Decision Sciences
Volume 40 Number 4
November 2009

Supply Chain Strategy, Product Characteristics, and Performance Impact: Evidence from Chinese Manufacturers*

Yinan Qi†
University of International Business and Economics, School of Business, No. 10, Huixing Dongjie, Chaoyang District, Beijing, China, 100029; e-mail: yinanqi@gmail.com

Kenneth K. Boyer
Management Sciences Department, Fisher College of Business, Ohio State University, Columbus, OH, 43210, e-mail: Boyer_9@osu.edu

Xiande Zhao
Department of Decision Sciences and Managerial Economics, The Chinese University of Hong Kong, Leung Kau Kui Building, CUHK, Shatin, Hong Kong, e-mail: xiande@baf.msmail.cuhk.edu.hk

ABSTRACT

Supply chain management has become one of the most popular approaches to enhance the global competitiveness of business corporations today. Firms must have clear strategic thinking in order to effectively organize such complicated activities, resources, communications, and processes. An emerging body of literature offers a framework that identifies three kinds of supply chain strategies: lean strategy, agile strategy, and lean/agile strategy based on in-depth case studies. Extant research also suggests that supply chain strategies must be matched with product characteristics in order for firms to achieve better performance. This article investigates supply chain strategies and empirically tests the supply chain strategy model that posits lean, agile, and lean/agile approaches using data collected from 604 manufacturing firms in China. Cluster analyses of the data indicate that Chinese firms are adopting a variation of lean, agile, and lean/agile supply chain strategies identified in the western literature. However, the data reveal that some firms have a traditional strategy that does not emphasize either lean or agile principles. These firms perform worse than firms that have a strategy focused on lean, agile, or lean/agile supply chain. The strategies are examined with respect to product characteristics and financial and operational performance. The article makes significant contributions to the supply chain management literature by examining the supply chain strategies used by Chinese firms. In addition, this work empirically tests the applicability of supply chain strategy models that have not been rigorously tested empirically or in the fast-growing Chinese economy.

*This research is supported by a research grant from "211" Key Disciplines Development Project of University of International Business and Economics (project #73200033), an RGC Direct allocation grant (project #2070386), and a research fund from Center for Supply Chain Management and Logistics, Li & Fung Institute of Supply Chain Management and Logistics, The Chinese University of Hong Kong.

†Corresponding author.

Subject Areas: Analysis of Variance (ANOVA), Cluster Analysis, Product Characteristics, Strategic Management, and Supply Chain Design.

INTRODUCTION

Today's competition is not between autonomous business entities, but between integrated supply chains (Lambert & Cooper, 2000). Therefore, supply chain management has received increasing attention from practitioners and academia. Effectively managing the flow of materials from supply sources to the ultimate customer represents a major challenge for today's managers (Mabert & Venkataramanan, 1998). Thus, firms need to posses a clear strategic planning in order to effectively organize such complicated activities, resources, communications, and processes. Prior research has identified three major supply chain strategies: lean, agile, and lean/agile strategies (Christopher, 2000; Christopher & Towill, 2000; Bruce, Daly, & Towers, 2004; Yusuf, Gunasekaran, Adeleye, & Sivayoganathan, 2004). Research on supply chain strategy is closely linked with product characteristics. For example, Fisher (1997) and Christopher and Towill (2000) posit that supply chain strategies must match with product characteristics, competitive strategies, and the environment in order for them to be effective.

Despite its well-recognized importance, research on supply chain strategy is still in its infancy. Most studies on supply chain strategy are based on case studies of companies in western or highly developed countries (e.g., the United States, Canada, Europe, or Japan) and are highly descriptive. While these studies help us understand the concept of supply chain strategies, there remains a need for large-scale empirical testing and validation of the conceptual frameworks employed (Flynn, Sakakibara, Schroeder, Bates, & Flynn, 1990). Furthermore, most studies on supply chain strategies are based on observations from companies in the United States or Europe. Very few studies have examined supply chain strategies in emerging economies and cultural settings other than North America and Europe. Relatively little is known about supply chain management in China (Zhao, Flynn, & Roth, 2007). In particular, there are no published systematic studies on supply chain strategies in China.

China is the world's fastest growing economy with a gross domestic product (GDP) growth rate of 11.1% in 2006, making it the fourth largest economy in terms of GDP (Wikipedia, 2007). Chinese manufacturers play very important roles in the global supply chain. The extremely rapid growth has created great pressure on supply chain relationships between Chinese manufacturers and companies in other countries (Farh, Cannella, & Li, 2006). To illustrate, Zhao, Sum, Qi, Zhang, and Lee (2006) find that the patterns of operations strategies adopted by Chinese manufacturers are quite different from those from western companies. Zhao et al. (2006) call for more investigations of how Chinese manufacturers compete in the global marketplace. Similarly, Jiang, Frazier, and Heiser (2007) conduct a thorough review of the China-related supply chain literature and emphasize the necessity of an in-depth study on supply chain strategies in China.

Based on the calls of the aforementioned authors, we focus our research on Chinese firms. While there are limitations to research using a single country, there are also important benefits. From a Chinese perspective, it is important to understand how to use supply chain strategy to compete effectively and to evaluate how well western models fit in this environment. From a western perspective, it is important for managers and researchers to understand the application of supply chain strategy by their Chinese partners in order to work effectively with them to leverage their capabilities. Findings of studies on China's supply chain strategies will contribute to the theoretical development on supply chain management and provide important and interesting managerial implications to practitioners.

The current study investigates supply chain strategies adopted by Chinese manufacturers and seeks to empirically test the lean/agile supply chain strategy framework posited by several researchers (Fisher, 1997; Christopher, 2000; Christopher & Towill, 2000; Bruce et al., 2004; Yusuf et al., 2004). We develop a survey instrument to assess product characteristics, supply chain strategy, and financial and operational performance and collect data from 604 manufacturing plants in China. More specifically, the objectives of this research are the following:

(i) To develop and test a taxonomy of supply chain strategies used by Chinese manufacturers. We use as our foundation the lean/agile supply chain strategy model that has received substantial research attention.

(ii) To assess the role and fit of product characteristics with the supply chain strategy employed.

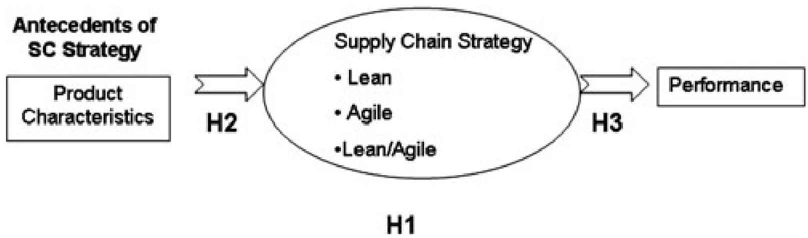
(iii) To assess the impact of supply chain strategies on financial and operational performance.

In the next section, the theoretical background and research hypotheses are presented. This is followed by a description of research methodology. Next, analytical results are presented. Finally, the article is concluded with major findings, contributions, limitations, and future research directions.

THEORETICAL BACKGROUND AND HYPOTHESES

While there is a substantial body of theory and empirical support for the fundamental frameworks underlying operations strategy, the literature on supply chain strategy is in a more developmental stage. There has been a great deal of discussion, but relatively little consensus and empirical testing of supply chain strategies. One of the more influential works is that of Fisher (1997), who proposed a framework that describes the relationship between product characteristics and supply chain strategy. Fisher argued that supply chain strategy must be aligned with product characteristics. The posited 2×2 matrix consisted of two supply chain strategies and two product types. The two strategies were labeled as physically efficient and market-responsive. Each strategy was matched with a product type. Functional products have a relatively predictable demand while innovative products have a relatively unpredictable demand. Functional products are characterized by longer product life cycles, lower product variety, and relatively long lead times. In contrast, innovative products are characterized by short life cycles, high product variety, and short lead times. Fisher's framework considered functional products to require a physically efficient supply chain, while innovative products required a market-responsive supply chain. Thus, there is a "match" when functional products

Figure 1: Research model.



are paired with a physically efficient supply chain or when innovative products are paired with a market-responsive supply chain. The framework by Fisher (1997) has been cited by numerous authors, yet the work is somewhat limited due to its use of small sample observations of a few companies. The need to match supply chain strategy with product characteristics has been examined and supported via case study research conducted by Childerhouse, Aitken, and Towill (2002) and Aitken, Childerhouse, and Towill (2003).

Our general research model is presented in Figure 1. This shows that we first identify and classify firms according to their approach to supply chain strategy (Hypotheses 1a–c). Then, we examine how product characteristics affect the choice of strategy (Hypotheses 2a–c). Finally, we test for performance outcomes based on supply chain strategy (Hypotheses 3a–c). Fisher's model is thus tested in separate, yet linked steps because it is not feasible to test the model in a single, holistic step.

Supply Chain Strategies

Several authors have taken Fisher's work and collected empirical data to support and refine the theory. In particular, much of this work has been focused on examining two fundamental supply chain strategies: lean, which is roughly equivalent to Fisher's physically efficient and agile, which is roughly equivalent to Fisher's market-responsive. Lean means developing a value stream focused on eliminating all kinds of waste (Naylor, Naim, & Berry, 1999). Since the early 1990s, manufacturing companies around the world have implemented a lean production strategy to increase their competitiveness (Bruun & Mefford, 2004). Lean practices require a stable product demand in order to facilitate a level production schedule, which in turn leads to reduced cycle time, work-in-process, and finished goods inventories. Recently, lean thinking in manufacturing (Womack & Jones, 2003) has been extended to the broader supply chain. The major objective of a lean supply chain strategy is to reduce cost and enhance efficiency through elimination of wastes in both inter- and intra-organizational processes. Lean supply chains are best matched with a relatively stable environment.

In contrast to lean, the goal of an agile supply chain is to provide customer-driven products with unique features to the market quickly in order to maintain a competitive advantage in a rapidly changing environment. Decreasing product life cycles and rapidly changing customer requirements have increased the pressure on the entire supply chain to provide products and services in a quicker and more responsive manner. In particular, with the emergence of e-business, the responsiveness of the supply chain becomes an increasingly important competitive weapon in the marketplace. In order to cope with the challenges of an increasingly turbulent and dynamic environment, researchers such as Kidd (1994) and Goldman, Nagel, and Preiss (1995) proposed a new paradigm: agility. Yusuf, Sarhadi, and Gunasekaran (1999) described agility as "the successful exploration of competitive bases (speed, flexibility, innovation proactivity, quality, and profitability) through the integration of reconfigurable resources and best practices in a knowledge-rich environment to provide customer-driven products and services in a fast changing market environment." Recently, researchers including Christopher (2000), Mason-Jones, Naylor, and Towill (2000) and Yusuf et al. (2004), have extended the idea of agility from individual companies to broader supply chains. These researchers suggest that an agile supply chain strategy can help manufacturers deal with a rapid environmental change more efficiently and effectively. For example, Christopher (2000) argues that leveraging supplier relations allows companies to create agile supply chains by reducing lead time between organizations. Lee (2004) emphasized that agility can help the supply chain respond to short-term changes quickly and manage the external disturbance easily. When the market environment is more dynamic and turbulent, companies need to adopt an agile supply chain strategy.

While most authors focus on a single one of these two types of supply chain strategies, Bruce et al. (2004) identified a combination strategy called "leagile" strategy. "Leagile takes the view that lean and agile approaches shall be combined at a decoupling point for optimal supply chain management" (Bruce et al., 2004, p. 155). A leagile supply chain can operate cost-effectively or in a lean manner in the upstream supply chain and responsively to volatility or in an agile manner in the market downstream (Bruce et al., 2004). While authors have identified this approach and shown some companies to be successful with it, it is worth pointing out that the leagile strategy is likely to be challenging due to the need to master two different and sometimes conflicting managerial styles. Selldin and Olhager (2007) found that some companies operate on a "supply chain frontier" by seeking to combine physical efficiency (we label this as lean) and market responsive (we label this as agile) supply chains, but noted that this position was difficult to achieve and worthy of further research attention. Our expectation is that implementing a leagile strategy will be very challenging—somewhat analogous to operating at the business' performance frontier (Schmenner & Swink, 1998). In particular, a leagile strategy involves managing the upstream and downstream portions of the supply chain in a very different manner. Our questions use a single firm as the unit of analysis and ask the respondent to answer looking both upstream and downstream. While this key informant approach is not the optimal way to measure two directions in the supply chain, we believe that it is effective in capturing the respondent's intent regarding his/her own company's supply chain strategy. Due to our difficulty in assessing the decoupling point based on a single informant, our findings will be presented as lean/agile rather than leagile because we can not explicitly assess how companies combine the two approaches.

The existing typology of supply chain strategies (i.e., agile, lean, and lean/agile) is identified and described through case studies of companies in the

United States or Europe. As China has become an important manufacturing center in the world and has become an attractive target for global sourcing, Chinese manufacturers are establishing closer relationships with supply chain partners in the western world. Chinese managers are learning modern supply chain management principles and practices from their partners and beginning to implement modern supply chain strategies and practices to enhance their relationships with their partners and improve their performance (Zhao, Huo, Flynn, & Yeung, 2008). Much of the manufacturing in China is low cost focused, thus it might be expected that lean approaches would dominate over agile. However, Porter's (1986) strategic theory suggests that companies may pursue competitive niches through differentiation and thus some Chinese companies may also pursue agile strategy to meet the dynamically changing needs of the customer. Furthermore, companies may have to emphasize both lean and agile strategies in order to achieve lower cost in a rapidly changing environment. As such, we examine a general proposition with respect to Chinese manufacturers, followed by three specific hypotheses. A priori, there is greater support for Hypothesis 1a regarding lean than for Hypothesis 1b or 1c:

Proposition 1**:** Chinese manufacturers can be mapped using the typology of lean, agile, and lean and agile supply chain strategies.

H1a: A subset of Chinese manufacturers pursues a supply chain strategy focused on lean strategy.

H1b: A subset of Chinese manufacturers pursues a supply chain strategy focused on agile strategy.

H1c: A subset of Chinese manufacturers pursues a supply chain strategy focused on both lean and agile strategies.

Product Characteristics and Supply Chain Strategies

The manufacture of products with different characteristics incurs two categories of supply chain costs: production costs (Cooper, 1990) and market mediation costs (Fisher, 1997). Production costs include material, labor, manufacturing, overhead costs, and production technology investments (Randall & Ulrich, 2001). Mediation costs occur due to market variability (Randall & Ulrich, 2001). Mediation costs include inventory holding costs, product mark-down costs, and opportunity costs for not having the right products to meet the demands. Production and mediation costs can be influenced by the choice of supply chain strategy as noted by Fisher (1997) and examined in the work of Randall and Ulrich (2001).

When selecting an appropriate supply chain strategy, the first step for manufacturers is to consider the characteristics of end-products, including product life cycle length, predictability of demand, product variety, and market standards for lead times and service (Fisher, 1997). Similarly, Huang, Uppal, and Shi (2002) also argue that the primary factor associated with supply chain strategy selection is the product characteristics of a particular supply chain. The literature has reached a general consensus that companies providing functional products need efficient/lean chains, while companies offering innovative products require a more responsive/agile supply chain.

Several studies have examined the relationship between supply chain strategy and product characteristics. Childerhouse et al. (2002) described the evolution of focused-demand chains over a long period of time via a case study that examines the path along which a UK lighting company developed from a traditional supply chain to an organization with four focused-demand chains. Using the DWV3 (delivery window, variability, volume, and variety) scheme, they classified the major products of the company into four clusters. For each cluster, they proposed a corresponding focused-demand chain strategy. Aitken et al. (2003) found four similar supply chain strategies that are used in different phases in the product life cycle, which can be considered as a proxy for product characteristics.

Narasimhan and Kim (2002) proposed four factors that can affect supply chain strategy selection: nature of business, competitive environment, technological intensity of the product, and product and market characteristics. Their study theoretically highlighted the importance of product characteristics, but because it focused on supply chain integration it did not examine specific supply chain strategies. Similarly, Huang et al. (2002) emphasized the relationship between product characteristics and supply chain strategy selection. They then proposed a computer program to select supply chain strategy according to the product characteristics, but the program was not tested using actual empirical data.

Bruce et al. (2004) analyzed different supply chain strategies, including lean, agile, and lean/agile, in the textiles and clothing industry. According to the authors this industry manufactures primarily innovative products because its products tend to have short product life cycles, high volatility, and low predictability. By examining four case studies, the authors argue that the lean/agile approach is most appropriate for the textiles and clothing industry. Companies in this industry require a quick response to customer demands and strong strategic alliances and sourcing relationships with their suppliers in order to gain a sustainable competitive edge. The focused sample in the research by Bruce et al. (2004) thus provides limited support for the hypothesized relationships between product characteristics and supply chain strategies. We note that while Bruce et al. (2004) identified lean/agile as a strategy, there is limited support due to the small sample. There is a strong need to examine this strategy to test whether it is feasible because conceptually it is likely to be very difficult to successfully capture the positive benefits of lean and agile in a single firm or supply chain.

In a broad-based empirical study, Safizadeh, Ritzman, and Mallick (2000) found that strategic emphasis tends to shift from flexibility and a high-performance design quality to a consistent quality and cost as companies move away from customization toward standardization. While this study was focused on operations strategy within individual firms and was not examining the product characteristics/supply chain strategy relationship explicitly, it does provide some support for the fundamental relationship.

In a study tightly focused on a single industry, Randall and Ulrich (2001) explore the relationship among product variety, supply chain structure, and firm performance using data from the U.S. bicycle industry. Utilizing different types of cost, the authors classified companies into two groups based on product variety:

production-dominant and mediation-dominant. Similarly, a supply chain structure is characterized along two dimensions: the distance of production facilities from a target market and the degree to which production facilities reach a minimum efficient scale. Randall and Ulrich (2001) found that the firms using scale-efficient processes and located away from target market will use a production-dominant variety policy. In contrast, firms using scale-inefficient processes and located near the target market will use a mediation-dominant variety policy. While this study provides substantial support for the relationship between product variety and supply chain structure (location of its production facilities), it did not clearly examine the relationship of a firm's supply chain strategy and product characteristics. It employs specialized measures to test the relationships that are limited in their generalizability. Furthermore, there are two other limitations. First, the study focuses on the bicycle industry, thus its conclusion may not be generalizable to firms that produce a larger variety of products. Second, the study classified the groups using the sample median and then tested their associations. This approach requires data from an entire industry—which is not feasible for a broad range of studies. Thus, there is a need for a more broadly applicable methodology.

A recent study by Selldin and Olhager (2007) closely mirrors our work. These authors examine the relationship between product characteristics and supply chain strategy using a sample of 128 Swedish companies. Selldin and Olhager (2007) found support for the matrix proposed by Fisher (1997) in that companies where product characteristics and supply chain strategy were well matched outperformed companies with poor match. Selldin and Olhager (2007) call for further research in other countries to support, validate, and elaborate their work.

Based on this review of the literature, several studies have supported the relationship between product characteristics and supply chain strategy. However the bulk of extant research is based on deductive reasoning and case analyses. Little systematic broad-sample empirical analysis has tested these relationships. There is an increasing acknowledgment that inductive-based propositions and theories should be verified through deductive analyses (Flynn et al., 1990). The current research seeks to address this gap by providing empirical evidence to validate the relationship between supply chain strategy and product characteristics. We accomplish this by empirically deriving a supply chain strategy taxonomy using data collected from 604 manufacturers in China. The results of the empirical taxonomy are compared to those predicted by the Fisher (1997), Selldin and Olhager (2007), and other researchers. It is also tested by correlating supply chain strategies with product characteristics. We believe that Chinese manufacturers are matching their supply chain strategy and product characteristics and thus propose the following proposition and three related hypotheses:

***Proposition 2*:** Supply chain strategy are correlated with product characteristics.

H2a: *Companies utilizing a lean supply chain strategy will have higher value of functional product characteristics.*

H2b: *Companies utilizing an agile supply chain strategy will have higher value of innovative products characteristics.*

H2c: Companies utilizing a lean/agile supply chain strategy will have high value of functional and innovative products characteristics.

Impact of Supply Chain Strategy on Performance

As discussed earlier, the characteristics of three types of supply chain strategies (lean, agile, and lean/agile) are different. The lean supply chain strategy requires that manufacturers make cost reduction their first priority. Adopters of lean strategy may implement practices such as mass production, just-in-time, and long-term supplier relationships to eliminate waste and achieve a lower cost. On the other hand, the agile supply chain strategy underscores flexibility and responsiveness. Hence, adopters of agile strategy need more capacity buffers to handle the market volatility. In the short run, there are likely to be trade-offs between the two kinds of strategies. However, over time, companies may develop innovative ways to improve both leanness and agility. One way to do this is to combine the lean and agile approaches at a decoupling point to form the lean/agile supply chain by operating cost-effectively in the upstream supply chain and responsively to volatility in the market downstream as observed by Bruce et al. (2004). Firms may also use other ways to develop both the lean and agile capabilities in their supply chain. Each of these supply chain strategies has been identified in prior literature based on relatively small sample sizes, thus there is a strong need to assess their effectiveness in a larger sample. In particular, the successful implementation of a lean/agile strategy seems to be a more challenging hurdle than implementing either a lean or agile strategy due to the need to master two sets of guiding principles.

Since Porter (1986) proposed the well-known typology of competitive strategies, many studies have examined the firm's strategic behavior and their impacts on performance. Several studies found that the firm's performance would deteriorate if it does not have a clear strategic thinking (Dess & Davis, 1984). However, the strategic management literature strongly emphasizes that strategy involves careful matches between internal strategy, organization and structure, and external environment (Bozart, Warsing, Flynn, & Flynn, 2009). We believe that similar thinking can be extended in supply chain strategies and test the following proposition and hypotheses:

***Proposition 3*:** Supply chain strategy significantly influences firm's performance.

H3a: Supply chain strategy significantly influences firm's financial performance.

H3b: Supply chain strategy significantly influences firm's customer service performance.

H3c: Supply chain strategy significantly influences firm's operating cost performance.

RESEARCH METHODOLOGY

In this research, data are collected via a mail survey. The unit of analysis is the manufacturing company. The supply chain manager, operations manager, and general manager were selected as potential respondents for this study. Managers in these positions have enough knowledge to answer the questions we asked in the questionnaire, specifically the questions concerning the supply chain strategies and practices used in the company.

Questionnaire Design

The items designed to measure supply chain strategy are extracted from a variety of sources, including Katayama and Bennett (1999), Yusuf et al. (1999), Christopher (2000), Mason-Jones et al. (2000), and Heikkilä (2002). The items employed in the current study are shown in the Appendix. In the questionnaire, we listed several statements that describe the characteristics of lean and agile supply chain. Then, we asked the respondents to answer "to what extent do you agree that the supply chain of your company's major product/product mix has the following characteristics?" The measurement scales employ a seven-point Likert scale with 1 = *strongly disagree* and 7 = *strongly agree*.

The measurement items for product characteristics are extracted from Fisher (1997), Childerhouse et al. (2002), and Huang et al. (2002). The items are divided into two parts. In part 1, we include three statements related to the general characteristics of product. The question asked in the first part is "to what extent are the following statements suitable descriptions of your company's end products or production process." These items are seven-point Likert scales with 1 = *most unsuitable* and 7 = *most suitable* as the anchors. The item in part two requires the respondents to provide estimates regarding the introduction interval of new products. We asked the respondents to indicate the best estimate for times ranging from 1 = *<3 months* to 7 = *≥5 years*.

The items for the financial performance and operational performance are based on Beamon (1999), Gunasekaran, Patel, and Tirtiroglu (2001), De Toni and Tonchia (2001), and Vickery, Jayaram, Droge, and Calantone (2003). In our questionnaire, we include six dimensions of financial performance based on our literature review of commonly used measures. They are return on investment (ROI), return on assets (ROA), Market Share, Growth in ROI, Growth in ROA, and Growth in Market Share. We also include 15 items of operational performance in the questionnaire. The question asked is "to what extent does your company perform compared with your main competitors?" The items are seven-point Likert scales ranging from 1 = *much worse* and 7 = *much better*.

The questionnaire includes some other questions concerning the characteristics of the firm, which include ownership, the role (leader or subordinate), and the position (supplier, components manufacturer or finished product manufacturers) of the firm in the supply chain.

Questionnaire Translation

To ensure the reliability of the questionnaire, the English version of the questionnaire was first developed by the research team and reviewed by knowledgeable professors of operations management. This version was translated into Chinese, and then translated back to English. The back-translated English version was then checked against the original English version. As a result, some questions were reworded to better reflect the original meaning of the questions in English.

The Chinese version of the questionnaire was then pilot-tested on more than 40 manufacturing managers from Tianjin, Guangzhou, and Hong Kong in China. The data collected from the pilot study were used to assess whether every question in the questionnaire was understood correctly by the respondents. When there was a confusion or ambiguity in the wording of the questions or scales, modifications were made. The combination of translation to Chinese, back translation to English, and a careful pilot testing provides important evidence to support reliability and validity of measurement in research in developing countries, particularly China (Zhao, Flynn, & Roth, 2007).

Data Collection and Nonresponse Bias

Geographically, China is a very large country with 31 provinces and autonomous regions, cities under the direct administrative guidance of the central government, and two special administrative regions (Hong Kong and Macau). Therefore, it is very difficult to obtain samples from all parts of China. Furthermore, the topic of this research is relatively new for managers in China. Hence, we sought to select the target cities in which the manufacturing companies are relatively better developed and supply chain management concepts are better established than other areas in China. As a result, we chose three representative cities from economically advanced areas in China: Beijing, Shanghai, and Guangzhou.

We used a database provided by Beijing Ebuywww Info Co. Ltd in our sampling. Founded in August 2000, Ebuywww provides a high-quality list of Chinese companies. The source of information is based on a close relationship between Ebuywww and various business journals, the government statistical bureaus, and various industrial societies. The data provided by Ebuywww are used by numerous large multinational companies to identify and assess potential suppliers in China. As suggested by Li, Rao, Ragu-Nathan, and Ragu-Nathan (2005), the target sampling list was limited to manufacturers with more than 100 employees because manufacturers with fewer than 100 employees seldom engage in sophisticated supply chain management. There were 9,764 companies that met the aforementioned criteria. Within each city, we selected companies using probability sampling according to distributions of industries and the number of employees in the database.

To maximize the response rate, we followed the approach used in Frohlich (2002). A total of 3,187 companies were selected from the database and contacted by telephone. However, 463 companies could not be reached because the telephone numbers were incorrect or the company had moved or closed down. Of the remaining 2,724 companies, 614 completed the questionnaire after several rounds of follow-up calls, which represent an effective response rate of about 23%. This response rate is comparable to or higher than recent studies on operations management (Das & Joshi, 2007; Rabinovich, Knemeyer, & Mayer, 2007). After screening, we determined that 10 of the 614 questionnaires had not been completed properly and were thus removed from further analysis. Therefore, 604 responses were used in our subsequent analysis.

Table 1: Industry distribution of respondents and population.

Industries	Respondents	Population
Food and beverage	10.10%	8.66%
Electronic and communication equipment	8.79%	8.38%
Transportation equipment	8.63%	8.79%
Textile and garment	33.22%	33.37%
Electrical equipment	8.38%	10.93%
Machinery	16.12%	17.74%
Chemicals and petroleum	7.17%	6.97%
Plastic and latex	5.37%	5.16%
Total	100%	100%

To assess nonresponse, we compared the industry distributions of the respondent companies and the population per the advice of Malhotra and Grover (1998). The results are shown in Table 1. Table 1 shows that the percentages of the respondents were close to the percentages of companies in the population for most industries, A chi-square test ($\chi^2 = 1.17$) indicated no significant difference between the distribution of respondents and the overall population ($p > .05$), suggesting that our sample was not biased toward any particular industry.

Profiles of Respondents

Table 2 provides a profile of the respondents to the survey. Part A indicates the position of each respondent within the company, with the largest grouping being production and operations manager, general manager, or factory director. The respondents cover a variety of positions—all relating to some aspect of supply chain management. Part B shows that a majority of the respondents have been with the company longer than 5 years. These results show that our respondents are capable of answering the questions about product characteristics, supply chain strategies, and financial performance.

Table 3 shows the profile of the responding companies by size, ownership, and their roles and position in the supply chain. Part A shows that more than 40% of the responding companies had fewer than 200 employees, over 84% had fewer than 500 employees, and about 7% had 1,000 or more employees. Part B shows about 35% of the respondents had annual sales of below 10 million Yuan (approx US$1.46 million), and 7% of the companies had annual sales of over 250 million Yuan (approx US$36.44 million). This distribution is typical of Chinese manufacturing companies, which are more likely to be in the medium-size category (100–1,000 employees) and have lower revenue than companies in more developed countries such as North America and Europe.

Another important factor that can potentially influence supply chain management is the ownership of Chinese companies. Part C shows that there is a high percentage of state-owned enterprises (companies in which capital investments are wholly or partly owned by the state and are directly or indirectly controlled and managed by government) and collective-owned enterprises (where capital is wholly or partly owned by laborers working in these enterprises, municipal

Table 2: Respondent profile.

A. Job Title	Frequency	Percent (%)
General manager	84	13.9
Production and operations manager	245	40.5
SCM and logistics manager	4	0.7
Purchasing and supply manager	3	0.5
Factory director	97	16.1
General manager assistant	58	9.6
Chief financial officer (CFO)	17	2.8
Marketing manager	39	6.5
R&D manager	27	4.5
Others	30	4.9
Total	604	100
B. Years with the company		
<5	282	46.7
5–9	171	28.3
10–14	80	13.2
15–19	36	6.0
≥ 20	35	5.8
Total	604	100

R&D = research and development; SCM = supply chain management.

government, or some types of social organizations). Another 30% of companies are private. The wholly foreign owned enterprises and joint ventures are about 30%. The final 10% of responding companies are joint-stock companies.

Finally, parts D and E indicate the position of the company within the supply chain. A majority of respondents consider their company to be in a leadership (61.8%) versus a subordinate role. Similarly, a majority of firms are considered to be higher value-added manufacturers (72.2%) rather than raw material or components suppliers.

Assessing Reliability and Validity

As suggested by Narasimhan and Jayaram (1998), we performed an exploratory factor analysis for each construct to ensure the unidimensionality of the scales. The factor analysis was done on items LS1–LS7 and AS1–AS7 in the Appendix. In the first step, indicator items are deleted if they load on more than two factors or their factor loadings on are smaller than .5 (Johnson & Wichern, 1998) or if there are cross-loadings higher than .40 (Hair, Anderson, Tatham, & Black, 1998). Moreover, the items that did not load on the factor they were designed to measure were also deleted per Chen and Paulraj (2004). According to these criteria, we dropped LS4 because it has factor loadings below .50 for all factors. We also dropped item AS2 due to its high cross-loading (above .40).

In the second step, another factor analysis is done to assess unidimensionality. Eigenvalues, loadings, and percentage of explained variances for each construct are provided in the Appendix, which also shows item means and correlations. The scale for lean strategy consists of six items and explains 25.2% of the variance

Table 3: Company profile.

	Percent (%)
A. Number of employees	
100–199	42.7
200–499	41.6
500–999	9.6
1,000–4,999	5.5
5,000 or more	0.7
B. Annual sales (in million Yuan, 1 US$ = ¥ 6.86 RMB)	
Below 5 (0.73 million USD)	14.4
5–10 (0.73–1.46 USD)	18.2
10–15 (1.46–2.19 USD)	13.2
15–25 (2.19–3.64 USD)	13.6
25–30 (3.64–4.37 USD)	7.9
30–50 (4.37–7.29 USD)	11.1
50–100 (7.29–14.58 USD)	9.9
100–250 (14.58–36.44 USD)	4.8
250–500 (36.44–72.88 USD)	3.8
500 to 1000 (72.88–145.77 USD)	1.3
Above 1000 (145.77 USD)	1.7
C. Ownership	
State-owned	20.5
Collective owned	11.1
Private owned	30.0
Wholly foreign owned	13.1
Joint-venture	14.7
Joint-stock company	10.3
D. Role of company within supply chain	
Leader	61.8
Subordinate	38.2
E. Position of company in supply chain	
Raw material supplier	10.3
Components supplier	17.5
Manufacturer	72.2
Total	100

(eigenvalue = 3.02/12 items). The scale for agile strategy consists of six items and explains 22.8% of the variance (eigenvalue = 2.70/12 items).

The Appendix also shows results for two separate exploratory factor analyses—one on operational performance and one on financial performance. The factor analysis for operational performance resulted in two factors. One is labeled Customer Service because it consists of 10 items that all focus on some aspect relating to services, quality, flexibility, or delivery. In comparison, the second factor is labeled Operating Cost because its five items focus on costs of products. The eigenvalues are 5.18 and 2.86, respectively, thus these factors account for 53.6% of the variance. A separate factor analysis for the financial performance measures shows that it is unidimensional with a single factor (eigenvalue = 3.96) accounting for 66.06% of the overall variance.

Flynn et al. (1990) suggested that the most widely accepted measure of a measure's internal consistency is Cronbach's alpha. The Appendix shows the Cronbach's alpha results for the lean and agile strategy and the operational and financial performance constructs. The alpha values are larger than .60, the threshold value recommended by Nunnally (1978) and Flynn et al. (1990). The data suggest that our constructs possess sufficient reliability.

We assessed the convergent validity by using confirmatory factor analysis (CFA), suggested by O'Leary-Kelly and Vokurka (1998). The model fit indices are chi-square(486) = 2169.03, root mean square error of approximation = 0.076, comparative fit index = 0.95, and Tucker Lewis index = 0.94, which are better than the threshold values recommended by Hu and Bentler (1998). Furthermore, all of the factor loadings in our CFA model are greater than .5 and the *t*-values are significantly greater than 2.0. As a result, convergent validity is ensured in our study. To assess discriminant validity, we compared the unconstrained model with the constrained models of the constructs used in our study (Choi & Eboch, 1998). A significant difference of the χ^2 between the constrained and unconstrained models would indicate high discriminant validity (Choi & Eboch, 1998). In our study, all of the differences of χ^2 are significant, which shows support to the discriminant validity of the constructs.

RESULTS

The Taxonomy of Supply Chain Strategies

Cluster analysis was used to develop a taxonomy based on the constructs for lean and agile supply chain characteristics. We followed several rules similar to those used in Kathuria (2000) and Frohlich and Dixon (2001) to select the number of clusters. As in Frohlich and Dixon (2001), we used a hierarchical cluster analysis to generate a hierarchical dendogram and an agglomeration schedule table. Our goal was to balance parsimony or few clusters with accuracy (more clusters retains more data). The choice of the final number of clusters is a subjective one that is generally guided by a few rules of thumb. Lehmann (1979) indicates the number of clusters should lie between *n*/30 and *n*/60. Because our sample size is 604, this would suggest a solution with between 10 and 20 clusters. Unfortunately, this high number of clusters makes managerial interpretability difficult due to the lack of parsimony. We employed *K*-mean cluster analysis to generate three-, four-, and five-cluster solutions. After a careful examination of the three-, four-, and five-cluster solutions, we decided that the four-cluster solution shown in Table 4 provided the best interpretability. The five-cluster group had two clusters that were very similar in that they were heavily focused on lean with very little emphasis on agile. The three-cluster choice did not have the group that focused primarily on agile to the exclusion of lean. We feel that the four-cluster choice provides more explanatory power than the choice of three clusters without the added complexity of a five-cluster solution, thus we chose four clusters, which is a common number in the literature (Roth & Miller, 1992; Boyer, Ward, & Leong, 1996). We prefer the four-cluster solution because it provides more explanatory power—in fact we believe the difference between Lean/agile and Traditional to be very important.

Table 4: Analysis of variance of supply chain strategies.

	$N = 172$ Agile Cluster #1	$N = 151$ Lean/Agile Cluster #2	$N = 147$ Traditional Cluster #3	$N = 134$ Lean Cluster #4	F Value
Lean supply chain					
Cluster mean	4.81[a](2, 3, 4)[b]	5.97(1, 3, 4)	4.23(1, 2, 4)	5.83(1, 2, 3)	$F = 609.67^*$
SE	0.03	0.04	0.03	0.04	
Agile supply chain					
Cluster mean	5.17(2, 3, 4)	5.90(1, 3, 4)	4.16(1, 2)	4.24(1, 2)	$F = 429.07^*$
SE	0.03	0.04	0.03	0.05	

SE = standard error.
*Significant at .01 level.
[a]Based on seven-point Likert scale.
[b]Numbers in parentheses indicate the cluster from which this cluster is significantly different at .05 level of significance based on the Scheffe pairwise comparison.

In order to assess cross-group differences, we conducted a one-way analysis of variance (ANOVA) to test for differences in group means. Table 4 provides data for the cluster means, standard errors (SE), the F test, and Scheffe comparisons. Cluster 1 has a relatively high value for agile supply chain characteristics and lower value of lean supply chain characteristics, thus we can name it the *Agile* strategy group. Cluster 2 has the highest values of both lean and agile supply chain characteristics among all the groups. Therefore, we name it as *Lean/Agile* group. This name is chosen to represent the group that combines lean and agile characteristics, because they appear to emphasize both lean and agile strategies. As we will examine later, this is not to say that they are achieving both strategies, rather they are *trying* to achieve both. Cluster 3 has the lowest values for both lean and agile supply chain characteristics. Due to the apparent lack of a singular focus, we name this group the *Traditional* group. Finally, Cluster 4 has a very high value for lean supply chain characteristics but the lowest value for agile supply chain characteristics. Thus, this relatively focused group is named as pure *Lean* group. Our results provide support for Proposition 1 and its related subhypotheses.

As a check for the influence of several demographic variables, we tested the lean and supply chain strategies against other factors using ANOVA. To gauge the impact of firm size, we divided our sample into three roughly equal size groups based on company sales (small = less than US$1.46 million, medium = US$1.46 to US$4.37 million, and large = more than US$4.37 million). Table 5A shows that medium-sized companies have significantly lower emphasis on lean strategy than small companies. Table 5B shows that collective-owned companies have significantly lower emphasis on lean strategy than foreign-owned companies. Neither size nor ownership shows significant impacts on agile strategy. Table 5C shows that companies in the plastic and latex companies show significantly higher emphasis on lean strategy than machinery and chemical/petroleum industries. These companies also have significantly higher emphasis on agile strategy than companies in the food and beverage and electrical industries. Finally, Table 5D shows that raw material suppliers are significantly less likely to use lean than are manufacturers. An ANOVA for role (subordinate or leader) did not reveal any significant differences, thus the result is not included here.

Table 5: Analysis of variance for control variables versus supply chain strategy.

A. Size

	(1) $N = 197$ Small	(2) $N = 210$ Medium	(3) $N = 197$ Large	F Value
Lean supply chain				
Cluster mean	5.31(2)	5.07(1)	5.18	$F = 4.38^*$
SE	0.06	0.06	0.06	
Agile supply chain				
Cluster mean	4.87	4.77	4.77	$F = 0.90$
SE	0.07	0.05	0.06	

B. Ownership

	(1) $N = 124$ State-owned	(2) $N = 67$ Collective-owned	(3) $N = 181$ Private	(4) $N = 79$ Foreign-owned	(5) $N = 91$ Joint Venture	(6) $N = 62$ Public Listed	F Value
Lean supply chain							
Cluster mean	5.10	4.88(4)	5.23	5.44(2)	5.25	5.13	$F = 4.08^*$
SE	0.07	0.11	0.06	0.09	0.09	0.10	
Agile supply chain							
Cluster mean	4.70	4.77	4.88	4.90	4.75	4.74	$F = 1.02$
SE	0.07	0.08	0.07	0.11	0.09	0.11	

C. Industry

	$N = 62$ (1)	$N = 54$ (2)	$N = 53$ (3)	$N = 199$ (4)	$N = 65$ (5)	$N = 97$ (6)	$N = 42$ (7)	$N = 32$ (8)	F Value
Lean supply chain									
Mean	5.366	5.32	5.27	5.17	5.24	4.97(8)	4.92(8)	5.44(6, 7)	$F = 2.86^*$
SE	0.10	0.11	0.10	0.06	0.10	0.08	0.11	0.15	
Agile supply chain									
Mean	4.59(8)	5.12	4.88	4.78	4.65(8)	4.73	4.70	5.28(1, 5)	$F = 3.71^*$
SE	0.12	0.12	0.12	0.06	0.09	0.08	0.12	0.20	

Industry:

(1) Food and beverage
(2) Electronic and communication equipment
(3) Transportation equipment
(4) Textile and garment
(5) Electrical equipment
(6) Machinery
(7) Chemicals and petroleum
(8) Plastic and latex

D. Position

	(1) $N = 62$ Raw Material Supplier	(2) $N = 106$ Components Supplier	(3) $N = 436$ Manufacturer	F Value
Lean supply chain				
Mean	4.85(3)	5.18	5.23(1)	$F = 6.11^*$
SE	0.10	0.07	0.04	

Continued

Table 5: (Continued)

D. Position				
	(1) $N = 62$ Raw Material Supplier	(2) $N = 106$ Components Supplier	(3) $N = 436$ Manufacturer	F Value
Agile supply chain				
Mean	4.77	4.78	4.81	$F = 0.09$
SE	0.09	0.09	0.04	

SE = standard error.
*Significant at .01 level.
No roles tested.

Product Characteristics and Supply Chain Strategies

More important than simply determining the supply chain strategies in Table 4, we wish to assess the degree of fit between the product characteristics and each strategy. To do this, we examine the two product characteristics factors labeled Functional and Innovative, as shown in the Appendix. The Functional scale is labeled as such because the two items that load highly are both associated with more functional products (Fisher, 1997; Selldin & Olhager, 2007). Namely, PC3 asks about the volume of each product type with higher responses indicating higher volume and PC4 asks about the length of the introduction interval with a higher number indicating longer intervals for new production introductions. In both cases, the high loadings fit with a more functional product. The second scale is labeled as Innovative because the two items that load highly are associated with innovative products (Fisher, 1997; Selldin & Olhager, 2007). PC1 addresses the variation in demand for each product, with higher responses equating to high variability, while PC2 addresses the time-to-market with high responses equating to shorter times. The high loadings fit well with an innovative product. As shown in the Appendix, the two factors explain 67.3% of the variance.

Table 6 provides the results of an ANOVA of the two product characteristics based on the supply chain strategy group from Table 4. The data generally fit with the predictions of Fisher (1997) and Selldin and Olhager (2007). In particular, the lean strategy group has the lowest value for Innovative and a relatively

Table 6: Analysis of variance of product characteristics by supply chain strategy.

	(1) Agile ($n = 172$)	(2) Lean/Agile ($n = 151$)	(3) Traditional ($n = 147$)	(4) Lean ($n = 134$)	F Value
Functional					
Cluster mean	4.72(2, 3)	5.08(1, 3)	4.20(1, 2, 4)	4.85(3)	$F = 18.32^*$
SE	0.08	0.08	0.09	0.09	
Innovative					
Cluster mean	4.58(3, 4)	4.50(3, 4)	4.22(1, 2)	4.09(1, 2)	$F = 6.88^*$
SE	0.07	0.10	0.07	0.11	

SE = standard error.
*Significant at .01 level.
Numbers in parentheses indicate the cluster from which this cluster is significantly different at .05 level of significance based on the Scheffe pairwise comparison.

high value for Functional products. In contrast, the Agile and Lean/Agile groups have the highest values for Innovative. Interestingly, there is less difference for functional product characteristics, with the main difference in that the traditional strategy group is significantly lower than the other groups. It is unclear why there is insignificant difference between the Agile and Lean groups in the functional product characteristics. It may be because most Chinese companies are producing functional products and they need both lean and agile capabilities in order to reduce cost. In other words, all of the companies have some functional products, but the Lean companies are different in that they make little or no effort to pursue innovative products while the agile and lean/agile companies do emphasize more on innovative products.

In summary, the data in Table 6 provide good support for Proposition 2 and related Hypotheses. While the fit between product characteristics is not always as strong as we would like, it is relatively good. Selldin and Olhager (2007) used a more bivariate approach, but ended their research noting that there was a need to examine firms on the supply chain frontier—or our Lean/Agile group—thus we examine the relationship between strategy and performance next.

Impact of Supply Chain Strategy on Performance

To examine the impact of a fit between product characteristics and supply chain strategies on financial performance, we conduct a one-way ANOVA of supply chain strategy on financial performance and two operational performance factors—customer service and operating cost. The results of the ANOVA are shown in Table 7.

For all three performance measures, the Traditional group is significantly worse than the other three groups. The Lean/Agile group is the best performing group overall, with significantly better customer service than all other three groups and significantly better operating cost performance than Agile and Traditional companies. The Lean group has significantly better operating cost than the Agile

Table 7: Analysis of variance of financial and operational performance by supply chain strategy.

	(1) $N = 172$ Agile	(2) $N = 151$ Lean/Agile	(3) $N = 147$ Traditional	(4) $N = 134$ Lean	F Value
Financial performance					
Cluster mean	4.68 (3)	4.90 (3)	4.25 (1, 2, 4)	4.75 (3)	$F = 15.33^*$
SE	0.06	0.08	0.05	0.09	
Customer Service					
Cluster mean	5.42 (2, 3)	5.90 (1, 3, 4)	4.73 (1, 2, 4)	5.60 (2, 3)	$F = 76.75^*$
SE	0.06	0.05	0.05	0.06	
Operating Cost					
Cluster mean	4.80 (2, 3, 4)	5.19 (1, 3)	4.33 (1, 2, 4)	5.17 (1, 3)	$F = 45.24^*$
SE	0.05	0.07	0.05	0.07	

SE = standard error.
*Significant at .01 level.
Numbers in parentheses indicate the cluster from which this cluster is significantly different at .05 level of significance based on the Scheffe pairwise comparison.

group. This supports the concept that a Lean strategy should improve operating costs better than an Agile strategy. Interestingly, the Agile group does not have better customer service than the Lean group. Overall, the data provide good support for Proposition 3 and its three related subhypotheses.

DISCUSSION

Our study is one of the first large-scale empirical studies to investigate supply chain strategies and examine the relationship between product characteristics and supply chain strategy. Using data from Chinese manufacturers and statistical analyses, we obtained several important results regarding supply chain strategy, product characteristics, and financial performance. The focus on Chinese companies is particularly important, because supply chain characteristics that have been developed and validated in heavily industrialized and developed nations of the world have not been tested in rapidly developing countries such as China. Our study confirms the generalizability of previous research findings in the fastest growing economy of the world, China.

First, our research shows that manufacturers in China can be classified into four strategic groups: lean, agile, lean/agile, and traditional. The first three groups are consistent with those found in prior research. This result shows that the concepts of lean, agile, and lean/agile strategies in developed economies can be generalized to more dynamic and developing economies. The identification of companies utilizing agile and lean/agile strategies is of particular interest. The focus of multinational companies in seeking to reduce costs through outsourcing in China and other Asian countries, suggests that the agile strategy proposed by researchers including Fisher (1997), Christopher (2000), and Yusuf et al. (2004), may not be applicable in China. In contrast, our findings suggest that a subset of companies is successfully applying an agile or lean/agile strategy in China. Furthermore, our research goes beyond a descriptive approach and provides prescriptive insights. For managers, this indicates that it is possible to follow a strategy that focuses on either developing a lean or agile supply chain strategy. A combination of the two, or lean/agile, appears to outperform either strategy individually, but likely requires more challenging management.

Second, we examine the product characteristics/supply chain strategy matrix proposed by Fisher (1997). While this matrix has been widely accepted by researchers, it has not been tested in a broad empirical manner. Results of a cluster analysis indicate that a firm's product characteristics match well the supply chain strategy predicted by existing typologies. In particular, a lean strategy is associated with very low values for innovative products while an agile strategy is marked by much higher values for innovative products. These results provide support for the product characteristics/supply chain strategy matrix.

Finally, we test for differences in financial performance of companies using different supply chain strategies. The group with a traditional strategy was found to have substantially worse financial and operational performance due to its lack of emphasis on supply chain capabilities. This suggests that choosing a focused path—either lean or agile or a combination—is of a substantial benefit. The three groups of companies with emphasis on lean, agile, or a combination of the two strategies have statistically equal financial performance. These results provide support for the concept of equifinality or the ability to achieve similar positive outcomes by pursuing different supply chain strategies. This extends prior research on a corporate strategy to the area of supply chain strategy (Doty, Glick, & Huber, 1993). Interestingly, the lean/agile strategy performed better than other strategies in terms of customer Service and better than all strategies except lean on operating cost performance. In addition, the lean/agile strategy and lean strategy performed significantly better than agile strategy in terms of operating cost. These results substantiate the previous findings that agile capabilities can help firms increase customer service, while lean capabilities can improve cost performance.

Although this study makes a significant contribution to the supply chain management research, there are some limitations as well as numerous opportunities for future research. First, while the study provides support for the applicability of a general typology of supply chain strategies and the product characteristics/supply chain strategy (PC/SCS) matrix in the rapidly developing economy of China, the data underscore the complexity of supply chain management. There is clearly a strong need to continue to refine and improve both measures of supply chain strategy and the ways in which it is implemented. It will also be fruitful to test and validate the measures of supply chain strategy and product characteristics and to examine the PC/SCS matrix using data from different industries and from different parts of the world.

Second, there is a strong need to identify the factors that influence the choice of supply chain strategies and investigate their impacts on adoption of supply chain strategies and effectiveness of these strategies. These factors will include competitive environment, competitive strategies, and organizational characteristics. For example, how does the firm's competitive strategy influence supply chain strategy and how does environmental uncertainty influence the effectiveness of supply chain strategies? Investigations of these questions will help firms adopt the most effective strategies to enhance their performance. Furthermore, more in-depth investigations of how ownership and governance mechanism of firms within the supply influence the choice and implementation of supply chain strategies can also help to reveal how firms interact with each other in strategic supply chain decisions.

Finally, this study used cross-sectional data to testify the conceptual model. Future longitudinal studies would be very helpful to provide insights regarding evolutionary changes between product characteristics and supply chain strategy. In particular, there is a strong need to study and map the evolutionary path of Chinese companies over the next 10 years to see how closely it parallels and diverges from the path taken by North American, European, and Japanese firms in the past decades. [Received: December 2007. Accepted: May 2009.]

REFERENCES

Aitken, J., Childerhouse, P., & Towill, D. (2003). The impact of product life cycle on supply chain strategy. *International Journal of Production Economics, 85*(2), 127–140.

Beamon, B. M. (1999). Measuring supply chain performance. *International Journal of Operations & Production Management, 19*(3), 275–292.

Boyer, K. K., Ward, P. T., & Leong, G. K. (1996). Approaches to the factory of the future: An empirical taxonomy. *Journal of Operations Management, 14*(4), 297–313.

Bozart, C. C., Warsing, D. P., Flynn, B. B., & Flynn, E. J. (2009). The impact of supply chain complexity on manufacturing plant performance. *Journal of Operations Management, 27*(1), 78–93.

Bruce, M., Daly, L., & Towers, N. (2004). Lean or agile: A solution for supply chain management in the textiles and clothing industry? *International Journal of Operations & Production Management, 24*(2), 151–170.

Bruun, P., & Mefford, R. N. (2004). Lean production and the internet. *International Journal of Production Economics, 89*(3), 247–260.

Chen, I. J., & Paulraj, A. (2004). Towards a theory of supply chain management: The constructs and measurements. *Journal of Operations Management, 22*(2), 119–150.

Childerhouse, P., Aitken, J., & Towill, D. R. (2002). Analysis and design of focused demand chains. *Journal of Operations Management, 20*(6), 675–689.

Choi, T. Y., & Eboch, K. (1998). The TQM paradox: Relations among TQM practices, plant performance, and customer satisfaction. *Journal of Operations Management, 17*(1), 59–75.

Christopher, M. (2000). The agile supply chain: Competing in volatile markets. *Industrial Marketing Management, 29*(1), 37–44.

Christopher, M., & Towill, D. R. (2000). Supply chain migration from lean and functional to agile and customized. *Supply Chain Management: An International Journal, 5*(4), 206–213.

Cooper, R. (1990). Cost classification in unit-based and activity-based manufacturing cost systems. *Journal of Cost Management, 6*(Fall), 4–14.

Das, S. R., & Joshi, M. P. (2007). Process innovativeness in technology services organizations: Roles of differentiation strategy, operational autonomy and risk-taking propensity. *Journal of Operations Management, 25*(3), 643–660.

De Toni, A., & Tonchia, S. (2001). Performance measurement systems: Models, characteristics and measures. *International Journal of Operations & Production Management, 21*(1/2), 46–70.

Dess, G., & Davis, P. (1984). Porter's (1980) generic strategies as determinants of strategic groups membership and organizational performance. *Academy of Management Journal, 27*(3), 467–488.

Doty, D. H., Glick, W. H., & Huber, G. P. (1993). Fit, equifinality, and organizational effectiveness: A test of two configurational theories. *Academy of Management Journal, 36*(6), 1196–1250.

Farh, J. L., Cannella, A. A., & Li, C. (2006). Approaches to scale development in Chinese management research. *Management and Organizational Review, 2*(3), 301–318.

Fisher, M. L. (1997). What is the right supply chain for your product? *Harvard Business Review, 75*(2), 105–116.

Flynn, B. B., Sakakibara, S., Schroeder, R. G., Bates, K. A., & Flynn, E. J. (1990). Empirical research methods in operations management. *Journal of Operations Management, 9*(2), 250–284.

Frohlich, M. T. (2002). Techniques for improving response rates in OM survey research. *Journal of Operations Management, 20*(1), 53–62.

Frohlich, M. T., & Dixon, J. R. (2001). A taxonomy of manufacturing strategies revisited. *Journal of Operations Management, 19*(5), 541–558.

Goldman, S., Nagel, R., & Preiss, K. (1995). *Agile competitors and virtual organizations*. New York: Van Nostrand Reinhold.

Gunasekaran, A., Patel, C., & Tirtiroglu, E. (2001). Performance measures and metrics in a supply chain environment. *International Journal of Operations & Production Management, 21*(1/2), 71–87.

Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (1998). *Multivariate data analysis* (5th ed.). Upper Saddle River, NJ: Prentice Hall.

Heikkilä, J. (2002). From supply to demand chain management: Efficiency and customer satisfaction. *Journal of Operations Management, 20*(6), 747–767.

Hu, L., & Bentler, P. M. (1998). Fit indices in covariance structure modeling: Sensitivity to underparameterized model misspecification. *Psychological Methods, 3*(4), 424–453.

Huang, S. H., Uppal, M., & Shi, J. (2002). A product driven approach to manufacturing supply chain selection. *Supply Chain Management: An International Journal, 7*(4), 189–199.

Jiang, B., Frazier, G. V., & Heiser, D. (2007). China-related POM research: A literature review and suggestions for future research. *International Journal of Operations and Production Management, 27*(7), 662–684.

Johnson, R. A., & Wichern, D. W. (1998). *Applied multivariate statistical analysis*. Upper Saddle River, N.J.: Prentice-Hall.

Katayama, H., & Bennett, D. (1999). Agility, adaptability and leanness: A comparison of concepts and a study of practice. *International Journal of Production Economics, 60–61*, 43–51.

Kathuria, R. (2000). Competitive priorities and managerial performance: A taxonomy of small manufacturers. *Journal of Operations Management, 18*(6), 627–641.

Kidd, P. T. (1994). *Agile manufacturing: Forging new frontiers*. Boston: Addison-Wesley Longman.

Lambert, D. M., & Cooper, M. C. (2000). Issues in supply chain management. *Industrial Marketing Management, 29*(1), 65–83.

Lee, H. (2004). The triple-A supply chain. *Harvard Business Review, 82*(10), 102–112.

Lehmann, D. R. (1979). *Market research and analysis*. Homewood, IL: R. D. Irwin.

Li, S., Rao, S. S., Ragu-Nathan, T. S., & Ragu-Nathan, B. (2005). Development and validation of a measurement instrument for studying supply chain management practices. *Journal of Operations Management, 23*(6), 618–641.

Mabert, V. A., & Venkataramanan, M. A. (1998). Special research focus on supply chain linkages: Challenges for design and management in the 21st century. *Decision Sciences, 29*(1), 537–552.

Malhotra, M. K., & Grover, V. (1998). An assessment of survey research in POM: From construct to theory. *Journal of Operations Management, 16*(4), 407–425.

Mason-Jones, R., Naylor, B., & Towill, D. R. (2000). Lean, agile or leagile? Matching your supply chain to the marketplace. *International Journal of Production Research, 38*(17), 4061–4070.

Narasimhan, R., & Jayaram, J. (1998). An empirical investigation of the antecedence and consequences of manufacturing goal achievement in North American, European and Pan Pacific firms. *Journal of Operations Management, 16*(4), 159–176.

Narasimhan, R., & Kim, S.W. (2002). Effect of supply chain integration on the relationship between diversification and performance: Evidence from Japanese and Korean firms. *Journal of Operations Management, 20*(3), 303–323.

Naylor, J. B., Naim, M. M., & Berry, D. (1999). Leagility: Integrating the lean and agile manufacturing paradigms in the total supply chain. *International Journal of Production Economics, 62*(1–2), 107–118.

Nunnally, J. C. (1978). *Psychometric theory* (2nd ed.). New York: McGraw-Hill.

O'Leary-Kelly, S. W., & Vokurka, R. J. (1998). The empirical assessment of construct validity. *Journal of Operations Management, 16*(4), 387–405.

Porter, M. E. (1986). *Competitive strategy: Techniques for analyzing industries and competitors*. New York: Free Press.

Rabinovich, E., Knemeyer, A. M., & Mayer, C. M. (2007). Why do internet commerce firms incorporate logistics service providers in their distribution channels? The role of transaction costs and network strength. *Journal of Operations Management, 25*(3), 661–681.

Randall, T., & Ulrich, K. (2001). Product variety, supply chain structure, and firm performance: Analysis of the U.S. bicycle industry. *Management Science, 47*(12), 1588–1604.

Roth, A. V., & Miller, J. G. (1992). Success factors in manufacturing. *Business Horizons, 35*(4), 73–81.

Safizadeh, M. H., Ritzman, L. P., & Mallick, D. (2000). Revisiting alternative theoretical paradigms in manufacturing strategy. *Production and Operations Management, 9*(2), 111–127.

Schmenner, R. W., & Swink, M. L. (1998). On theory in operations management. *Journal of Operations Management, 17*(1), 97–113.

Selldin, E., & Olhager, J. (2007). Linking products with supply chains: Testing Fisher's model. *Supply Chain Management: An International Journal, 12*(1), 42–51.

Vickery, S. K., Jayaram, J., Droge, C., & Calantone, R. (2003). The effects of an integrative supply chain strategy on customer service and financial performance: An analysis of direct versus indirect relationships. *Journal of Operations Management, 21*(5), 523–539.

Yusuf, Y. Y., Gunasekaran, A., Adeleye, E. O., & Sivayoganathan, K. (2004). Agile supply chain capabilities: Determinants of competitive objectives. *European Journal of Operational Research, 159*(2), 379–392.

Yusuf, Y. Y., Sarhadi, M., & Gunasekaran, A. (1999). Agile manufacturing: The drivers, concepts and attributes. *International Journal of Production Economics, 62*(1–2), 33–43.

Wikipedia (2007). Economy of the People's Republic of China, accessed October 4, 2007, Available at http://en.wikipedia.org/wiki/Economy_of_the_People's_Republic_of_China.

Womack, J., & Jones, D. (2003). *Lean thinking*. London: Simon & Schuster.

Zhao, X., Huo, B., Flynn, B., & Yeung, H. (2008). The impact of power and relationship commitment on the integration between manufacturers and customers in a supply chain. *Journal of Operations Management, 26*(3), 368–388.

Zhao, X., Sum, C. C., Qi, Y., Zhang, H., & Lee, T. S. (2006). A taxonomy of manufacturing strategies in China. *Journal of Operations Management, 24*(5), 621–636.

Zhao, X., Flynn, B. B., & Roth, A. V. (2007). Decision science research in China: Current status, opportunities, and propositions for research in supply chain management, logistics, and quality management. *Decision Sciences, 38*(1), 39–80.

APPENDIX: ITEMS AND SCALES

The following items are rated from 1 = Strongly Disagree to 7 = Strongly Agree

Table A1: Factor analysis for supply chain strategy.

	Lean Strategy Eigenvalue = 3.02 Cronbach's Alpha = 0.79	Agile Strategy Eigenvalue = 2.70 Cronbach's Alpha = 0.75
LS1. Our supply chain supplies predictable products	**.717**	−.015
LS2. Our supply chain reduces any kind of waste as much as possible	**.758**	.183
LS3. Our supply chain reduces costs through mass production.	**.566**	.182
LS4. Our supply chain provides customer with standardized products[a]	*NA*	*NA*
LS5. Our supply chain needs to maintain a long and rigid relationship with a small number of suppliers	**.718**	.057
LS6. Our supply chain selects the suppliers based on their performance on cost and quality	**.733**	.157

Continued

Table A1: (Continued)

	Lean Strategy Eigenvalue = 3.02 Cronbach's Alpha = 0.79	Agile Strategy Eigenvalue = 2.70 Cronbach's Alpha = 0.75
LS7. Our supply chain structure seldom changes	**.638**	.039
AS1. Our supply chain always faces the volatile customer demand	.020	**.573**
AS2. Our supply chain responds to the changing market environment quickly[a]	*NA*	*NA*
AS3. It is necessary for our supply chain to maintain a higher capacity buffer to respond to volatile market	.287	**.525**
AS4. Our supply chain provides customer with personalized products	.002	**.670**
AS5. Our supply chain selects the suppliers based on their performance on flexibility and responsiveness	.206	**.677**
AS6. Our supply chain needs to maintain a short and flexible relationship with a large number of suppliers	.149	**.715**
AS7. Our supply chain structure often changes in order to cope with volatile market	.015	**.760**

Note: The numbers greater than 0.50 are in bold.
[a]These items were dropped from the final construct due to low loadings on the primary factor (below 0.50) or high cross-loadings (above 0.40).

Operational performance (OP) rated from 1 = Much Worse than Competition to 7 = Much Better than Competition.

Table A2: Factor analysis for operational performance.

	Customer Service Eigenvalue = 5.18 Cronbach's Alpha = 0.90	Operating Cost Eigenvalue = 2.86 Cronbach's Alpha = 0.77
OP1. Unit manufacturing cost	.122	**.714**
OP2. Inventory turnover	.171	**.763**
OP3. Overall labor productivity	.301	**.651**
OP4. Stockout cost	.131	**.641**
OP5. Obsolescence cost	.228	**.672**
OP6. Overall product quality	**.674**	.302
OP7. Customer service level	**.771**	.221
OP8. Pre-sale customer service	**.756**	.075
OP9. Product supports	**.772**	.088
OP10. Responsiveness to customers	**.721**	.113

Continued

Table A2: (Continued)

	Customer Service Eigenvalue = 5.18 Cronbach's Alpha = 0.90	Operating Cost Eigenvalue = 2.86 Cronbach's Alpha = 0.77
OP11. Delivery speed	**.697**	.232
OP12. Delivery dependability	**.692**	.283
OP13. Volume flexibility	**.683**	.249
OP14. Product mix flexibility	**.643**	.214
OP15. New product flexibility	**.630**	.268

Note: The numbers greater than 0.50 are in bold.

Financial performance (FP) rated from 1 = Much Worse than Competition to 7 = Much Better than Competition.

Table A3: Factor analysis for financial performance.

	Financial Performance Eigenvalue = 3.96 Cronbach's Alpha = 0.90
FP1. Return on investment (ROI)	**.853**
FP2. Return on sale (ROS)	**.808**
FP3. Market share	**.737**
FP4. Growth in ROI	**.852**
FP5. Growth in ROS	**.839**
FP6. Growth in market share	**.781**

Note: The numbers greater than 0.50 are in bold.

Product Characteristics (PC)—To what extent are the following statements *suitable* descriptions of your company's end products or production process? (Rated from 1 = Most Unsuitable to 7 = Most Suitable)
PC4 was rated on the following scale:
1 = <3 months, 2 = 3–6 months, 3 = 7–11 months, 4 = 1–2 years, 5 = 2–3 years, 6 = 3–5 years, 7 = >5 years

Table A4: Factor analysis for product characteristics.

	Innovative Eigenvalue = 1.38	Functional Eigenvalue = 1.32
PC1. The demand of each type of end product vary quickly	**.841**	−.055
PC2. The new product's time-to-market is very short	**.787**	.225
PC3. The volume of each type of end product is very high	−.056	**.828**
PC4. The introduction interval of new products	.223	**.763**

Note: The numbers greater than 0.50 are in bold.

Item Correlations:

Agile supply chain Strategy (AS)																															
	Mean	SD	LS1	LS2	LS3	LS4	LS5	LS6	LS7	AS1								Lean Supply Chain Strategy (LS)													
AS1	4.57	1.26	0	0.12	0.14	−0.02	−0.01	0.08	0.12	1	AS2								Mean	SD	LS1										
AS2	5.08	1.16	0.25	0.44	0.27	0.21	0.24	0.39	0.24	0.33	1	AS3						LS1	5.19	1.09	1	LS2									
AS3	4.92	1.16	0.16	0.22	0.26	0.16	0.21	0.26	0.18	0.26	0.39	1	AS4					LS2	5.27	1.24	0.49	1	LS3								
AS4	4.61	1.44	0.04	0.08	0.06	0.14	0.07	0.1	0.08	0.21	0.2	0.34	1	AS5				LS3	5	1.24	0.3	0.38	1	LS4							
AS5	4.93	1.13	0.14	0.28	0.19	0.12	0.12	0.22	0.16	0.38	0.43	0.3	0.36	1	AS6			LS4*	5.29	1.18	0.3	0.33	0.28	1	LS5						
AS6	4.96	1.18	0.13	0.22	0.16	0.15	0.13	0.22	0.09	0.31	0.42	0.28	0.36	0.42	1	AS7		LS5	5.31	1.17	0.4	0.42	0.32	0.53	1	LS6					
AS7	4.84	1.23	0.02	0.16	0.16	0.1	0.09	0.11	−0.02	0.31	0.36	0.35	0.37	0.4	0.53	1		LS6	5.37	1.18	0.38	0.54	0.34	0.47	0.49	1					
Financial performance (FP)																	FP1	LS7	4.94	1.18	0.38	0.39	0.25	0.19	0.35	0.32					
FP1	4.57	1.09	0.15	0.13	0.18	0.26	0.26	0.27	0.05	−0.04	0.14	0.19	0.18	0.13	0.16	0.13	1	FP2									OP10				
FP2	4.64	1.09	0.14	0.17	0.13	0.24	0.28	0.26	0.09	−0.03	0.12	0.13	0.14	0.11	0.06	0.11	0.73	1	FP3							OP10	1	OP11			
FP3	4.68	1.14	0.09	0.11	0.11	0.2	0.17	0.21	0.15	−0.05	0.13	0.13	0.15	0.09	0.08	0.05	0.59	0.53	1	FP4						OP11	0.18	1	OP12		
FP4	4.61	1.15	0.06	0.03	0.14	0.21	0.16	0.18	0.08	0.03	0.14	0.21	0.19	0.1	0.13	0.16	0.62	0.58	0.54	1	FP5					OP12	0.22	0.23	1	OP13	
FP5	4.65	1.11	0.05	0.05	0.17	0.21	0.19	0.2	0.04	0.05	0.15	0.18	0.21	0.13	0.2	0.22	0.62	0.54	0.5	0.76	1	FP6				OP13	0.13	0.19	0.21	1	OP14
FP6	4.7	1.13	0	0.02	0.13	0.2	0.14	0.19	0.01	0.01	0.11	0.17	0.23	0.14	0.14	0.19	0.57	0.51	0.46	0.61	0.64	1				OP14	0.39	0.35	0.32	0.32	1
Operating Cost Performance (OS)																							OP1			OP15	0.42	0.38	0.29	0.35	0.29
OP1	4.76	1.04	0.15	0.09	0.17	0.16	0.14	0.26	0.11	0.03	0.13	0.14	0.14	0.19	0.1	0.12	0.36	0.36	0.36	0.38	0.39	0.45	1	OP2							
OP2	4.92	1.15	0.19	0.23	0.21	0.2	0.26	0.32	0.24	0.05	0.21	0.14	0.11	0.11	0.06	0.02	0.36	0.33	0.37	0.32	0.32	0.3	0.51	1	OP3						
OP3	5.07	1.1	0.22	0.32	0.22	0.25	0.26	0.37	0.25	0.06	0.29	0.2	0.11	0.26	0.21	0.14	0.38	0.36	0.38	0.36	0.37	0.39	0.42	0.47	1	OP4					
OP4	4.65	1.12	0.22	0.11	0.15	0.2	0.17	0.24	0.13	0.13	0.13	0.19	0.2	0.14	0.11	0.01	0.27	0.24	0.25	0.26	0.26	0.24	0.28	0.34	0.33	1	OP5				
OP5	4.91	1.18	0.27	0.28	0.2	0.19	0.18	0.28	0.21	0.14	0.22	0.18	0.12	0.24	0.2	0.1	0.32	0.33	0.25	0.28	0.31	0.25	0.34	0.42	0.37	0.47	1				
Customer Service (CS) Performance																												OP6			
OP6	5.44	1.08	0.31	0.36	0.25	0.43	0.39	0.46	0.24	0.02	0.26	0.22	0.12	0.18	0.22	0.13	0.39	0.42	0.32	0.32	0.32	0.28	0.26	0.31	0.39	0.25	0.11	1	OP7		
OP7	5.43	1.12	0.29	0.3	0.18	0.32	0.33	0.42	0.15	0.06	0.26	0.2	0.12	0.19	0.23	0.19	0.35	0.38	0.25	0.32	0.31	0.27	0.23	0.31	0.38	0.25	0.03	0.05	1	OP8	
OP8	5.33	1.13	0.27	0.17	0.15	0.32	0.27	0.29	0.12	0.05	0.2	0.2	0.18	0.15	0.16	0.21	0.32	0.29	0.22	0.28	0.31	0.23	0.2	0.2	0.22	0.23	0.13	0.21	0.29	1	OP9
OP9	5.42	1.11	0.28	0.21	0.18	0.33	0.28	0.35	0.14	0.01	0.25	0.29	0.16	0.15	0.17	0.2	0.32	0.35	0.27	0.34	0.37	0.27	0.2	0.21	0.29	0.2	0.14	0.14	0.2	0.19	1
OP10	5.44	1.05	0.22	0.25	0.19	0.27	0.26	0.27	0.15	0.06	0.28	0.17	0.18	0.24	0.22	0.25	0.29	0.3	0.23	0.25	0.3	0.26	0.2	0.24	0.34	0.15	0.14	0.11	0.11	0.2	0.12
OP11	5.62	1.03	0.32	0.31	0.23	0.32	0.34	0.36	0.21	0	0.28	0.21	0.04	0.18	0.19	0.15	0.33	0.34	0.2	0.24	0.25	0.2	0.23	0.29	0.39	0.19	0.19	0.11	0.26	0.14	0.24
OP12	5.62	1.07	0.34	0.35	0.25	0.39	0.39	0.39	0.21	0.02	0.27	0.21	0.12	0.16	0.19	0.15	0.33	0.34	0.21	0.24	0.27	0.21	0.24	0.35	0.36	0.25	0.1	0.06	0.21	0.11	0.2
OP13	5.38	1.06	0.26	0.33	0.27	0.35	0.34	0.34	0.19	0.12	0.31	0.3	0.21	0.22	0.21	0.2	0.29	0.28	0.22	0.27	0.3	0.21	0.27	0.32	0.31	0.22	0.12	0.02	0.14	0.01	0.1
OP14	5.2	1.16	0.11	0.12	0.24	0.25	0.17	0.27	0.09	0.14	0.23	0.32	0.31	0.26	0.25	0.27	0.32	0.26	0.25	0.31	0.35	0.28	0.24	0.26	0.31	0.23	0.36	0.36	0.38	0.27	0.32
OP15	5.24	1.23	0.14	0.13	0.19	0.23	0.18	0.25	0.07	0.12	0.24	0.28	0.34	0.26	0.27	0.33	0.32	0.24	0.25	0.35	0.38	0.32	0.29	0.28	0.34	0.26	0.36	0.33	0.36	0.24	0.33

Note: All correlations > 0.07 are significant at $p < .05$, all correlations > 0.09 are significant at $p < .01$.

Yinan Qi is an assistant professor of operations management at the School of Business, University of International Business and Economics. He received a PhD in operations management from The Chinese University of Hong Kong and joined the University of International Business and Economics in 2006. He has taught courses on operations management, supply chain management, and business strategy game. He has published several journal articles in publications including *Journal of Operations Management* and *International Journal of Operations and Production Management*.

Kenneth K. Boyer is a Dean's Distinguished Professor of operations management at the Fisher College of Business, Ohio State University. He is co-editor in chief of the *Journal of Operations Management.* He previously was a professor of supply chain management at the Broad College of Management, Michigan State University from 2000 to 2008. Prior to that, he was an assistant/associate professor at DePaul University from 1995 to 2000. He earned a BS in mechanical engineering from Brown University and an MA and a PhD in business administration from Ohio State University. He worked as a project engineer with General Dynamics Electric Boat Division in Groton, CT. He has published more than 40 journal articles in publications including *Management Science*, *Journal of Operations Management*, and *Production and Operations Management Sciences*.

Xiande Zhao is a professor of operations management in the Department of Decision Sciences and Managerial Economics and is director of the Center for Supply Chain Management and Logistics, Li and Fung Institute of Supply Chain Management and Logistics, The Chinese University of Hong Kong. He received his PhD in operations management and a minor in international business at the University of Utah. He has published more than 50 journal articles in *Journal of Operations Management*, *Production and Operations Management*, *Journal of Consumer Research*, and *International Journal of Production Research*. He is an associate editor of the *Journal of Operations Management, Decision Sciences, Operations Management Research*, and *International Journal of Business and Systems*. He is the president of the Asia Pacific Institute of Decision Sciences and International Association of Information and Management Sciences.