizations have considered and pursued external collaboration, but often to the detriment of their efforts to promote internal collaboration (Barratt and Green, 2001; Fawcett and Magnan, 2002 ; Barratt, M., 2004). Internal collaboration overcomes functional myopia and has the potential to enable internal integration (Stevens, 1990; Kahn and Mentzer, 1996; Stank et al., 2001).

Because the size of supply chains has increased through collaboration, numerous scholars have extended the supply chain concept and expanded it to include upstream, midstream, and downstream partners who share information and risk, synchronize business operations, improve customer services, and enhance satisfaction to create the perfect supply chain. Supply chain collaboration is the active participation of all supply chain partners in collectively achieving a common goal. Michel et al. (2008) proposed that firms change their value creation by embedding operant resources into objects, by changing the resource integrators, and by reconfiguring value constellations. Therefore, firm value creation is altered through innovation. Only by promoting constant product innovation, service-process improvement, and overall supply chain value can enterprises maintain a sustainable competitive advantage and sustainable business, and create business value (Matheson and Matheson, 1998). Kim et al. (2006) suggested that innovations of supply chain communication systems (SCCS) affect channel relationships and market performance.

By sharing plans for new products and market development, market performance reflects enhanced channel functions. Collaboration is a crucial process that leads to value-creation opportunities in SCM (Fu and Piplani, 2004). Simatupang and Sridharan (2002) indicated that collaborative supply chains are able to deliver excellent-quality products on time.

Based on Kim et al. (2006), Michel et al. (2008), and Simatupang and Sridharan (2005), we used three dimensions to measure value innovation in supply chain collaboration: information sharing (IS), decision synchronization (DS), and incentive alignment (IA).

2.2 Supply chain capability

The emergence of global operations, scientific and technological progress, and a rapidly changing industrial environment have shortened product life cycles. Therefore, SCCs are increasingly crucial. Morash (2001) stated, "Supply chain capability is the building block for supply chain strategy and a source of competitive advantage for firm success." Morash et al. (1996) indicated that different capabilities support different value disciplines. The first value discipline is demand-oriented logistics capability, and the second value discipline is supply-oriented logistics capabilities.

Lynch et al. (2000) divided SCCs into supply-driven process capability and demand-driven value-added capabilities. Supply-driven process capability involves a streamlined and standardized supply chain business process for analyzing extensive or intensive distribution to create methods for delivering products and services efficiently and for reducing total distribution costs. Demand-driven value-added capabilities meet customer demand for special products or customized services, which are designed to create added customer value and to maximize customer satisfaction and continuous improvement.

We focused on coordinating upstream, midstream, and downstream supply chain partners, and the coordination effect on overall value innovation. SCCs can be divided into five simple categories: supply chain process capabilities, product/service standardization and unification, improved product and service quality, maintaining customer and partner relationships, and customer and partner capacity to solve problems (Morash et al., 1996; Lynch et al., 2000).

2.3 Firm performance

Because of a fiercely competitive environment, firm performance has recently drawn the attention of numerous scholars and research experts. Performance dimensions are typically divided into two major types: subjective and objective performance. Subjective indicators of performance are the environment, strategies, and objectives of a firm. Therefore, no clear definition of the applicable performance standards for each enterprise exists. We can only develop general indicators to measure the performance standard. Subjective indicators are based on satisfaction, adaptability, and effectiveness. Satisfaction is based on attitudes and values, such as customer satisfaction, whereas adaptation and performance refer to the degree of achievement (Anderson, 1988).

Venkatraman and Ramanujam (1986) proposed three scales of firm performance: financial, business, and organization performance. Financial performance indicators include sales growth, profitability (reflected by ratios such as return on investment, return on sale, and return on equity), and earnings per share. In addition to financial performance indicators, business performance involves operational performance, which is the latest expansion of regular adoption. Measures such as market shares, new products, product quality, marketing effectiveness, value-added manufacturing, and other technological-efficiency measures are used within the business-performance domain. Organization performance is the most extensive definition of organizational performance. Tracey et al. (2005) used perceived product value, customer loyalty, market performance, and financial performance to measure the supply chain dimensions of performance indicators.

We integrated views from Venkatraman and Ramanujam (1986), Tracey et al. (2005), and Chiu (2006), and used the three dimensions of financial performance, business performance, and customer value to measure firm performance.

2.4 Relationships between collaborative supply chain value innovation and supply chain capabilities

Manthou et al. (2004) presented a supply chain collaboration framework in a virtual environment. This model classifies partner roles, identifies key capabilities to structure each collaborative relationship, and evaluates partner readiness to collaborate. Lin et al., (2010) found market-orientation supply chain collaboration to be significantly related to embedding operant resources and resource integration, which is significantly related to value co-creation and innovation, embedding operant resources, and resource integration. Lin et al., (2010) emphasized the importance of innovation in channel integration between supply chain partners collaborating to co-create new customer value. Thus, drivers of SCP and capabilities can be implemented from a strategically oriented perspective.

We infer that collaborative supply chain value innovation enhances supply chain capability (SCC). Thus, we propose the first hypothesis as follows:

Hypothesis 1：Collaborative supply chain value innovation has a positive influence on

supply chain capabilities.

2.5 Relationships between collaborative supply chain value innovation and firm performance

Saad et al. (2002) suggested that, although a collaborative supply chain involves certain SCM knowledge, a greater conceptual understanding of systematic innovation approaches is necessary for its implementation and to enhance firm performance. Li et al. (2009) investigated the relationships among three factors: IT implementation, supply chain integration (SCI), and SCP. They presented a conceptual model in which IT implementation affects SCP either directly or indirectly with collaborative innovations through SCI. They suggested that IT implementation has no direct effect on SCP, but that it enhances SCP through its positive effect on SCI. Lin et al. (2010) proposed a model to address innovation drivers in supply chain channel integration and SCP.

We infer that collaborative supply chain value innovation improves firm performance. We thus propose the second hypothesis as follows:

Hypothesis 2: Collaborative supply chain value innovation has a positive influence on firm performance.

2.6 Relationship between supply chain capabilities and firm performance

Based on the resource-based view (RBV), Wu et al. (2006) proposed that IT-enabled SCCs are firm specific and difficult to copy across organizations. These capabilities serve as a catalyst for transforming IT-related resources into improved firm performance. Kim (2009) examined the causal linkages among SCM practice, competition capability, the level of SCI, and firm performance. He developed a framework for linking a firm's SCI strategy to its competitive strategy and identifying how to connect such linkages to improved firm performance. Kristal et al. (2010) investigated the influence of an ambidextrous supply chain strategy on manufacturers' combined competitive capabilities—the capabilities to excel simultaneously in quality, delivery, flexibility, and cost—and, in turn, on firm performance. They found that an ambidextrous supply chain strategy coincides with combined competitive capabilities and business performance.

Thus, we propose the third hypothesis as follows:

Hypothesis 3: Supply chain capabilities have a positive influence on firm performance.

2.7 Relationships among collaborative supply chain value innovation, SCCs, and firm performance

Roth and Nigh (1992) and Gunasekaran et al. (2001) indicated that enterprise collaboration involves flexibility, delivery time, product quality, and other non-financial indicators. Performance measures provide multiple perspectives and corporate non-financial measurement information and tools. Sheu et al. (2006) defined the social factors of supply chain collaboration, such as interaction, trust, and technological factors (e.g., information technology capabilities and IS), that affect collaborative supply chain value innovation. Lin et al. (2010) suggested that innovation value in supply chain collaboration is a resource that enhances business performance and capabilities.

Collaborative supply chain value innovation affects firm performance through SCC. Thus, we propose the following hypothesis:

Hypothesis 4: Collaborative supply chain value innovation affects firm performance through supply chain capability.

2.8 Supply chain echelon (moderating effect)

We used the concept of multiclass-level inventory to develop a supply-chain-level collaborative mechanism for supply chain value innovation, SCCs, and business performance and to analyze the regulation effect. We measured upstream, midstream, and downstream supply chain levels in the inventory echelon.

Clark and Scarf (1960) first introduced the concept of the inventory echelon. They considered the problem of determining optimal purchasing quantities in a multi-installation model of this type. Axsater and Rosling (1993) also compared installation and echelon stock policies for multilevel inventory control, and determined that inventory-echelon policies are more favorable than installation-stock policies. Based on their findings, we inferred that the supply chain echelon has a regulatory effect on collaborative supply chain value innovation, SCCs, and business performance.

We used basic questionnaire information to address the distinctions among upper, midstream, and downstream firms in the thin-film transistor liquid crystal display (TFT-LCD) industry in Taiwan. Thus, we propose the following hypotheses:

H5: The supply chain echelon has a moderating effect on supply chain collaboration in value innovation, supply chain capabilities, and firm performance.

H5a: The supply chain echelon has a moderating effect on supply chain collaboration in value innovation and supply chain capabilities.

H5b: The supply chain echelon has a moderating effect on supply chain collaboration in value innovation and firm performance.

H5c: The supply chain echelon has a moderating effect on supply chain capabilities and firm performance.

Accordingly, we investigated the relationships among value innovation, SCCs, and firm performance within supply chain collaboration. The research framework is shown in Fig. 2.

【Insert Fig. 2 about here】

3. Measurement, data analysis, and results

3.1 Measurement

3.1.1 Collaborative supply chain value innovation (CSCVI)

We measured the features of upstream, midstream, and downstream partners involved in a collaborative supply chain in value innovation (CSCVI). The key features, including the three dimensions of IS, DS, and IA, were implemented in this study. We referenced IS surveys developed by Simatupang et al. (2002), Simatupang and Sridharan (2005), Kim et al. (2006), Michel et al. (2008), Lai and he (2012),Yu et al.(2013) and adopted a 7-point Likert scale, ranging from 1 (*strongly disagree*) to 7 (*strongly agree*; Table 1).

IS is the degree of supply chain collaboration for one variable measure (i.e., IS between supply chain members that can be immediately accessed). We also transferred relevant market information to facilitate decision-maker planning and control (Kim et al., 2006; Michel et al., 2008; Simatupang and Sridharan, 2005). At the cooperative level in collaborative-value innovation, supply chain partners share information, including future market trends, new technologies, and process innovation and knowledge management capabilities, to improve supply chain members and enhance value.

DS is a dimension for measuring the degree of supply chain collaboration. DS refers to supply chain collaboration and value innovation in market planning at the implementation level and through joint planning of target markets and product assortment. IA is a dimension for measuring the degree of supply chain collaboration by investigating the alignment of supply chain partners.

Regarding supply chain collaboration and value innovation, IA represents how supply chain members share costs, risks, and benefits (Kim and Mauborgne,1997;Kim et al., 2006; Michel et al., 2008, Simatupang et al., 2005). The existing motivation affects how individual supply chain members behave and interact with other members. Conflicts of interest often lead individual members who are concerned with self-maximizing benefits to reduce overall supply chain profit and benefits. Conflict between partners prevents the supply chain from attaining the expected benefits and creating value.

【Insert Table 1 about here】

3.1.2 Supply chain capability

Measurement source: We mainly referenced the measuring table of SCC proposed by Morash et al. (1996) and Lynch et al. (2000) to establish five quizzes using a 7-point Likert scale measurement, from *strongly disagree* to *strongly agree*. A higher score indicated more effective executing ability in the supply chain (Table 2).

Supply-oriented: The firm or its supply chain, including upstream, midstream, and downstream suppliers, simplifies the standardized supply chain processes.

Demand-oriented: This refers to customer demand-driven value-added capability or the upstream, midstream, or downstream supply chain. Customer-tailored or customized products and services or special products designed for the downstream supply chain allow partners to create the greatest added value and to continually improve customer satisfaction.

【Insert Table 2 about here】

3.1.3 Firm performance

We referenced the studies of Venkartraman and Ramanujam(1986), Tracey et al. (2005), Lai and he (2012),Yu et al.(2013), and adopted the 7-point Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). A firm with a higher total score has higher performance.

【Insert Table 3 about here】

3.2 Sample

A total of 900 questionnaires were distributed. Two hundred were returned from the upstream, and 113 were valid responses. Two hundred were returned from the midstream, and 134 were valid responses. A total of 127 valid responses were returned from the downstream. Upstream firms from the optoelectronic materials industry accounted for 24.6% of the responses. Midstream-panel manufacturing firms accounted for 27.5%. Downstream manufacturers of electronic-related industries accounted for 21.4%. Manufacturers and suppliers in the upstream, midstream, and downstream with an average of 4-6 years of cooperation accounted for 47.6%. Companies with turnovers of $50-100 million accounted for 19.8%. Companies with turnovers of $10 billion or more accounted for 33.4%. Men accounted for 69.0%, whereas women accounted for 31.0%; 63.1% of the respondents were aged 31-40 years. Respondents with a university education accounted for 50.5%, whereas those with a master's degree accounted for 40.4%. Respondents working in the R&D sector accounted for 34%, whereas 25.9% worked in the purchasing department.

3.3 Measurement model

3.3.1 Confirmatory Factor Analysis

We implemented confirmatory factor analysis (CFA) to test the fitness-to-factor and variable items, as listed in Table 4. CFI performed well for both the small and large samples, with the GFI value equal to or exceeding 0.9. The SRMR value should be below 0.05, and the RMSEA value should be below 0.08. The CFI value was equal to or exceeded 0.9. All indices matched the benchmarks.

【Insert Table 4 about here】

3.3.2 Reliability analysis

Cronbach's α for all variables in this study exceeded 0.70; therefore, the reliability of the questionnaire was high (Table 5).

【Insert Table 5 about here】

3.3.3 Convergent Validity

The T values of all the research items were between 10.06 and 21.36, indicating that all observation items significantly represented latent variables.

3.3.4 Discriminant Validity

We based discriminant validity testing on the method of Anderson and Gerbing (1988). If the chi-square ($\chi2$) value of the difference between the restricted model and the non-restricted model ($\Delta\chi2$) is greater than 3.84, the discriminant validity of these two dimensions is good. Because the chi-square value ranged from 17.40 to 129.13, the discriminant validity of the questionnaire was good (Table 6).

【Insert Table 6 about here】

3.5 Research Hypotheses

We used maximum likelihood estimation to estimate the theoretical model of γ and β, and to test whether the hypotheses were significantly supported. The sample size should be between 100 and 150 when using the maximum likelihood estimation method to estimate a structural model (Ding et al., 1995). The sample size in this study was 374, meeting the sample-size requirements. The test results are shown in Table 7. Based on the structural model, the research results are described as follows:

(1) Relationship between CSCVI and SCCs

Table 7 shows that CSCVI and SCCs were significantly correlated ($\gamma 11 = 0.67$, $p < .05$), indicating that CSCVI has a direct influence on SCCs. Therefore, H1 was supported.

(2) Relationship between CSCVI and firm performance

Table 7 shows that CSCVI and firm performance were significantly correlated ($\gamma 11 = 0.36$, $p < .05$), indicating that CSCVI has a positive influence on SCCs. Therefore, H2 was supported.

(3) Relationship between SCCs and firm performance

Table 7 shows that SCCs and firm performance were significantly correlated ($\beta 21 = 0.42, P < 0.05$), indicating that SCCs have a direct influence on firm performance. Therefore, H3 was supported.

(4) The relationships among CSCVI, SCCs, and firm performance

The total and indirect effects according to LISREL 8.80 are shown in Table 7. The total effect of CSCVI on firm performance was 0.64, and the indirect effect was 0.28 ($p < .05$), as shown in Tables 4-10. According to the results, the relationship between CSCVI and firm performance is partially mediated by SSCs. Therefore, H4 was supported.

【Insert Table 7 about here】

3.6 Total and indirect effect

In this case, SCCs mediate the relationship between CSCVI and firm performance. Therefore, H4 was supported (Table 8).

【Insert Table 8 about here】

【Insert Fig. 3 about here】

3.8 Supply chain echelon (moderating effect)

We referenced Brockman and Morgan (2006) and used multi-group analysis to test whether the supply chain echelon has a regulatory effect on the theoretical models. In the supply chain echelon, SCCs and firm performance ($\triangle\ \chi2$ = 16.35) were significantly correlated. In the supply chain echelon, CSCVI and SCCs exhibited a non-convergence effect. Therefore, the data were not statistically useful. Supply chain collaboration in value innovation and firm performance was also correlated at a less than significant level, $\triangle\ \chi2$ (Table 9).

【Insert Table 9 about here】

According to this path, SCCs had a significant moderating effect on firm performance. Upstream, midstream, and downstream parameter estimates were 0.48, 0.14, and 0.94, respectively, indicating that the downstream estimates are higher than the upstream and midstream estimates (Table 10).

【Insert Table 10 about here】

4. Research results and implications

4.1 Research results

Based on theoretical studies and developing assumptions, we proposed research architectures and hypotheses. Our detailed statistical analyses elucidate the examination outcomes, as shown in Table 11.

【Insert Table 11 about here】

4.2 Implications

Our study results demonstrate that CSCVI has a positive effect on SCCs. This result is similar to that of Simatupang and Sridharan (2005). In the upstream, midstream, and downstream supply chain of the Taiwan TFT-LCD industry, a high degree of CSCVI improves the supply chain.

Our results show that CSCVI has a positive effect on firm performance. This means that a higher level of CSCVI results in more favorable firm performance. This can help firms create sustainable business. The result is similar to that of Sounder (1988), who indicated that innovation involves developing new high-risk ideas with high-profit potential.

SCCs have a positive effect on firm performance. This indicates that a TFT-LCD firm with good SCCs has a high level of firm performance. This result is consistent with those of Morash et al., (1996) and Lynch et al., (2000), who proposed that SCCs are divided into supply-driven process capabilities and demand-driven value-added capabilities.

SCCs are a crucial variable affecting CSCVI and firm performance. Therefore, we suggest that the TFT-LCD industry improve SCCs to improve business performance.

Previous studies have examined the correlations among CSCVI, SCCs, and firm performance. However, studies focused on the moderating effect of multi-echelon supply chains (upstream, midstream, and downstream) are scant. By investigating the moderating effect of the supply chain echelon, we show that CSCVI has a moderating effect on SCCs and firm performance in the upstream, midstream, and downstream echelons of the TFT-LCD industry.

Because of the multi-echelon supply-chain-moderating effect on the TFT-LCD industry, the correlation between CSCVI and SCCs was non-significant and did not require adjustment. Therefore, H5a was not supported. This path is lower for the midstream of the TFT-LCD industry. Because the upstream supply chain manages key raw materials and equipment, the United States and Japan hold the most control, leaving little room for price negotiation. Upstream control is difficult and indirectly affects midstream-panel factories. Establishing upstream sources with stable supplies of raw materials and stable production is the only means of control. In these cases, the regulating effect is non-significant.

The results of the multi-echelon of the supply chain-moderating effect on the TFT-LCD industry showed that the correlation between CSCVI and firm performance was non-significant and did not require adjustment. Therefore, H5b was not supported. The correlation between CSCVI and firm performance was lower in the upstream supply chain because it manages key raw materials and equipment, and the United States and Japan hold the most control. Partial manufacturing technology is also transferred by Japanese firms, resulting in easy control of certain costs and the inability to reduce costs. CSCVI for the upstream, midstream, and downstream supply chain is not easily realized in a short time, and R&D and manufacturing technology development are time-consuming processes that affect performance.

The results of the multi-echelon supply chain-moderating effect on the TFT-LCD industry showed a significant correlation between SCCs and firm performance that required adjustment. Thus, H5c was supported. To increase firm performance, the TFT-LCD industry must improve SCCs.

The benefit of SCI is attained through efficient linkages among various supply chain activities that are organized effectively and in which various practices are used to integrate supply chains. A firm pursuing the effective organization of SCM practices must focus on SCI. SCM practices that are implemented to achieve superior SCP (cost, quality, flexibility, and timeliness) require internal cross-functional integration within a firm and external integration with suppliers or customers to be successful (Cagliano et al., 2006; Swink et al., 2007; Fuente et al., 2008; Nurmilaakso, 2008; Van der Vaart and Van Donk, 2008). Therefore, the level and effectiveness of SCI influences firm success in achieving the intended results of SCM practices. We found that SCI in pursuit of these practices might differ in scope and emphasis. This result is similar to those of studies showing that SCI plays a strategic "lever" role in which SCM practices are used to enhance the probability of firm success (Kim, 2009).

Few previous studies on the correlations among CSCVI, SCCs, and firm performance have examined the upstream, midstream, and downstream echelons of the TFT-LCD industry. We analyzed the upstream, midstream, and downstream echelons of the TFT-LCD industry. To verify the correlations among CSCVI, SCCs, and firm performance, we combined both theory and substantive content, which is another crucial contribution of this study.

5. Conclusion

Most scholars concur that CSCVI is a crucial factor (Drucker, 1985; Corsten and Felde, 2005; Hitt et al., 2008). Our research results indicate that CSCVI enhances firm performance through SCCs. We suggest that the TFT-LCD supply chain industry focus on CSCVI and use SCCs to improve firm performance. Few studies on CSCVI, SCCs, and firm performance have investigated the upstream, midstream, and downstream supply chain of the TFT-LCD industry. Our study analyzed the midstream and downstream firms of the TFT-LCD industry. Finally, further testing of the moderating effect of the supply chain echelon on the TFT-LCD industry showed two non-significant paths.

Abstract

Academic and business fields have frequently examined the significance and influence of collaborative development interactions and feedback mechanisms for supply chain value innovation. Value co-creation and value constellations, which serve as innovation drivers in channel integration, are positively associated with supply chain performance. We investigated the relationships among collaborative supply chain value innovation (CSCVI), supply chain capabilities (SCCs), and firm performance by examining a case of the thin-film transistor liquid crystal display (TFT-LCD) industry in Taiwan.

Table 1 The measurement of collaboration for supply chain value innovation.

Dimensions	Items	
Information sharing (IS)	1. Current trends and future opportunities for external prediction. 2 .New customers with their own preferences. 3. Products may be used more effectively. 4. New markets and forecasts of potential demand. 5. Preference for new customers, new product development and design (functional change) change. 6. Demand for innovation of new product design parts and components (service flow). 7. The cost structure of new product design. 8. Related projects with particular expertise knowledge databases. 9. The best features of new products / Utility Engineering Solutions (Integrated Services) program. 10. New product specifications and standards.	Kim et al. (2006) & Michel et al. (2008) Simatupang & Sridharan (2005)
Decision synchronization (DS)	1. Joint planning related to the impact of potential trends on current business models and business opportunities in the future. 2. Joint redefinition of the industrial customer base and common needs. 3. Re-planning of joint function products. 4. Joint development of new products and expansion of new demand benefits. 5. Joint planning and development and design of new products or services benefits. 6. Joint planning and development benefits of new product designs or parts and components required for innovation. 7. Joint planning benefits for the development of new products, using the target cost approach.	

	8. Joint planning and analysis required for the development of new product planning, technology and knowledge. 9. Conjoint analysis and planning to provide total solution products required by technology. 10. Joint planning and designed specifications for new products.	Kim et al. (2006) & Michel et al. (2008) Simatupang & Sridharan (2005)
Incentive alignment (IA)	1. By cross-functional core team meetings, partners will open up discussions about new ideas. 2. Coordination of new business ideas will reduce revenue and the market position of suppliers and lead to potential conflict. 3. A win-win partnership is a shared vision between partners. 4. Participation in the process of innovation and the development of intellectual properties a cooperative agreement between firms to share a common way. 5. Partners reach an agreement about the overall development costs of new services. 6. Partners have a common coordinating mechanism for the introduction of new product ideas in order to save time. 7. Partners share a common coordination mechanism for the concept of target cost. This leads to new benefits resulting from the effectiveness of coordination. 8. Partners have a joint coordination mechanism to increase or reduce the cost of the development of innovative new materials. 9. Partners have a common coordinating mechanism for continuous growth through sustained revenue and profitability. This can be ensured by a close relationship between partners. 10. Partners have common coordination mechanisms for autonomy and recognition of the value of cooperation between them.	Kim et al. (2006) & Michel et al. (2008) Simatupang & Sridharan (2005)

Table 2 The measurement of supply chain capability.

Variables	Items	
Supply chain capability (SCC)	1. We are ready to simplify supply chain processes and have the strength to remove unnecessary or duplicated processes. 2. We provide high quality products and prompt delivery capacity. 3. We have good relations with customers and partners. 4. We have the ability to solve problems for customers. 5. We are capable of standardizing and unifying products and services.	Morash et al. (1996) & Lynch et al. (2000)

Table 3 The measurement of firm performance.

Variables	Item	
Firm performance (FP)	Financial Performance (FP) 1. Growth of the company's profit rate. 2. Operating costs down. 3. Enhance the company's overall competitive position. Business Performance (BP) 4. To increase market share of products. 5. To increase product sales growth rate. Customer Value (CV) 6. Products to increase customer satisfaction. 7. New products to meet the changing demands of custome requirements. 8. New products to meet the needs of customers from different industries.	Venkartraman & Ramanujan (1986) & Tracey et al. (2005)

Table 4 Confirmatory factor analysis.

Index	The collaboration for supply chain value innovation	Supply chain capabilities	Performance
(GFI)	0.90	0.99	0.99
(SRMR)	0.05	0.02	0.02
(RMSEA)	0.07	0.05	0.06
(NNFI)	0.97	0.99	0.99
(CFI)	0.98	1.00	1.00
(Normed Chi-Square)	2.90	1.99	2.14

Table 5 Reliability analysis.

Variable name	Dimension	Cronbach's α	
		Dimension	Variable
The collaboration for supply chain value innovation	Information sharing	0.786	0.921
	Decision synchronisation	0.871	
	Incentive alignment	0.815	
Supply chain capabilities	Supply chain capabilities	----	0.793
Performance	Financial Performance	0.765	0.876
	Business Performance	0.843	
	Customer Value	0.757	

Table 6 Discriminant validity.

	Model	χ2	DF	Δχ2
The collaboration for supply chain value innovation	Non-restricted model	336.90	116	--
	Information sharing – Decision Synchronisation	413.47	117	76.57*
	Information sharing – Incentive alignment	466.03	117	129.13*
	Decision Synchronisation-Incentive alignment	423.73	117	86.83*
Performance	Non-restricted model	12.84	6	--
	Financial Performance- Business Performance	30.24	7	17.4*
	Financial Performance – Customer Value	84.62	7	71.78*
	Business Performance – Customer Value	78.33	7	65.49*

Note.1：Δχ2 = Restricted model χ2—Non-restricted model χ2。

Note2：>3.84 good

Table 7 Path variables.

Path	Parameter estimate	Standard error	T Value	Hypotheses	Result
The collaboration for supply chain value innovation → Supply chain capabilities	0.67*	0.07	9.03	Positive	Supported
The collaboration for supply chain value innovation → Firm performance	0.36*	0.08	4.46	Positive	Supported
Supply chain capabilities → Firm performance	0.42*	0.09	4.58	Positive	Supported
Note 1: □T □□1.96 , *p 0.05 level。					

Table 8 The total and indirect effect.

	Variable name	Effect	Supply chain capabilities		Firm performance	
			Effect	T Value	Effect	T Value
Exogenous Variable	The collaboration for supply chain value innovation	Direct effect	0.67	9.03	0.36	10.80
		Indirect effect	----	----	0.28**	4.45
		Total effect	0.67	9.03	0.64	
Endogenous Variable	Supply chain capabilities	Direct effect	----	----	0.42	4.58
		Indirect effect	----	----	----	---
		Total effect	----	----	0.42	4.58

Table 9 Supply chain echelon (moderating effect).

Path	Chi-square	Df	□χ2
No limit	163.60	72	
The collaboration for supply chain value innovation - Supply chain capabilities	189.04	74	25.44
The collaboration for supply chain value innovation - Firm performance	164.50	74	0.9
Supply chain capabilities -Firm performance	179.95*	74	16.35

Noted 1: The collaboration for supply chain value innovation - Supply chain capabilities: No convergence.
Noted 2: The supply chain collaboration in value innovation -Firm Performance: No need to adjust.
Noted 3: Supply chain capabilities -Firm performance: Need to adjust.

Table 10 Path limit.

	Up Stream		Middle Stream		Down Stream	
	Estimates	T value	Estimates	T value	Estimates	T value
The collaboration for supply chain value innovation - Supply chain capabilities	1.59	3.78	0.58	3.95	0.88	5.21
The collaboration for supply chain value innovation - Firm performance	0.27	0.63	0.41	2.98	0.67	3.10
Supply chain capabilities -Firm performance	0.48	1.88	0.14	1.09	0.94	3.84

Table 11 The validation results of research hypotheses.

Hypothesis	Verify situation	Results
Hypothesis 1: The collaboration for supply chain value innovation has a positive influence on supply chain capabilities	The collaboration for supply chain value innovation has a positive influence on supply chain capabilities	Supported
Hypothesis 2: The collaboration for supply chain value innovation has a positive influence on firm performance	The collaboration for supply chain value innovation has a positive influence on firm performance	Supported
Hypothesis 3: Supply chain capabilities have a positive influence on firm performance	Supply chain capabilities have a positive influence on firm performance	Supported
Hypothesis 4: The collaboration for supply chain value innovation affects firm performance through supply chain capability	The collaboration for supply chain value innovation affects firm performance through supply chain capability	Supported
H5: Supply chain echelon has a moderating effect on the collaboration for supply chain value innovation, supply chain capabilities and firm performance	Supply chain echelon has a moderating effect on the collaboration for supply chain value innovation, supply chain capabilities and firm performance	Partial supported
H5a: Supply chain echelon has a moderating effect on the collaboration	Supply chain echelon does not have a moderating effect on the	Not supported

for supply chain value innovation and supply chain capabilities	collaboration for supply chain value innovation and supply chain capabilities	
H5b: Supply chain echelon has a moderating effect on the collaboration for supply chain value innovation and firm performance	Supply chain echelon does not have a moderating effect on the collaboration for supply chain value innovation and firm performance	Not supported
H5c: Supply chain echelon has a moderating effect on supply chain capabilities and firm performance.	Supply chain echelon has a moderating effect on supply chain capabilities and firm performance	Supported

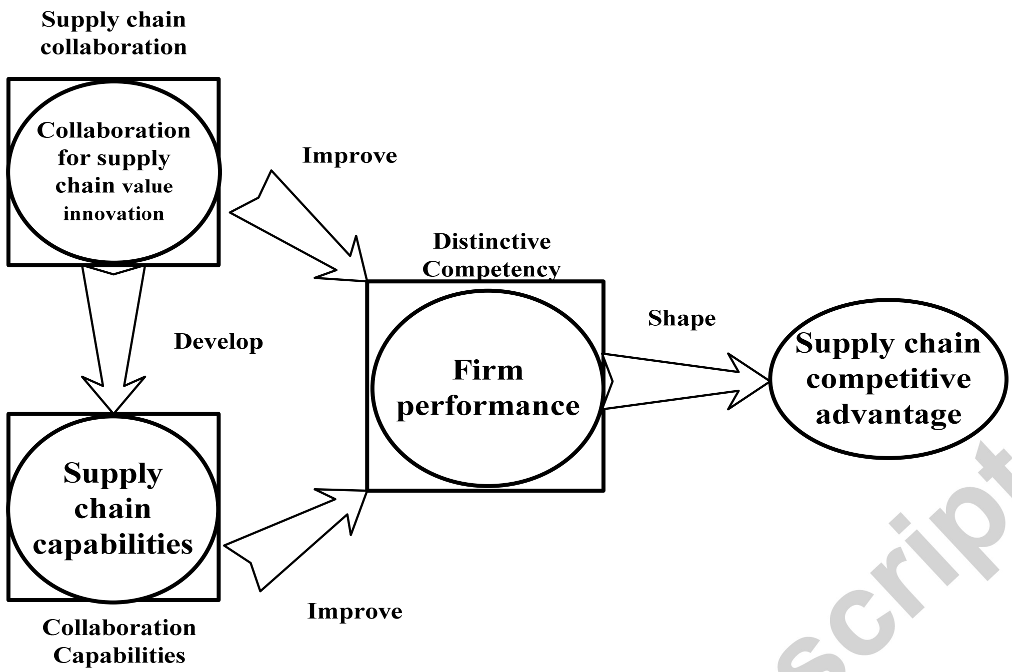


Fig. 1 Conceptual framework.

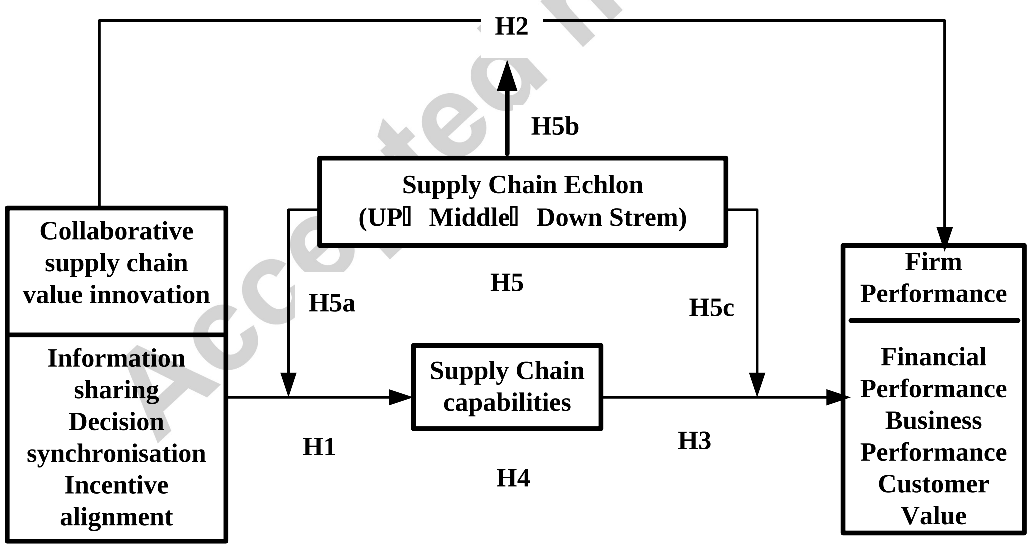
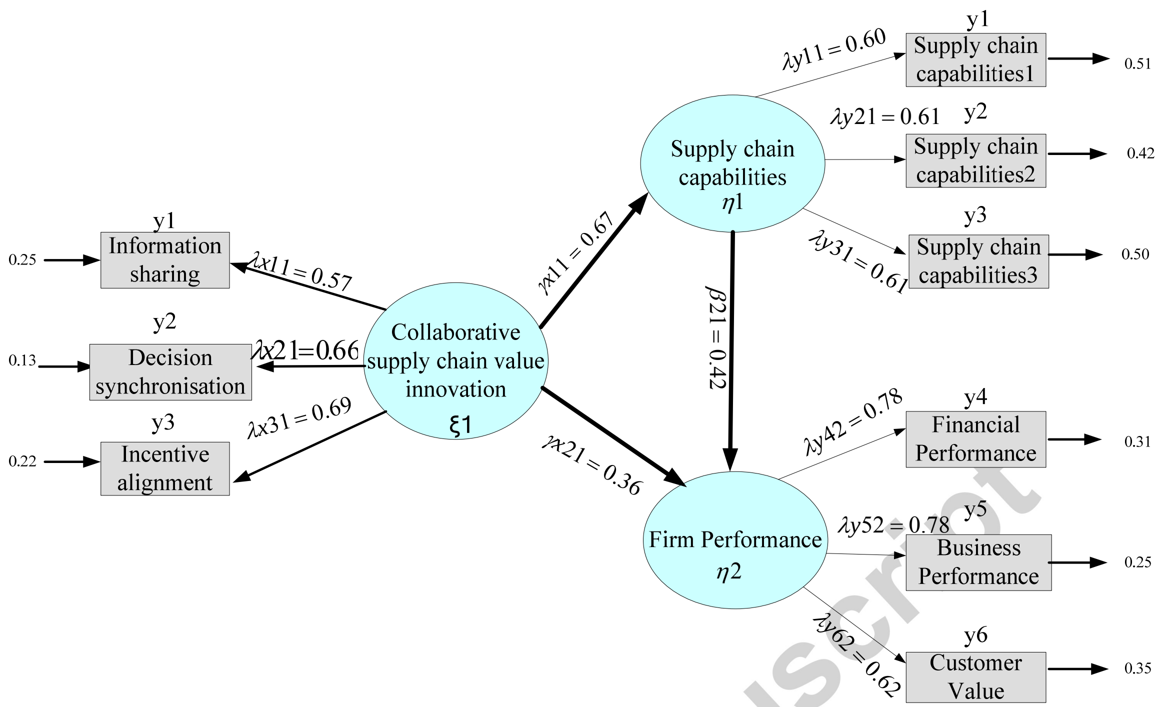


Fig. 2. The research framework.



Chi-Square=107.38, df=24, P-value=0.00000, RMSEA=0.097

Fig. 3. Path diagram.

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