Research paper

Supply chain flexibility in an uncertain environment: exploratory findings from five case studies

Candace Y. Yi
Institute of Textiles and Clothing, The Hong Kong Polytechnic University, Kowloon, Hong Kong

E.W.T. Ngai
Department of Management and Marketing, The Hong Kong Polytechnic University, Kowloon, Hong Kong, and

K-L. Moon
Department of Clothing and Textiles, Hanyang University, Seoul, South Korea

Abstract

Purpose – The objective of this paper is to illustrate and examine the different flexibility strategies adopted by supply chain participants as a result of different environmental uncertainties.

Design/methodology/approach – An exploratory multi-case study, involving five Chinese companies in the textile and apparel industry, was conducted.

Findings – The analysis, based on the supply chain literature, reveals that the unpredictable dynamics of the supply chain can arise from a variety of internal and external sources, including suppliers, operating systems, customers, and competitors. In response to the various environmental uncertainties and risks in the supply chain, four types of flexibility strategy are identified in our case analysis: laggard, conservative, agile, and aggressive. The results also suggest that the adoption of flexibility strategies should match a firm's business environment and that better supply chain responsiveness can be achieved in two ways: by reducing uncertainties and by improving supply chain flexibility.

Research limitations/implications – The key limitation of the study is that it focuses solely on the textiles and clothing industry, which makes it difficult to generalize the results to other industries. Another difficulty arises from the subjective criteria employed in some constructs, such as the perceived aggressiveness of competition, the predictability of customer demand, and the designations of companies in the proposed strategy categories.

Practical implications – The proposed theoretical framework can assist managers in properly diagnosing and deploying supply chain flexibility strategies. The actions identified for promoting supply chain flexibility can also be used to assess the various options for exploiting or acquiring flexibility strategies.

Originality/value – Expanding on the previous research approach of examining flexibility strategies from the perspective of a single firm, this study draws on the multi-case approach to posit a series of propositions that link the adoption of specific supply chain flexibility strategies to various environmental conditions in a supply chain context and proposes a conceptual framework to illustrate how supply chain responsiveness can be improved in today's volatile market environment.

Keywords Supply chain management, Garment industry, Managers, China

Paper type Research paper

1. Introduction

With the proliferation of product varieties and the increased volatility of the global marketplace, uncertainty is now an important feature of the contemporary business environment. For instance, in the fast- or high-fashion industry, product ranges and styles are being constantly renewed; while in the basic apparel industry, long production and distribution lead times continue to be found. To cope with various uncertain issues, many firms are now restructuring their operational processes to better manage

The current issue and full text archive of this journal is available at **www.emeraldinsight.com/1359-8546.htm**

Supply Chain Management: An International Journal
16/4 (2011) 271–283

[DOI 10.1108/13598541111139080]

The authors are grateful for the support of The Hong Kong Polytechnic University in carrying out this project as well as for the constructive comments of the two referees on the earlier versions of this paper.

Received: March 2011
Accepted: March 2011

Supply Chain Management: An International Journal
Volume 16 · Number 4 · 2011 · 271–283

their environmental dynamics and to achieve competitive priority.

Flexibility represents the capability of a firm to respond to unanticipated environmental changes in its production process and in the marketplace. Manufacturing flexibility, which is one of the major competitive weapons for manufacturers in today's increasingly turbulent market (Beamon, 1999; Oke, 2005), has been well acknowledged and studied in previous research. However, as more participants become involved in the supply chain environment, including various suppliers, manufacturers, distributors, and customers, the relationships among them are becoming increasingly complicated. As a result, there are more sources of uncertainty to be dealt with, such as supplier lead time, market demand, product quality, and information flow. Despite these changes, there is a lack of research on the nature of supply chain flexibility (SCF). In particular, the relationship between flexibility strategies and environmental uncertainties has yet to be fully acknowledged.

This study attempts to fill this research gap by examining various SCF strategies. Specifically, we initiate two research questions:

1 What is the relationship between flexibility strategies and environmental uncertainties in the supply chain context?
2 How can supply chain responsiveness be improved in today's fast-moving environment?

To answer these questions, we adopted a multi-case approach using five companies in the textile and apparel industry in Mainland China. By observing the actual functioning of the industry, we ascertained four dimensions of flexibility, namely sourcing, operating system, distribution and organizational; and by examining the strategic measures these companies adopted to respond to perceived supply chain uncertainties, we further identified four flexibility strategies, namely conservative, laggard, agile, and aggressive. Following this, we posit a series of propositions linking the adoption of SCF strategies to various environmental conditions and propose a conceptual framework to illustrate how supply chain responsiveness can be improved. This framework can help corporate decision-makers and supply chain managers enhance their understanding of flexibility strategies from the supply chain perspective and shape the ways they used to manage their supply chains.

The rest of this paper is organized as follows. Section 2 provides a review of the literature on SCF and Section 3 presents the research design and data collection. Section 4 outlines the empirical evidence from five cases while Section 5 develops a set of propositions and a conceptual framework. The final section, summarizes the main findings of the study, describes the theoretical and managerial implications, and proposes directions for further research.

2. Literature on supply chain flexibility

Many studies have investigated the performance impact of environment-strategy consistency (e.g. Prescott, 1986; Swamidass and Newell, 1987; Venkatraman and Prescott, 1990). Although various conclusions have been drawn as to the effect of different environments on organizational performance, there is evidence that, in specific situations, those firms that align their internal and external environments perform better than those that do not (Pagell and Krause, 1999).

"Flexibility" has been researched from the perspectives of economic (Lavington, 1921; Jones and Ostroy, 1984; Devereux and Engel, 2003) and organizational (Burns and Stalker, 1961; Boynton and Victor, 1991; Golden and Powell, 2000) for years. In the area of operations management, flexibility was initially proposed to help managers deal with unexpected changes in manufacturing systems, such as equipment breakdowns, variable task times, queuing delays, and reworks (Sethi and Sethi, 1990). In this regard, flexibility signifies the ability to reconfigure a manufacturer's resources to improve both productivity and quality.

As a result of the increasingly globalized marketplace, inter-firm competition now extends to supply-chain competition. As this demands the cooperation of upstream suppliers and downstream distributors, the concept of flexibility needs to be expanded from manufacturing to include supply chain scenarios. A number of studies have addressed the need to reduce the risk in supply chains that contain environmental uncertainties, such as Wernerfelt and Karnani (1987), Caputo (1996), Sanchez and Heene (1997), van der Vorst *et al.* (1998), Pagell and Krause (1999), Childerhouse and Towill (2004), Bhatnagar and Sohal (2005), Sawhney (2006), Avittathur and Swamidass (2007) and Stevenson and Spring (2007). These studies can generally be classified into two main streams: those aiming to reduce uncertain conditions and those aiming to accept and withstand uncertainty.

The first stream aims to improve the performance of the supply chain by reducing or, in some cases, eliminating uncertain conditions (e.g. Caputo, 1996; van der Vorst and Beulens, 2002; Childerhouse and Towill, 2004). Ho *et al.* (2005) apply e-commerce solutions to increase coordination and resource integration among supply chain partners, reduce potential risks, and monitor and assess the performance of the supply chain. Drawing from the postponement strategy for demand uncertainty, Mo (2002) proposes a hybrid postponement strategy that allows for stocks of both finished goods and generic products. All of these studies further suggest that various management mechanisms, such as effective coordination among partners or the application of information technology, are capable of eliminating uncertainties in the supply chain.

In contrast, the second stream of studies proposes the adoption of flexible management strategies to accept and withstand uncertainties in the supply chain. Considerable research has been carried out on the relationship between flexibility and environmental uncertainty and between flexibility and firm performance (e.g. Pagell and Krause, 1999; Vickery *et al.*, 1999; Bhatnagar and Sohal, 2005; Ebben and Johnson, 2005; Sánchez and Pérez, 2005; Ketokivi, 2006; Sawhney, 2006). After examining five components of SCF, Vickery *et al.* (1999) found that the key responses to marketing and product uncertainty are volume flexibility and launch flexibility, and that there is a positive relationship between a firm's performance and the flexibility of the supply chain. In another study, Avittathur and Swamidass (2007) investigate how a flexible relationship between a manufacturer and its suppliers affects profitability. Their most notable finding is that, while greater or at least average profitability is achieved when a plant's strategy for flexibility matches that of its suppliers, a mismatch between the flexibility of the plant and the supplier will result in below-average profitability.

Supply Chain Management: An International Journal
Volume 16 · Number 4 · 2011 · 271–283

In summary, these studies provide a general understanding of how flexibility can serve as a mechanism to enable companies to deal with dynamic, unpredictable market situations and achieve competitive priority in an uncertain environment.

Although a comprehensive and widely accepted theoretical framework has yet to be developed, previous studies have contributed to the theoretical exploration of a unified theory of flexibility (Sethi and Sethi, 1990; Toni and Tonchia, 1998; Sawhney, 2006). Furthermore, these studies provide valuable experiences through their examination of whether specific dimensions of flexibility are significant in improving a firm's performance and customer satisfaction. However, one major restriction of the literature is that most of the studies are confined to a single firm and thereby neglect the other important processes in, and aspects of, the supply chain, such as sourcing and distribution. As the frameworks for flexibility employed in these studies are unable to include the multiple interdependencies that exist among supply chain partners, their proposed options are less applicable to supply chain managers and researchers.

A further limitation of the previous research is that flexibility strategies are generally regarded as defensive adjustments to unpredictable uncertainties. As Gerwin (1993) states, flexibility is not just an adaptive response to an uncertain environment, it can also act as a proactive function by creating uncertainties that other competitors are unable to deal with. Despite this recognition of the dual purpose of flexibility strategies, little work has been done to synthesize these competing uses to provide supply chain managers with a diagnostic tool to assess supply chain strategies. In this study, we advance the theoretical understanding of SCF by identifying the generic and specific supply chain management strategies adopted in response to perceived uncertainties and risks.

3. Research methodology

Owing to the exploratory nature of our research, the case study design was considered to be an appropriate methodology (Yin, 2003). A qualitative case study captures the reality of a given situation in substantial detail and is particularly useful when a natural setting or a focus on contemporary events is required. Inevitably, this approach has been criticized for having a limited capacity for scientific generalisation (Scapens, 1990). However, it can be argued that the objective of qualitative research is to refer back to a theory or application rather than to draw inferences about some larger population (Yin, 2003). Furthermore, as we aimed to develop a systemic perspective on the flexibility strategies adopted in different situations, cases with differing backgrounds and configurations were needed to observe the differences in the phenomena under study and their relevance.

In this study, we collected data exclusively from five companies in the textile and apparel industry in Mainland China through in-depth personal interviews. We selected our sample firms from China because of China's importance to the global textile and clothing trade, particularly its enormous export value (World Trade Organization, 2007) and market size (Fong and Dodes, 2006). We used face-to-face interview approach as this provided us the opportunity to probe beyond initial responses, resolve ambiguities, and even overcome any unwillingness to answer particular questions (Yin, 2003). Though there are no precise guidelines as to the number of cases that should be included in this type of study, the widest accepted range falls between two and four as the minimum and 10 and 15 as the maximum (Perry, 1998). We chose five as this number falls into the middle band of the recommended range.

One important criterion in a case study is that the sample units need to cover the object of interest and its context, thus to yield a larger number of potentially relevant variables (Yin, 2003). In this regard, this study selected companies that represent various participants in the supply chain, including a fabric manufacturer (Company E), a garment manufacturer (Company A), two trading companies (Companies C and D), and a brand company (Company B). This wide diversity in the sample increases the possibility of generalizing the results and exploring patterns within the industry. Indeed, the firms selected meet the diversity requirements in terms of SCF, as they range from the highly volatile and uncertain sector of fashion apparel to the relatively stable sector of fabric and textiles. Thus, the information provided by these companies is capable of supporting the development of our initial set of propositions and the conceptual framework. The profiles of the participating companies are shown in Table I.

The participants in this study were product managers, general managers, supply chain managers, and other executives who possessed relevant knowledge of the textile and clothing industry. Personal interviews were arranged in the length of one to two hours and used the focused interview format, in which the interviewer follows a set of predetermined questions (see Appendix). Even so, the interviews still remained fairly open-ended to allow the interviewees to express their opinions on and insights into certain issues. With the permission of the participants, the interviews were recorded on audiotape while the interviewer made hand-written notes. If any questions were not answered satisfactorily, follow-up telephone interviews were undertaken for further clarification. All of the interviewees were sent organized minutes of the interview via e-mail to enable them to check for errors and to evaluate the validity of our interpretation and description. Any errors were duly corrected. In addition, secondary data were also collected from published information, company documents and company web sites to provide background and context for the primary research data gathered from the interviews.

After a full transcript of the interviews was compiled and edited by the research team and confirmed by the interviewers, a further review was conducted. The three researchers of this study jointly discussed the transcript to identify the key themes relating to the research topic under study. These themes are presented and discussed in Sections 4.1.1 and 4.1.2. Following this, the interview transcripts, notes, and secondary materials were integrated to identify the relationship between adopted strategic measures and perceived environment uncertainties in a textile and apparel supply chain. These findings are discussed in Section 4.2. The quality, accuracy, and correctness of the transcript contents were verified by an independent researcher. This comprehensive documentation process enhances the validity of the data and strengthens the grounds of theory (Yin, 2003).

Table I Background information on the companies in the exploratory study

	Companies				
	A	B	C	D	E
Nature of business	Manufacturer	Brand marketer	Trading company	Trading company	Manufacturer
Product sector	Knitwear	Knitted underwear	Fabric and garments	Fabric and household textiles	Fabric
Turnover (2008, approx.) (USD)	7 million	1 million	50 million	200 million	6 million
Geographic markets served	North America and Europe	Mainland China	Korea and Japan	USA	North America, Europe and Asia
Approximate number of employees	1,300	100	30	50	1,500

4. Findings and discussion

Empirical findings from the five case studies are discussed in this section, which is organized into three subsections – empirical observations, strategic measures in response to environmental uncertainties, and nature of supply chain flexibility strategies.

4.1 Empirical observations

Key empirical observations were made regarding each company's responses to the uncertainties they encountered and the strategic measures they adopted to deal with these uncertainties.

4.1.1 Environmental uncertainties in the supply chain

According to Matson and McFarlane (1999), uncertain changes occurring "internally or externally in a production system" can in turn affect "operational performance that is either outside its control or has not been planned by the system". van der Vorst and Beulens (2002) further describe the concept of supply chain uncertainty as a decision making situation in which "the decision maker does not know definitely what to decide as he is indistinct about the objectives, lacks information about (or understanding of) the supply chain or its environment, lacks information processing capacities, is unable to accurately predict the impact of possible control actions on supply chain behavior, or lacks effective control actions (non-controllability)"

Based on this description, we asked each of our case companies to report any supply chain uncertainties they encountered in their daily operations. As shown in Table II, these uncertainties were categorized into three classes according to their nature and source, namely demand, supply, and competition. This classification advances the previous research by highlighting the effect of competition on the supply chain. As Davis (1993) points out, it is essential to consider and cope with the uncertainties that are propagated through a manufacturing network from the supply chain perspective. Because the textile and clothing industry is perceived to be fiercely competitive, the uncertainties that arise from competitors are considered to be important factors within the supply chain.

In the case analysis, the three most frequently mentioned uncertainties were emergent orders, cost, and the aggressiveness of the competition. The relevant examples provided by the case companies show that emergent orders mainly arise from the unpredictable demands of customers due to fashion trends, seasonality, or the accuracy of demand forecasts. Filling an emergent order requires an efficient response from the entire supply chain; that is, from suppliers to manufacturers and to deliverers. As the textile and clothing industry is profit-vulnerable, cost is also perceived to be an essential supply uncertainty. All of the interviewees stated that their companies are sensitive to cost. If customer demands for quality and time are satisfied, companies will take all possible measures to save on costs. As a result of aggressive competition, caused by low barriers to new entry and low profit margins, most of our interviewees felt that competition uncertainties challenged their company's survival. Yet, interestingly, none of them considered low cost and price to be a competitive advantage. Instead, adding flexibility to operating systems or organizations, including widening the range of new products or introducing new technologies, was perceived to be a main source of competitive advantage.

While uncertainties relating to demand and competition were consistently perceived as the most prevalent and difficult to deal with, uncertainties relating directly to suppliers seem to have had less influence on our case companies. This can be partly explained by the features of the apparel industry that the global apparel trade is a typical consumer-driven industry characterized by rigorous competition, which means that buyers from either manufacturers or brand companies generally have greater negotiating power than suppliers. Consequently, our case companies tended to use this to their advantage and to break cooperative norms with their suppliers.

4.1.2 Strategic measures in response to environmental uncertainties

Supply chain management covers raw material and component sourcing, product manufacture and assembly, warehousing and inventory tracking, order entry and management, distribution and delivery, as well as the information systems necessary to monitor these activities. A complete definition of SCF should include an understanding of the strategic measures adopted by supply chain participants to successfully meet customer demand (Duclos *et al.*, 2003).

Table III summarizes the strategic measures used by the case companies to respond to perceived uncertainties and presents relevant examples provided by the interviewees. These measures have been further categorized in view of their nature and according to their corresponding place in the supply chain into four dimensions of flexibility, namely sourcing, operating system, distribution, and organizational (Swafford *et al.*, 2006; The Supply Chain Council, 2006).

The first dimension, sourcing flexibility, is defined here as the availability of sources of qualified materials and services, and the ability to implement effective purchasing processes to respond to changing requirements. In general, sourcing activities are the pre-activities of an enterprise's core business that provide crucial links between suppliers and manufacturers, and are responsible for the upstream procurement of qualified materials, components, products,

Table II Summary of case study results on perceived environmental uncertainties

Perceived uncertainties	Cases involved	Example from cases	Nature of uncertainty
Emergent order	All	"Compared with a general order that has a lead time of half a year, the lead time of an emergent order is as short as two months from supplier selection to our customer receiving the garments. Sometimes this is really a challenge for us" (Company A)	Demand uncertainty
Product forecast error	Companies A, B, and E	"It is not easy for us to make demand predictions, especially in a new developing market, in which our agents and retailers cannot provide us with accurate product information as they do not understand the customers' tastes and demands very well" (Company E)	Demand uncertainty
Product deterioration	Companies A and C	"Some of our products with Korean or Japanese styles are fashionable garments with a short product cycle, and we need to do all we can to reduce the lead time." (Company C)	Demand uncertainty
Reliability of material quality	Companies C and D	"The product quality of our suppliers is sometimes not as good as those of overseas suppliers due to our suppliers' equipment or technologies. Quality control is therefore vital when selecting suppliers" (Company D)	Supply uncertainty
Lead time of suppliers	Companies A, C, D, and E	"When dealing with new products, especially those with new technologies in knitting, weaving, or materials, our suppliers may find it difficult to fulfill the order on time" (Company A)	Supply uncertainty
Responsiveness of suppliers	Company A	"The failure of our suppliers to provide us with the required materials on time will affect our production process accordingly." (Company A)	Supply uncertainty
Material cost	All	"The cost of our materials increased greatly this year. As a whole, the profit of our industry is becoming lower than ever. Some of our suppliers and competitors are even said to be almost in a losing proposition" (Company D)	Supply uncertainty
Low entry barrier	Companies A, B, and E	"The entry barrier is low in our industry. New competitors keep on emerging" (Company E)	Competition uncertainty
Aggressiveness of competition	All	"Generally speaking, our industry is characterized by the fierce competition. Even our long-term relationships with customers may be disrupted if we cannot always satisfy their demands" (Company A)	Competition uncertainty

or services to support material requirements (Lummus *et al.*, 2003; Swafford *et al.*, 2006). The second dimension, operating system flexibility, is defined as the ability to exploit the resources obtained to provide a range of products and services that respond effectively to changing requirements. This dimension is concerned with the provision of qualified products in numerous features, mixes, and volumes to meet various customer specifications (Sethi and Sethi, 1990; D'Souza and Williams, 2000; Koste *et al.*, 2004). Distribution flexibility, the third dimension, refers to the ability to adapt and effectively control the flow and storage of materials, components, finished goods, and services in response to dynamic market conditions (Duclos *et al.*, 2003; Swafford *et al.*, 2006). Finally, organizational flexibility refers to an organization's structures and systems of managing and controlling its capacity, especially in situations of unexpected disturbance (Lee, 2000; Duclos *et al.*, 2003; Swafford *et al.*, 2006).

4.2 The relationship between strategic measures and environmental uncertainties

This subsection summarizes the strategic measures adopted by our case companies in terms of the four flexibility dimensions and identifies their corresponding relationship to each class of environmental uncertainty in a supply chain. The results are shown in Table IV, in which a company code appearing in a specific cell means that that company considers the strategic measures adopted in the flexibility dimension to be important in relation to the corresponding specific supply chain uncertainty.

It is notable that most of the strategic measures were initially employed as efficient expediencies for multiple purposes. For example, one perceived advantage of building partnerships with multiple suppliers (sourcing flexibility) is that it helps companies to gain competitiveness in both cost and quality (competition uncertainty). However, this strategy also provides access to backup suppliers that can be called upon in case of emergencies (supply uncertainty or demand uncertainty). Another notable point is that the enactment of many of the strategic measures is usually affected or driven by external dominant companies. For example, the scheduling of a production plan is dependent on the buyer's request of make-to-order or make-to-stock.

The data collected in this study do not afford us the ability to make any claims about which tactics are more successful than others. Consequently, we cannot draw normative conclusions from Table IV. However, valuable managerial implications can be obtained by examining the variety in and interactions among the strategic measures presented.

Of the four flexibility dimensions, strategic measures relating to sourcing flexibility and operating system flexibility are most widely adopted. As shown in Tables III and IV, all of the companies interviewed engage in particular activities related to these two dimensions. For example, all of the companies have formed cooperative relationships with multiple suppliers, implying that close attention has been paid

Table III Summary of case study on strategic measures of supply chain flexibility

Strategic measures	Cases involved	Example from cases	Nature of flexibility
Availability of multiple suppliers	All	"We should always be familiar with the features and advantages of each of our various suppliers so that in cases of emergent orders we can get reliable ones immediately" (Company C) "We make inquiries to more suppliers than we need and choose two or three of them as our backup suppliers with all of the details of price, lead times, and delivery schedules set beforehand. If our primary suppliers cannot fulfil our orders on time, we can then get backups efficiently" (Company A)	Sourcing flexibility
Changeover among various suppliers	Companies A, B, D, and E	"We should always be familiar with the production capabilities of our suppliers and pay special attention to their quality. If problems are found, we can change to other suppliers" (Company D) "Cost is an important factor in selecting our suppliers. We may switch to other suppliers if the existing ones cannot provide us with competitive prices" (Company A)	Sourcing flexibility
Adjustment of production	Companies A, B, and E	"To eliminate slack capacity in off-season or overload in peak season, production has to be well-assigned and -adjusted according to company's competency and the market demand" (Company A)	Operating system flexibility
Availability of sub-contractors	Companies A, C, and E	"We use sub-contractors if we cannot fulfill an order on time" (Company A) "Sometimes sub-contractors are also adopted to improve our efficiency of performing emergent tasks" (Company C)	Operating system flexibility
New product development	All	"We always need to provide new products to satisfy our customers. We are sensitive to fashion trends" (Company C) "Compared with our competitors, we can provide more fashionable and stylish products. Our company invests a great deal in new product development, which enables our products to keep in step with fashion trends" (Company E)	Operating system flexibility
Standardized modules for multiple products	Companies A, B, and E	"We may use standardized modules of accessories (e.g. buttons, zippers, and laces), styles, or fabrics to develop more products" (Company A)	Operating system flexibility
Flexible delivery modes	Companies A, C, and E	"Sometimes we use air delivery for emergent orders, which results in an extra cost of US$2.5-3 per item of apparel" (Company A) "We prefer a connecting flight to a direct one on condition that the former can meet our customer's delivery schedule. This saves us a considerable cost" (Company C)	Distribution flexibility
Alignment of product characteristics and customer requirements	Companies A and B	"Consumers' tastes, habits and behaviour vary in different areas that affect their buying habits. Even the same individual agent or buyer can behave in different ways when buying different products. Therefore, we have to arrange various marketing and channel strategies" (Company B)	Operating system flexibility & distribution flexibility
Secure external funding for future development	Companies C and E	"With the development of our company in the past few years, we have established a good industrial reputation. Therefore, it is not difficult for us to get loans from banks to improve our production line or to introduce new machines and technology" (Company E)	Organizational flexibility
Availability of casual labor	Company A and E	"We hire casual labour in peak seasons" (Company A)	
Technology innovation	Company A	"Newly developed technology is important for us to improve the manufacturing process and save on costs, e.g. postponement can help us save on costs and excess inventory. However, it cannot be achieved without the support of information technology and innovations in knitting and dyeing" (Company A)	Organizational flexibility
Balance of the needs for proactive and responsive organizational structure	Company A	"Sales managers and production managers are familiar with the variation in production capability and demand among seasons. Communication and cooperation are important for an efficient organization to balance the needs for a proactive and responsive organizational structure" (Company A)	Organizational flexibility

Table IV Results of case analysis of flexibility dimensions and environmental uncertainties

	Flexibility dimensions			
	Sourcing	Operating system	Distribution	Organizational
Environmental uncertainties				
Demand	A, B, C, D, E	A, B, C, D, E	A, B, C, E	A, E
Supply	A, B, D, E	A, B, E	A, C	C
Competition	A, B	A, B, C, D, E	C	C, E

to the dynamics and complexities of the sourcing network. However, because these buyers hold an advantageous position, they tend to shift the pressure from their downstream customers to their upstream suppliers. Some of them even stated that they felt confident about switching suppliers if their present ones were to have any cost or quality problems, and that they felt at liberty to do so.

The tactic of improving the flexibility of operating systems was more widely adopted by manufacturers and brand companies than by trading companies. An interesting example is the case of Company A, which behaves as both an original equipment manufacturer (OEM) for several European brands and as an original brand manufacturer (OBM) for its own retail market. This company has adopted a composite strategy with regard to its operating system. For its OEM business, it has adopted a responsive and adaptive strategy. For example, it reserves certain slack capacity for rush orders or for anticipated seasonal demands at the beginning of each season. For its OBM business, in contrast, it has adopted a much more proactive and initiative-based strategy to reduce the dynamics and complexity of the supply chain. For example, it uses more standardized modules of garment accessories (e.g. buttons, zippers, and laces), styles, and fabrics in its product designs to alleviate the challenges of product line complexity. The company was also in the pilot stage of adopting a postponement strategy, originally used by Benetton (Waller *et al.*, 2000), to reduce prediction errors and inventories. Moreover, because of its familiarity with its self-owned brands and markets, the company was able to implement a flexible organizational structure that balanced the needs of both proactive and adaptive flexibility, reduced the risk of environmental uncertainties, and made substantial savings in operating costs.

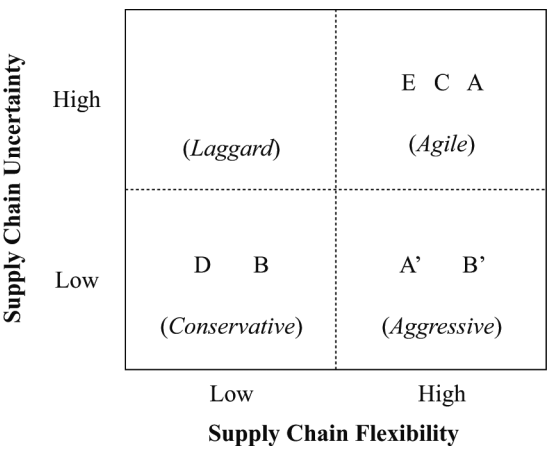
The companies under study generally regarded distribution flexibility to be of less importance than sourcing and operating system flexibility. This might be because most companies (i.e. A, B, C, and D) have outsourced their logistics to third-party logistics providers (3PL) and their selection of delivery modes and carriers is generally in accordance with their customers' requirements. Accordingly, these companies are not fully knowledgeable about how to control logistics costs and improve logistics efficiency. Nonetheless, trading companies seem to pay more attention to this dimension compared to manufacturers. For instance, Company C, a fashion apparel trading company, is highly sensitive to logistics costs. Since it is rather familiar with the situations of its customers' distribution centers and shops, it can carefully arrange flights for every shipment. In addition, it prefers to use connecting rather than direct flights to save on costs, as long as the former are able to meet its customers' delivery schedule.

The case companies also paid close attention to organizational flexibility and many important strategic measures were identified. The most frequently mentioned related to information systems, manufacturing technology innovations, and flexible organizational structures; all of which are perceived to be important enablers of SCF. For example, Company A indicated that its postponement strategy involves tactics relating to technological innovations in dyeing and finishing, the rebuilding of the manufacturing process, the application of information technology to supply chain management, and financial support.

4.3 Nature of supply chain flexibility strategies

As previously discussed, the characteristics of the supply chain environment require a corresponding flexibility strategy in operations management (Table IV). After analyzing the strategic measures adopted by the companies under study, an across-case comparison was conducted. This comparison is considered to be appropriate and meaningful as it provided an opportunity to determine whether one company might be more advanced than others in its adoption of flexibility strategies and to see how this advantage develops. As in Figure 1, we mapped each case according to the level of perceived supply chain uncertainty and its SCF strategies. Intensive discussions among the three researchers took place to designate the companies to their respective cells in the map. Consensus was reached on each rating to ensure the reliability of the designations. The letters A to E represent the current positions of Companies A to E in the matrix of supply chain uncertainty and SCF strategies. Because Companies A and B had already indicated their flexibility strategies for future development, A' and B' are employed to indicate their future positioning on the map.

Figure 1 Supply chain flexibility strategies



Based on the characteristic of each quadrant in Figure 1, we categorized the companies by their SCF strategies as conservative, laggard, agile and aggressive. Marked by moderation or caution in the norms of supply chain management, a conservative strategy is disposed to maintaining existing strategies and institutional structures and to making a comparatively small degree of change at a given time. Laggard refers to a SCF strategy that lags behind that of other firms in the industry. Such companies are less responsive to the changing environment and have difficulty in meeting the demands of customers and of dynamic and turbulent markets. An agile strategy involves not only responding to changing market conditions but also taking advantage of these changes to sustain competitiveness. Indeed, agile strategies enable a company to be more flexible and better able to respond to environmental uncertainties than its competitors. Finally, an aggressive strategy is not only responsive and adaptable to market dynamics, it is also initiative- and intention-focused, thereby allowing a company to exploit and create new opportunities. Compared with conservative, laggard, and agile, which can be reactive or passive, an aggressive strategy is proactive or positive.

5. Research propositions and conceptual framework

Another major objective of this study is to develop a series of propositions to illustrate the interrelationships between specific SCF strategies and various environmental conditions and to propose a conceptual framework to express how the adoption of different SCF strategies can improve supply chain responsiveness in a volatile market environment.

5.1 Development of research propositions

Based on the theory of environment-strategy consistency, we explored the causal relationship between a firm's external dynamic environment and the adoption of one of its internal strategies, SCF. The character of each SCF strategy and its involvement in our empirical observations from the case studies are further discussed in the following sub-sections, as is the reasoning behind the propositions that we posit below.

5.1.1 Conservative flexibility strategy

Companies B and D are marked by low levels of uncertainty in their supply chains. As a young company in the men's underwear industry, Company B has already outsourced all of its manufacturing, delivery, and retailing activities. Its current business is focused on the design and marketing of its products. Compared with women's underwear, which has a much higher obsolescence rate, men's underwear is characterized by fewer demand uncertainties, product varieties, and forecast errors. For Company D, the characteristics of their products and supply chain are similar to those of Company B, as it trades in staple fabrics and household textiles. In a comparative stable environment, Company D's production lead time from fabric design to dyeing and finishing and to readiness for shipping can be as long as half a year.

In view of supply chain management, both Company B and Company D have focused on maintaining their current relationships with trading partners and improving the cost efficiency of their supply chains. They are familiar with the available resources in their trade and prefer to cooperate with qualified long-term suppliers and customers. Cost and quality are their main considerations when they select suppliers. They have strived hard to eliminate non-value-added activities and to pursue economies of scale. Slow and inexpensive modes of transportation are thus adopted whenever possible for the best capacity utilization and cost savings. Certain important sale and inventory data are shared with their strategic partners; this had been identified as an effective way of reducing uncertainties and achieving a lean supply chain. Their organizational structures are designed to be efficient and tightly integrated, and information systems are established to ensure the most efficient, accurate, and cost-effective transmission of information across the supply chain (Lee, 2002). In conditions of weaker competitive intensity and fewer uncertainties, investments in flexible resources and strategic options seem to be less useful. Thus, we offer the following proposition.

P1. A low level of uncertainty in the supply chain leads to the adoption of a conservative flexibility strategy.

5.1.2 Agile flexibility strategy

Companies A, C and E face an environment containing various uncertainties arising from the supply and customer interfaces within their systems in addition to external and environmental uncertainties. For example, Company C is a fashion garment trading company and acts as an intermediary in the entire supply chain. The consumers of its products are young women in Japan and Korea aged 15 to 30 who seek to be innovative initiative-takers, aim for a striking appearance, and are highly sensitive to fashion trends. The character of these consumers determines the constantly changing and highly competitive business environment for Company C. On the other hand, Companies A and E are manufacturers serving mainly North American and European markets. These are the traditional overseas markets where uncertainties arise from the unpredictable consumer demand and keen competition of rival brands.

To deal with such dynamics, these companies have adopted an agile strategy in their supply chain management that has a number of distinguishing features. For example, all of them are located in areas with very extensive transportation networks – that is, the Pearl River Delta (Companies A and C) and the Yangtze River Delta (Company E) – which enables them to adopt multiple delivery modes with minimal lead-times to meet their customers' needs. They also retain strategic cooperative relationships with their core supply partners to avoid supply risks while developing new relationships with potential customers to further extend their business. In addition, they adopt mass customized processes in their operating systems to satisfy the small batches that their customers specifically require. Important information, such as detailed design drawings, prototype models, and production and shipment schedules, is communicated closely to their supply chain partners. Company organization is designed to be an open system, which allows these companies to react to possible fluctuations in demand. In conclusion, this leads to the following proposition.

P2. A high level of uncertainty in the supply chain leads to the adoption of an agile flexibility strategy.

Supply Chain Management: An International Journal
Volume 16 · Number 4 · 2011 · 271–283

5.1.3 Aggressive flexibility strategy

Compared with Companies C, D, and E, which have adopted specific flexibility strategies in accordance with their present supply chain environments, Companies A and B are identified as the industrial innovators in our study due to their orientations towards having more aggressive and responsive SCF strategies than their competitors. A' and B' are mapped in Figure 1 to represent their orientations towards future development. We propose aggressive as the term for this type of flexibility strategy to highlight the initiatives taken to exploit new opportunities and to reduce the dynamics and complexity of the supply chain.

Company A, which evolved from an OEM that produced functional and basic knitwear for European and American brands in the 1980s, has gradually advanced its OBM business in the past ten years by designing and producing fashion knitwear for its retail market. On the basis of the agile strategy that it has been adopted in response to the previously discussed radical changes in the supply chain, the company pays more attention to future developments, which entails reducing supply chain uncertainties while maintaining a satisfactory level of service. Its synthesized OEM and OBM strategies enable its supply chain to be more flexible than is that of its competitors that adopt single strategies. For its OEM business, Company A utilizes an agile but adaptive strategy as their manufacturing is order-initiated. For its newly developed OBM business, however, it has begun to employ a more proactive and assertive strategy. The company's strategy of postponement in manufacturing and marketing as well as standardization in design and production is helping it to alleviate product line complexity and prediction error.

As knitwear is a seasonal product with two distinct collections per year, Company A has adopted a number of measures to deal with various uncertainties. With respect to product development, for example, the company has invested heavily in producing fashionable and desirable lightweight items for its spring/summer and inter-season collections, which are expected to stabilize its production capacity. In market development, the company has focused on global markets in recent years, particularly countries in the southern hemisphere, including Australia and New Zealand. These new markets are expected to further reduce the supply chain uncertainties that are caused by seasonal demand fluctuation. Thus, we propose the following.

P3a. An aggressive flexibility strategy can be proactively adopted through restructuring a firm's operating system to reduce environmental uncertainties.

Company B has planned an even more proactive strategy for its future development. Although it is presently identified as a conservative adopter for its core men's underwear business, which faces fewer supply chain uncertainties, the company is intending to add a new e-branch business producing customized dolls. An online shopping web site is under development, on which every part of the doll and its relevant details – including color and quality of fabric, hair-style, facial expression, and posture – can be customized. Consumers can even upload their own photos to produce a unique personalized cartoon version. These completely customized products require a high degree of flexibility throughout the entire supply chain process. Consequently, Company B, which has outsourced manufacturing to external firms, is involved in restructuring the manufacturing processes that these supplier firms will use. This reform is expected to be effective, with Company B stating that the number of production processes is anticipated to be reduced from 50 to 28 with no increase in the workforce.

The development of this new business model is expected to improve supply chain performance in several ways. Because the entire project is designed to be online-order initiated, the uncertainties in the supply chain should not fluctuate greatly with demand or season. The new business will enable Company B to face its end consumers directly and to provide them with more customized products, thus greatly improving its profitability. For its outsourced manufacturers, a more efficient and responsive production line for varying levels of customer demand will be achieved through the restructuring and optimization of the manufacturing process. The selection of suppliers for this project has already been finalized, and negotiations are completed. The restructuring of the production process, website construction, and other critical issues are currently being dealt with. The pilot run will be launched next year. Based on this example, we present the following proposition.

P3b. An aggressive flexibility strategy can be proactively adopted through creating new opportunities to improve a firm's supply chain flexibility.

5.1.4 Laggard flexibility strategy

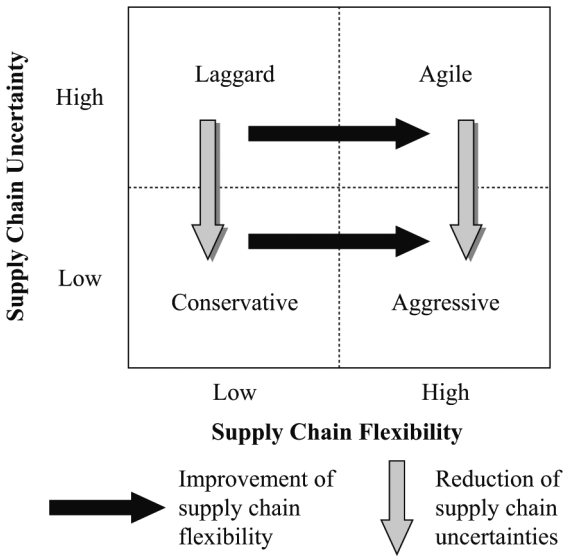
It is not surprising that none of the companies in our case study were identified as adopting a laggard strategy. Characterized as having many environmental uncertainties and a low degree of flexibility in supply chain management, this SCF strategy fails to meet the demands of the ever changing market of the textile and clothing industry and is unlikely to support an organization's survival and further development.

5.2 Development of a conceptual framework for improving supply chain responsiveness

From the cases of Companies A and B, we find that, despite the similarities in their future positioning using "aggressive" strategies, their supply chain responsiveness is expected to improve in different ways. Company A hedges risks by reducing perceived uncertainties through restructuring its operating system while also preserving favorable strategic flexibility – that is implementing postponement and standardization strategies. Company B, however, improves it SCF by aggressively creating more opportunities – that is providing more customized and flexible products and services to a new market. Through these different mechanisms, both companies respond more promptly to supply chain dynamics than their competitors.

According to these aggressive flexibility strategies adopted by Companies A and B, we propose a conceptual framework to illustrate how competitive advantages can be obtained through the improvement of supply chain flexibilities and the reduction of supply chain uncertainties. The arrows in Figure 2 depict the different directions in the exploitation of the competitive advantages of a firm for better responsiveness in its supply chain. The vertical arrow at the right-hand side represents the tactics adopted by Company A (i.e. reducing supply chain uncertainties), while the horizontal arrow at the

Figure 2 A conceptual framework for improving supply chain responsiveness



lower position represents those of Company B (i.e. improving supply chain flexibility).

Indeed, aggressive SCF strategies, such as Company A's restructuring of its operating system and Company B's provision of customized and flexible products and services, are proactive functions that aggressively reduce anticipated uncertainties and create new opportunities. In return, a firm's competitive priority can be achieved and profit margins enhanced. Nonetheless, when viewing the uncertainties and opportunities that simultaneously emerge from environmental shifts, some important factors that influence decision-making should be considered. As noted by the participants, these factors include product characteristics (e.g. basic, fashion, and seasonal products), plant capabilities (e.g. number of production lines, line capability), operational uncertainties (e.g. sales, forecasting, breakdowns, and supply), and perceived costs and benefits (e.g. material cost, labor cost, and customer satisfaction). As the aggressive flexibility strategies adopted by these two companies are still in the pilot stage, the administration and application of the two tactics need follow-up observation, analysis, and evaluation in a future study.

6. Conclusions and implications

Unpredictable dynamics in the supply chain can arise from upstream suppliers (e.g. reliability of material quality, lead-time of suppliers, responsiveness of suppliers), downstream customers (e.g. emergent orders, product forecast errors, product obsolescence), or industrial competitors (e.g. low entry barriers, aggressive competition). In today's volatile market environment, SCF is perceived to be an important competitive priority. Our study has investigated the flexibility strategies that supply chain participants adopt in response to various perceived environmental uncertainties. Four types of SCF strategy were identified according to their capacity to mediate perceived uncertainties: laggard, conservative, agile, and aggressive. Although no company in our case study adopted the laggard strategy, the other three strategies were fully examined and verified in relation to the manners in which they are practised in the marketplace. The conservative strategy highlights cost efficiency and the maintenance of an organization's existing structure and supply chain partnerships. In contrast, the agile strategy is characterized by the effective formation of business alliances, which are capable of quickly "pulling" products into the marketplace. Finally, the aggressive strategy calls for a concurrent view where uncertainties are perceived to be both risks and opportunities and new chances to respond with initiative and intention ahead of competitors are explored.

Our case study indicates the importance of firms adopting proper strategies for present and future development under specific environments. Prior to making decisions on supply chain strategy, companies must undertake a careful and comprehensive analysis of the characteristics of and potential risks in their supply chains. Companies that are coping with more highly dynamic environments need to be more agile and to enhance their flexibility capabilities; otherwise, they may be laggards that are unable to survive intense market competition. Those that deal with fewer uncertainties, however, should pay more attention to cost savings and efficiency improvements in their supply chains. If a balance between environment and strategy is achieved, a further development strategy can be considered; for instance, an aggressive strategy to advance SCF.

6.1 Theoretical implications

Academically, this study advances the flexibility literature in three significant directions. First, it expands upon the previous approach of treating a single firm as a complete system by considering collaboration and integration within the supply chain to involve both suppliers and customers. This value-chain conceptualization of flexibility strengthens the theoretical foundation required for the supply chain discipline and substantiates its strong ties to the area of operations management. Second, in contrast to prior studies, which regard flexibility as a defensive adjustment to unpredictable uncertainties, this study provides a concurrent view of reactive and proactive applications for improving supply chain responsiveness. A view that simultaneously considers environmental dynamics to be the source of both potential risks and opportunities is anticipated to promote a stream of supply chain studies that investigate in greater depth the "fit" between environment and SCF strategies. Finally, this study takes an original step forward by employing an inductive approach to identify SCF dimensions. A standardized instrument to measure the dimensions of SCF is expected to be developed on the basis of this study so as to test useable hypotheses and to communicate the results effectively. In consequent, this will enrich theory building in the area and facilitate further supply chain management research.

6.2 Managerial implications

This study also has important implications for practicing managers. First, it identifies four dimensions of SCF. Strategic measures to promote these dimensions require collaborative planning, production, and monitoring among supply chain partners and among companies' internal functional departments. The identified framework for SCF can assist operations managers in viewing and deploying the internal setup of their plants. It can also reinforce the value of

developing a close working relationship among the managers of operations, marketing, design, human resources, and the other departments involved. Second, our concurrent view of opportunities and uncertainties from the perspective of the entire supply chain provides a diagnostic tool with which managers can assess and deploy flexibility strategies. This improved understanding of SCF and the proposed framework depicted in Figure 2 will assist managers to strategically manage their supply chain and facilitate a free flow of resources to support such activities. A better match between an organization's environments and strategies can then be anticipated.

6.3 Limitations

This study has several limitations. First, all of the respondents were from the textile and clothing industry, which may make generalization difficult. Second, our empirical evidence provides support for only three of our four proposed flexibility strategies. More cases that investigate the "laggard" strategy may improve the validity and reliability of the developed conceptual framework. Another difficulty is the subjective criteria of some of the variables, given that the perceived aggressiveness of the competition, the predictability of customers' demand, and the responsiveness of suppliers were estimated by the interviewees. In addition, the designation of the companies to their respective cells in Figure 1, although based on intensive discussion among the research team, was somewhat subjectively judged.

6.4 Further research

Despite the attention given to and the discussions that have resulted from defining and managing flexibility over the past years, the development of a strong theoretical foundation in this area is still in a preliminary stage (Sawhney, 2006). The conceptual framework developed in this study attempts to define and encourage a theory of flexibility management that can be further discussed, dissected, and advanced in a supply chain context. The following are some of the areas that merit future attention. First, interesting findings might be obtained from studies that explore SCF strategies in other industries or settings. For example, further qualitative or quantitative research could be conducted in supply chains of different types. Empirical investigation of industries other than the textile and apparel industry may also be considered. This would help to validate the proposed framework and improve its generalizability. Second, on the basis of the cross comparison of cases and the identification of the four types of flexibility strategies in Section 4.3, we hope that subsequent supply chain studies will investigate the "fit" between environment and SCF in greater depth, focusing specifically on the following questions:

- How do various management actions promote the acquisition of the different strategic measures of flexibility and reduce uncertainties in the supply chain?
- Are there any linkages among the various dimensions of SCF?
- What is the impact of flexibility management practice; for example, does a particular flexibility strategy improve organizational performance?

Finally, new approaches to managing flexibility are expected to be generated on the basis of a more critical investigation and review. This will further enrich theoretical and managerial development in this area.

References

Avittathur, B. and Swamidass, P. (2007), "Matching plant flexibility and supplier flexibility: lessons from small suppliers of US manufacturing plants in India", *Journal of Operations Management*, Vol. 25 No. 3, pp. 717-35.

Beamon, B.M. (1999), "Measuring supply chain performance", *International Journal of Operations & Production Management*, Vol. 19 No. 3, pp. 275-92.

Bhatnagar, R. and Sohal, A.S. (2005), "Supply chain competitiveness: measuring the impact of location factors, uncertainty and manufacturing practices", *Technovation*, Vol. 25 No. 5, pp. 443-56.

Boynton, A.C. and Victor, B. (1991), "Beyond flexibility: building and managing the dynamically stable organization", *California Management Review*, Vol. 34 No. 1, pp. 53-66.

Burns, T.R. and Stalker, G.M. (1961), *The Management of Innovation*, Tavistock, London.

Caputo, M. (1996), "Uncertainty, flexibility and buffers in the management of the firm operating system", *Production Planning and Control*, Vol. 7 No. 5, pp. 518-28.

Childerhouse, P. and Towill, D.R. (2004), "Reducing uncertainty in European supply chains", *Journal of Manufacturing Technology Management*, Vol. 15 No. 7, pp. 585-98.

D'Souza, D.E. and Williams, F.P. (2000), "Toward a taxonomy of manufacturing flexibility dimensions", *Journal of Operations Management*, Vol. 18 No. 5, pp. 577-93.

Davis, T. (1993), "Effective supply chain management", *Sloan Management Review*, Vol. 34 No. 4, pp. 35-46.

Devereux, M.B. and Engel, C. (2003), "Monetary policy in the open economy revisited: price setting and exchange-rate flexibility", *Review of Economic Studies*, Vol. 70 No. 4, pp. 765-83.

Duclos, L.K., Vokurka, R.J. and Lummus, R.R. (2003), "A conceptual model of supply chain flexibility", *Industrial Management & Data Systems*, Vol. 103 No. 6, pp. 446-56.

Ebben, J.J. and Johnson, A.C. (2005), "Efficiency, flexibility, or both? Evidence linking strategy to performance in small firms", *Strategic Management Journal*, Vol. 26 No. 13, pp. 1249-59.

Fong, M. and Dodes, R. (2006), "Style & substance: some apparel makers now see China as a customer", *Wall Street Journal (Eastern edition)*, 23 June, p. B1.

Gerwin, D. (1993), "Manufacturing flexibility: a strategic perspective", *Management Science*, Vol. 39 No. 4, pp. 395-410.

Golden, W. and Powell, P. (2000), "Towards a definition of flexibility: in search of the Holy Grail?", *Omega*, Vol. 28 No. 4, pp. 373-84.

Ho, C.-F., Chi, Y.-P. and Tai, Y.-M. (2005), "A structural approach to measuring uncertainty in supply chains", *International Journal of Electronic Commerce*, Vol. 9 No. 3, pp. 91-114.

Jones, R.A. and Ostroy, J.M. (1984), "Flexibility and uncertainty", *The Review of Economic Studies*, Vol. 51 No. 1, pp. 13-32.

Ketokivi, M. (2006), "Elaborating the contingency theory of organizations: the case of manufacturing flexibility strategies", *Production and Operations Management*, Vol. 15 No. 2, pp. 215-28.

Koste, L.L., Malhotra, M.K. and Sharma, S. (2004), "Measuring dimensions of manufacturing flexibility", *Journal of Operations Management*, Vol. 22 No. 2, pp. 171-96.

Lavington, F. (1921), *The English Capital Market*, Methuen, London.

Lee, H.L. (2000), "Creating value through supply chain integration", *Supply Chain Management Review*, Vol. 4 No. 4, pp. 30-6.

Lee, H.L. (2002), "Aligning supply chain strategies with product uncertainties", *California Management Review*, Vol. 44 No. 3, pp. 105-19.

Lummus, R.R., Duclos, L.K. and Vokurka, R.J. (2003), "Supply chain flexibility: building a new model", *Global Journal of Flexible Systems Management*, Vol. 4 No. 4, pp. 1-13.

Matson, J.B. and McFarlane, D.C. (1999), "Assessing the responsiveness of existing production operations", *International Journal of Operations & Production Management*, Vol. 19 No. 8, pp. 765-84.

Mo, Y. (2002), "A robust supply chain design under demand uncertainty and hybrid postponement strategies: issues in supply chain management", PhD thesis, Pennsylvania State University, University Park, MD.

Oke, A. (2005), "A framework for analysing manufacturing flexibility", *International Journal of Operations & Production Management*, Vol. 25 Nos 9/10, pp. 973-96.

Pagell, M. and Krause, D.R. (1999), "A multiple-method study of environmental uncertainty and manufacturing flexibility", *Journal of Operations Management*, Vol. 17 No. 3, pp. 307-25.

Perry, C. (1998), "Processes of a case study methodology for postgraduate research in marketing", *European Journal of Marketing*, Vol. 32 Nos 9/10, pp. 785-802.

Prescott, J.E. (1986), "Environments as moderators of the relationship between strategy and performance", *The Academy of Management Journal*, Vol. 29 No. 2, pp. 329-46.

Sánchez, A.M. and Pérez, M.P. (2005), "Supply chain flexibility and firm performance: a conceptual model and empirical study in the automotive industry", *International Journal of Operations & Production Management*, Vol. 25 Nos 7/8, pp. 681-700.

Sanchez, R. and Heene, A. (1997), "Managing for an uncertain future: a systems view of strategic organizational change", *International Studies of Management & Organization*, Vol. 27 No. 2, pp. 21-42.

Sawhney, R. (2006), "Interplay between uncertainty and flexibility across the value-chain: towards a transformation model of manufacturing flexibility", *Journal of Operations Management*, Vol. 24 No. 5, pp. 476-93.

Scapens, R.W. (1990), "Researching management accounting practice: the role of case study methods", *The British Accounting Review*, Vol. 22 No. 3, pp. 259-81.

Sethi, A.K. and Sethi, S.P. (1990), "Flexibility in manufacturing: a survey", *International Journal of Flexible Manufacturing Systems*, Vol. 2 No. 4, pp. 289-328.

Stevenson, M. and Spring, M. (2007), "Flexibility from a supply chain perspective: definition and review", *International Journal of Operations & Production Management*, Vol. 27 No. 7, pp. 685-713.

(The) Supply Chain Council (2006), *Supply-Chain Operations Reference-Model SCOR Version 8.0*, Supply Chain Council, Inc.

Swafford, P.M., Ghosh, S. and Murthy, N. (2006), "The antecedents of supply chain agility of a firm: scale development and model testing", *Journal of Operations Management*, Vol. 24 No. 2, pp. 170-88.

Swamidass, P.M. and Newell, W.T. (1987), "Manufacturing strategy, environmental uncertainty and performance: a path analytic model", *Management Science*, Vol. 33 No. 4, pp. 509-24.

Toni, A.D. and Tonchia, S. (1998), "Manufacturing flexibility: a literature review", *International Journal of Production Research*, Vol. 36 No. 6, pp. 1587-617.

van der Vorst, J.G.A.J. and Beulens, A.J.M. (2002), "Identifying sources of uncertainty to generate supply chain redesign strategies", *International Journal of Physical Distribution & Logistics Management*, Vol. 32 No. 6, pp. 409-30.

van der Vorst, J.G.A.J., Beulens, A.J.M., de Wit, W. and van Beek, P. (1998), "Supply chain management in food chains: improving performance by reducing uncertainty", *International Transactions in Operational Research*, Vol. 5 No. 6, pp. 487-99.

Venkatraman, N. and Prescott, J.E. (1990), "Environment-strategy coalignment: an empirical test of its performance implications", *Strategic Management Journal*, Vol. 11 No. 1, pp. 1-23.

Vickery, S., Calantone, R. and Droge, C. (1999), "Supply chain flexibility: an empirical study", *Journal of Supply Chain Management*, Vol. 35 No. 3, pp. 16-25.

Waller, M.A., Dabholkar, P.A. and Gentry, J.J. (2000), "Postponement, product customization, and market-oriented supply chain management", *Journal of Business Logistics*, Vol. 21 No. 2, pp. 133-60.

Wernerfelt, B. and Karnani, A. (1987), "Competitive strategy under uncertainty", *Strategic Management Journal*, Vol. 8 No. 2, pp. 187-94.

World Trade Organization (2007), "International Trade Statistics", United Nations, available at: www.wto.org/english/res_e/statis_e/its2007_e/section2_e/ii63.xls

Yin, R.K. (2003), *Case Study Research: Design and Methods*, Sage Publications, Thousand Oaks, CA.

Further reading

Holmberg, S. (2000), "A systems perspective on supply chain measurements", *Management*, Vol. 30 No. 10, pp. 847-68.

Appendix. The interview protocol

Note: Before the interview, the research objectives, the information we want to collect and the explanation of the relevant concepts should be presented to each informant:

- Please describe your industry sector and the role of your company in it.
- Please describe the following processes in your company: purchasing planning, purchasing, production, delivery, supply base management, distribution management.
- Please indicate the uncertainties in the management of your supply chain. Which ones concern you most?
- How do you describe the relationship between your company and your suppliers?
- What measures have been taken to deal with sourcing uncertainties? What are the effects of these measures? Will

your company cooperate with your suppliers to deal with those uncertainties? How?
- How do you describe the relationship between your company and your distributors or clients?
- What measures have been taken to deal with marketing uncertainties? What are the effects of these measures? Will your company cooperate with your distributors/customers to deal with those uncertainties? How?
- How do you describe the influences of the current uncertainties on the design of your operating systems?
- What measures have been taken to deal with uncertainties in your operating system? What are the effects of these measures? Will the different operations departments in your company cooperate to deal with these uncertainties? How?
- According to your experience and understanding of supply chains, what is an environment-strategy fit? What measures other than the aforementioned have you taken to achieve such a "fit"?
- What are the constraints within your existing supply chain management? What kinds of changes would you suggest to make your supply chain run more smoothly?
- How would you perceive the effect of the introduction of a flexibility strategy on supply chain performance?

Corresponding author

K-L. Moon can be contacted at: tcmoonkl@gmail.com; tcmoonk@hanyang.ac.kr