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An Empirical Investigation of the Impact of Strategic Sourcing and Flexibility on Firm's Supply Chain Agility

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Review

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Abstract

Purpose – The objective of this study is to investigate two potentially key drivers of a firm’s supply chain agility, namely strategic sourcing and firm’s strategic flexibility. Despite some theoretical and conceptual works suggesting that some elements of these two constructs may relate to agility, this has not yet been assessed together empirically. This study aims to address this gap in the literature.

Design/Methodology/approach - This study involves an empirical investigation of a theory-based model based on the competence-capability framework, and a dynamic capabilities theoretical perspective, where the internal competencies of strategic sourcing and firm’s strategic flexibility relate to the dynamic capability of the firm’s supply chain agility. This investigation also includes the testing of a possible mediation effect of firm’s strategic flexibility on the relationship between strategic sourcing and the firm’s supply chain agility. The model is tested utilizing data from 144 U.S. manufacturing firms via partial least square (PLS) methodology.

Findings – The results of the empirical study indicated that both strategic sourcing and firm’s strategic flexibility were significantly related to the firm’s supply chain agility. In addition, while a full mediation effect was not found on the part of strategic flexibility, there was evidence for partial mediation.

Research limitations/implications – Given that the data is from specific U.S. industries, the generalizability of current findings to other industries or countries may require additional investigation.

Originality/value – Given the attention paid to agility in terms of its importance to responding to business uncertainty, and more recently, as an important capability in managing supply chain disruption risks, this paper investigates how strategic sourcing and flexibility can contribute to agility.

Key words: *Supply Chain Management; Strategic Sourcing; Strategy Development; Partial Least Squares*

Paper type: Research paper

INTRODUCTION

Supply chain agility has received increasing attention over the last decade due to two important developments. First, firms have increasingly been competing in business environments characterized by short product life cycles, globally extended supply chains, and volatile demand patterns. Second, issues relating to supply chain disruption risk have been gaining prominence. Given such developments, the cultivation of supply chain agility has been suggested as an effective response strategy (Braunscheidel and Suresh, 2009; Lee, 2004; Swafford *et al.*, 2006).

Research on issues surrounding flexibility, agility and responsiveness has been of topical interest to both academics and practitioners. One of the key developments in this context has been the recognition that the terms flexibility and agility have been used somewhat interchangeably in the past. Accordingly, a new research stream investigating the differences between flexibility and agility has emerged in the context of improving the competitiveness of firms operating in volatile business conditions. Among the recent works, study of Swafford *et al.* (2006) considered flexibility-agility to have a competence-capability relationship (Prahalad and Hammel, 1990), where competence is about “what an organization can do particularly well” (Andrews, 1987), and capability is defined as “appropriately adapting, integrating, and reconfiguring internal and external organizational skills, resources, and functional competences to match the requirements of a changing environment” (Teece *et al.*, 1997). This raises issues relating to the fit of a competence with the needs of an organization facing fast-changing demands in the marketplace.

This framework has subsequently been used in other studies on flexibility and agility (e.g., Braunscheidel and Suresh, 2009; Li and Ogunmokun, 2008). It has been recognized that a system can be flexible without being agile, while an agile system is definitely flexible (Prahalad and Hammel, 1990). In line with these developments, flexibility is defined in this study as: a competence built by an organization to be able to change or react with little penalty in time, cost, or performance (Swafford *et al.*, 2006) whereas a “firm’s supply chain agility” is defined as: the

capability of the firm, internally, and in conjunction with its key suppliers and customers, to adapt or respond in a speedy manner to a changing marketplace, contributing to agility of the extended supply chain (Braunscheidel and Suresh, 2009). In other words, while flexibility concerns the manager in terms of what kind of processes should be designed, what kind of resources should be obtained and what investments made to reduce time, cost or performance penalties to adjust to changes, agility is more specifically about whether the organization has made investments that are aligned with the competitive demands of the environment.

In addition to flexibility-agility linkage, a second emerging stream of research has been on how different sourcing strategies may contribute to the agility of a firm. Christopher (2000) was an early work recognizing the linkages between sourcing, flexibility and agility. Paulraj and Chen (2007) concluded that firms become more agile with enhanced strategic buyer-supplier relationships. Ledyard and Keough (2007) described the case of a firm which augmented agility through better information sharing with its suppliers. Swafford *et al.* (2006) found that sourcing flexibility has a positive and direct impact on agility. However, with the exception of Khan and Pillania (2008), the above studies in this stream have investigated the influence of various elements of strategic purchasing with agility, without considering them comprehensively under the construct of strategic sourcing. In the work of Khan and Pillania (2008), flexibility is not considered as a separate construct, and it was shown that strategic sourcing has a positive impact on supply chain agility and business performance. In Kocabasoglu and Suresh (2006), the notion of strategic sourcing is defined as a construct consisting of four sub-constructs: strategic purchasing, inter-functional integration of purchasing, information sharing with suppliers, and supplier development. We utilize this comprehensive construct of strategic sourcing for the current study. Table 1 provides a summary of past research studies which have partially explored the linkages between the three constructs of strategic sourcing, flexibility and agility. It is seen from Table 1 that only four studies address the issue of agility, based on various antecedents.

TABLE 1
Comparisons of the Impact of Strategic Sourcing and Flexibility on Agility

Work	Antecedent	Intermediate variables	DV	Conclusion
Narasimhan and Das (1999a)	Strategic Sourcing Advanced Manufacturing Technology	Modif. Flexibility Volume Flexibility New Prod. Flexibility	Mfg. Cost Reduction	Strategic sourcing assists in achievement of modification flexibilities, which has a positive impact on new product flexibility and mfg. cost reduction.
Das (2001)	Purchasing Competence Advanced Manufacturing Technology	Modif. Flexibility Mix Flexibility New Product Flexibility	Fit with Business Strategy Firm Performance Mfg. Priorities	A framework linking purchasing competence and advanced mfg. technology with mfg. flexibility and mfg. flexibility with agility.-related practices. A positive connection between mfg. flexibility and agility activities was found.
Swafford <i>et al.</i> (2006)	Procurement Flexibility Mfg. Flexibility Distribution Flexibility		Supply Chain Agility	Degree of flexibility present in procurement / sourcing and mfg. process has direct and positive impact on supply chain agility while distribution/ logistics process only provides an indirect impact.
Paulraj and Chen (2007)	Strategic Buyer-supplier Relationships Information Technology	External Logistics Integration	Agility Performance	Strategic buyer-supplier relationships and information technology engender external logistics integration, which in turn, enhance agility performance.
Khan and Pillania (2008)	Strategic Sourcing		SC Agility Org. Performance	Strategic sourcing has positive impact on both supply chain agility and organizational performance.
Braunscheidel and Suresh (2009)	Market Orientation Learning Orientation	Internal Integration External Integration External Flexibility	Supply Chain Agility	Internal integration, external integration, and external flexibility were examined to have positive influences on the firm's supply chain agility.

Given these developments, it is of significant interest currently to investigate the influence of strategic sourcing alongside flexibility on supply chain agility, with all three constructs defined comprehensively. This study is also based on a theoretical platform that considers strategic sourcing and flexibility as internal *competences* which may lead to the *capability* of agility. In addition to this competence-capability relationship, we consider agility as a dynamic capability, drawing from the theory of dynamic capabilities (Teece *et al.*, 1997; Teece 2007), which extends both resource-based view (RBV) of the firm and the competence-capability perspective.

This work contributes to the research literature on agility in the following ways. First, it examines the antecedents of a firm’s agility in the supply chain context more broadly than prior studies. A few past studies have investigated the relationship individually between sub-elements of strategic sourcing and agility, between firm-level flexibilities and firm-level agility, and between strategic sourcing and firm-level flexibilities. This study considers all three key factors (strategic sourcing, flexibility and agility) together. Secondly, this study examines these relationships within a theoretical framework of competence-capability relationship, utilizing a dynamic capability perspective. This study also explores whether flexibility is a possible mediator between strategic sourcing and agility, affecting the direct relationship between strategic sourcing and agility.

From a methodology point of view, this study applies structural equation modeling to test the relationship among the three constructs, and a method for testing mediation effects. Thirdly, this research considers the influence of contextual factors such as firm size, manufacturing process, and the product characteristics, in order to examine the robustness of the relationships in various business settings. Prior works such as Swafford *et al.* (2006), Khan and Pillania (2008) and Braunscheidel and Suresh (2009) did not consider influences from the external environment, product nature, or production process.

The next section provides the theoretical background and model development, including definition of the constructs and the rationale for the research hypotheses. The following section

describes data collection and research methodology. A discussion of survey results and managerial implications of the results are provided next. Finally, the conclusions, limitations, and future research issues are mentioned in the last section.

THEORETICAL BACKGROUND AND MODEL DEVELOPMENT

In this study, strategic sourcing and the firm's strategic flexibility (FSF) are explored as two major antecedent competences for the enhancement of the firm's supply chain agility (FSCA), which is viewed as a dynamic capability. In addition, FSF is also investigated as a possible mediator that may influence the relationship between strategic sourcing and FSCA. The theoretical model postulated is shown in Figure 1. The definitions for the various constructs and the rationale for the hypothesized model structure are outlined below, after first describing the theoretical underpinnings.

----- Insert Figure 1 Approximately Here -----

A dynamic capabilities perspective (DCP) refers to the ability of a firm to achieve new forms of competitive advantage by renewing competences to achieve congruence with changing business environments (Teece *et al.* 1997; Teece 2007). The DCP is a framework which extends and applies both *resource-based view (RBV)* and the *competence-capabilities perspective* to explain the sources of firm-level competitive advantage over time (Teece *et al.*, 1997; Teece 2007). DCP explains how firms create value by developing relevant organizational processes and structures to leverage relationship assets. Dynamic capabilities, which continuously create, extend, upgrade, and protect the firm's unique asset base, are capabilities that: (1) sense and shape opportunities and threats, (2) seize chances, and (3) maintain competitiveness through enhancing, combining, protecting, and reconfiguring the organization's intangible and tangible assets. This framework assumes that firms with dynamic capabilities are able to provide timely response, and rapid, flexible product innovation, coupled with the management capability to effectively coordinate and redeploy organizational competencies. DCP has also been applied in the context of new technologies and related processes. For instance, in Wheeler (2002), DCP was

invoked to demonstrate that digital network technology (including Internet) in organizations is a dynamic capability which enables firms to create customer value in volatile environments. A description of this application was also provided by Zahra and George (2002).

Model Constructs and Sub-Constructs

The first major construct in Figure 1 pertains to strategic sourcing. The concept of strategic sourcing has evolved over the past two decades. Strategic sourcing is defined as “the process of designing and managing supply networks in line with operational and organizational performance objectives” (Narasimhan and Das, 1999) and is measured by the four sub-constructs of strategic purchasing, internal integration, information sharing, and supplier development (Kocabasoglu and Suresh, 2006). The survey items for each of these sub-constructs are adopted from Kocabasoglu and Suresh (2006), and the four sub-constructs are explained below.

Strategic purchasing: Considering increasing uncertainty in the business environment due to globalization, outsourcing and shorter product life cycles, purchasing can play a major role as a boundary spanning function that has ties both within the firm and with several business partners (Kocabasoglu and Suresh, 2006). In this study, strategic purchasing is defined as a demonstration of the strategic role of purchasing in the firm’s long-term planning and, as explained further below, this is posited to have a bearing on supply chain agility.

Internal integration: It has been shown that when firms consider the purchasing function in a strategic role, internal communication between purchasing and other departments occurs more frequently and deeply (Krafcik, 1988). Integration with other departments was found to be more frequent within firms in which purchasing managers took a proactive role (Cavinato, 1991; Reck and Long, 1988) and it improves business performance (Eng, 2005; Sislian and Satir, 2000). Our definition for internal integration is the presence of cross-functional communication between purchasing and other functions, and integrated decision making activities.

Information sharing with suppliers: Communication and information sharing are effective means to maintain mutually beneficial long-term relationships which improve supply chain performance (Monczka *et al.*, 1998; Paulraj *et al.*, 2008; Stank *et al.*, 1999). A comprehensive

review of information sharing in supply chains is available in Sahin and Robinson (2002). In this study, information sharing with suppliers refers to coordination and information sharing behavior.

Supplier development: The practice of supplier development is aimed at strengthening relationships with key suppliers so that risk of opportunistic behavior is limited. Dyer and Singh (1998) and Dwyer *et al.* (1987) claimed that if firms invest in relationship-specific assets and have shared know-how, opportunistic risk is decreased and such relationships might improve performance and reduce uncertainty. In this study, the definition of supplier development follows Krause (1999) as being any activity that a buyer undertakes to improve a supplier's performance and/or capabilities to meet the buyer's short-term or long-term supply needs.

Many past studies have investigated the impact of various aspects of strategic sourcing on business performance, but rarely on business agility. Strategic purchasing has been shown to enhance financial performance (Carr and Pearson, 1999; Chen *et al.*, 2004; Kerlinger, 1973), business performance (Gonzalez-Benito, 2007), supply chain performance (Paulraj and Chen, 2007), and customer responsiveness (Chen *et al.*, 2004). Strong buyer-supplier relationships have also been seen to improve supply chain agility (Paulraj and Chen, 2007) and enhance knowledge transfer between supply chain partners (Squire *et al.*, 2009). It also has been established that better information sharing with suppliers improves flexibility and responsiveness of the supply chain (Schmenner and Tatikonda, 2005; Stevenson and Spring, 2007). Finally, supplier development has been shown to have a positive relationship on supplier's performance (Krause *et al.*, 2000). However, the focus of interest in the current study is on the impact of strategic sourcing on the agility dimension.

The second major construct in the model shown in Figure 1 pertains to the firm's strategic flexibility (FSF). Over the years, many studies have categorized various types of flexibility. Vokurka and O'Leary-Kelly (2000) provided definitions and a review of various types of manufacturing flexibility. In recent years, the emphasis has shifted from manufacturing flexibility to supply chain flexibility. Vickery *et al.* (1999) argued that supply chain flexibility is composed of five customer-focused flexibilities: product, volume, responsiveness to target

markets, launch, and access flexibilities. They found that firms with stronger supply chain flexibility demonstrated better business performance. Among the five flexibility dimensions, volume and launch flexibilities were more linked to time-based performance measures. Sanchez and Perez (2005) identified ten supply chain flexibility dimensions, which were categorized into a framework of three layers: aggregate (supply chain), system (company) and basic (shop floor) levels. They found that firms tend to devote more efforts on the development of basic flexibilities like volume flexibility and product flexibility than on aggregate flexibilities. However, it is aggregate flexibility, including launch flexibility, sourcing flexibility, response flexibility, and access flexibility, which is more positively related to firm performance. Hence they concluded that firms should emphasize more on these high-level, strategic flexibilities.

Stevenson and Spring (2007) provided a conceptual hierarchy of flexibilities in a supply chain, consisting of four layers: operational, tactical, strategic, and supply chain flexibilities. However, no empirical research was performed to investigate the effectiveness of these flexibilities. Zhang *et al.* (2002; 2003) developed a framework for value chain flexibility based on competence and capability theory. This was tested to explore the relationships among flexible competence (machine, labor, material handling, and routing flexibilities), flexible capability (volume flexibility and mix flexibility), and customer satisfaction.

The notion of strategic flexibility introduced by Worren *et al.* (2002) was product and technology design oriented. They measured strategic flexibility by: 1) model variety, 2) model introduction rate, and, 3) new product introduction rate. Hitt *et al.* (1998) argued that firms require strategic flexibility to survive in an environment characterized by rapid technological change. Tachizawa and Thomsen (2007) suggested that supply flexibility has a strategic influence as well. Beckman (1990) considered that product flexibility and process flexibility are two types of production resource flexibility.

The current research focuses on the issue of flexibility from a strategic perspective, by taking into account the competence-capability framework and an integrative approach to strategic flexibility. We measure strategic flexibilities as being those which are inter-firm or

intra-firm flexibilities which constitute important factors to enhance a firm's flexibility competence. This construct recognizes the linkages with strategic sourcing, and hence supply flexibility was also considered within strategic flexibility. Thus, this construct, referred to as the firm's strategic flexibility (FSF) comprises: 1) supply flexibility, 2) product design-related flexibility, and 3) process-related flexibilities. These three sub-constructs are defined below.

Supply flexibility: Duclos *et al.* (2003) defined supply flexibility as the ability to meet changing needs from customers and changing supply of products, including mix, volume, product variations and new products. Sanchez and Perez (2005) defined sourcing flexibility as a firm's ability to find alternative suppliers for different raw materials and components. Swafford *et al.* (2006) defined sourcing flexibility as the availability of a range of options and the ability to effectively exploit them so as to respond to changing requirements related to the supply of purchased components. Similarly, Tachizawa and Thomsen (2007) considered supply flexibility as an ability to respond in a timely and cost-effective manner to changing requirements of purchased components. In the current study, supply flexibility is defined as the buyer's (focal company) evaluation of major suppliers' ability to satisfy the buyer's dynamically changing specifications in terms of quality, time, and product mix.

Product design-related flexibility: This is an aggregate concept consisting of three individual product design-related manufacturing flexibilities: new product design flexibility, modification flexibility, and mix flexibility. Sanchez (1995) stated that product flexibility increases the range of products which a production system can process and reduces the cost and time required to switch production resources. We thus define the product design-related flexibility as the competence of the system to develop new products, make minor design change, and adjust the product mix to satisfy the dynamic market demand in timely and cost-effective manner.

Process-related flexibility: Sanchez (1995) argued that process-related flexibility enhances the ability of a production system to deal with internal or supply contingencies and increases the rate and cost efficiency of capacity utilization. In the current study, process-related flexibility is considered to include volume flexibility, process flexibility, and labor flexibility. Thus, we define

process-related flexibility as an internal competence to adjust the production processes and volumes based on the changing needs of the marketplace.

The third major construct in the research model refers to the firm’s supply chain agility (FSCA). Consistent with the recent work of Braunscheidel and Suresh (2009), FSCA in this study is defined as the capability of the firm, internally, and in conjunction with its key suppliers and customers, to adapt or respond in a speedy manner to a changing marketplace, contributing to agility of the extended supply chain. FSCA consists of: 1) customer responsiveness, 2) demand response, and 3) joint planning. The survey items for the three sub-constructs are adapted from Kocabasoglu (2002), and Braunscheidel and Suresh (2009). The specific scale items for these measures can be seen in the Appendix.

Following the above definitions for the constructs and sub-constructs in the model, we next develop hypotheses for the various relationships in the proposed model structure.

Impact of Strategic Sourcing on FSCA

Past research has suggested that some of the elements of strategic sourcing are positively related to agility (Khan and Pillania, 2008; Mason *et al.*, 2002; Narasimhan and Das, 1999b; Paulraj and Chen, 2007). This relationship has been attributed to enhanced buyer-seller relationships, facilitating the exchange of demand and supply information, and helping to develop inter-organizational trust. However, while some of the links between various elements of strategic sourcing and agility have been established, the construct of strategic sourcing as a whole by collectively considering its sub-dimensions of strategic purchasing, internal integration, information sharing, and supplier development has not been investigated before. Likewise, the notion of agility is expanded in the current study to the firm’s supply chain agility (FSCA), composed of the sub-dimensions of joint planning, demand response, and customer responsiveness. In addition, this notion of agility and the antecedent of firm’s strategic flexibility (FSF) are viewed in a competence-capability relationship, providing an opportunity for an enhanced understanding of these relationships.

One of the four sub-constructs of strategic sourcing is strategic purchasing, as stated

earlier. Strategic purchasing reflects a strategic and proactive role on the part of the purchasing function, enabling the purchasing function to work closely and collaboratively with selected suppliers in various planning processes. Similarly, strategic purchasing gives the purchasing function the ability to communicate market demand changes quickly to suppliers, which may enable suppliers to understand and plan to meet the changing supply needs of the organization and help the organization be responsive to their customers' needs and expectations. Likewise, internal integration sub-construct of strategic sourcing provides the purchasing function the ability to recognize changing requirements in earlier stages when developing new products or while facing changes in the existing product mix, and giving timely information to suppliers and enabling them to respond effectively. In addition, internal integration enables different functions within the firm to share information seamlessly, enabling faster and more coordinated responses to changing environments.

Similar positive relationships can also be expected between the other sub-constructs of strategic sourcing and FSCA. The sub-construct of information sharing with suppliers reflects the ability of the organization and its suppliers to acquire information on marketplace changes as well as current supply chain inventory levels, which should enable them to collectively develop demand response strategies and improve customer responsiveness. The sub-construct of supplier development reflects a strengthening of the relationships with key suppliers, enabling organizations to help suppliers build responsiveness capabilities that are more aligned with market needs. With these expected relationships among the strategic sourcing elements and the FSCA components, we hypothesize a causal relationship between strategic sourcing and FSCA:

Hypothesis 1. Strategic sourcing has a positive impact on a firm's supply chain agility.

Impact of Strategic Sourcing on FSF

The second hypothesis is aimed at investigating the relationship between strategic sourcing and the firm's strategic flexibility (FSF), which was defined above as consisting of supply flexibility, product design-related flexibility and process-related flexibility.

1
2
3 Some prior studies have confirmed some positive relationships between elements of
4 strategic sourcing and a few flexibility measures (e.g., Narasimhan and Das, 1999a; Das, 2001).
5 Das (2001), for instance, has shown that internal integration of purchasing may improve product
6 design-related flexibility. Likewise, it may be surmised that stronger external integration, enabled
7 by strategic sourcing, may result in more effective co-design of products and processes with
8 suppliers and, in the process, may help build strategic flexibility. However, many of the possible
9 relationships between various elements of strategic sourcing and strategic flexibility are yet to be
10 fully investigated.

11
12 The positive linkage between strategic purchasing and supply flexibility aspect may be
13 expected. Strategic purchasing helps the firm to identify the most appropriate supply base for its
14 needs. It enables a firm to implement flexible sourcing, and to reconfigure the supply chain
15 continuously in line with changing flexibility requirements (Tachizawa and Thomsen, 2007).
16 Supplier selection based on flexibility and internal collaboration are two major practices in
17 pursuit of this strategy. Development of long-term buyer-supplier relationships, information
18 sharing, and supplier development, etc. may all be expected to contribute towards supply
19 flexibility. There is also a significant role for suppliers as input providers with the advent of just-
20 in-time (JIT) systems. Supplier's role in supporting operational goals such as flexibility has
21 become important in JIT systems. Thus, strategic purchasing may be expected to improve several
22 dimensions of a firm's supply flexibility. Likewise, internal integration, information sharing and
23 supplier development sub-constructs of strategic sourcing may also be expected to be positively
24 related to supply flexibility aspect. Information sharing aspect of strategic sourcing allows for
25 improved supplier responsiveness, due to suppliers being able to work with more complete
26 information, contributing to supply flexibility (Tachizawa and Thomsen, 2007). Better
27 information sharing can help suppliers align their plans with the needs of the buying firm and
28 allow for better preparedness and response on the part of suppliers to changing needs, thus
29 resulting in increased supply flexibility.

30
31 In addition, strategic purchasing, reflecting a strategic orientation and authority for the

purchasing function, has been shown to improve product design-related flexibility by improving new design, mix and product modification flexibility (Das, 2001). The link between information sharing and process related flexibility has been partially validated by Narasimhan and Das (1999a), who showed that information sharing specifically improved volume flexibility, which is a part of process-related flexibility. Information sharing and supplier development were also examined by Suarez *et al.* (1996) on how they enable the suppliers to quickly respond to product feature changes and improve the new design flexibility and modification flexibility for the buying company.

Thus, it may be expected that process-related flexibility may be positively influenced by strategic sourcing. Volume flexibility, process flexibility, and labor flexibility are considered to measure the process-related flexibility. Volume flexibility is improved when the supplier has the ability to respond quickly and efficiently to unexpected changes through enhanced relationships created from sharing information and supplier development (Narasimhan and Das, 1999a).

Supplier development sub-construct of strategic sourcing may help a buying firm support the development of its supplier's process flexibility, the ability to produce efficiently in small quantities, etc. Past research has also shown it to be positively related to product design related flexibility (Narasimhan and Das, 1999a; Suarez *et al.* 1996). Similar to the case of information sharing, the relationship between supplier development and process-related flexibility has been partially validated. Thus, based on the above fragmented findings, and expected relationships, the second hypothesis is advanced as:

Hypothesis 2: Strategic sourcing has a positive impact on a firm's strategic flexibility.

Impact of FSF on FSCA

Flexibility has been stated to be a major antecedent of agility in recent research (Aitken *et al.*, 2002; Swafford *et al.*, 2006). It may be expected that a firm's strategic flexibility may influence all three elements of FSCA, joint planning, demand response and customer responsiveness. For instance, supply flexibility aspect of FSF may be expected to strongly influence joint planning aspect of FSCA. When the supplier can consistently satisfy the buyer's requirement, trust and

stronger relationship are created between the firms so that the buying company is motivated to work closely with the supplier. In addition, supply flexibility ensures that the suppliers are capable of supporting organizations for their changing supply needs, thus improving demand response and customer responsiveness aspects of FSCA. Krause and Scannell (2002) suggested that the imperative of working closely is a required foundation for joint planning and many other supply chain practices. Hence, through the development of trust, supply flexibility may have a positive impact on the level of joint planning. Similarly, demand response and customer responsiveness aspects of FSCA may be influenced by supply flexibility. Supply flexibility may enable fast response to demand variations and customer requirement in dynamic markets, characterized by short product life cycles, more product variety, and customization, and may thus positively influence demand response and customer responsiveness. .

Likewise, design-related flexibility may be expected to significantly affect, primarily demand response and customer responsiveness aspects of FSCA. The trend towards shorter product life cycles, more product variety, and increased pressure for customized products is well recognized and firms that have adequate levels design-related-flexibility may be more in line with their customers' needs, thus contributing to demand response and customer responsiveness.

The third aspect of FSF, process-related flexibility may provide a firm the ability to change its production plan and product designs in response to new information about changing demand trends and customization. Manufacturers adopting a push strategy make production plans several periods before demand is observed so that it may be hard to change from one product to the other. And even for supply chains that utilize a pull strategy downstream, it is unlikely that the entire chain can benefit from this strategy. Under such limitations, firms with superior process-related flexibility may more efficiently meet changing demands. Thus, a strong linkage between process-related flexibility and demand response and customer responsiveness aspects of FSCA may be expected.

Thus, all three FCF sub-constructs may be expected to have positive impacts on demand response and customer responsiveness dimensions of FSCA. Flexibility and agility have

frequently been discussed together, as overlapping concepts in much of past research (e.g. Aitken *et al.*, 2002). A clear distinction between these two concepts and empirically validation of the resulting constructs is of recent origin (Swafford *et al.*, 2006). In the current study, we investigate the relationship between FSF and FSCA more comprehensively, and thus the above arguments lead to the following hypothesis:

Hypothesis 3: A firm's strategic flexibility has a positive impact on the firm's supply chain agility.

Mediation Effect of Flexibility

The above three hypotheses are aimed at investigating the relationship between every two of the three major constructs. However, in order to investigate the mediation effect of FSF, which may or may not enhance the influence of strategic sourcing on FSCA, it is necessary to conduct a comparison between the direct and the indirect impacts of strategic sourcing on FSCA.

Fisher (1997) argued that a supply chain has both a physical distribution and market mediation function. While the physical distribution function focuses on getting the products to the market efficiently, the market mediation function is primarily related to scanning the market to make sure that a firm (or a set of firms in the supply chain) seizes opportunities in the market by synchronizing the demand with their supply. This raises the following question about the exact nature of the relationship between strategic sourcing and FSCA. If one considers only the physical function, strategic sourcing can be primarily seen as comprehending procurement needs of an organization and ensuring the arrival of supplies consistent with these needs. If one focuses on the market mediation aspect, the question becomes whether there is additional information that purchasing can collect, given its boundary spanning role and its relationships with other firms regarding the market, which may help a firm synchronize the supply with end-customer demands better. If the former scenario applies, one may expect flexibility to fully mediate the relationship between strategic sourcing and agility since the positive or negative contributions of strategic sourcing will be fully absorbed by the internal operations. If, on the other hand, purchasing has a role in market mediation, one would not expect to see full mediation.

No prior study, to the best of our knowledge, has considered this issue. Khan and Pillania (2008) tested only the direct influence of the implementation of strategic sourcing on supply chain agility. The possible mediating effects of flexibility in this relationship has not been considered in past research. Thus we formulate the following hypothesis:

Hypothesis 4: There is a significant mediation effect from FSF on the relationship between strategic sourcing and the firm's supply chain agility.

Control Variables

Four control variables are considered in this study: 1) firm size, 2) type of production process, 3) product seasonality, and 4) product perishability. It may be expected that firm size may have a negative relationship with FSCA. Cohen and Klepper (1992) claimed that small firms have more creativity and agility, while larger firms may be bureaucratic. Firm size, thus, may have a negative impact on the development of FSCA. Rogers (1995) suggested that firm size is commonly applied as a control variable to serve as a surrogate measure of total resources and organization structure. Prior studies have used either sales or the number of full time employees (FTE) to measure firm size. In this study, the number of FTE is applied.

Production process, the second control variable, included engineer-to-order, make-to-order, assemble-to-order, and make-to-stock process types. Lee (1996) asserted that production process is strongly related to the level of customization and the level of inventory, either as work-in-process or the final product. Lamming *et al.* (2000) suggested that high inventory level, which implies mass production and less customization, may be necessary to develop agility in response of market dynamics. Based on this logic, it is expected that the production process may have an influence on the model relationships.

Product seasonality and product perishability are two causes for demand uncertainty. van Hoek *et al.* (2001) suggested that agility is important to create competitive advantages in current dynamic market characterized with uncertain demand. Likewise, Baker (2008) stated that agility is needed to cope with the demand uncertainty caused by seasonality, short product life cycles, and consumer demand fluctuations. Firms facing strong demand uncertainty may be more likely

to implement an agility developing strategy. Hence, product seasonality and product perishability are expected to have an influence on the model relationships.

RESEARCH METHODOLOGY

To develop the survey instrument, an extensive literature review was first conducted to identify scales used in past literature that were shown to have strong validity and reliability. The first draft of this survey instrument was tested through reviews and semi-structured interviews with supply chain professionals, business consultants and academics in U.S. and Netherlands. The survey was sent to the interviewees in advance. During interviews lasting between 30 to 90 minutes, the interviewees were asked to provide suggestions to improve the clarity of the survey, the format and the time required for completing the questionnaire. The survey was then refined based on the suggestions received. A pilot study was then conducted and the results were analyzed to ensure avoidance of systematic bias in the survey instrument.

The specific questions for each variable, the sources and anchors for the questions in final survey instrument are provided in the Appendix. In addition to items relating directly to the three major research constructs, several questions for the contextual factors were selected to serve as control variables. A 5-point Likert scale was used, with two different schemes: very low to very high, and strongly disagree to strongly agree, as shown in the Appendix.

The respondents for the final survey were selected from senior supply chain and purchasing executives of manufacturing firms in the U.S. who were members of the Institute for Supply Management (ISM). Senior-level executives were deemed to be at a sufficiently high level in the organizational hierarchy to have supply chain-level visibility and knowledge. High-ranking respondents, with sufficient level of seniority tend to be more reliable sources of information than their subordinates, in accordance with Phillips (1981) and numerous other past studies. In accordance with Dillman's (1978) guidelines for mail surveys, a mailing package was sent, which included a letter of support from ISM, a cover letter from the investigators of this study, the questionnaire, and a paid return envelope. A reminder postcard was mailed two weeks

later. The survey was sent to 1972 potential respondents, after which 144 valid responses were obtained with a response rate 7.3%, which is consistent with other empirical studies using complex survey instrument. For instance, the response rate was 7.25% in the study of Kristal, Huang, and Roth (2010); 6.4% in Tan and Vonderembse (2006), etc. One method for testing non-response bias is to test for significant differences between the responses of early and late waves of returned surveys via t-tests (Armstrong and Overton, 1977). We utilized this approach of comparing early and late respondents in terms of demographic variables (e.g. annual sales, full time equivalent employees). The t-tests yielded no statistically significant differences among the demographic variables.

The survey respondents were from firms belonging to SIC codes 34 to 38. It can be seen that the respondents were primarily from firms in either the growth or maturity stages of their life cycles. Regarding firm size, the annual sales for most firms was 20 to 99.99 million, or 100 to 499.99 million dollars. About 50% of the responding firms carried less than 500 stock keeping units (SKUs) as finished products. A summary of the respondent profile is provided in Table 2.

To investigate the relationships among the major constructs by using the partial least squares (PLS) technique, SmartPLS 2.0 (Ringle *et al.*, 2005) was used to assess the measurement model and structural model. PLS analysis was chosen because it can analyze all paths at once (Barclay *et al.*, 1995; Gefen *et al.*, 2000) and does not require a large sample size (Gefen and Straub, 2005). To test the relationships, all measurement items were standardized and missing values were replaced by sample means to examine validity, reliability, and statistical power. The bootstrapping method was used, which approximates the sampling distribution of an estimator by re-sampling with replacement from the original sample (Moore and McCabe, 2005; Temme *et al.*, 2006), to derive more reliable results. The size of subsamples to run the bootstrapping technique followed the suggestions in Efron and Tibshirani (1998, p.52).

To test second-order constructs in the model, a repeated indicators approach, also known as the hierarchical component model (Wold, 1982) was used. This technique is widely used to estimate higher order constructs for PLS studies (Wilson, 2007; Zhang *et al.*, 2006). The impacts

of each factor were represented by the path coefficients and corresponding levels of significance.

TABLE 2
Sample Demographics

Category		Freq.	%	Category		Freq.	%
No. of Manufacturing Plants	One	52	36.11	Annual Sales (Million)	< 20	12	8.63
	Two	16	11.11		20 - 99.99	52	37.41
	3 - 10	38	26.39		100 - 499.99	42	30.22
	10+	32	22.22		500 - 1000	15	10.79
	Missing	6	4.17		> 1000	18	12.95
Stage of Main Product in Its Life Cycle	Introduction	1	0.69	No. of FTEs	< 100	21	14.58
	Growth	36	25.00		101 - 1000	80	55.56
	Maturity	97	67.36		1001 - 5000	29	20.14
	Decline	5	3.47	Process Type	> 5000	14	9.72
	Missing	5	3.47		ETO	34	23.61
No. of SKUs	< 100	38	26.39		MTO	49	34.03
	100 - 499	38	26.39		ATO	21	14.58
	500 - 999	18	12.50		MTS	33	22.92
	1000 +	50	34.72		Missing	7	4.86

RESEARCH RESULTS

Measurement Model

Figure 1 provides overall results for the hypothesized model. A good model fit in PLS is seen when there are significant path coefficients, acceptable R^2 values, and good construct reliability (Gefen *et al.*, 2000). This is seen in Figure 1. The predictability of the model, reflected by the R^2 values, is another important determinant of the strength of the model (Chin, 1998; Komiak and Benbasat, 2004). The R^2 value for the second-order variables are acceptable (25% for FSCA and

13% for FSF) when compared to the R^2 values seen in past empirical research studies in supply chain management.

For the assessment of reliability, composite reliability and average variance extracted (AVE), shown in Table 3 are the two main measurements used in this study. Composite reliability does not assume that all indicators are equally weighted (Chin, 1998) which implies that composite reliability may be more appropriate to measure reliability. Composite reliability is recommended to be larger than 0.7 (Barclay et al., 1995; Fornell and Larcker, 1981). The other measure, AVE, denotes the amount of variance that a construct captures from its indicators relative to the amount due to measurement error (Chin, 1998). For the first-order factor, the recommended minimal critical value for AVE is 0.5 (Hu *et al.*, 2004). The composite reliability and AVE values shown in Table 3 are seen to meet these criteria though the AVE for demand response is relatively smaller than the desired value.

Convergent validity is the ability of items in a scale to converge or load together as a single construct. It is measured by examining individual loadings for each block of indicators. The standardized loadings should be greater than 0.7, implying that the indicators share more variance with their respective latent variable than with error variance. A lower bound of 0.50 may be sufficient (Chin, 1998). Table 4 provides a list of standardized loadings for each construct, and it is seen that they are above the acceptable minimum values. As for second-order constructs, convergent validity is established by having path coefficients that are significant, and greater than 0.7, between each 1st order construct and the corresponding 2nd order construct (Fornell and Larcker, 1981). All the path coefficients in this study are statistically significant and greater than 0.5. Although the numerical value for several path coefficients do not satisfy the 0.7 critical value, since these 2nd-order constructs were considered in prior studies, we believe that the level of convergent validity is acceptable.

Discriminant validity represents how well each item factor links to its hypothesized construct relative to others (Kerlinger, 1973; Swafford *et al.*, 2006). Discriminant validity is estimated through: 1) cross-loadings, and 2) the relationship between correlations among first-

order constructs and the square roots of AVE (Chin, 1998; Fornell and Larcker, 1981). The cross-loadings shown in Table 5 exhibit adequate levels of discriminant validity for each construct. Every item factor in the highlighted areas of Table 5 shows strong loadings to the corresponding latent construct and low loadings to other constructs. The relationship between square roots of the AVE values and the correlations among first-order latent constructs support the same conclusion. In Table 3, it is seen that the square roots of AVE (bold numbers in diagonal) are greater than the correlations among the constructs (off-diagonal values).

To test for common method bias, the analytical approach proposed by Liang *et al.*, (2007) was adopted. Based on the insignificant test results obtained, it was concluded that common method bias was not a concern in the study.

Structural Model

The results from evaluation of the structural model are reported in Figure 1 and Table 6. First, in Figure 1, it can be seen that the standardized path coefficient from strategic sourcing to FSCA is significant (0.347; $p < 0.01$). Thus, a high level of strategic sourcing is seen to result in a high level of FSCA, lending support to H_1 . Likewise, the path coefficient from strategic sourcing to FSF is also significant (0.353; $p < 0.05$), supporting the notion that strategic sourcing has a positive impact on the level of FSF. Hence, H_2 is supported. The standardized path coefficient from FSF to FSCA is also statistically significant with a path coefficient of 0.229 ($p < 0.05$). This result lends support to hypothesis H_3 that a high level of FSF significantly contributes towards a high level of FSCA. Thus, it can be stated that the level of FSCA is positively influenced by both implementation of strategic sourcing and the improvement of the levels of FSF.

TABLE 3
Reliability (Composite Reliability and AVEs) & Correlations among Latent Variables

	Composite reliability	AVE	SS	SP	IN	IS	SD	FSF	SF	DF	PF	FSCA	CR	DR	JP
SS	0.865	0.355	0.596												
SP	0.925	0.804	0.753	0.897											
IN	0.763	0.518	0.680	0.576	0.720										
IS	0.896	0.742	0.771	0.323	0.314	0.861									
SD	0.855	0.666	0.658	0.218	0.220	0.481	0.816								
FSF	0.743	0.255	0.353	0.205	0.044	0.438	0.247	0.505							
SF	0.828	0.618	0.427	0.300	0.057	0.404	0.391	0.762	0.786						
DF	0.829	0.619	-0.098	-0.085	-0.008	0.001	-0.194	0.518	0.082	0.787					
PF	0.768	0.528	0.241	0.091	0.022	0.373	0.140	0.686	0.201	0.220	0.727				
FSCA	0.773	0.291	0.441	0.276	0.195	0.359	0.413	0.362	0.388	0.086	0.175	0.540			
CR	0.848	0.653	0.220	0.141	0.080	0.169	0.228	0.281	0.276	0.181	0.085	0.816	0.808		
DR	0.704	0.454	0.147	0.146	0.041	0.102	0.109	0.155	0.155	0.000	0.121	0.610	0.367	0.674	
JP	0.811	0.593	0.541	0.300	0.278	0.465	0.501	0.302	0.361	-0.039	0.176	0.684	0.250	0.160	0.770
Firm Size			0.108	0.076	0.013	0.040	0.177	0.009	0.153	-0.196	-0.036	0.109	0.050	0.062	0.123
Perishability			0.098	0.062	0.208	0.078	-0.032	-0.028	0.049	-0.079	-0.066	0.020	-0.032	0.051	0.046
Process			-0.159	-0.145	-0.102	-0.129	-0.069	-0.073	-0.075	-0.042	-0.016	-0.092	0.025	-0.014	-0.207
Seasonality			0.060	0.073	0.086	0.027	-0.004	0.099	0.102	0.075	0.017	0.119	0.074	0.113	0.080

	Construct	14	15	16
14	Firm Size			
15	Perishability	0.066		
16	Process	0.007	-0.192	
17	Seasonality	-0.038	0.079	-0.173

Note 1: although one correlation (shown in *Italic*) between CR and FSCA construct is larger than the corresponding square root of AVE, this technique applies merely to investigate discriminant validity among first-order construct.

TABLE 4
Convergent Validity (Item Loading)

Construct	Sub-Construct	Factor	Loading
Strategic Sourcing (SS)	Strategic Purchasing (SP)	SP1	0.903 ^{***}
		SP2	0.918 ^{***}
		SP3	0.870 ^{***}
	Internal Integration (IN)	IN1	0.698 ^{***}
		IN2	0.687 ^{***}
		IN3	0.771 ^{***}
	Information Sharing (IS)	IS1	0.889 ^{***}
		IS2	0.916 ^{***}
		IS3	0.773 ^{***}
	Supplier Development (SD)	SD1	0.690 ^{***}
		SD2	0.897 ^{***}
		SD3	0.846 ^{***}
Firm's Strategic Flexibility (FSF)	Supply Flexibility (SF)	SF1	0.690 ^{***}
		SF2	0.857 ^{***}
		SF3	0.800 ^{***}
	Product Design-related Flexibility (DF)	DF1	0.761 [*]
		DF2	0.719 [*]
		DF3	0.873 ^{**}
	Process-related Flexibility (PF)	PF1	0.646 ^{***}
		PF2	0.681 ^{***}
		PF3	0.838 ^{***}
Firm's Supply Chain Agility (FSCA)	Customer Responsiveness (CR)	CR1	0.718 ^{***}
		CR2	0.813 ^{***}
		CR3	0.885 ^{***}
	Demand Response (DR)	DR1	0.553 ^{***}
		DR2	0.559 ^{***}
		DR3	0.863 ^{***}
	Joint Planning (JP)	JP1	0.612 ^{***}
		JP2	0.837 ^{***}
		JP3	0.839 ^{***}

Note: *** Significant at 0.01 level; ** significant at 0.05 level

TABLE 5
Cross-loading Among Variables

	SP	IN	IS	SD	SF	DF	PF	CR	DR	JP
SP1	0.903	0.566	0.343	0.236	0.309	-0.066	0.099	0.105	0.165	0.285
SP2	0.918	0.506	0.234	0.104	0.263	-0.065	0.054	0.151	0.155	0.241
SP3	0.870	0.472	0.283	0.238	0.230	-0.097	0.090	0.126	0.070	0.277
IN1	0.450	0.699	0.171	0.087	0.035	0.063	0.008	0.145	0.103	0.093
IN2	0.425	0.687	0.181	0.073	-0.042	0.079	-0.060	-0.106	0.038	0.129
IN3	0.384	0.771	0.307	0.284	0.109	-0.127	0.080	0.114	-0.037	0.344
IS1	0.296	0.279	0.889	0.434	0.374	-0.005	0.300	0.095	0.047	0.400
IS2	0.291	0.260	0.916	0.400	0.368	-0.035	0.312	0.153	0.061	0.430
IS3	0.244	0.272	0.773	0.409	0.298	0.048	0.357	0.194	0.163	0.370
SD1	0.110	0.155	0.255	0.690	0.264	-0.149	0.097	0.145	0.031	0.228
SD2	0.250	0.244	0.419	0.897	0.332	-0.140	0.062	0.223	0.115	0.490
SD3	0.154	0.132	0.477	0.846	0.354	-0.190	0.188	0.180	0.106	0.464
SF1	0.244	0.042	0.385	0.403	0.690	-0.009	0.133	0.194	-0.005	0.366
SF2	0.314	0.109	0.330	0.244	0.857	0.101	0.153	0.204	0.183	0.229
SF3	0.152	-0.020	0.255	0.300	0.802	0.087	0.185	0.253	0.162	0.279
DF1	-0.021	0.039	0.000	-0.239	-0.004	0.761	0.104	0.145	-0.033	-0.066
DF2	-0.022	0.074	-0.101	-0.142	-0.011	0.719	0.106	0.143	-0.037	-0.006
DF3	-0.122	-0.080	0.060	-0.112	0.152	0.873	0.259	0.147	0.042	-0.025
PF1	0.014	-0.012	0.118	0.041	0.108	0.339	0.646	0.117	0.123	0.006
PF2	0.067	0.036	0.247	0.093	0.037	0.060	0.681	-0.016	0.100	0.129
PF3	0.111	0.027	0.420	0.160	0.250	0.076	0.838	0.066	0.053	0.232
CR1	0.192	0.154	0.253	0.259	0.167	0.066	0.071	0.718	0.143	0.308
CR2	0.025	-0.017	0.052	0.059	0.206	0.150	0.013	0.813	0.275	0.101
CR3	0.122	0.058	0.110	0.224	0.285	0.211	0.112	0.885	0.441	0.198
DR1	0.042	-0.045	-0.008	0.098	0.200	0.016	0.073	0.214	0.553	0.019
DR2	-0.019	-0.010	-0.065	-0.049	-0.094	-0.077	0.023	0.133	0.559	-0.006
DR3	0.189	0.086	0.173	0.120	0.148	0.024	0.120	0.340	0.863	0.215
JP1	0.181	0.103	0.306	0.234	0.125	0.038	0.139	0.098	0.104	0.612
JP2	0.225	0.296	0.273	0.388	0.273	-0.020	0.073	0.241	0.154	0.837
JP3	0.281	0.214	0.496	0.501	0.399	-0.088	0.204	0.215	0.109	0.839

TABLE 6
Path Coefficients for Overall Hypothesized Model

	SP	IN	IS	SD	FSF	SF	DF	PF	FSCA	CR	DR	JP
SS	0.753***	0.680***	0.771***	0.658***	0.353**				0.347***			
FSF						0.762***	0.518***	0.686***	0.229**			
FSCA										0.818***	0.610***	0.684***

Note: FSF: Firm’s strategic flexibility; FSCA: Firm’s supply chain agility
*** Significant at 0.01 level; ** Significant at 0.05 level

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5 In order to test for the mediation effects of FSF (Hypothesis 4), the guidelines of Baron
6 and Kenny (1986) were followed: two separate models, as shown in Figure 1, needed to be
7 assessed: one with FSF and one without FSF, in order to assess the direct path coefficient of the
8 relationship between strategic sourcing and FSCA. This procedure has also been adopted in
9 many other studies e.g., Shamir *et al.* (1998). This procedure states three conditions for the
10 presence of a full mediation effect: 1) variations in level of the independent variable (strategic
11 sourcing) significantly account for variations in the presumed mediator (FSF), 2) variations in
12 the mediator (FSF) significantly account for variations in the dependent variable (FSCA), and, 3)
13 when the paths between independent variable and mediator, and between mediator and
14 dependent variable are controlled, a previously significant relation between the independent
15 variable (strategic sourcing) and dependent variable (FSCA) is no longer significant.
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28 Table 7 shows the results for the two PLS models: the hypothesized model with
29 mediation effect and the alternate model without FSF to assess the direct effects of strategic
30 sourcing on FSCA. In the alternate model, strategic sourcing was analyzed as the only
31 independent variable. Firm size, production process, product seasonality, and product
32 perishability were considered as control variables in both models. It can be seen in Table 7 that
33 the path coefficients for the hypothesized model are both positive and significant. The alternate
34 PLS model indicates that FSCA is positively and significantly related to strategic sourcing. Our
35 results meet the first two conditions, requiring FSF to be influenced by strategic sourcing, and
36 FSCA to be significantly affected by FSF. However, the results do not meet the third necessary
37 condition that the path coefficient between strategic sourcing and FSCA becomes insignificant or
38 at least reduced. Since the path coefficient between strategic sourcing and FSCA remains as
39 significant and strong, it can be concluded that a full mediation effect of FSF does not exist.
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TABLE 7
Standardized Path Coefficients for Testing for Mediation Effect of FSF

	Hypothesized Model	Alternate Model without FSF
Strategic Sourcing	0.346**	0.428***
FSF	0.344***	

Note: *** Significant at 0.01 level; ** Significant at 0.05 level

On the other hand, according to Sosik et al. (2009), partial mediation exists when the path coefficients between the predictor variable, strategic sourcing, and the intervening variable, FSF, and between the intervening variable and outcome variable, FSCA, are significant. Thus, since the direct path and the two mediating paths were both significant, a partial mediation effect can be stated to exist, and thus H₄ is supported for a partial mediation effect.

The path coefficients for all four control variables are positive but insignificant, as seen in Figure 1. The values for the path coefficient from firm size, production process, product seasonality, and product perishability to FSCA are 0.07, 0.01, 0.08, and 0.02, respectively. The insignificant path coefficients imply that these factors do not influence the relationships in the proposed model. The model relationships among strategic sourcing, strategic flexibility and agility were thus found to be robust, regardless of the settings of the contextual variables.

DISCUSSION & MANAGERIAL IMPLICATIONS

The research results are discussed below in the following order. First, the relationship between strategic sourcing and a firm’s supply chain agility (FSCA) is discussed. The impact of strategic sourcing on a firm’s strategic flexibility (FSF) is described next, followed by an examination of the relationship between FSF and FSCA. The mediation effect of FSF, which was not found to exist, is discussed next, followed by a discussion on the influence of contextual factors on FSCA.

Impact of Strategic Sourcing on FSCA

Strategic sourcing, consisting of strategic purchasing, internal integration, information sharing,

and supplier development, were found to be direct antecedents of FSCA, explaining a significant portion of the variance in the FSCA construct. In addition, strategic sourcing was also found to have an indirect relationship to FSCA through FSF. These results empirically validate the assertions made by Das (2001), Paulraj and Chen (2007), and Khan and Pillania (2008) that the adoption of strategic sourcing may be a contributing factor for supply chain agility. The results support the notion that the implementation of strategic sourcing enhances a firm's supply chain agility (FSCA) in order to adapt or respond in a speedy manner to marketplace changes, both before and after the changes have occurred.

From a dynamic capabilities perspective, Teece *et al.* (1997) suggested that competitive advantages result from a firm's distinctive processes, specific asset positions, and evolutionary path. Strategic sourcing, especially enhanced buyer-supplier relationships through information sharing and supplier development practices, may be regarded as a competence and expected to improve performance and competitiveness. More specifically, strategic sourcing is also considered a structural asset for external linkages in dynamic capabilities and, thus, has an important bearing on how competencies and capabilities co-evolve and develop. Hence, FSCA is seen to be a critical dynamic capability in a volatile environment, consistent with earlier assertions (e.g., Agarwal *et al.*, 2007).

Strategic purchasing helps to select a group of strategic suppliers to develop a possible long-term partnership. Internal integration enables purchasing to understand the needs of other functions like design, R&D and production. These two elements of strategic sourcing provide a basis for the company to connect its internal functions with external partners through one strategic and informative purchasing function. Information sharing and supplier development then enhances the relationship between the firm and its selected suppliers. The close relationship and the strategic role of purchasing, thus, provide a foundation to conduct joint planning, response to market demand change, and satisfy specific customer requirements on the product. These associations are examined through the correlations between factors. Thus, firms can strengthen FSCA and improve the performance through the implementation of strategic sourcing.

Impact of Strategic Sourcing on FSF

FSF was also found to be affected by the adoption of strategic sourcing. We found that strategic sourcing has significant and positive influence on product design-related flexibility (mix flexibility, new design flexibility, and modification flexibility), process-related flexibility (volume flexibility and labor flexibility), and supply flexibility. These results mostly satisfy our expectations in studying the relationship between strategic sourcing and the internal strategic flexibility competence, which serves as the foundation for the competence-capability mechanism in flexibility-agility relationship.

The only inconclusive relationship observed was between strategic sourcing and machine flexibility within process-related flexibilities. This result is consistent with the arguments made by Narasimhan and Das (1999a) that strategic sourcing may not have a bearing on machine and labor flexibilities. However, a positive association was found between strategic sourcing and multi-functionality of labor.

Impact of FSF on FSCA

FSF was found to be an antecedent of FSCA. This part of the investigation confirms past findings that flexibility is a valid antecedent to develop agility under the competence/capability paradigm (e.g. Swafford *et al.*, 2006). Yet, this study extends past research beyond the focal firm a little more to the supply chain level by evaluating supply flexibility in addition to the flexibility within the focal firm.

Impact of Mediation Effect of Flexibility

In this study, two causal paths were investigated between strategic sourcing and FSCA. The first is a direct path connecting the two factors while the other considers FSF as a mediator, linking strategic sourcing and FSCA. Prior studies have investigated relationships among selected pairs of sub-constructs of these three factors, but none has explored mediation effects of flexibility. The results demonstrate that the direct effect of strategic sourcing on FSCA is greater than the indirect influence through FSF. Thus, although it might be concluded that the implementation of strategic sourcing in itself contributes significantly and directly to external-facing FSCA, FSF

does have a partially mediating influence on the enhancement of FSCA. This is a new finding resulting from the current study.

CONCLUSIONS

A firm's supply chain agility is a critical capability for survival in today's dynamic business environments. Given this fact, this work examined the antecedent role of strategic sourcing in building FSCA and investigated the influence of contextual factors on the FSCA. Building on the foundations of works such as Kocabasoglu and Suresh (2006), Swafford *et al.* (2006), Khan and Pillania (2008), and Braunscheidel and Suresh (2009), this research extended our current understanding of FSCA in the following ways.

Strategic sourcing was examined in conjunction with the firm's strategic flexibility, as antecedents of FSCA. This study applied dynamic capabilities theoretical perspective and the competence-capability relationship to construct and examine the relationships among the three latent factors. To the best of our knowledge this is the first in the research stream of supply chain agility to utilize these theoretical bases. The findings also showed that strategic sourcing has a greater influence on FSCA than FSF. In addition, the mediation effect of FSF was not to be significant. This finding adds to the findings of previous studies, which primarily focused on only two of the three variables considered at a time. For example, in Swafford *et al.* (2006), supply chain process flexibility was proposed to directly contribute to the development of internal supply chain agility. Khan and Pillania (2008) investigated the relationship between strategic sourcing and supply chain agility. Braunscheidel and Suresh (2009) tested the relationship between FSCA and organizational practices and provided a more comprehensive formation for FSCA.

This study also examined the influence of contextual factors on FSCA. This research responds to van der Vaart and van Donk's (2008) call to investigate the effect of business conditions in survey studies. Through path analysis, none of the investigated contextual variables presented a significant impact on FSCA. Hence it can be stated that a manufacturing firm can

augment business agility through strategic sourcing and flexibility initiatives regardless of the specific business conditions or business characteristics such as firm size is, production process used, and whether the products offered have seasonality or perishability characteristics.

Since FSCA research is still in its early stages, a set of reliable and generally-accepted measurements are still under development. This study was based on US manufacturing firms. As another possible future extension, it may be important to understand whether similar relationships are observed in service industries. Service industries have significant influences in every supply chain to fulfill end consumer demand and to develop the supply chain agility. It is of great value to consider service industries such as the retail sector, when discussing the issues of supply chain agility. In addition, considering the importance of FSCA to survive in a dynamic market, it is critical to identify other antecedent factors by considering other manufacturing and non-manufacturing practices and organizational perspectives.

Some of the common limitations of survey-based research apply to this study as well. These include, for instance, the limitations arising from reliance on key informants and the need for further research improvements in the assessment and reduction of common methods variance. Furthermore, the survey data are cross-sectional, which may limit the predictive ability of the conclusions over time. In addition, due to the limited number of observations in the survey data, this study might only partially revalidate the finding so prior works. Likewise, there may be other limitations arising from the methods applied. The use of PLS is still relatively in the nascent stages, despite its strong theoretical groundings. PLS is often used when faced with small sample sizes, in conjunction with bootstrapping. In such cases, the stability of path coefficients may be reduced since bootstrapping is strongly influenced by the variation in the original sample.

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Appendix. Measurement scales for major constructs.

Major-Construct	Sub-Construct		Factor	Source
Strategic Sourcing	Strategic Purchasing (SP)	SP1	Top management emphasizes purchasing function's strategic role*	Kocabasoglu & Suresh (2006)
		SP2	Purchasing is viewed as equal to other functions by the CEO*	
		SP3	Purchasing is involved in corporate-level strategic planning*	
	Internal Integration (IN)	IN1	There is frequent communication between purchasing and other departments within our firm*	
		IN2	Purchasing personnel are included in concurrent engineering teams*	
		IN3	Purchasing executives receive cross-functional training*	
	Information Sharing (IS)	IS1	Production schedule information sharing with supplier **	
		IS2	Synchronized scheduling of production with suppliers **	
		IS3	Cost information sharing with supplier **	
	Supplier Development (SD)	SD1	Financial assistance to the suppliers **	
		SD2	Technological assistance to the suppliers **	
		SD3	Training in quality issues to suppliers' personnel **	
Firm's Strategic Flexibilities	Supply Flexibility (SF)	SF1	Suppliers show better quality of conformance to specifications*	Sanchez (2005); Kocabasoglu (2002)
		SF2	Suppliers are able to accept late 'mix' changes in orders*	
		SF3	Suppliers are able to supply newly designed or modified parts without excessive time/cost penalties*	
	Product Design-related Flexibility (DF)	DF1	It takes us a long time for us to introduce new products*	Kocabasoglu (2002); Braunscheidel & Suresh (2009)
		DF2	It takes a long time to accommodate minor design changes*	
		DF3	It takes a long time for us to change our product mix*	
	Process-related Flexibility (PF)	PF1	It takes us a long time to vary production by 20%*	Das (2001); Kocabasoglu (2002)
		PF2	Most of our workers can handle multiple machines*	
		PF3	We frequently utilize job rotation for workers*	

		PF4	<i>There are pools of identical machines for most processes in the factory*</i>	
		PF5	<i>Changes in machining processes can be handled by existing machines*</i>	
Firm's Supply Chain Agility	Customer Responsiveness (CR)	CR1	Responsiveness to firm's immediate customer**	Braunscheidel & Suresh (2009)
		CR2	Satisfaction of our end customers in the supply chain**	
		CR3	Responsiveness to expectations of end customers in the supply chain **	
	Demand Response (DR)	DR1	Our supply chain is capable of responding to market demand by providing a wide range of product	
		DR2	Our supply chain is able to leverage the competencies of our partners to respond to market demands**	
		DR3	Our supply chain is capable of forecasting market demand**	
	Joint Planning (JP)	JP1	Joint-problem solving with our supplier is**	
		JP2	Representation of our suppliers in product design teams**	
		JP3	Involvement of key suppliers in continuous improvement program**	
Control Variables		Firm Size: Number of Full-time Employees (As shown in Table 4)		
		Production Process (1: ETO 2: MTO 3: ATO 4: MTS)		
		Product Seasonality (1: non-seasonal; 7: seasonal)		
		Product Perishability (1: non-perishable; 7: perishable)		

* 1-Strongly Disagree; 5-Strongly Agree / ** 1-Very Low; 5-Very High

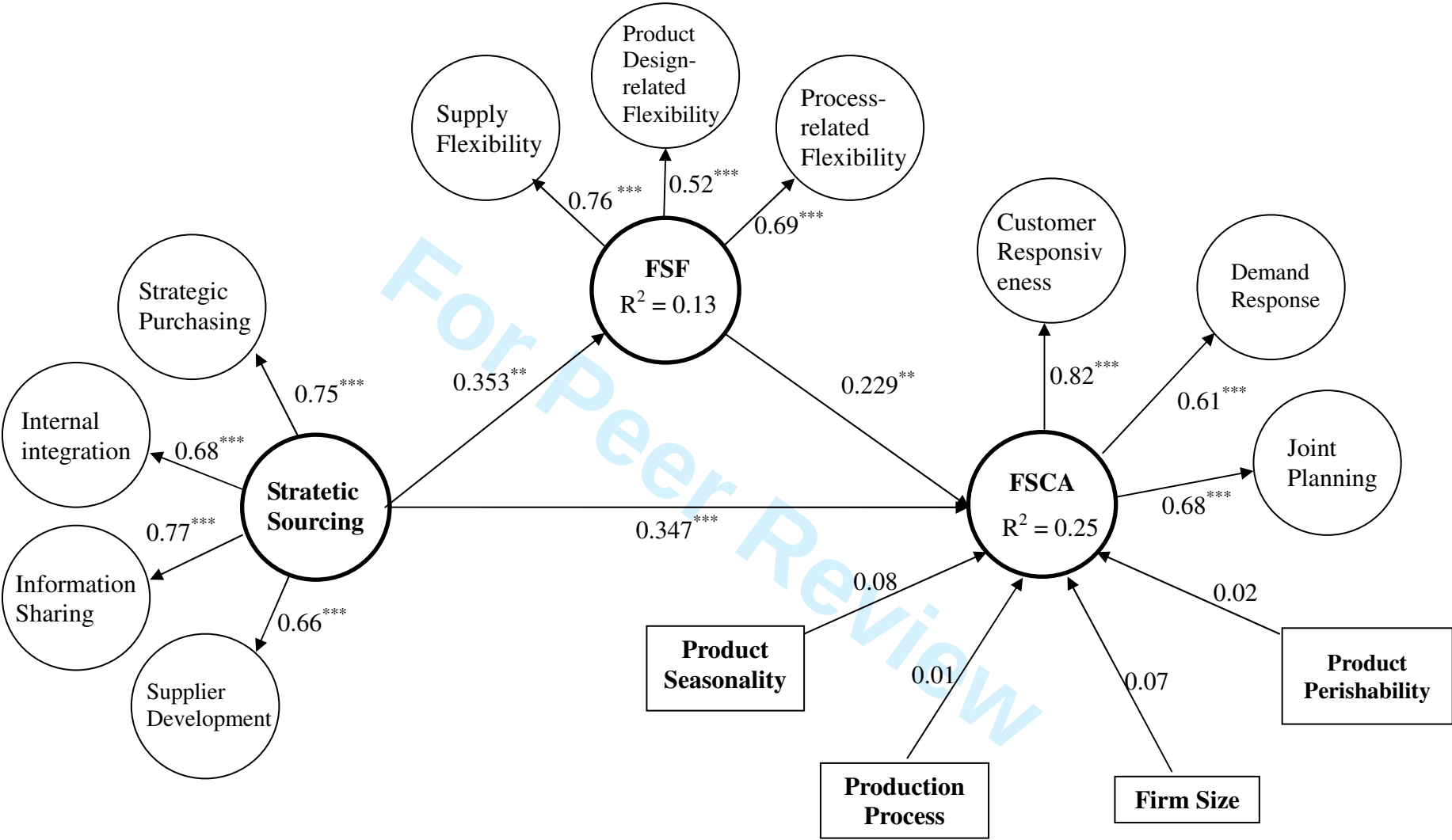


FIGURE 1: Hypothesized Model Structure & Results
H₄: A partial mediation effect exists from FSF on the relationship between strategic sourcing and FSFA.
Note: *** Significant at 0.01 level; ** Significant at 0.05 level

RESPONSES TO REVIEWER

Responses to Reviewer 1:

Responses to Comments under “Other Remarks”

1. Hypotheses - the hypotheses (especially H1 - H3) are not new, and most of them have been tested.

We thank the reviewer for this comment. We seem to have given the wrong impression somehow that H1-H3 are not new. In the revised manuscript, we have now more clearly brought out the new contributions of the study in the Introduction, as follows:

- *This study is based on a theoretical platform that considers both strategic sourcing and flexibility as internal competences which may lead to the dynamic capability of agility. This is a new, theory-based aspect in this stream of research.*
- *In addition to the above competence-capability theoretical framework, we consider supply chain agility as a dynamic capability, drawing from the theory of dynamic capabilities (Teece et al., 1997; Teece 2007), which extends both resource-based view (RBV) of the firm and the competence-capability perspective. This is again new.*
- *This study examines the antecedents of a firm's agility in the supply chain context more broadly than prior studies. The limited past studies on agility have investigated the relationship between sub-elements of strategic sourcing and agility; or sub-elements of firm-level flexibilities and agility. This study considers all three key factors (strategic sourcing, flexibility and agility) together.*
- *We have also relied on broader definitions for all three constructs, unlike past studies which have been based on sub-elements of these constructs, and based the study on more comprehensive definitions of the constructs, and tested the relationships in a broader framework.*
- *From a methodology point of view, this study applies structural equation modelling to test the relationship among the three constructs, and a method for testing mediation effects in this context.*
- *This research considers the influence of contextual factors such as firm size, manufacturing process, and the product characteristics, in order to examine the relationships in various business settings in contrast to prior studies such as Swafford et al. (2006), Khan and Pillania (2008) and Braunscheidel and Suresh (2009).*
- *This study also introduces discussion on the interdependence and balance between purchasing and manufacturing activities and how they jointly contribute to agile supply chains.*
- *Flexibility and agility have frequently been discussed as interchangeable terms in past literature (e.g. Aitken et al., 2002). A separation and clear distinction between flexibility and agility have been conceptualized and empirically validated only quite recently, in studies such as (Swafford et al., 2006) and in this study.*
- *Likewise, in various other parts of the paper, we have now attempted to clearly bring out the new aspects investigated in this paper.*

2. Research limitations section - The authors listed some trivial limitations such as the ability to generalize findings to other industries and country, but failed to mention the more severe problems of the research - both methodology and analysis related issues.

Thanks.... We have added a few more substantive limitations in the end.

3. This manuscript is extremely long (47 pages!). The introduction is almost 4 pages long.

Yes, indeed.... The previous manuscript was quite long. We noticed redundancies in the Literature Review and Model Development sections, and elsewhere. We have now eliminated the Literature Review section, moving its contents to Introduction and Model Development stages, and eliminating duplications. This also conforms to the format of more recent empirical research papers. We also combined Figures 1 and 2, etc.

*The revised manuscript is now **only 31 pages of text, including the tables** which are placed within the text. We kept the tables within the text to conform to IJOPM format. The References and one figure come after this.*

4. Why used PLS and not Lisrel, Mplus or EQS?

The primary reason for using the partial least squares (PLS), rather than the covariance-based technique of structural equation modelling (SEM) was the small sample size. This issue, and some other aspects of PLS that made it the preferred methodology is expanded upon in the subsequent paragraphs.

Similar to covariance-based SEM, the structural and measurement models under PLS (Wold, 1966; Lohmoller, 1989; Chin, 1998a, b; 2001) consist of three sets of relations: (a) The inner (structural) model, which specifies the relationships between latent variables, (b) The outer (measurement) model, which specifies the relationships between the latent variables and their associated observed variables, and (c) The weight relations upon which the case values for the latent variables can be estimated.

The PLS method is designed to maximize prediction rather than fit (Anderson and Gerbing, 1988). That is, PLS differs in its approach from other structural equation modelling techniques such as LISREL in that it tests the strength of individual component relationships rather than the overall fit of a proposed model to observed covariances amongst all of the variables. PLS uses a series of interdependent ordinary least squares (OLS) regressions to minimize residual variances, placing minimal demands on data in terms of measurement scales, sample size, and distributional assumptions (Chin, 1998b; Fornell and Bookstein, 1982; Wold, 1982). PLS is also a conservative modelling approach that tends to underestimate rather than overestimate path coefficients (Dijkstra, 1983), reducing the likelihood of Type 1 errors in hypothesis testing (Bagozzi et al., 1991). We can infer the relative strength of relationships among variables by their path loadings. We can also judge the extent to which variation in one set of variables might help explain variance in a variable of interest, through the R^2 calculated by the program. As with multiple regression, the predictive powers of PLS can help in refining theory by showing which assumed predictors have substantive links to outcomes.

Partial least squares (PLS) is preferable to covariance-based SEM in cases where the sample size is relatively small (Bagozzi et al., 1991; Hulland, 1999). Earlier work has demonstrated that PLS is capable of providing unbiased estimates with small sample sizes (Chin and Newsted, 1999; Falk and Miller, 1992). Of course, the larger the sample, the more stable the parameter estimates, yet there is no agreement as to the minimum required

sample size. A standard rule of thumb for PLS suggests a sample size equivalent to the larger of the following: (a) ten times the number of indicators for the scale with the largest number of formative (causal) indicators; or (b) ten times the largest number of structural paths directed at a particular construct in the structural model (Chin, 1998b).

Due to these characteristics, PLS has been used in several other studies in operations and supply chain management (e.g. Camison and Lopez, 2010; Jeffers, 2010; Johnston et al., 2004; Morgan et al., 2007; Ordanini and Rubera, 2008; Raymond and St-Pierre, 2005; Rosenzweig, 2009).

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- Morgan, N., Kaleka, A. and Gooner, R.A. 2007. Focal supplier opportunism in supermarket retailer category management," *Journal of Operations Management*, 25(2), pp. 512-527

Ordanini, A. and Rubera, G. 2008. "Strategic capabilities and internet resources in procurement: A resource-based view of B-to-B buying process," *International Journal of Operations & Production Management*, 28(1), pp. 27-52.

Raymond, L. and St-Pierre, J. 2005. "Antecedents and performance outcomes of advanced manufacturing systems sophistication in SMEs," *International Journal of Operations & Production Management*, 25(6), pp. 514-533.

Rosenzweig, E.D. 2009, "A contingent view of e-collaboration and performance in manufacturing," *Journal of Operations Management*, 27(6), pp. 462-478

Wold, H. (1966), "Nonlinear estimation by iterative least squares procedures", in David, F.N. (Ed.), *A Festschrift for J. Neyman*, Wiley, New York, NY, pp. 411-44.

Wold, H., 1982. *Soft modeling: the basic design and some extensions*. In: Joreskog, K.G., Wold, H. (Eds.), *Systems Under Indirect Observation. Part II*. North-Holland Publishing Co., New York, pp. 1-54.

5. The sample size of 144 cases is very small, and the low. 7.3% response rate is a serious concern. Was non-response bias tested?

One method for testing non-response bias is to test for significant differences between the responses of early and late waves of returned surveys via t-tests (Armstrong and Overton, 1977). We utilized this approach, comparing early and late respondents in terms of demographic variables (e.g. annual sales, full time equivalent (FTE)). The t-tests yielded no statistically significant differences among the demographic variables as can be seen in the table below. This is now mentioned in the manuscript.

References:

Armstrong, J.S., Overton, T.S., (1977) "Estimating non-response bias in mail surveys," *Journal of Marketing Research* 4, pp. 396-402.

Group Statistics

ID	N	Mean	Std. Deviation	Std. Error Mean
C12 >= 119	21	3.00	1.265	.276
< 119	97	2.58	1.116	.113

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
C12	Equal variances assumed	.043	.837	1.536	116	.127	.423	.275	-.122	.968
	Equal variances not assumed			1.416	27.155	.168	.423	.298	-.189	1.035

Group Statistics

ID	N	Mean	Std. Deviation	Std. Error Mean
C13 >= 119	21	3.29	.845	.184
< 119	100	3.16	.825	.083

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
C13	Equal variances assumed	.274	.602	.632	119	.529	.126	.199	-.268	.520
	Equal variances not assumed			.622	28.582	.539	.126	.202	-.288	.539

6. When was data collected?

The data was collected in 2002. We do recognize that the data set was collected 8 or 9 years ago. However, we respectfully submit that the research results based on this data set will still be of value to academic and practitioner communities. We would also expect these results to be conservative as the need for supply chain agility has increased over this time span.

7. Page 22, some citations are not provided in the references. For example, Huang and Roth (2010) & Tan and Vonderembse (2006).

We apologize.... All references have now been updated.

8. Page 22 and Table 2, what do you mean by "firms in growth or maturity stages of their life cycles"? I thought product life cycles apply to product, not the firms.

We apologize for the mistake and concur with the reviewer that it is the product's life cycle that is the focus. We reworded "Product life cycle stage" as "The stage of the product in its life cycle" to clarify.

We used Stanton's definition of a product's life cycle as "the stages a product goes through from its introduction, to its growth and maturity, to its eventual decline and death (withdrawal from the market or deletion from the company's offerings) (Stanton, 191, pg. 643). This position is also reflected in our specific survey question, which was: What stage of the product life cycle is your main product currently in?

Reference:

Stanton, W.J., Etzel, M.J., and Walker, B.J., 1991. Fundamentals of marketing, 9th ed. McGraw-Hill, New York: NY.

9. Page 24, what are the PLS fit indices?

PLS is a components-based approach to structural modelling (Chin et al., 2003). The structural and measurement models under PLS consist of three sets of relations: a) the inner (structural) model which specifies the relationships between latent variables; b) the outer (measurement) model which specifies the relationships between the latent variables and their associated observed variables; and, c) the weight relations upon which the case values for the latent variables can be estimated (Chin, 1998a, b). In PLS, a good model fit is established with significant path coefficients, acceptably high R^2 values and internal consistency (construct reliability) being above 0.7 for each construct (Gefen et al., 2000). Unlike covariance-based structural equation modelling, PLS does not use fit indices.

This standard way of applying PLS can be seen in numerous other studies in operations and supply chain management such as: Camison and Lopez (2010), Jeffers (2010), and Ordanini and Rubera (2008).

References:

- Chin, W. W. 1998a. Partial least squares approach to structural equation modeling. In I. G. A. Marcoulides (Ed.), Modern Methods for Business Research (pp. 295-336.). Mahwah, New Jersey: Lawrence Erlbaum Associates.*
- Chin, W. W., 1998b. Issues and opinion on structural equation modeling. MIS Quarterly 22 (1).*

- Chin, W. W., Marcolin, B. L., & Newsted, P. R., 2003. A partial least squares latent variable modeling approach for measuring interaction effects: results from a monte carlo simulation study and voice mail emotion/adoption study. *Information Systems Research* 14 (2), 189-217.
- Gefen, D., Straub, D. W., & Boudreau, M., 2000. Structural equation modeling and regression: Guidelines for research practice. *Communications of the Association for Information Systems* 4 (7).
- Camison, C., & Lopez, A. V. (2010). An Examination of the Relationship Between Manufactuirng Flexibility and Firm Performance. *International Journal of Operations & Production Management*, 30(8), 853 - 878.
- Jeffers, P. I. (2010). Embracing sustainability: Information technology and the strategic leveraging of operations in third-party logistics. *international Journal of Operations & Production Management*, 30(3), 260 - 287.
- Ordanini, A., & Rubera, G. (2008). Strategic capabilities and internet resources in procurement: A resource-based view of B-to-B buying process. *International Journal of Operations & Production Management*, 28(1), 27 - 52.

10. Page 24, The authors argued that the composite reliability and AVE shown in Table 3 met the reliability assessment criteria, despite that four out of 13 constructs has AVE lower than 0.5. All the three second-order constructs (strategic sourcing, strategic flexibility, and supply chain agility) fall in this group. Shouldn't this be an indication that there is a problem with the constructs?

We thank the referee for this insightful comment. We searched the literature to reexamine our understanding of this aspect.

As expected, we found that factor loadings, composite reliability, and average variance extracted (AVE) are three measures widely used for the analysis of measurement reliability (e.g., Sosik, et al. 2009, p.21, 3rd paragraph).

For the first two measures, factor loadings of indicators for the corresponding latent variable exceeding 0.6, and composite reliability developed by Werts et al. (1974) of over 0.7 have been suggested to ensure measurement reliability (Sosik, et al. 2009).

In our study, all thirteen factor loadings, except the one for product design-related flexibility are above the 0.6 threshold, while the results of composite reliability are all satisfied with the 0.7 cutoff point.

However, for the third measure, AVE, the AVEs for 4 out of the 13 constructs are indeed lower than the suggested 0.5 value. The AVE measure, created by Fornell and Larcker (1981) assesses predictiveness for the evaluation of PLS model (Chin, 1998, p.316). AVE attempts to measure the amount of variance that a latent variable component captures from its indicators relative to the amount due to measurement error (p. 321, 1st paragraph). Fornell and Larcker (1981) further suggested that AVE can also be interpreted as a measure of reliability for the latent variable component score (p.321, 3rd paragraph).

From our literature review, we have verified that not all three criteria must satisfy their respective criteria. In fact, Chin (1998, p.325), in an example of an empirical application of PLS showed that to conduct a PLS analysis, the researcher needs to first ensure the individual item reliability, which implies that the standardized loadings should be greater than 0.707. Once the individual reliabilities

are considered, the composite reliability is considered next (p.326). Chin (1998) tested the measurement reliability merely based on the two criteria mentioned and then, (p.327) moves on to test the discriminant validity by calculating AVE and comparing AVE to the square of the correlations among constructs. As a matter of fact, our reliability test procedure is completely followed the methods of Chin (1998) to conclude the reliability of our measurement model.

Moreover, we also notice that a few prior studies (e.g., Cousins, 2005; Oltra and Flor, 2010;Urgal-Gonzalez and Garcia-Vazquez, 2007), using covariance-based SEM techniques like LISREL, reported less than the desired reliability test results suggested in Nunnally (1978).

Due to the above mentioned observations, we submit that the reliability of our studied constructs is sufficiently adequate for this study.

References:

Chin, W. W. 1998. Partial least squares approach to structural equation modeling. In I. G. A. Marcoulides (Ed.), *Modern Methods for Business Research* (pp. 295-336.). Mahwah, New Jersey: Lawrence Erlbaum Associates.

Cousins, P. D. (2005) "The alignment of appropriate firm and supply strategies for competitive advantage." *International Journal of Operations and Production Management*. 25(5), pp.403 – 428.

Fornell, C., and D. Larcker (1981) "Evaluating structural equation models with unobservable variables and measurement error." *Journal of Marketing Research*, 18, pp. 39-50.

Nunnally, J. C. (1978) "Psychometric Theory" 2nd ed., McGraw-Hill, New York, NY.

Oltra, M. J. and M. L. Flor (2010)"The moderating effect of business strategy on the relationship between operations strategy and firms' results." *International Journal of Operations and Production Management*. 30(6), pp. 612 – 638.

Sosik, J. J., Kahai, S. S. and M. J. Piovoso (2009) "Silver bullet or voodoo statistics?: A primer for using the partial least squares data analytic technique in group and organization research." *Group & Organization Management*. 34(1), pp.5 – 36.

Urgal-Gonzalez, B. and J. M. Garcia-Vazquez (2007) "The strategic influence of structural manufacturing decisions." *International Journal of Operations and Production Management*. 27(6), pp.605 – 626.

Werts, C. E., Linn, R. L., and K. G. Joreskog (1974) "Intraclass reliability estimates: Testing structural assumptions." *Educational and Psychological Measurement*, 34, pp.25 – 33.

11. Some figures and tables were placed in the text while some are located at the end of the chapter. I think the placement of the figures and tables should be consistent.

We apologize for the inconsistency. The figures have now been moved to the end of the paper, while all the Tables are within the text, conforming to IJOPM format guidelines. We also noticed redundancy in Figure 1 and 2, and so we have combined both figures into just one figure.

Response to Comments under "Additional Questions":

1. Originality: Does the paper contain new and significant information adequate to justify publication?: The relationships among strategic sourcing, flexibility and supply chain agility have been explored quite extensively. Indeed, the authors have

identified quite a few of these studies. This paper concluded that strategic sourcing affects strategic flexibility and supply chain agility, and strategic flexibility affects supply chain agility. These findings have been concluded in the literature. Citing Frohlich and Dixon (2001) the authors argued that their study contributed to the literature by replicating past research results. In my opinion, the marginal contribution of this research is too insignificant to justify publication in IJOPM.

We sincerely believe that this study makes useful and timely contributions. But we do acknowledge that they were not laid out effectively in the earlier version. In particular, we did not quite convey the current gaps in literature, and the new contributions we have made. As stated under the response to the first comment above, we have:

- *This study is based on a theoretical platform that considers both strategic sourcing and flexibility as internal competences which may lead to the dynamic capability of agility. This is a new aspect.*
- *In addition to the above competence-capability theoretical framework, we consider supply chain agility as a dynamic capability, drawing from the theory of dynamic capabilities (Teece et al., 1997; Teece 2007), which extends both resource-based view (RBV) of the firm and the competence-capability perspective. This is again new.*
- *This study examines the antecedents of a firm's agility in the supply chain context more broadly than prior studies: the limited past studies on agility have investigated the relationship between sub-elements of strategic sourcing and agility; or sub-elements of firm-level flexibilities and agility. This study considers all three key factors (strategic sourcing, flexibility and agility) together.*
- *We have also relied on broader definitions for all three constructs, unlike past studies which have been based on sub-elements of these constructs, and based on more comprehensive definitions of the constructs, and tested the relationships in a broader framework.*
- *From a methodology point of view, this study applies structural equation modelling to test the relationship among the three constructs, and a method for testing mediation effects.*
- *This research considers the influence of contextual factors such as firm size, manufacturing process, and the product characteristics, in order to examine the relationships in various business settings in contrast to prior studies such as Swafford et al. (2006), Khan and Pillania (2008) and Braunscheidel and Suresh (2009).*
- *This study also introduces discussion on the interdependence and balance between purchasing and manufacturing activities and how they jointly contribute to agile supply chains.*
- *Flexibility and agility have frequently been discussed as interchangeable terms (e.g. Aitken et al., 2002), yet a separation between these concepts has been conceptualized and empirically validated only quite recently (Swafford et al., 2006).*
- *Likewise, in various other parts of the paper, we have now attempted to clearly bring out the new aspects investigated in this paper.*

3. Methodology: Is the paper's argument built on an appropriate base of theory, concepts or other ideas? Has the research or equivalent intellectual work on which the paper is based been well designed? Are the methods employed appropriate?:

- a. The paper's argument was not built on theory (such as the transaction cost economics or resource-based).

Actually, we did base our study on the theoretical aspects of competence-capability framework. In addition, we also based it on the dynamic capability theory proposed by Teece et al. (1997). It is just that we did not clearly highlight this in our earlier version of the manuscript.

The dynamic capability perspective is derived from and is an outgrowth of the resourced based view (RBV) and presents the sources of firm-level competitive advantage over time in dynamic situations. We have described the above theoretical aspects right at the beginning of Section 3: Model Development. In that section, we explained the dynamic capabilities perspective (DCP) as the ability of a firm to achieve new forms of competitive advantage by renewing competences to achieve congruence with changing business environments (Teece et al. 1997; Teece 2007). Our model is build on the dynamic capability theory as we explain how companies use strategic sourcing and strategic flexibility to build supply chain agility, which can help them: (a) sense and shape opportunities and threats, (b) seize chances, and (c) maintain competitiveness through enhancing, combining, protecting, and reconfiguring the organization's intangible and tangible assets. Dynamic capabilities theory is now increasingly applied in operations management research. Some examples of this emerging literature include (Holcomb and Hitt, 2007; Smart et al., 2007; Witcher et al., 2008).

References:

Holcomb, T. R. and Hitt, M. A. (2007), "Toward a model of strategic outsourcing." Journal of Operations Management; Vol. 25 No 2, pp. 464 – 481.

Smart, P., Bessant, J. and Gupta, A. (2007), "Towards technological rules for designing innovation networks: A dynamic capabilities view." International Journal of Operations & Production Management, Vol 27 No 10, pp. 1069 – 1092.

Witcher, B. J., Chau, V. S., and Harding P., (2008), "Dynamic capabilities: Top executive audits and hoshin Kanri at Nissan South Africa." International Journal of Operations & Production Management, Vol 28 No 6, pp. 540 – 561.

- b. I have some serious concerns regarding the survey instrument, data collection, and statistical analysis used in this paper. I could not understand why the survey instrument was designed and tested in the U.S. and Netherland when the population frame of the student was in the U.S. What is the purpose of testing it in Netherland?

It so happened that two of the authors involved in this research were interacting actively with supply chain academics & purchasing professionals in the Netherlands. The early part of the survey development took place while the two of us were in the Netherlands (one of us was a Visiting professor in a

Dutch university). Subsequently, after returning to US, the survey was administered to professionals in the US. No other special reasons existed for the choice of the two countries, and we respectfully submit that this does not affect the research results in any way. On the contrary, we have benefitted much from the academics and practitioners with whom we had an opportunity to interact outside of the US. One of the experts we interacted with during survey development was also the author of a widely-used text book in Europe and one who provided us access to many practitioners relevant to this study.

- c. There are several fatal flaws in the survey instrument and data used to test the hypotheses. First of all, the survey instrument measured perception, not actual implementation of the measured items. What was done to ensure that respondents' perceptions are accurate representation of actual practices? Was data collected from a second respondent in the same firm to cross validate the responses?

We did not collect data from a second respondent in the same firm to cross validate the responses. As in studies such as Frohlich and Westbrook (2002), it was felt that these were managers with enough seniority to know about their companies' upstream and downstream integration and performance. High-ranking respondents, with sufficient level of seniority tend to be more reliable sources of information than their subordinate rank, in accordance with Phillips (1981). This is also consistent with numerous past survey-based research studies in supply chain management (e.g., Swafford et al., 2006a,b; Braunscheidel and Suresh, 2009; Camison and Lopez, 2010). As a result, the single source employed in the study was deemed to be able to provide reliable and valid responses regarding the supply chain as a whole.

References:

- Braunscheidel, M. J. and N. C. Suresh (2009), "The Organizational Antecedents of a Firm's Supply Chain Agility for Risk Mitigation and Response", *Journal of Operations Management*, Vol.27 No.2, pp.119 - 140.
- Camison, C., & Lopez, A. V. (2010). *An Examination of the Relationship Between Manufactuirng Flexibility and Firm Performance. International Journal of Operations & Production Management*, 30(8), 853 - 878.
- Phillips, L.W. (1981) "Assessing measurement error in key informant reports: a methodological note on organizational analysis in marketing." *Journal of Marketing Research*, Vol. 18 No 4, pp. 395–415.
- Swafford, P. M., Ghosh, S. and Murthy, N. N., (2006a) "A framework for assessing value chain agility." *International Journal of Operations & Production Management*, Vol. 26 No 2, pp. 118 – 140.
- Swafford, P. M., Ghosh, S. and Murthy, N., (2006b) "The antecedents of supply chain agility of a firm: Scale development and model testing." *Journal of Operations Management*, Vol. 24 No 2, pp. 170 – 188.

- d. To make matter worse, the sampling frame targeted ISM's purchasing and supply managers when a large portion of the questions were operations and logistics oriented. I am doubtful that purchasing and supply managers are knowledgeable about the firms' strategic flexibility (supply flexibility, product design, and process flexibility) and agility (customer responsiveness, demand response, and joints planning). For example, some of the operations oriented

survey questions asked the respondents how long it takes to introduce new products, to accommodate design change, and to change product mix (these are items measuring the first-order product design flexibility construct). There are similar concerns with all the other first-order constructs measuring supply chain flexibility and supply chain agility.

In addition to the points mentioned above, for the previous comment, we would like to add the following. High-level Purchasing and supply chain executives have been shown to be more conversant with external aspects and demands on manufacturing situations than manufacturing managers, and manufacturing executives are generally aware of fewer sourcing issues (Narasimhan and Das, 1999). Similarly, in Braunscheidel and Suresh (2009) it was also pointed out that these executives with sufficient seniority tend to know about the firms' upstream and downstream integration aspects and performance. The respondents employed in our study are also consistent with most past survey-based research works in the supply chain management. Finally, the survey instrument was not overly technical and did not require detailed knowledge of manufacturing process/equipment, just as in studies such as Narasimhan and Das (1999). This is certainly a point for future refinements for research in this area. Hence, we submit that the responses from the purchasing executives and supply managers are valid and reliable.

References:

Braunscheidel, M. J. and N. C. Suresh (2009), "The Organizational Antecedents of a Firm's Supply Chain Agility for Risk Mitigation and Response", Journal of Operations Management, Vol.27 No.2, pp.119 - 140.

Narasimhan, R. and A. Das (1999a), "An Empirical Investigation of the Contribution of Strategic Sourcing to Manufacturing Flexibilities and Performance", Decision Sciences, Vol.30 No.3, pp.683 - 718.

- e. Another major concern of this study is how the research model was operationalized. The authors used 3 indicators to measure each first-order construct (Appendix). For example, are (1) top management emphasizes purchasing function's strategic role, (2) purchasing is viewed as equal to other functions by the CEO, and (3) purchasing is involved in corporate-level strategic planning (Appendix) adequate measure of the strategic purchasing construct? In order to properly measure strategic purchasing of a firm, I would expect to enquire whether there is a strategic alliance relationship between the buyer and supplier, supplier certification program, and supplier performance evaluation system, among others. Similar problem exists for all the other first-order constructs.

The scales for the research constructs and survey instrument employed in this study are mostly derived from existing studies. For example, the construct of strategic sourcing and the questions asked in the questionnaire are adopted from Kocabasoglu and Suresh (2006). We do agree with the reviewer that there may be other indicators which can be considered to present the concept of the corresponding construct. We submit that this might be true for most other empirical studies in the past in this research stream. We will keep this factor in mind in our future research efforts.

- f. Using 3 indicators per construct also preclude the authors' ability to use the two-step modeling approach to assess the fit of the structural model independently of the measurement models because the degrees of freedom for each measurement model will be negative (see references below).
 Byrne, B. M. (1998). Structural equation modeling with Lisrel, Prelis, and Simplis: Basic concepts, applications, and programming. Lawrence Erlbaum Associates, Mahwah, New Jersey.
 Schumacker, R. E., & Lomax, R. G. (1996). A beginner's guide to structural equation modeling. Lawrence Erlbaum Associates, Mahwah, New Jersey.

In PLS modeling, a universal fit measure, like model χ^2 for covariance-based SEM using maximum likelihood estimation and other similar fit indices is not utilized (Chin, 1998; Tenenhaus et al., 2005) though one global goodness-of-fit criterion which mainly serves a diagnostic purpose, has been proposed (Wetzels et al., 2009). As mentioned above for comment #9, using PLS, the evaluation of the fit of a structural model depends merely on the analysis of the predictability of the endogenous constructs and the strength of the relationships between the constructs (Camison and Lopez, 2010). The predictability of the endogenous constructs is evaluated by means of the R^2 value for the endogenous variables. The strength of the relationships between the constructs is assessed through the path coefficients (β) and the corresponding significant level.

Unlike traditional SEM approach used in Lisrel, the degrees of freedom for measure model is measured as “the number of bootstrapping size – 1” (Henseler et al., 2009) which is 999 in this study since the bootstrapping size considered in this study is 1000 subsamples, which is larger than the suggested 500 subsample size suggested by Chin (2001) and used by Camison and Lopez (2010).

References:

- Chin, W. W. (1998) *The Partial Least Squares Approach to Structural Equation Modeling*. In *Modern Business Research Methods*, G. A. Marcoulides (ed.), Mahwah, NJ: Lawrence Erlbaum Associates, pp. 295 – 336.
- Chin, W. W. (2001) *PLS-Graph User's Guide Version 3.0.*, Houston, TX: Soft Modeling Inc.
- Henseler, J., Ringle, C.M., & Sinkovics, R.R. (2009). *The Use of Partial Least Squares Path Modeling in International Marketing*. *Advances in International Marketing* 20, pp. 277-319.
- Tenenhaus, M., Vinzi, V. E., Chatelin, Y.-M., and Lauro, C. (2005) *PLS Path Modeling*. *Computational Statistics and Data Analysis* 48(1), pp. 159-205.
- Wetzels, M., Odekerken-Schroder, G. & van Oppen, C. (2009) *Using PLS path modeling for assessing hierarchical construct models: Guidelines and empirical illustration*. *MIS Quarterly* 33(1), pp. 177-195.

4. Results: Are results presented clearly and analysed appropriately? Do the conclusions adequately tie together the other elements of the paper?:

- a. Results are well-presented, but I am doubtful of using PLS to analyze the research model. I believe the model would not converge if the authors used Lisrel, MPlus or EQS due to the small sample size.

As explained in one of our responses, we have chosen PLS over covariance-based SEM because it has been suggested as a methodology appropriate for smaller samples sizes (Bagozzi et al., 1991; Hulland, 1999) and the fact that research has shown it to be capable of providing unbiased estimates with small sample sizes (Chin and Newsted, 1999; Falk and Miller, 1992). Our sample size does satisfy the rule of thumb for required sample sizes in PLS.

References:

Bagozzi, R.P., Yi, Y., Singh, S., 1991. On the use of structural equation models in experimental designs: two extensions. International Journal of Research in Marketing 8 (2), 125–140.

Chin, W. W. and P.R Newsted (1999), “Structural equation modeling analysis with small samples using Partial Least Squares.” In: R.H. Hoyle, Editor, Statistical strategies for small sample research, Sage Publications, London, pp. 308–341.

Falk, R.F. and Miller, N.B. (1992), A Primer for Soft Modeling, University of Akron Press, Akron, OH.

Hulland, J., 1999. The use of partial least squares in strategic management research: a review of four recent studies. Strategic Management Journal 20 (2), 195–204.

5. Implications for research, practice and/or society: Does the paper identify clearly any implications for research, practice and/or society? Does the paper bridge the gap between theory and practice? How can the research be used in practice (economic and commercial impact), in teaching, to influence public policy, in research (contributing to the body of knowledge)? What is the impact upon society (influencing public attitudes, affecting quality of life)? Are these implications consistent with the findings and conclusions of the paper?: I am doubtful of the research methodology and survey instrument; hence, I am reluctant to recommend whether the implications are consistent with the findings and conclusions of the paper.

We hope that the numerous changes we have now made in the paper, address the issues the reviewer had in terms of the contribution of the research and the empirical study.

We thank the referee for the perceptive comments which, we feel, have served to significantly strengthen the manuscript.

Responses to Reviewer: 2

Responses to Questions under “Comments”:

1. Define "agility" in the introduction - how is it different from flexibility? You'll also therefore need to explain your definition of "flexibility"

We thank the reviewer for this suggestion, since the distinction between these two concepts is critical for this study. As a result, we added a section in the Introduction (at the bottom of the first page of Introduction) where flexibility is defined early as the ability “to change or react with little penalty in time, cost, or performance” (Upton, 1994) whereas agility is defined as the capability of the firm, internally, and in conjunction with its key suppliers and customers, to adapt or respond in a speedy manner to a changing marketplace contributing to agility of the extended supply chain (Braunscheidel and Suresh, 2009).

References:

Braunscheidel, M. J. and N. C. Suresh (2009), "The organizational antecedents of a firm's supply chain agility for risk mitigation and response", Journal of Operations Management, Vol.27 No.2, pp.119 - 140.

Upton, D. M. (1994), “The management of manufacturing flexibility”, California Management Review, pp. 72- 89.

2. Explicitly explain the difference between competence and capability

In line with the reviewer’s request, we used the explanations given by Teece et al. (1997) in their seminal article, where they discuss competencies vs. capabilities. They explain competence as: “When firm-specific assets are assembled in integrated clusters spanning individuals and groups so that they enable distinctive activities to be performed, these activities constitute organizational routines and processes”. Thus, competence is “what an organization can do particularly well” (Andrews, 1987). But while this competence is unique, it provides that company profit potential only when it is linked to the needs of the market. Thus, Teece et al. (1997) suggested that capabilities are about “appropriately adapting, integrating, and reconfiguring internal and external organizational skills, resources, and functional competences to match the requirements of a changing environment.” In other words, capabilities are about matching the organization’s abilities with the market’s needs.

References:

Andrews, K. (1987). The Concept of Corporate Strategy (3rd ed.). Dow Jones-Irwin, Homewood, IL.

Teece, D. J., G. Pisano and A. Shuen (1997). ‘Dynamic capabilities and strategic management’, Strategic Management Journal, 18(7), pp. 509–533.

3. The arguments for H1 and H2 are very similar; there needs to be a clearer distinction;

We thank the reviewer for this comment. We have strengthened arguments for hypotheses 1 and 2 (and also the other two hypotheses) and clarified their differences by taking the following steps:

In line with one of the reviewer’s earlier comments,

- a) *We provide definitions for all three constructs, this provides a clear delineation of the flexibility and agility constructs also helping establish a clear difference on how strategic sourcing relates to flexibility vs. agility*
- b) *We explain the difference between competence and capability thereby again separating the flexibility and agility constructs.*
- c) *We rearrange the hypotheses section to bring out the differences in the hypotheses section and bringing out that strategic sourcing relates to agility by ensuring that its operations is aligned to the needs of the market whereas its role in improving flexibility is primarily due to the fact that suppliers provide key input to a firm's operations and poor supply management can seriously disrupt operations, etc.*

4. For both H1 and H2, there should be more explanation of why the relationships are hypothesized in addition to providing references that support these relationships. There is some explanation but not enough.

We have rewritten the sections related to Hypothesis 1 and 2, and provided more explanations in response to this comment of the referee. .

5. Again, there is not a very clear distinction between agility and flexibility, so it is difficult to see the significance of the argument for H3.

As stated before, the definitions of flexibility and agility are now in the Introduction, especially relating them in a competence-capability framework helped us strengthen our argument for H3. It should be stated that this is why we consider this study be timely, only recently have these concepts been clearly separated, and the constructs defined, measured and empirically validated.

6. The argument for H4 is not well developed. Again, the authors need to explain why there should be a mediation effect. What would it mean for FSF to mediate the relationship between strategic sourcing and agility, and why would you expect there to be such an effect?

To respond to this request, we considered the role of purchasing in physical distribution versus market mediation as defined by Fisher (1997), and introduced the following in the development of H4:

Fisher (1997) argued that a supply chain has both a physical distribution and market mediation function. While the physical distribution function focuses on getting the products to the market efficiently, the market mediation function is primarily related to scanning the market to make sure that a firm (or a set of firms in the supply chain) seizes opportunities in the market by synchronizing the demand with their supply. This raises the following question about the exact nature of the relationship between strategic sourcing and FSFA. If one considers only the physical function, strategic sourcing can be primarily seen as comprehending procurement needs of an organization and ensuring the arrival of supplies consistent with these needs. If one focuses on the market mediation aspect, the question becomes whether there is additional information that purchasing can collect, given its boundary spanning role and its relationships with other firms regarding the market, which may help a firm synchronize the supply with end-customer demands better. If the former scenario applies, one may expect flexibility to fully mediate the relationship between strategic sourcing and agility since the positive or negative contributions of strategic sourcing

will be fully absorbed by the internal operations. If on the other hand, if purchasing has a role in market mediation, one would not expect to see full mediation.

Reference:

Fisher, M. L. (1997) *What Is the Right Supply Chain for Your Product?*, Harvard Business Review, Vol. 75 Issue 2, p105-116.

7. One control variable that seems to be missing is industry. The authors apparently have SIC codes for their respondents, so it would not seem to be difficult to control for industry. Different industries have very different characteristics, and those characteristics would likely affect agility and flexibility.

In response to this suggestion, we reanalyzed the relationships among the proposed research constructs, adding industry as a control variable. The path coefficients and corresponding significance level among constructs are provided below.

	<i>SP</i>	<i>IN</i>	<i>IS</i>	<i>SD</i>	<i>FSF</i>	<i>SF</i>	<i>DF</i>	<i>PF</i>	<i>FSCA</i>	<i>CR</i>	<i>DR</i>	<i>JP</i>
<i>SS</i>	0.753***	0.680**	0.771***	0.658***	0.353**				0.346***			
<i>FSF</i>						0.762***	0.518***	0.686***	0.224**			
<i>FSCA</i>										0.819***	0.608***	0.682***
<i>Firm Size</i>									0.069			
<i>Perishablility</i>									-0.019			
<i>Process</i>									-0.018			
<i>SIC</i>									0.082			
<i>Seasonality</i>									0.080			

*Note: *** is significant at 0.01 level; ** is significant at 0.05 level; * is significant at 0.1 level*

The results shown above are pretty similar to the results presented in Table 6 (P.27 in original submission). The path coefficients between each control variable and FSCA are all insignificant and close to zero.

8. It seems that there should have been some direct measure of demand uncertainty instead of two variables that might be related to demand uncertainty.

We could have considered one of the two following options with regards to demand uncertainty:

- 1.) Taken a measure of demand uncertainty from economics, such as a variable driven by changes in sales. We preferred not to, since this variable assumes that there was enough capacity to absorb the variability.
- 2.) Taken a well established construct such as dynamism or munificence. While this was seriously considered, we had to abandon the idea given that the survey was already quite long.

We do believe that perishability and seasonality are to alternative measures, given the large body work on fast fashion (e.g. Fisher and Raman, 1996), where the product is both perishable and seasonal.

Reference:

Fisher, M., and Raman, A., 1996, "Reducing the cost of demand uncertainty through accurate response to early sales," *Operations Research*, 44(1), pp. 87-99.

9. A response rate of 7.3% is low, even if the authors have been able to find other published studies with comparably low response rates. Also, the authors did not appear to have tested for non-response bias, which is important with such a low response rate.

One method for testing non-response bias is to test for significant differences between the responses of early and late waves of returned surveys via t-tests (Armstrong and Overton, 1977). We utilized this approach comparing early and late respondents in terms of demographic variables (e.g. annual sales, full time equivalent (FTE)). The t-tests yielded no statistically significant differences among the demographic variables as can be seen in the table below.

References:

Armstrong, J.S., Overton, T.S., (1977) "Estimating non-response bias in mail surveys," *Journal of Marketing Research* 4, pp. 396–402.

Group Statistics					
ID		N	Mean	Std. Deviation	Std. Error Mean
C12	>= 119	21	3.00	1.265	.276
	< 119	97	2.58	1.116	.113

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
C12	Equal variances assumed	.043	.837	1.536	116	.127	.423	.275	-.122	.968
	Equal variances not assumed			1.416	27.155	.168	.423	.298	-.189	1.035

Group Statistics					
ID		N	Mean	Std. Deviation	Std. Error Mean
C13	>= 119	21	3.29	.845	.184
	< 119	100	3.16	.825	.083

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
C13	Equal variances assumed	.274	.602	.632	119	.529	.126	.199	-.268	.520
	Equal variances not assumed			.622	28.582	.539	.126	.202	-.288	.539

10. Another potential issue is the possibility of common method bias as a result of using a single respondent. One possible check for this problem is Harman's one-factor test.

Yes, indeed... the test for common method bias is needed for survey-based research work. Liang et al. (2007) (Appendix E, page 85 – 87), based on Podsakoff et al. (2003) and Williams et al. (2003), suggested a method to test the common method bias under the PLS program as quoted below:

“According to Williams et al. (2003), evidence of common method bias can be obtained by examining the statistical significance of factor loadings of the method factor and comparing the variances of each observed indicator explained by its substantive construct and the method factor. The squared values of the method factor loadings were interpreted as the percent of indicator variance caused by method, whereas the squared loadings of substantive constructs were interpreted as the percent of indicator variance caused by substantive constructs. If the method factor loadings are insignificant and the indicators’ substantive variances are substantially greater than their method variances, we can conclude that common method bias is unlikely to be a serious concern. “

Test results for Common Method Bias

Construct	Indicator	Substantive Factor Loading (R1)	R1 ²	Method Factor Loading (R2)	R2 ²
CR	CR1	0.631***	0.399	0.171**	0.029
	CR2	0.895***	0.801	-0.158**	0.025
	CR3	0.880***	0.774	0.008	0.000
DF	DF1	0.804***	0.646	-0.023	0.001
	DF2	0.770***	0.592	-0.017	0.000
	DF3	0.805***	0.647	0.038	0.001
DR	DR1	0.581***	0.337	-0.003	0.000
	DR2	0.731***	0.535	-0.188***	0.035
	DR3	0.732***	0.536	0.158**	0.025
IN	IN1	0.736***	0.542	-0.040	0.002
	IN2	0.774***	0.600	-0.122	0.015
	IN3	0.656***	0.431	0.153**	0.023
IS	IS1	0.906***	0.821	-0.020	0.000
	IS2	0.960***	0.921	-0.052	0.003
	IS3	0.701***	0.492	0.085	0.007
JP	JP1	0.719***	0.516	-0.113	0.013
	JP2	0.888***	0.789	-0.092	0.009
	JP3	0.710***	0.504	0.176**	0.031
PF	PF1	0.582***	0.338	-0.084	0.007
	PF2	0.786***	0.618	-0.056	0.003
	PF3	0.809***	0.654	0.104*	0.011
SD	SD1	0.829***	0.687	-0.161**	0.026
	SD2	0.850***	0.723	0.051	0.003
	SD3	0.781***	0.610	0.080	0.006
SF	SF1	0.599***	0.359	0.164*	0.027
	SF2	0.888***	0.788	-0.051	0.003

	SF3	0.850***	0.722	-0.090	0.008
SP	SP1	0.848***	0.718	0.079	0.006
	SP2	0.981***	0.962	-0.090*	0.008
	SP3	0.862***	0.743	0.012	0.000
Average		0.785	0.627	-0.003	0.011

Note: *** is significant at 0.01 level; ** is significant at 0.05 level; * is significant at 0.1 level

As seen from the results in the above table, the common method bias test results show that average variance of the substantive factor loading (0.627) is 62 times more than that of the method factor loading (0.011). Moreover, most method factor loadings are insignificant. Hence, we consider that the common method bias is less likely to be a concern.

References:

Liang, H., Saraf, N., Hu, Q., & Xue, Y. (2007). Assimilation of Enterprise Systems: The Effect of Institutional Pressures and the Mediating Role of Top Management. *MIS Quarterly*, 31(1), 59 - 87.

Podsakoff, P., MacKenzie, S., Lee, J., & Podsakoff, N. (2003). Common Method Biases in Behavioral Research: A Critical Review of the Literature and Recommended Remedies. *Journal of Applied Psychology*, 88(5), 879 - 903.

Williams, L. J., Edwards, J. R., & Vandenberg, R. J. (2003). Recent Advances in Causal Modeling Methods for Organizational and Management Research. *Journal of Management*, 29(6), 903 - 936.

11. Why did the authors use PLS instead of structural equation modeling?

The primary reason for using the partial least squares (PLS) rather than the covariance-based of technique structural equation modeling (SEM) was the small sample size. This issue and some other aspects of PLS that made it the preferred methodology is expanded upon in the subsequent paragraphs.

Similar to covariance-based SEM, the structural and measurement models under PLS (Wold, 1966; Lohmohller, 1989; Chin, 1998a, b; 2001) consist of three sets of relations: The inner (structural) model, which specifies the relationships between latent variables, (b) The outer (measurement) model, which specifies the relationships between the latent variables and their associated observed variables, and (c) The weight relations upon which the case values for the latent variables can be estimated.

The PLS method is designed to maximize prediction rather than fit (Anderson and Gerbing, 1988). That is, PLS differs in its approach from other structural equation modeling techniques such as LISREL in that it tests the strength of individual component relationships rather than the overall fit of a proposed model to observed covariances amongst all of the variables. PLS uses a series of interdependent ordinary least squares (OLS) regressions to minimize residual variances, placing minimal demands on data in terms of measurement scales, sample size, and distributional assumptions (Chin, 1998b; Fornell and Bookstein, 1982; Wold, 1982). PLS is also a conservative modeling approach that tends to underestimate rather than overestimate path coefficients (Dijkstra, 1983), reducing the likelihood of Type 1 errors in hypothesis testing (Bagozzi et al., 1991). We can infer the relative strength of relationships among variables by their path loadings. We can also judge the extent to which variation in one set of variables might help explain variance in a variable of interest, through the R^2 calculated by the program. As with

multiple regression, the predictive powers of PLS can help in refining theory by showing which assumed predictors have substantive links to outcomes.

Partial least squares (PLS) is preferable to covariance-based SEM in cases where the sample size is relatively small (Bagozzi et al., 1991; Hulland, 1999). Earlier work has demonstrated that PLS capable of providing provide unbiased estimates with small sample sizes (Chin and Newsted, 1999; Falk and Miller, 1992). Of course, the larger the sample, the more stable the parameter estimates, yet there is no agreement as to the minimum required sample size. A standard rule of thumb for PLS suggests a sample size equivalent to the larger of the following: (a) ten times the number of indicators for the scale with the largest number of formative (causal) indicators; or (b) ten times the largest number of structural paths directed at a particular construct in the structural model (Chin, 1998b).

Due to these characteristics PLS has been used in several other studies in operations and supply chain management (e.g. Camison and Lopez, 2010; Jeffers, 2010; Johnston et al., 2004; Morgan et al., 2007; Ordanini and Rubera, 2008; Raymond and St-Pierre, 2005; Rosenzweig, 2009)

References:

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12. The test for mediation can include a partial mediation, where there can still be a significant relationship between the predictor variable (SS) and the outcome variable (FSCA) when the hypothesized mediator variable (FSF) is included in the model. Partial mediation is indicated when the magnitude of the effect from the predictor to the outcome variable is reduced. That appears to be the situation here. The magnitude of the standardized coefficient for SS, while significant in both models, decreases from 0.428 to 0.347. The literature is not clear on the extent to which the magnitude must be decreased to allow a conclusion of partial mediation, but the authors should investigate this possibility. I would suggest that the authors consult the literature on mediation and partial mediation to guide them on this issue.

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In addition to the full mediation effect described in Baron and Kenny (1986), Sosik et al. (2009) suggested the existence of partial mediation effect under PLS. One formal approach to test the existence of mediation effect is to examine whether the product of the two mediating paths is significantly different from zero (MacKinnon et al., 2002). Sobel test (Sobel 1982) is the most common tool used for such a test. However, this test is not able to be applied in this study because the path coefficients are not independent since PLS is used. Moreover, under PLS, there are no unstandardized path coefficients as required to run Sobel test.

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Sosik et al. (2009) considered that partial mediation exists when the path coefficients between the predictor variable, strategic sourcing, and the intervening variable, FSF, and between the intervening variable and outcome variable, FSCA, are significant. In other words, if the direct path and the two mediating paths were significant, a partial mediation effect should be concluded. In this study, the path

coefficients are both significant (0.346 and 0.344) and the partial mediation effect is concluded.

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