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# Flexibility and quality in logistics and relationships

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ABSTRACT

This research focuses on supplier-buyer relationships in a distribution channel. It uses a contingency theory to claim that, under different environmental conditions, logistics flexibility and relationship flexibility for a focal firm (a manufacturer in this study) will have distinct effects on logistics service quality (when treated as a controllable mediator) and the firm's satisfaction in its relationship with its key downstream account. Using data from a survey of manufacturers in China, it uses structural equation modeling to test the main effects and moderated regression together with moderated path analysis to examine the contingent effects of environmental uncertainty. The results show that, as distinctive capabilities, both logistics flexibility and relationship flexibility have significant positive effects on the level of logistics service quality that the manufacturer offers, which, in turn, enhance how much it values and is satisfied with its relationship with its key account. However, the direct effect of logistics flexibility on relationship satisfaction is stronger under an uncertain environment, while the direct and total effect of relationship flexibility on relationship satisfaction is stronger under a stable environment.


## 1. Introduction

Stable environments allow organizations to simply utilize well-learned or dominant responses to address environmental disturbances (Fredericks, 2005). However, globalization, rapidly changing information technology, and increasing diversification of consumer requirements cause many firms to face increasingly uncertain environments. In such instances, existing routines and procedures may be inappropriate in that a mismatch exists between organizational responses and external demands (Fredericks, 2005). Some years ago, a special issue in *Industrial Marketing Management* on "Rigidity versus Flexibility in Business Marketing" pointed to the need to create flexibility in business-to-business marketing settings (Matthyssens, Pauwels, & Vandenbempt, 2005). Studies published in that issue emphasized concepts such as intra-firm flexibility and inter-firm flexibility (Fredericks, 2005), service providers' flexibility (Ivens, 2005), purchasing/supply chain management flexibility (Giunipero, Denslow, & Eltantawy, 2005), and marketing-based flexibility (i.e. applied customer knowledge) (Claycomb, Drőge, & Germain, 2005). Furthermore, many ensuing studies also support the definitions and arguments of those studies (Hsieh, Chiu, & Hsu, 2008; Money, Hillenbrand, Day, & Magnan, 2010; Wang & Wei, 2007). Those emphasize the important role of flexible arrangements of firms embedded in relationships with their partners (Fernie, Sparks, & McKinnon, 2010). However, focusing not on relational norms but on resources invested in the relationship, Swafford, Ghosh, and Murthy (2006) define logistics flexibility as the capability to adapt the process of controlling the flow of physical and other resources to changing marketplace conditions, which is widely adopted in a channel context. Thus, this study argues that flexibility in B2B context has both resource-based and norm-based components, in effect, either pushing a logistical transformation to quick response and efficient customer response (McKinnon, 1994), or forcing many buyers and suppliers to make adaptations in their relationships and to modify the rules of exchange as circumstances change (Sezen & Yilmaz, 2007).

As a strategic capability that fits environment requirements, flexibility can be critical to organizational performance (Anand & Ward, 2004; Patel, 2011; Yu, Cadeaux, & Song, 2012). When flexibility is addressed as a tier of a system, its outcomes are often connected with financial or business performance such as return on investment (ROI), return on sales (ROS) and market share (Duclos, Vokurka, & Lummus, 2003; Sánchez & Pérez, 2005; Vickery, Calantone, & Dröge, 1999). In contrast, when defining flexibility as a capability or in terms of relational norms, researchers often focus on such direct or function-specific performance outcomes as product quality, delivery speed, delivery dependability, and new product introduction, all of which lead to customer satisfaction and ultimately influence competitive advantage (Young, Sapienza, & Baumer, 2003; Zhang, Vonderembse, & Lim, 2002). However, most of these studies treat flexibility as a universally effective strategy for enhancing performance and tend not to consider its relative strength as a capability under differing environmental conditions. Even though

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some empirical studies include environmental factors such as uncertainty, they often treat uncertainty only as an antecedent (see review by Fayezi, Zutshi, & O'Loughlin, 2014). Yet, Pagell and Krause (2004) show that the main effects model of uncertainty as a simple antecedent for flexibility does not fit well. Furthermore, Fantazy, Kumar, and Kumar (2009) found that some dimensions of flexibility can even have negative effects on firm performance. One reason for such results may be that relationships might vary across contexts.

Recent studies have just begun to test the moderating effect in accordance with a contingency theory. The present study aims to contribute to this stream of literature by examining several issues. Most of the existing studies test moderators of the effect on flexibility of its antecedents (Chang & Huang, 2012; Gligor, 2014; Kim, Suresh, & Kocabasoglu-Hillmer, 2013; Tamayo-Torres, Ruiz-Moreno, & Verdu, 2010) rather than moderators of the effect of flexibility on its performance outcomes. Thus, the present study considers how the effects of flexibility on performance vary across environmental circumstances. Even though some researchers do examine moderators of the effect of flexibility on performance, they focus on *structural* rather than *environmental* moderators (Li & Ogunmokun, 2008; Liao, Paul, & Rao, 2010; Patel, Terjesen, & Li, 2012). However, there are some researchers who do propose theoretical frameworks that explicate a comprehensive mechanism for how environmental factors can moderate the effect of flexibility on performance (Ketokivi & Schroeder, 2004; Vokurka & O'Leary-Kelly, 2000; Yu et al., 2012). Although some empirical studies have also tested such moderating effects (Hallavo, 2015; Li, 2010), they neither distinguish between different dimensions or types of flexibility nor do they examine its effects on more immediate and focused function-specific performance outcome. In light of contingency arguments developed from information processing theory and transaction cost theory, this study tries to determine the conditions under which two types of flexibility, specifically logistics flexibility and relationship flexibility, can enhance function-specific relationship performance.

## 2. Literature review and development of hypotheses

Empirical studies of customer satisfaction in the business-to-consumer market all support the theory that quality has a significant positive effect on overall customer satisfaction (Fornell, Johnson, Anderson, Cha, & Bryant, 1996). Arguably, in the context of business-to-business distribution channels, the higher the level of logistics service quality offered, which represents efficiency, accuracy and consistency in delivery (Mentzer, Flint, & Kent, 1999), the more positive will be the affective state resulting from the appraisal of all aspects of a distributor-manufacturer relationship, a construct that defines relationship satisfaction (Anderson & Narus, 1984; Webb & Hogan, 2002; Yu, Cadeaux, & Song, 2013). However, previous studies only propose a significant role for flexibility in enhancing service quality and customer satisfaction without distinguishing between direct and indirect effects (Young et al., 2003; Zhang et al., 2002). Thus, a question remains as to whether logistics service quality mediates the effect of flexibility on relationship satisfaction. The present study argues that both resource-based logistics flexibility and norm-based relationship flexibility are critical capabilities that underlie a firm's ability to offer logistics services with high quality in terms of availability, timeliness, and physical condition of stock and which can in turn lead to higher levels of satisfaction in a firm's relationship with its key downstream account.

However, the essence of the organizational contingency theory paradigm is that there is no universal set of strategies that are optimal for all businesses, and that, therefore, organizations need to design strategies for specific environment contexts. Most commonly, a contingency theory states that the effective level of some planning variable depends on the level of some environmental variables (Cadeaux, 1994). Miller (1979) suggests that "organizations are complex entities and the relationship between two variables may be influenced by many contextual conditions" (p. 296). Or, in other words, a contingency theory usually involves a theory of environmental moderation that is more explicit than a simple theory about how organization structures and strategies somehow "match" the environments in which they lie. Following this view, many empirical studies test not only the "match" between environmental uncertainty and flexibility (Fantazy et al., 2009; Merschmann & Thonemann, 2011; Vickery et al., 1999) but also how environmental factors moderate the effect of flexibility on performance (Hallavo, 2015; Li, 2010).

Some studies also argue that environmental uncertainty manifests itself in several dimensions and that a certain type of flexibility is a reaction to a specific dimension of uncertainty (Dreyer & Grønhaug, 2004; Tachizawa & Thomsen, 2007). Thus, it may be important to determine the conditions under which flexibility, or more particularly, each type of flexibility, can enhance a firm's performance. In a supply chain, demand uncertainty and competition uncertainty are the main dimensions of environmental uncertainty (Kumar, Stern, & Achrol, 1992). As an important contingency variable, environmental uncertainty in demand and competition may moderate the mediating effects of logistics service quality on the effects of logistics flexibility and relationship flexibility on relationship satisfaction. Following this view, Fig. 1 shows the theoretical model underlying this study. The following sections will illustrate the corresponding hypotheses for this model.

### 2.1. Flexibility, logistics service quality and satisfaction

Logistics flexibility is the ability of the organization to respond quickly to customer needs in delivery, support, and service (Zhang et al., 2002). To make such adjustments requires a sufficient quantity and quality of information as a resource. Information capability refers to an organization's ability to acquire, process, and transmit information to support decision-making (Grover & Malhotra, 2003). Logistics flexibility is related to information processing in such logistics activities as transportation planning and management, facility structure management (e.g. warehouse location), inventory management, material handling (e.g. packaging and loading), as well as reverse logistics, tracking, and delivery (Duclos et al., 2003; Williamson, Spitzer, & Bloomberg, 1990). The present study suggests that in order to adjust storage capacity, delivery capacity or schedules, transportation mode, inventory and other outbound logistics activities in response to direct and indirect customer demands, logistics flexibility involves processing material and information flow between the focal firm (e.g. manufacturer, the organizing hub of the supply chain network which integrates upstream and downstream resources) and its supply chain partners (Bowersox, 1972; Swafford et al., 2006).

In processing timely and sensitive data on demand, inventory, and shipping status (La Londe & Masters, 1994), the focal firm responds to those uncertainties that arise during delivery of physical products which directly affect the supply or distribution ability of the market and influence downstream distributors' operations. In this way, logistics flexibility minimizes operational costs, saves delivery time and enhances the consistency of delivery. Adjusting warehouse capacity in terms of size, locations, resources, technology, and automating or balancing inventory level can enhance the availability of products significantly; adjusting delivery capacity in transport routes and schedules or bundling shipments to achieve economies can allow shorter delivery time and allow goods to arrive in better condition (Rexhausen, Pibernik, & Kaiser, 2012). The implication is that a higher level of logistics flexibility allows a firm to offer its customers a higher level of logistics service quality. Since the effect of logistics service quality on relationship satisfaction has already been addressed, we hypothesize that:

**H1a.** The higher the level of logistics flexibility, the higher will be the level of logistics service quality offered by the focal firm, which in turn, ultimately enhances the level of relationship satisfaction.

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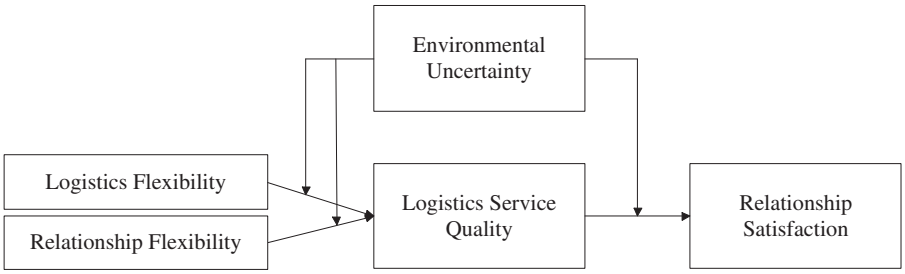


**Fig. 1.** Proposed conceptual model.

Flexibility in a channel context not only has a resource-based dimension but also a norm-based dimension. Yu et al. (2013) identify two reasons for this. First, studies of relationship flexibility connect flexibility to relational norms suggesting that, as circumstances change, relationships can change (Heide & John, 1992; Sezen & Yilmaz, 2007). Furthermore, a complete definition of flexibility components should include the flexibility dimensions required by all of the participants in the supply chain in order to successfully meet customer demand (Duclos et al., 2003). Thus, relationship flexibility complements logistics flexibility as a distinct dimension. Relationship flexibility defines a bilateral expectation of willingness in a trading relationship to adapt, change, or adjust to new knowledge without resorting to a series of new contracts and renegotiations (Richey, Adams, & Dalela, 2012; Young et al., 2003). From a supplier's perspective, it represents assurance that the relationship will be subject to good-faith modification if a particular practice proves detrimental in light of changed circumstances (Heide, 1994). For example, facing fierce competition in the air-conditioner market, GREE, the world's largest specialized air conditioner company, carried out a "Vague Refund Profits Policy" to give a certain percentage of whole year profits to distributors whenever competition caused a dramatic decrease in distributors' profits (Huang, Dai, & Zhang, 2009). They also implemented an "Off-season Sales Policy" to give refunds of profits with an interest rate higher than the bank rate to distributors who pay for goods before the arrival of the peak season (Huang et al., 2009). Such policies help support distributors by sharing the costs of managing stocks in a volatile environment, which in turn can strengthen relationships with distributors. Thus, both policies reflect the strategic capability of GREE to flexibly coordinate with their distributors in reaction to environment changes. Compared with logistics flexibility, relationship flexibility requires a bilateral expectation of willingness to make adjustments of ongoing relationships (Heide & John, 1992).

Information capability is especially critical to logistics performance because logistics operations are heavily dependent on effective and efficient information sharing (Daugherty, Chen, & Mattioda, 2009), which, in turn, requires critical and proprietary information to be communicated to one's supply chain partners (Monczka, Petersen, Handfield, & Ragatz, 1998). As a relational competency, open and frequent communication is essential to the maintenance of these value-enhancing relationships. Effective and efficient communication between supply chain partners reduces product and performance-related errors, thereby enhancing quality, timeliness, and customer responsiveness (Chen & Paulraj, 2004; Dyer, 1996). When firms exhibit flexibility in their behavior toward partners, they implicitly communicate their good faith and good intentions in the relationship (Johnson, 1999). Due to this positive and pro-relationship message, the focal firm is able to apprise partners of potential situations that might influence operations, and, reciprocally, partners provide the focal firm with guarantees of future volumes and prices, which may be tied to their cost reduction and quality improvement efforts (Heide & John, 1992). In this sense, a greater capability of adjusting ongoing relationships allows a firm to offer greater levels of logistics service quality, which, in turn, leads to relationship satisfaction. Thus,

**H1b.** The higher the level of relationship flexibility, the higher will be the level of logistics service quality offered by the focal firm which, in turn, ultimately enhances the level of relationship satisfaction.

### *2.2. Adaptations to environmental uncertainty*

The theoretical framework shows that the focus of contingency factors in this study is environmental uncertainty. However, the argument for environmental uncertainty is quite distinctive and is based on distinct theories. Organizational information processing theory defines uncertainty as the difference between information possessed and information required to complete a task (Tushman & Nadler, 1978). Thus, Nonaka and Nicosia (1979) depict an uncertain environment as one of low quality information about the market. A basic proposition in organizational information processing theory is that the greater the uncertainty of the task, the greater the amount of information that has to be processed among decision makers during the execution of the task (Galbraith, 1974). Effective information processing includes the collection of appropriate information, the movement of information in a timely fashion, and its transmission without distortion (Wright & Ashill, 1998). It also involves the information capabilities of its strategic planning system to handle needed quantities of information according to these criteria (Rogers, Miller, & Judge, 1999). If a task is well understood prior its execution, much of the activity can be preplanned. If it is not understood, then during task execution more knowledge must be acquired, which leads to changes in resource allocation, schedules, and priorities. All such changes or adaptations require additional information to be processed. These outcomes suggest that the greater the uncertainty of a task, the greater the amount of information that decision makers must process during task execution in order to achieve a given level of performance. Since logistics flexibility offers time efficiency and enhances the consistency of delivery by adjusting storage, inventory, and delivery activities in response to customer requirements (Swafford et al., 2006), what underpins logistics flexibility is a capability of processing logistics-related market information from distributors or end customers of the focal firm. Thus, to allow a firm to offer a high quality of logistics service and maintain buyer-seller relationships in an uncertain environment requires logistics flexibility as a strong capability to process market information. Thus,

**H2a.** The effect of logistics flexibility on the level of logistics service quality offered by the focal firm will be stronger in a relatively uncertain environment.

**H2b.** The effect of logistics flexibility on the level of satisfaction in the relationship with a key account will be stronger in a relatively uncertain environment.

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From the organizational information processing perspective, in order to respond to environmental uncertainty, firms may either a) increase their capacity to process information or b) reduce the amount of information that needs to be processed (Galbraith, 1977). As discussed above, logistics flexibility is clearly a viable mechanism to increase the *capacity* to process information. However, in contrast to logistics flexibility, relationship flexibility emphasizes information exchanges between buyers and suppliers to reach an agreement of mutual adaptation to the external environment (Wang, Tai, & Grover, 2013), which, *in itself*, requires a large quantity of information to be processed (above and beyond that needed to adapt to an uncertain environment). In this sense, a flexible relationship, in contrast to a more rigid one, creates its own uncertainties associated with the task of maintaining and managing relationship flexibility, a task that would have been either non-existent or far more easily managed and with more certainty in a rigid relationship; that is, one with more formal rules and procedures. In this sense, relationship flexibility differs from logistics flexibility in that, although it does not necessarily add any capacity to process information, it does add to the inter-organizational *demand* for information and thus fails to reduce the dyad's need for information processing capacity. Specifically, in a flexible supplier-buyer relationship, relational norms expect both parties to share information with their counterpart. This sharing expectation may require the development of databases and systems that are relevant and understandable to their counterpart (buyer or supplier). Such information sharing obligations add even more to the demand for the production and distribution of information beyond that already required for adaptation to an uncertain environment.

No doubt, relationship flexibility generally facilitates greater levels of logistics service quality at the same time as it enhances relationship satisfaction via the communication of good faith and intentions regarding the adjustment of relationships (Heide, 1994). Such a main effect as stated in H1b is quite clear. However, an uncertain environment manifesting a high quantity of relatively un-reliable market information over a short time span could disturb the delivery of positive and pro-relationship messages (Nonaka & Nicosia, 1979), which, in turn, increases the need for information processing and can result in sub-optimal decision making (Srinivasan, Mukherjee, & Gaur, 2011). Thus, following these arguments, relationship flexibility, which, in itself, demands reliable information sharing in order to reach agreement and fulfill normative expectations, would be more effective in a relatively certain environment where market information has both long time span applicability and is high in reliability, thus balancing total demand for information in the system. Thus, following the prescription of organizational information processing theory for information demand reduction rather than its prescription for information processing capacity enhancement, we hypothesize as follows:

**H2c.** The effect of relationship flexibility on the level of logistics service quality offered by the focal firm will be weaker in a relatively uncertain environment.

**H2d.** The effect of relationship flexibility on the level of satisfaction in the relationship with a key account will be weaker in a relatively uncertain environment.

Transaction cost theory makes a very different claim about environmental uncertainty as it affects seller-buyer relationships. It does so by invoking two concepts not directly observed in this study (nor in most such studies) but that offer theoretical explanatory power. These are a) the relative ability or inability for formal contracts to be set that could potentially handle environmental uncertainties and b) the significant commitment to relationship-specific assets that a flexible relationship entails. From such a transaction cost theory perspective, environmental uncertainty (including information uncertainty) contributes to the inability of formally structured or rigid relationships to stipulate (in advance) courses of action between parties to best deal with unforeseeable contingencies. To the extent that relationship flexibility entails normative contracts with relation-specific assets, such a view of uncertainty leads to a potential for higher levels of opportunism in relatively inflexible relationships and thus would tend to reduce relationship satisfaction in more formally contractual (rigid) relationships.

In a very basic sense, transaction cost theory claims that greater uncertainty in the environment leads to higher levels of opportunism in relationships (Williamson, 1985), which constitutes a threat to buyer-seller relationships. Thus, in reaction to such uncertainty, firms will start deploying costly safeguards such as long-term relationships with a few suppliers, investments in relation-specific resources or relational norms that, although reducing efficiency, can help minimize environmental uncertainty (Cadeaux & Ng, 2012; Premkumar, Ramamurthy, & Saunders, 2005). To the extent that relationship flexibility concerns the strong expectations for flexible adjustment processes taken in a long-term oriented manner as a bilateral governance mechanism (Heide, 1994), it thus restrains partners from opportunism through a socialization process that leads to shared values (Bello & Gilliland, 1997). This mechanism leads to less need for formal contractual re-negotiation in order to make adaptive decisions (Wang et al., 2013). In this sense, transaction cost theory implies that investments in flexible relationships yield even greater returns in the face of high environmental uncertainty because they reduce the risks associated with opportunism and formal contract re-renegotiation. Thus, we propose the following *competing* hypotheses about the effects of relationship flexibility (See Table 1):

**H2c'.** The effect of relationship flexibility on the level of logistics service quality offered by the focal firm will be stronger in a relatively uncertain environment.

**H2d'.** The effect of relationship flexibility on the level of satisfaction in the relationship with a key account will be stronger in a relatively uncertain environment.

## 3. Research design

In order to test relationships between variables and obtain variance in environmental uncertainty, this study samples companies across different sub-sectors of manufacturing industry. This design involves an unavoidable trade-off since it would be almost impossible to find companies in the same sector who distribute the same products with the same process yet face systematically different environments. Thus, as it employs a cross-industry survey, this study requires general rather than sector-specific measures of the theoretical constructs. Table 2 shows how the total sample captured a wide range of manufacturing industries.

### 3.1. Data collection

Since information on most variables of interest is relationship-specific and not available from published sources, key informants from companies in business-to-business settings respond to survey instrument questions. This constrains independent corroboration of questionnaire response (Parkhe, 1993). The sample covers almost all categories of manufacturing industry in China and includes such industries as food manufacturing, tobacco processing, textile and garment manufacturing, furniture manufacturing, stationery and sporting goods manufacturing, pharmaceuticals manufacturing, PC and electronic equipment manufacturing, and machine building. Furthermore, the manufacturing output of the top five districts studied here, Guangdong Province, Jiangsu Province, Shandong Province, Zhejiang Province and Shanghai, account for a combined 57% of total manufacturing output in China. These regions and industries well represent China's manufacturing sector.

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**Table 1**
Competing hypotheses for environmental moderation of relationship flexibility effects.

| Theory | Information processing theory | | Transaction cost theory | |
|---|---|---|---|---|
| **Constructs** | | | | |
| Uncertainty | *Key facet*: A high quantity of relatively un-reliable market information | | *Key facet*: Tendency to encourage opportunism in relationships | |
| Relationship flexibility | *Key facet*: Relational task uncertainty and information sharing norm increases demand for information *within* relationship | | *Key facet*: Flexible adjustment processes function as bilateral governance mechanism (Heide, 1994) | |
| **Effects** | *Hypothesis* | *Direction* | *Hypothesis* | *Direction* |
| Uncertainty × Relationship flexibility → Logistics service quality | H2c | - | H2c' | + |
| Uncertainty × Relationship flexibility → Relationship satisfaction | H2d | - | H2d' | + |

The survey uses a convenience sample because it is extremely difficult to conduct a direct mail survey to obtain a random sample of respondents in China for several reasons: (a) the challenge to direct the questionnaire to the right person, (b) the tendency of busy Chinese executives to ignore such requests, and (c) suspicion and distrust of researchers from outside the *guanxi* network (Zhao, Flynn, & Roth, 2006). To obtain executive managerial samples in China, researchers often resort to *guanxi* networks (Zhu & Sarkis, 2004). Thus, this study uses a contact directory of managers previously enrolled in short-term business training programs held at a major university in China. These managers include CEOs, presidents, senior executives or senior managers with middle or higher experience of their company's operations and who are highly involved in strategic decision making processes. The researcher team approached 460 managers of qualified local firms in the manufacturing industry via email or by phone. The qualified respondents range from middle managers and senior managers to presidents/vice presidents. Key informants provide their background information through three additional items: a) How experienced would you say you are in dealing with distribution channel management? b) How knowledgeable are you of distribution channel management? c) How representative are your answers to the questions about distribution channel management among these persons? Returned questionnaires were discarded if these items were rated lower than three on a five-point scale. As a result, a total of 262 executives responded to the request for information about their company. This number represents 57% of the original firms contacted. A follow-up screening process reveals that 212 questionnaires were usable, yielding a pure response rate of 46%, which is satisfactory in light of other B2B surveys of a similar nature (Fantazy et al., 2009; Liao et al., 2010; Wang & Wei, 2007; Zhang, Vonderembse, & Lim, 2005).

**Table 2**
Sample composition.

| | N | % |
|---|---|---|
| *Manufacturing category* | | |
| Food and drink | 24 | 11.3 |
| Clothing and clothes | 18 | 8.5 |
| Wood and furniture | 8 | 3.8 |
| Printing and stationery | 9 | 4.2 |
| Oil and chemical products | 12 | 5.7 |
| Pharmacy | 10 | 4.7 |
| Mine and metal | 18 | 8.5 |
| Special or general equipment | 46 | 21.7 |
| Electrical appliance | 21 | 9.9 |
| Telecom and electric products | 30 | 14.2 |
| Others like construction | 3 | 1.4 |
| Total | 199 | 93.9 |
| *Age of the company* | | |
| Less than 1 year | 8 | 3.8 |
| 1–2 years | 12 | 5.7 |
| 2–5 years | 22 | 10.4 |
| 5–10 years | 62 | 29.2 |
| More than 10 years | 108 | 50.9 |
| Total | 212 | 100.0 |
| *Number of employees* | | |
| 0–100 | 80 | 37.7 |
| 100–300 | 36 | 17.0 |
| 300–500 | 13 | 6.1 |
| 500–600 | 11 | 5.2 |
| 600–1000 | 20 | 9.4 |
| 1000–2000 | 14 | 6.6 |
| 2000–3000 | 8 | 3.8 |
| More than 3000 | 30 | 14.2 |
| Total | 212 | 100.0 |
| *Sales revenues* | | |
| Less than 5 million RMB | 33 | 15.6 |
| 5–10 million RMB | 18 | 8.5 |
| 10–20 million RMB | 20 | 9.4 |
| 20–30 million RMB | 11 | 5.2 |
| 30–50 million RMB | 23 | 10.8 |
| 50–150 million RMB | 30 | 14.2 |
| 150–300 million RMB | 28 | 13.2 |
| >300 million RMB | 49 | 23.1 |
| Total | 211 | 100.0 |
| *Total assets* | | |
| Less than 10 million RMB | 53 | 25.0 |
| 10–20 million RMB | 23 | 10.8 |
| 20–30 million RMB | 10 | 4.7 |
| 30–40 million RMB | 16 | 7.5 |
| 40–100 million RMB | 23 | 10.8 |
| 100–200 million RMB | 17 | 8.0 |
| 200–400 million RMB | 20 | 9.4 |
| >400 million RMB | 50 | 23.6 |
| Total | 212 | 100.0 |

A comparison of the survey results to several known population parameters reveals no non-response bias. For example, companies that constitute the largest proportion of the final sample locate in the industry of manufacturing special or general equipment/instruments (27.1%), which is close to the proportion reported by the National Bureau of Statistics of China (23.1% in 2009). In addition, in China, the proportions of the numbers of large to middle to small enterprises are about 1:10:100. In this sample, the distribution of different sizes of companies also resembles such an inverted pyramid. Another commonly used method of testing non-response bias rests on the assumption that late respondents share similar characteristics and response biases with non-respondents (Armstrong & Overton, 1977). The questionnaire was distributed in several waves. Within and across waves, early-returned questionnaires did not significantly differ from late-returned questionnaires on a number of company descriptors: company age, number of employees, sales revenue, and total assets.

### 3.2. Measure development

The measures for each construct are based on an extensive literature study as well as interviews with practitioners and use multiple-item, 5-point Likert-type scales where "1" means "strongly disagree" and "5"means "strongly agree". A preliminary English version of the survey instrument as derived from a thorough literature review of constructs and measures was translated into Chinese and backward to English for double-checking by two separate groups of researchers. The final Chinese version was pretested through two stages. At the first stage,

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participants were aware that they were taking a pretest, during which eleven industrial experts (middle or senior managers who are familiar with logistics and relationship management) were involved in an interview setting (face-to-face or over the telephone) to gather as much insight as possible. A second stage conducted two rounds of undeclared pretests, presented just as the survey instrument would be in the field, during which respondents were not informed of the pretest status of the survey. A revised version incorporated feedback from the pretests along with comments and suggestions from industry experts and academic researchers. A third stage pretested a preliminary version of the survey instrument on 23 local executives from different companies in the manufacturing industry of China. A final revised version of the survey instrument used feedback from these executives along with comments and suggestions from industry experts and academics.

An initial measure of logistics flexibility used conventional items for logistics adaptability designed by Swafford et al. (2006). But since internal consistency of their final four-item measure was not very high (CR = 0.62), that scale was combined with several other items that are concerned with flexibility across several aspects of logistics activities: (a) flexibility in storage, which is related to either the number of warehouses or space available in warehouses in response to demand fluctuation, (b) flexibility in delivery refers to the flexibility in the reliability, coverage and lead time in response to volatility in the volume of deliveries, (c) flexibility in transportation modes is about flexibility in the number and variety of transportation modes used in response to changing delivery schedules (Zhang et al., 2005), and (d) flexibility in inventory, which is associated with the volume of inventory in different places (Morash & Lynch, 2002). The measure of relationship flexibility used items for measuring flexibility as a relational norm developed by Wang and Wei (2007) (CR > 0.70; AVE > 0.70), which are enriched by three items designed by Heide and John (1992): (a) the extent to which flexibility in response to requests for changes is a characteristic of a relationship; (b) the extent to which the parties expect to be able to make adjustments in the ongoing relationship to cope with changing circumstances; and (c) whether when an unexpected situation arises, the parties would rather work out a new deal than hold each other to the original terms.

Numerous researchers have attempted to replicate Parasuraman, Berry, and Zeithaml's (1985, 1988) instrument to measure perceived service quality (SERVQUAL). However, the SERVQUAL scale with its primarily functional or process dimensions may not adequately address the context where the service provider and the customer are physically separated or the services are directed at "things" (Bienstock, Mentzer, & Bird, 1997). That is the main reason why simply applying SERVQUAL would not be appropriate for physical distribution service quality. Incorporating functional quality aspects of logistics services, the general construct of service quality was expanded into a logistics context by following the general methodology used to develop the physical distribution service quality scale (Mentzer et al., 1999). In developing that scale, Mentzer et al. (1999) divide nine constructs into two components: order placement (personnel contact quality, order release quantities, information quality and ordering procedures) and order receipt (order accuracy, order condition, order quality, timeliness, order discrepancy handing). However, logistics flexibility and relationship flexibility are capabilities of adjusting actions during the time period between order receipt and order shipment, so a measure of logistics service quality should concentrate on such constructs as order accuracy, order condition, order quality, timeliness and order discrepancy handling. Those indicators are consistent with the basic measure of physical distribution service quality developed by Bienstock et al. (1997). As first defined by Mentzer, Gomes, and Krapfel (1989), that measure consisted of three dimensions including a) timeliness, the order cycle time performance of the entire distribution system linking buyers and sellers; b) availability, the proportion of units, order lines, or orders completely filled; and c) condition or quality, depending on the incidence of in-transit damage, shipment of incorrect items and incorrect shipment quantity. Their second-order CFA model shows very good fit.

The measure of relationship satisfaction uses the measures of channel satisfaction designed by Webb and Hogan (2002). They adapted the scale from Anderson and Narus (1984) who suggest that "satisfaction is a construct defined as a positive affective state resulting from the appraisal of all aspects of a firm's working relationship with another firm" (p. 66). The original items developed by Anderson and Narus (1984) capture the construct in terms of whether the partner is satisfied with the relationship, whether the relationship is a happy one, and whether the partner has a positive attitude toward selecting the manufacturer as their partner. Webb and Hogan (2002) add another item to emphasize the appraisal of the relationship characteristics from the perspective of communication. Their final construct with four items has a Cronbach's α of 0.82.

The measure of environmental uncertainty is perceptual. From a perceptual perspective, a firm's task environment is the organization's interpretation of what inputs of information mean for behavior, generally including many external information sources such as customers, competitors, suppliers, regulatory groups, and the technological requirements of an industry (Dill, 1958). In particular, Achrol and Stern (1988) partitioned environmental dynamism into several dimensions including dynamism in marketing practices, competitor dynamism and customer dynamism. However, assessing reseller performance from the perspective of the supplier, Kumar et al. (1992) focused on environmental variables such as demand uncertainty and competition uncertainty in a reseller's territory, an approach which clearly fits the context of this study. Thus, this study uses their scale as a measure of perceived environmental uncertainty.

### 3.3. Measure validation

As stated earlier in Subsection 3.2, all the scales used were derived from a thorough literature review and panel experts discussed whether the measure represents all facets of each construct. Following a traditional method to assess content validity (Lynn, 1986; Grant & Davis, 1997), inter-rater agreement (IRA) was computed as the number of items considered at least 80% reliable divided by the total number of items for which there were more than five experts (Rubio, Berg-Weger, Tebb, Lee, & Rauch, 2003). The results show that the average IRA for each dimension in this study was 100%. With the guiding principle that the theoretical meaning rather than statistical results should always be considered in the first place, the industrial and academic experts only suggested minor modifications after three stages of pretesting. These all guarantee content validity of the measure.

To the extent that confirmatory factor analysis (CFA) affords a strict interpretation of unidimensionality (Anderson & Gerbing, 1988), the analysis used CFA first to assess the measurement properties of each construct separately. Two higher order constructs need to be illustrated. An initial test examines logistics service quality as a second-order confirmatory factor model as suggested by Bienstock et al. (1997). The first-order factors of availability, timeliness and condition have respective loadings of 0.803, 0.947, and 0.671 on the second-order factor and all loadings are significant ($p < 0.001$). The fit indices for this second-order model suggest a good fit with the data ($\chi^2/df = 3.503$; RMR = 0.038; GFI = 0.936; CFI = 0.920; RMSEA = 0.109). Thus, the results validate that availability, timeliness, and condition form a higher-order construct of logistics service quality. However, the CFA model of environmental uncertainty did not fit very well ($\chi^2/df = 9.536$; RMR = 0.081; GFI = 0.957; CFI = 0.904; RMSEA = 0.201). When Carson, Madhok, and Wu (2006) measured volatility in the R&D context, they used a second-order factor structure with two dimensions of market volatility and technological volatility, and each dimension was weighted equally following purification in the final scores (two items in each dimension after purification). Following this

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approach, this study develops two sub-dimensions of competition uncertainty and demand uncertainty as composing perceived market uncertainty in the context of distribution channels. Assuming that competitors and customers are equally important as sources of low quality information in this context, the approach used here does not distinguish the priorities of these two dimensions and thus constructs a second-order CFA of uncertainty with equal weights for each sub-dimension. After doing this, the revised second-order measurement model fit improves dramatically ($\chi^2$/df = 0.724; RMR = 0.010; GFI = 0.998; CFI = 1.000; RMSEA = 0.000), indicating that the model fits the data much better.

After testing for the unidimensionality of all the other constructs, a CFA then examines the whole measurement model. The test for overall fit included all measures that had two or more reflective items including logistics flexibility, relationship flexibility, logistics service quality, relationship satisfaction, and perceived environmental uncertainty. This process eliminated several items from the initial measurement model due to very low loadings or for model fit improvement (if there was no change to a construct). Table 3 represents these items with the note of "*dropped*". According to Kenny and McCoach (2003), most goodness-of-fit indices such as CFI and TLI share the problem of unfairly punishing models with a relatively greater number of observed variables per latent construct. In contrast, the RMSEA and the RMR actually provide an advantage when a model contains a large number of variables (Hair, Black, Babin, Anderson, & Tatham, 2006). Thus, the final model fit indices indicate a good fit ($\chi^2$/df = 1.879; RMR = 0.046; GFI = 0.867; IFI = 0.909; CFI = 0.907; RMSEA = 0.065). To assess the reliability of the items comprising each construct, this study first considers the standard internal consistency criterion of Cronbach's alpha (Cronbach, 1951; Nunnally & Bernstein, 1994). Typically, reliability coefficients of 0.70 or higher are considered adequate although Nunnally and Bernstein (1994) claim that permissible alpha values can be slightly lower for new scales (i.e., around 0.60). As Table 3 shows, Cronbach's alphas for each construct exceed the cut-off value of 0.70. However, since the number of indicators composing a latent construct, in itself, affects the value of Cronbach's alpha, Fornell and Larcker (1981) recommend examining an estimate of composite reliability (CR). Usually, CR value of 0.70 or higher suggest good reliability (Fornell & Larcker, 1981). As Table 3 shows, all of the CR values as well as the Cronbach's alphas are above the cut-off value.

The next step assesses the validity of constructs in terms of convergent validity and discriminant validity. Convergent validity assesses the similarity or convergence between the individual items that measure the same construct (Steenkamp & Trijp, 1991). The larger are either the t-values or loadings, the stronger is the evidence that the individual items represent the underlying factors (Bollen, 1989). The CFA results confirm that the t-value for each indicator was > 1.96, indicating a significant loading (Schumacker & Lomax, 2004). In addition, the average percentage of variance extracted (AVE) among a set of construct items is a summary indicator of convergence (Fornell & Larcker, 1981). In Table 3, the AVE of each construct exceeds the variance attributable to its measurement error cut-off value of 0.50 (with the single exception of relationship flexibility which falls slightly below 0.50, since AVE is a conservative measure, the convergent validity of the measures as a whole is still acceptable) (Chin, 1998; Fornell & Larcker, 1981). As evidence of discriminant validity of the measures, the square root of the AVE should exceed the correlations of the construct with the other constructs in the model (Fornell & Larcker, 1981). Table 4 shows that

**Table 3**
Assessing reliability of the measurement model.

| Construct and items | Standard loading | Cronbach's alpha | CR |
|---|---|---|---|
| **Logistics flexibility** | | **0.759** | **0.766** |
| LF1: Adjust storage capacity if demand fluctuates | 0.666 | | |
| LF2: Adjust delivery capacity to meet volume for delivering | 0.792 | | |
| LF3: Make flexible use of multiple transportation modes to meet the schedule for delivering | 0.706 | | |
| LF4: Frequently balance inventory | *Dropped* | | |
| LF5: Adjust order fulfillment time at request | *Dropped* | | |
| **Relationship flexibility** | | **0.705** | **0.722** |
| RF1: The relationship is able to respond quickly to requests. | *Dropped* | | |
| RF2: Expect to be able to make adjustments in the ongoing relationship | 0.644 | | |
| RF3: Revalue the ongoing situation to achieve a mutually satisfactory solution when disagreements arise in transactions | 0.793 | | |
| RF4: Modify the working agreement rather than hold each other to its original terms when an unexpected situation arises | 0.600 | | |
| **Logistics service quality** | | **0.819** | **0.891** |
| ***Timeliness*** | *0.975* | | |
| SQT1: The time between placing and receiving an order is short. | 0.785 | | |
| SQT2: The time between receiving and shipping the order is short. | 0.727 | | |
| SQT3: The time between placing and receiving an order is consistent. | 0.602 | | |
| ***Availability*** | *0.740* | | |
| SQA1: Orders are available in inventory where ordered. | 0.904 | | |
| SQA2: The products are consistently available in inventory . | 0.437 | | |
| SQA3: A wide assortment is available. | *Dropped* | | |
| ***Condition& quality*** | *0.664* | | |
| SQC1: Respond with accurate information in response to inquiries concerning an order. | 0.720 | | |
| SQC2: All orders are fulfilled accurately (items ordered arrive, no unordered items). | 0.812 | | |
| SQC3: All orders are delivered undamaged. | 0.644 | | |
| **Relationship satisfaction** | | **0.872** | **0.877** |
| CS1: Have a good working relationship with the key account | 0.910 | | |
| CS2: The working relationship is characterized by open and honest communication. | 0.906 | | |
| CS3: When the need arises to work together, it is always conducted in a positive manner. | 0.812 | | |
| CS4: The key account is satisfied with the arrangement of the overall distribution system. | 0.534 | | |
| **Perceived environmental uncertainty** | | **0.707** | **0.811** |
| ***Demand uncertainty*** | *0.697* | | |
| EU1: Customers' demand is changing. | 0.820 | | |
| EU2: There are a number of changes taking place in customers' preferences. | 0.755 | | |
| ***Competition uncertainty*** | *0.865* | | |
| EU3: The level of competitive activity is changing (e.g. number or strength of competitors is increasing). | 0.660 | | |
| EU4: There are a number of changes taking place in competitors' sales and promotional strategies. | 0.636 | | |

Note: The focal firm is the referent. Their key account is identified among all direct customers that may have any of the following features: a) the largest percentage of key product revenue; b) the largest percentage of key product sales volume; c) the one on which you spend most of your time and effort to manage. Construct reliabilities are shown in bold.

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**Table 4**
Assessing convergent validity and discriminant validity.

| Constructs | Mean | Std. dev. | AVE | LF | RF | LSQ | RS | PEU |
|---|---|---|---|---|---|---|---|---|
| Logistics flexibility (LF) | 3.931 | 0.682 | 0.523 | 0.723 | | | | |
| Relationship flexibility (RF) | 3.906 | 0.604 | 0.468 | 0.319** | 0.684 | | | |
| Logistics service quality (LSQ) | 3.876 | 0.553 | 0.514 | 0.434** | 0.470** | 0.717 | | |
| Relationship satisfaction (CS) | 4.037 | 0.665 | 0.648 | 0.409** | 0.496** | 0.479** | 0.805 | |
| Perceived environmental uncertainty (EU) | 3.604 | 0.786 | 0.521 | 0.190** | 0.232** | 0.339** | 0.253** | 0.722 |

Note: The square root of AVE is on the diagonal.

the highest correlation between any pair of the constructs is 0.496, while the lowest square root of AVE is 0.684. Consequently, all constructs exhibit satisfactory discriminant validity.

### 3.4. Common method variance

Because the same key informants respond to all items in the model, common method bias may be a threat to validity (Podsakoff, MacKenzie, Podsakoff, & Lee, 2003). The first test for common method bias applied the Harman single-factor test. Traditionally, researchers using this technique load all of the variables in their study into an exploratory factor analysis (EFA). Thus, we examined the unrotated factor solution and found that there are six factors emerging from the factor analysis and that the first factor only accounts for 30.5% of the variance, which indicates that no general factor accounts for the majority of the covariance among the measures. Confirmatory factor analysis (CFA) offers a more sophisticated test. This test compares, via a chi-square difference test, a single-factor model where all manifest variables are explained through one common method factor to the multi-factor measurement model actually used in the study. In this study, the single-factor model yields a chi-square of 982.179 with a freedom degree of 209. The fit of this model is significantly worse than the fit of the measurement model that includes all constructs in the model ($\Delta\chi^2$ (14) = 615.766, $p < 0.001$). This result indicates that the correlations between observed variables cannot be adequately explained by a single common method factor.

However, Podsakoff et al. (2003) argue that Harman's single-factor test does not statistically control for common method variance. Instead, they suggest single-method-factor approaches in which items are allowed to load on their theoretical constructs, as well as on a latent common methods variance factor. According to the method suggested by Podsakoff et al. (2003), a further test examined the significance of the structural parameters both with and without the latent common methods variance factor in the structural model described in the next section. Every item from the constructs in the basic structural framework was allowed to load on a general method factor, where common method effects seem very unlikely. According to the assumption that the degree of common method bias is not associated with the magnitude of the constructs themselves (Podsakoff et al., 2003), the test specified the general method factor to be uncorrelated with the other constructs because it is unlikely that the subsets of firms with both high flexibility and high performance will be more (or less) prone to common method biases. The results show that the significance of the path coefficients is exactly the same, revealing that the effects remain even if a common method factor is included. Thus, these diagnostics imply that the findings are not affected by the use of the same data source. The next section presents the results of the hypothesis tests.

## 4. Analyses and results

### 4.1. Results of structural equation modeling (SEM)

A structural equation model (SEM) tested key linear relationships in the theoretical model without any interactions as shown in Fig. 2. The fit indices indicate a good fit ($\chi^2$/df = 2.112; RMR = 0.041; GFI = 0.880; IFI = 0.914; CFI = 0.913; RMSEA = 0.073).

A comparison of models with and without the common method factor (Table 5) shows no difference between the two models in the pattern of significant and non-significant hypothesized effects for the corresponding performance outcomes and environmental drivers of flexibility. Specifically, both logistics flexibility and relationship flexibility have significant positive effects on logistics service quality ($\gamma = 0.374$, $p < 0.01$; $\gamma = 0.778$, $p < 0.001$, respectively). Also, logistics service quality affects relationship satisfaction positively and significantly ($\gamma = 0.323$, $p < 0.05$).

The results of a *Sobel* test show that the indirect effects through logistics service quality of logistics flexibility and relationship flexibility on relationship satisfaction are both significant ($z = 1.924$, $p < 0.05$; $z = 2.127$, $p < 0.05$, respectively). In addition, although not hypothesized here, logistics flexibility and relationship flexibility have positive and

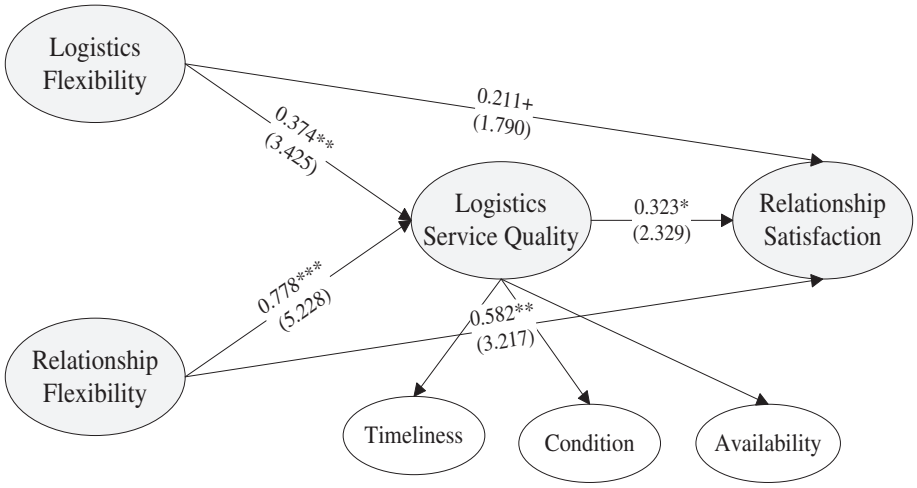


**Fig. 2.** Result for theoretical model. Note: $^{+}p < 0.1$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

**Table 5**
Summary of hypotheses and estimates.

| Hypotheses | Paths | Model without common method factor | | | Model with common method factor | | | Results |
|---|---|---|---|---|---|---|---|---|
| | | Estimate | S.E. | zscore | Estimate | S.E. | zscore | |
| H1a | Logistics flexibility → Logistics service quality | 0.374** | 0.109 | 3.425 | 0.217** | 0.083 | 2.626 | Supported |
| H1b | Relationship flexibility → Logistics service quality | 0.778*** | 0.149 | 5.228 | 0.833*** | 0.149 | 5.593 | Supported |
| | Logistics flexibility → Relationship satisfaction | 0.211+ | 0.118 | 1.790 | 0.255** | 0.087 | 2.920 | Not hypothesized |
| | Relationship flexibility → Relationship satisfaction | 0.582*** | 0.181 | 3.217 | 0.545*** | 0.173 | 3.140 | Not hypothesized |
| H1a/b | Logistics service quality → Relationship satisfaction | 0.323* | 0.139 | 2.329 | 0.324* | 0.128 | 2.531 | Supported |

Note: $^{+}p < 0.1$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$, one tail z-test under the standard normal curve. S.E. is the standard error. Z score measures the distance of a measure from the mean in units of standard deviation.

significant direct effects on relationship satisfaction ($\gamma = 0.211$, $p < 0.10$; $\gamma = 0.582$, $p < 0.01$, respectively). These results show that even *after* accounting for the direct effects of logistics flexibility and relationship flexibility on relationship satisfaction, both logistics flexibility and relationship flexibility have significant and powerful *indirect* effects on relationship satisfaction in that they allow the firm to offer generally higher levels of logistics service quality.

### 4.2. Results of moderated regression analysis (MRA)

This study made use of the four steps suggested by Sharma, Durand, and Gur-Arie (1981) to identify and analyze the moderator variables. Since a strong correlation exists between the interactions and the predictors, which would create a problem of multicollinearity, the analysis first employed standardized centering and then tested moderating effects. Table 6 shows the results of MRA with perceived environmental uncertainty as moderator.

The baseline Model 1 explains 34.1% of the variance in logistics service quality. After entry of perceived environmental uncertainty, the total variance explained in Model 2 is 37.1% ($\Delta R^2 = 3.1\%$, $p < 0.01$), which increases to 39.2% in Model 3 ($\Delta R^2 = 2.0\%$, $p < 0.05$) when interaction terms are included. Model 3 shows that the interaction between perceived environmental uncertainty and logistics flexibility does not affect logistics service quality significantly ($\beta = 0.032$, ns), which rejects H2a. However, the interaction between perceived environmental uncertainty and relationship flexibility has a significant negative effect on logistics service quality ($\beta = -0.138$, $p < 0.05$), indicating that in a low perceived uncertainty environment, the positive effect of relationship flexibility on logistics service quality is stronger than in a high perceived uncertainty environment. Thus, the results support the organizational information processing theory hypothesis H2c but reject its competing transaction cost theory hypothesis H2c'. The second baseline Model 4 explains 32.4% of the variance of relationship satisfaction, which increases to 33.6% when perceived environmental uncertainty is included in Model 5 ($\Delta R^2 = 1.3\%$, $p < 0.05$). After adding the interaction term, the total variance explained increases to 37.3% in Model 6 ($\Delta R^2 = 3.7\%$, $p < 0.01$). Model 6 also shows that the interactions between either perceived environmental uncertainty and logistics flexibility or perceived environmental uncertainty and relationship flexibility have a significant effect on relationship satisfaction ($\beta = 0.154$, $p < 0.01$; $\beta = -0.157$, $p < 0.01$, respectively), but the former effect is positive while the latter is negative. Thus, the higher the level of perceived environmental uncertainty, the stronger will be the effect of logistics flexibility on relationship satisfaction, a finding that supports H2b. But the effect is exactly the opposite for relationship flexibility, indicating that the positive effect of relationship flexibility on relationship satisfaction is stronger in an environment that is perceived to be stable. Thus, these results support the organizational information processing theory hypothesis H2d but reject the competing transaction cost theory hypothesis H2d'.

**Table 6**
Results of moderated regression with perceived environmental uncertainty as moderator.

| DV | Logistics service quality | | | Relationship satisfaction | | |
|---|---|---|---|---|---|---|
| IV | M1 | M2 | M3 | M4 | M5 | M6 |
| Constant | 0.000 | 0.000 | 0.026 | 0.000 | 0.000 | 0.007 |
| | (0.000) | (0.000) | (0.459) | (0.000) | (0.000) | (0.127) |
| Firm age | −0.062 | −0.050 | −0.034 | 0.014 | 0.022 | 0.030 |
| | (−0.977) | (−0.797) | (−0.551) | (0.211) | (0.337) | (0.482) |
| Number of employees | −0.135 | −0.113 | −0.096 | −0.098 | −0.083 | −0.069 |
| | (−1.465) | (−1.249) | (−1.074) | (−1.044) | (−0.897) | (−0.756) |
| Annual sales | −0.096 | −0.084 | −0.071 | 0.005 | 0.013 | 0.019 |
| | (−0.915) | (−0.818) | (−0.692) | (0.048) | (0.121) | (0.185) |
| Total assets | 0.096 | 0.081 | 0.004 | 0.134 | 0.124 | 0.053 |
| | (0.842) | (0.731) | (0.034) | (1.160) | (1.087) | (0.461) |
| Logistics flexibility (LF) | 0.328*** | 0.302*** | 0.305*** | 0.279*** | 0.263*** | 0.309*** |
| | (5.395) | (5.028) | (4.886) | (4.540) | (4.259) | (4.885) |
| Relationship flexibility (RF) | 0.363*** | 0.329*** | 0.260*** | 0.388*** | 0.366*** | 0.301*** |
| | (5.939) | (5.405) | (3.963) | (6.255) | (5.845) | (4.517) |
| Perceived environmental uncertainty (PEU) | | 0.184** | 0.155** | | 0.118* | 0.094 |
| | | (3.165) | (2.646) | | (1.975) | (0.116) |
| LF × PEU | | | 0.032 | | | **0.154**** |
| | | | (0.590) | | | **(2.784)** |
| RF × PEU | | | **−0.138*** | | | **−0.157**** |
| | | | **(−2.574)** | | | **(−2.892)** |
| N | 212 | 212 | 212 | 212 | 212 | 212 |
| $R^2$ | 0.341 | 0.371 | 0.392 | 0.324 | 0.336 | 0.373 |
| $\Delta R^2$ | 0.341*** | 0.031** | 0.020* | 0.324*** | 0.013* | 0.037** |
| ΔF | 17.646 | 10.016 | 3.387 | 16.355 | 3.902 | 5.888 |
| F | 17.646*** | 17.221*** | 14.460*** | 16.355*** | 14.774*** | 13.350*** |

Note: $^{+}p < 0.01$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. The first line in each cell is unstandardized coefficient and the second line is *t* value. Siginificant interactions are shown in bold.

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### 4.3. Post hoc analysis: results of moderated path analysis (MPA)

Although MRA is a commonly used method for testing moderating effects, it does not deal with a complex situation combining mediation and moderation, which is the key problem addressed in this study. Edwards and Lambert (2007) present a general analytical framework that integrates moderated regression analysis with path analysis. Although MRA reveals that perceived environmental uncertainty moderates the direct effects of relationship flexibility on logistics service quality and relationship satisfaction, it does not reveal how perceived environmental uncertainty influences the indirect effects and total effects via the mediating effect of logistics service quality. Fig. 3 shows the total effect moderation model. A regression module provides estimates of coefficients for the full sample, and a constrained nonlinear regression (CNLR) module provides estimates of coefficients from 1000 bootstrap samples (SPSS Syntax is presented in the Appendix A).

Thus, the direct effect and indirect effect of X on Y as well as the effect of Z on the intercept could be calculated using the terms in Equation 3. These formulas were written into an Excel file to compute direct effects, indirect effects, and total effects at selected levels of the moderator (one standard deviation above and below the mean for perceived environmental uncertainty). Expressions that contained products of coefficients were tested with bias-corrected confidence intervals based on the bootstrap coefficient estimates generated by the CNLR module (Edwards & Lambert, 2007). Table 7 shows that except for the difference of indirect effect, the confidence intervals of the difference of first stage, second stage, direct effect and indirect effect all excluded 0, indicating that the moderating effects in these paths are statistically significant.

Specifically, in the first stage, the effect of relationship flexibility on logistics service quality is weaker under high uncertainty than it is under low uncertainty, and the difference is negative and significant ($0.270–0.410 = -0.140$, $p < 0.1$). This is consistent with the result of MRA. In the second stage, the difference of the effect of logistics service quality on relationship satisfaction between high uncertainty and low uncertainty is positive and significant ($0.360–0.008 = 0.280$, $p < 0.05$), but the effect under low uncertainty is insignificant. Furthermore, the direct effect of relationship flexibility on relationship satisfaction is significantly weaker under high uncertainty than under low uncertainty ($0.160–0.480 = -0.320$, $p < 0.01$), which confirms the result of MRA. However, the difference of the indirect effect is positive but not significant ($0.097–0.033 = 0.064$, *ns*), which together with the negative direct effect produces the significant difference of the total effect ($0.257–0.513 = -0.256$, $p < 0.1$).

Fig. 4 depicts differences in these effects. Although the lines in Fig. 4A and B have meaningful differences in slopes, the positive moderating effect of perceived environmental uncertainty on the second stage combined with the negative moderating effect of perceived environmental uncertainty on the first stage is not sufficient to produce a significant difference for the indirect effects as shown in Fig. 4D. A comparison of Fig. 4C with Fig. 4D also shows that the difference in slopes for the direct effect was the primary reason for the difference in slopes for the total effect in Fig. 4E. Thus, perceived environmental uncertainty moderates the direct effect of relationship flexibility on relationship satisfaction, the first stage, and the second stage of the indirect effect of relationship flexibility on relationship satisfaction as mediated by logistics service quality, and these difference are sufficient to produce a larger total effect for low uncertainty, which supports the hypotheses based on organizational information processing theory rather than the competing alternatives based on transaction cost theory.

## 5. Discussion and implications

Previous studies suggest that flexibility has been an effective strategy for responding to the external environment; one that enhances firm performance (Anand & Ward, 2004; Patel, 2011; Yu et al., 2012). However, the present study argues that such a view depends on the level of environmental uncertainty. Although contingency theory supports the moderating effect of environmental uncertainty on the relationship between general flexibility and firm performance in the business-to-business context (Hallavo, 2015; Li, 2010), existing studies have not addressed whether the effects are the same across the different kinds of inter-organizational flexibility. This study distinguished between the performance outcomes of both logistics flexibility and relationship flexibility as responses to environmental uncertainty. Although the results of structural equation modeling reveal that both types of flexibility are critical for maintaining buyer-seller relationships, their performance effects differ depending on the level of environmental uncertainty. In particular, perceived environmental uncertainty plays a very complex role in moderating the effects of relationship flexibility on relationship satisfaction. We discuss this matter further below.

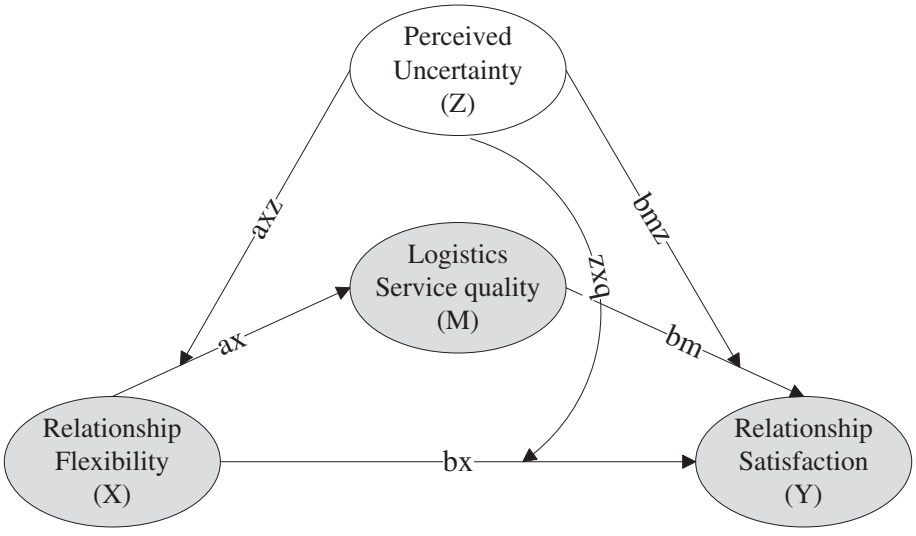


**Fig. 3.** Total effect moderation model. Adapted from: Edwards and Lambert (2007). Methods for integrating moderation and mediation: a general analytical framework using moderated path analysis. *Psychological Methods*, *12*(1), 1–22.

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**Table 7**
Results of moderated path analysis with subgroups by uncertainty (Resampling = 1000).

| | Uncertainty = 1 | | | | | Uncertainty = −1 | | | | | Difference | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1st stage | 2nd stage | Direct effect | Ind. effect | Total effect | 1st stage | 2nd stage | Direct effect | Ind. effect | Total effect | 1st stage | 2nd stage | Direct effect | Ind. effect | Total effect |
| | 0.270 | 0.360 | 0.160 | 0.097 | 0.257 | 0.410 | 0.080 | 0.480 | 0.033 | 0.513 | −0.140 | 0.280 | −0.320 | 0.064 | −0.256 |
| *Bootstrap results* | | | | | | | | | | | | | | | |
| AVG | 0.271 | 0.355 | 0.154 | 0.096 | 0.250 | 0.392 | 0.085 | 0.460 | 0.038 | 0.498 | −0.122 | 0.270 | −0.307 | 0.059 | −0.248 |
| MEDIAN | 0.270 | 0.350 | 0.150 | 0.094 | 0.254 | 0.400 | 0.100 | 0.460 | 0.036 | 0.504 | −0.120 | 0.260 | −0.300 | 0.060 | −0.258 |
| MIN | 0.020 | 0.130 | −0.120 | 0.008 | −0.062 | 0.020 | −0.510 | 0.000 | −0.156 | 0.041 | −0.560 | −0.260 | −0.800 | −0.187 | −0.695 |
| MAX | 0.520 | 0.580 | 0.450 | 0.230 | 0.549 | 0.650 | 0.560 | 0.900 | 0.265 | 0.861 | 0.260 | 0.960 | 0.140 | 0.291 | 0.211 |
| STD | 0.082 | 0.073 | 0.090 | 0.036 | 0.101 | 0.100 | 0.169 | 0.140 | 0.070 | 0.118 | 0.127 | 0.187 | 0.161 | 0.078 | 0.152 |
| SKEW | −0.126 | 0.241 | −0.100 | 0.360 | −0.073 | −0.304 | −0.297 | 0.129 | 0.222 | −0.206 | 0.034 | 0.348 | −0.085 | −0.113 | 0.119 |
| KURT | 0.174 | −0.019 | −0.024 | 0.254 | −0.209 | 0.034 | −0.107 | 0.171 | 0.112 | 0.397 | −0.025 | 0.189 | −0.040 | 0.122 | −0.177 |
| T | 3.285 | 4.957 | 1.784 | 2.709 | 2.539 | 4.099 | 0.473 | 3.435 | 0.472 | 4.353 | −1.101 | 1.495 | −1.982 | 0.821 | −1.685 |
| *Bias correlated percentile method* | | | | | | | | | | | | | | | |
| $p(Q^* < Q)$ | 0.468 | 0.529 | 0.516 | 0.538 | 0.519 | 0.548 | 0.452 | 0.548 | 0.488 | 0.538 | 0.413 | 0.524 | 0.465 | 0.515 | 0.503 |
| Zo | −0.080 | 0.073 | 0.040 | 0.095 | 0.048 | 0.121 | −0.121 | 0.121 | −0.030 | 0.095 | −0.220 | 0.060 | −0.088 | 0.038 | 0.008 |
| BC 10% | 0.160 | 0.270 | 0.050 | 0.058 | 0.130 | 0.290 | 0.190 | 0.320 | −0.053 | 0.373 | **−0.340** | 0.060 | −0.540 | −0.034 | **−0.434** |
| BC 80% | 0.360 | 0.460 | 0.280 | 0.149 | 0.389 | 0.540 | 0.260 | 0.672 | 0.126 | 0.670 | **0.000** | 0.540 | −0.120 | 0.159 | **−0.037** |
| BC 5% | 0.110 | 0.250 | 0.010 | 0.048 | 0.092 | 0.250 | −0.240 | 0.270 | −0.074 | 0.326 | −0.380 | **0.000** | −0.600 | −0.068 | −0.481 |
| BC 95% | 0.390 | 0.500 | 0.308 | 0.163 | 0.421 | 0.570 | 0.310 | 0.740 | 0.151 | 0.700 | 0.020 | **0.620** | −0.060 | 0.188 | 0.011 |
| BC 2.5% | 0.080 | 0.230 | −0.020 | 0.035 | 0.053 | 0.210 | −0.320 | 0.230 | −0.096 | 0.286 | −0.420 | −0.040 | **−0.660** | −0.097 | −0.544 |
| BC 97.5% | 0.420 | 0.520 | 0.330 | 0.184 | 0.454 | 0.590 | 0.350 | 0.800 | 0.174 | 0.751 | 0.060 | 0.665 | **−0.020** | 0.212 | 0.046 |
| BC 0.5% | 0.041 | 0.200 | −0.077 | 0.018 | 0.005 | 0.138 | −0.443 | 0.130 | −0.142 | 0.195 | −0.494 | −0.140 | −0.780 | −0.144 | −0.600 |
| BC 99.5% | 0.470 | 0.560 | 0.390 | 0.216 | 0.501 | 0.620 | 0.430 | 0.850 | 0.232 | 0.804 | 0.160 | 0.870 | 0.060 | 0.270 | 0.150 |

### 5.1. Discussion

Many existing studies support the argument that greater perceived environmental uncertainty elicits a greater capability for flexibility in logistics activities as reviewed by Fayezi et al. (2014), but very few studies argue for the moderating effects of environmental uncertainty on the main path of "flexibility-performance". Only two recent studies have begun to look into this problem (Hallavo, 2015; Li, 2010), however, they both focus on general business performance outcomes rather than function-specific performance outcomes like service quality and relationship satisfaction which have been more closely identified as the more proximal performance outcomes of flexibility (Young et al., 2003; Zhang et al., 2002). This study further investigates moderating effects on how flexibility affects function-specific performance by considering underlying mechanisms based on contingency theory complementary with organizational information processing theory. The findings only partially support the hypotheses about how perceived environmental uncertainty moderates the effects of logistics flexibility on the value and performance of supplier-buyer relationships. These hypotheses, based on contingency theory together with organizational information processing theory, claim that in highly uncertain environments, logistics flexibility requires a strong capability to process environmental information in order to enhance logistics service quality and maintain satisfaction in a relationship.

Although the results confirm that environmental uncertainty strengthens the positive effect of logistics flexibility on relationship satisfaction, the effect of logistics flexibility on the level of logistics service quality that a supplier offers remains the same regardless of the level of perceived environmental uncertainty. The reason for this non-contingent effect may be that, in an uncertain environment, demand is dynamic, thus provoking distributor-customers to generally require high levels of service quality in terms of maintaining inventory and in terms of quick and accurate order delivery. This scenario would then induce the focal firm to offer generally higher levels of logistics service quality in response to customers' demand. Via such a process, although not directly observed in this study, environmental uncertainty simply induces a market demand for greater logistics service quality. In which case, a relatively greater capability for logistics flexibility may not be particularly necessary in order to offer a given quality level of logistics service.

Even fewer studies explore the function-specific performance outcomes of relationship flexibility (Ivens, 2005; Money et al., 2010), and none of these consider whether the effects on such outcomes are consistent under different conditions. Following a contingency perspective, the findings indicate that the total effect of relationship flexibility on relationship satisfaction is weaker under high uncertainty than it is under low uncertainty. Since relationship flexibility is a bilateral expectation of willingness to adapt, change, or adjust to new knowledge (Richey et al., 2012; Young et al., 2003), a perspective of short term information transfer can help explain these results. That is, highly reliable market information in a stable environment would help to deliver a message of good faith and good intentions which in turn would prompt any adjustments of ongoing relationships needed in order to increase relational performance and retain customers (Bello & Gilliland, 1997; Heide & John, 1992; Johnson, 1999). In this study, only relational performance has been discussed but costs of implementing flexibility strategies have not been considered. Compared with formal governance, relationship flexibility without normative contracts may still incur substantial coordination and negotiation costs if partners' interpretations about the unexpected events and judgments on the needed adaptations are different (Wang et al., 2013). This may be one reason why some researchers adopting transaction cost theory suggest that environmental uncertainty increases needs for formal governance (Han, Sung, & Shim, 2014; MacNeil, 1981), but the results of this study do not support the competing hypotheses based on transaction cost theory.

### 5.2. Managerial implications

The highly volatile and dynamic nature of the contemporary business environment forces many firms to make adaptations in channel relationships and to modify the rules of exchange as circumstances change (Sezen & Yilmaz, 2007). To achieve sustainable competitive advantage, suppliers must not only develop flexibility capabilities for intra-organizational manufacturing processes but also invest effort in aligning their supply chain partners in order to establish

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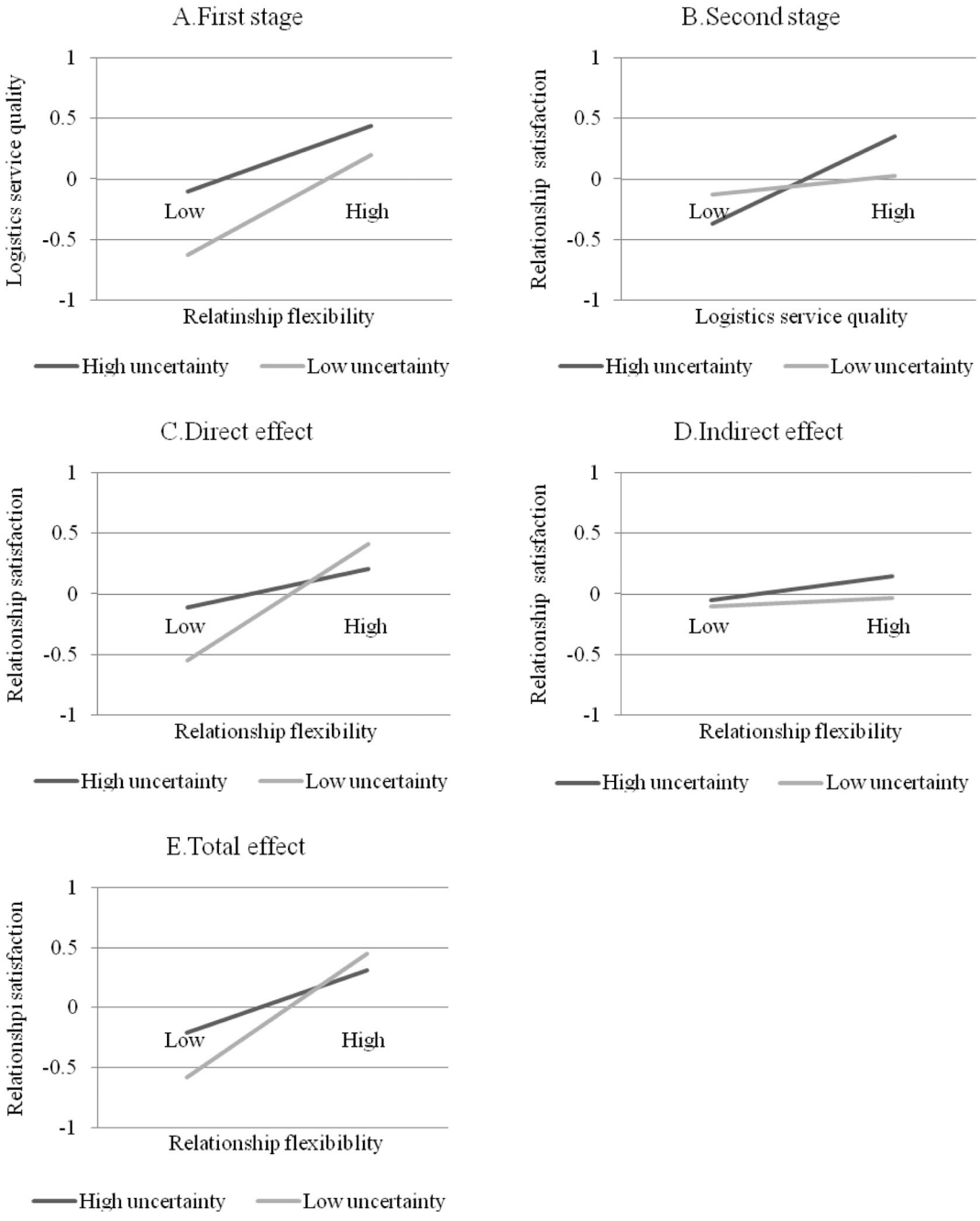


**Fig. 4.** Plots of simple paths and effects with uncertainty as moderator.

a flexible and adaptable supply chain. From a contingency perspective, the analysis of flexibility capabilities in this study highlights the strategic choices between logistics flexibility and relationship flexibility under different contexts for many forward-looking companies who are trying to make their downstream channels more flexible and responsive.

In Table 8, we argue that the effect of fit between flexibility strategy and environment uncertainty on relational performance based

**Table 8**
Implications of matching strategy with environment to achieve performance outcomes.

| Environment strategy | High environmental uncertainty | Low environmental uncertainty |
|---|---|---|
| High logistics flexibility | *High relationship satisfaction*<br>*High logistics service quality* | Low relationship satisfaction<br>*High logistics service quality* |
| High relationship flexibility | Low logistics service quality<br>Low relationship satisfaction | *High logistics service quality*<br>*High relationship satisfaction* |
| Other strategies to enhance logistics service quality | *High relationship satisfaction* | Low relationship satisfaction |

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on traditional contingency theory becomes much more complex when there are alternative choices among different strategies. In this study, logistics flexibility and relationship flexibility represent different capabilities for reacting to the external environment or making changes in response to customers. Logistics flexibility is the ability to adjust such activities as storage, inventory, transportation and delivery, while relationship flexibility refers to the ability to adjust activities related to relationship management. Which one is more important? Would it be better to integrate these strategies into a hybrid strategy? The answers to these questions depend on firm's specific environmental conditions.

According to our results, in an environment of high uncertainty, the high logistics flexibility that *fits* with this environment would help a supplier to both enhance its logistics service quality and develop more satisfactory relationships with its buyers. In contrast, a policy of high relationship flexibility which *misfits* this environment would reduce the above benefits. Also, it is possible that implementing other strategies to enhance logistics service quality (such as, for example, investing in specific information systems to facilitate distribution) would also allow a supplier to develop more satisfactory relationships with its buyers. In other words, a supplier's general logistics efforts in maintaining sufficient buffer inventory and in delivering orders quickly and accurately may constitute an adequate response to dynamic demand conditions. However, considering the congruence among different strategies, it may be better to develop a stronger capability for logistics flexibility than for relationship flexibility in order for a supplier to enhance its logistics service quality.

Although a relatively high level of perceived environmental uncertainty would likely prompt a supplier to adjust ongoing relationships with its buyers, the extent to which such a policy results in more satisfactory relationships depends on environmental conditions. As shown in Table 8, a stable environment would help a firm to obtain the benefits of relationship flexibility which, when compared to logistics flexibility, may work better to maintain supplier-buyer relationships under a less uncertain environment. Under this condition, even though a greater capability for logistics flexibility allows a firm to enhance its logistics service quality, it may be less useful for maintaining satisfactory relationships with buyers. Thus, under low environment uncertainty, a greater emphasis on relationship flexibility alone may be sufficient is for maintaining quality relationships.

## 6. Limitations and future research

In this study, we consider perceived environmental uncertainty as a second-order construct that includes demand uncertainty and competition uncertainty. However, other researchers suggest that a given substantive type of flexibility capability best suits a matching substantive category of uncertainty. For example, Dreyer and Grønhaug (2004) propose that the value of different substantive types of flexibility such as volume flexibility, labor flexibility, and product flexibility depend on such factors of uncertainty in the competitive environment as raw materials, product volume, and product mix. In addition, Tachizawa and Thomsen (2007) propose that when mix and delivery uncertainties are predominant, firms opt for “improved supplier responsiveness”, while when volume and mix uncertainties are predominant, firms opt for “flexible sourcing”. Future study might partition environmental uncertainty into several dimensions and explore each specific effect on different dimensions of flexibility capabilities.

In addition, the research method entails some unavoidable limitations. First, the headquarters of all of the sampled companies are in China. Although the political and institutional environment in China is very different from that of western countries, we did not consider any of such substantive environmental factors in this study. Future research could conduct a comparative study or replication in a different political and institutional environment. Second, both the interviews and responses to questionnaires rely on a single key informant from the perspective of a manufacturer. However, partnerships between channel members are created by bilateral and coherent behaviors rather than through the expectation of one party. Therefore, although posing other challenges and limitations, future research could consider using multiple informants and dyadic data.

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## Appendix A. Sample SPSS regression and CNLR syntax

The following SPSS syntax produces results for relationship flexibility (rflexibility) as the independent variable, logistics flexibility (lflexibility) as the control variable, logistics servie quality (service) as the mediator variable, customer satisfaction (satisfaction) as the outcome variable, and market uncertainty (ugroup) as the moderator variables. All continuous variables are standardized, as indicated by the letter z in the variable name. Product variables uses names that concatenated the names of the variables that constitute the product (e.g. uzrflexibility, uzlflexibility, uzservice).

```
* REGRESSION syntax for Equation 1.
REGRESSION
/DEPENDENT zservice /*Dependent variable*/
/METHOD = ENTERzrflexibilityugroupuzrflexibilityzlflexibilityuzl
flexibility /*Independent variables*/.

* REGRESSION syntax for Equation 2.
REGRESSION.
/DEPENDENT zsatisfaction /*Dependent variable*/.
/METHOD = ENTERzrflexibilityzserviceugroupuzserviceuzr
flexibilityzlflexibilityuzlflexibility /*Independent variables*/.

* CNLR syntax to produce bootstrap estimates for Equation 1.
SET RNG=MT MTINDEX=54,321 /*Merseene Twister random
number generator, seed set at 54,321*/.
MODEL PROGRAM a0=-.022 ax=.426az=.199 axz=-.080
ax1=.312 ax2=.049 /*Starting values for coefficients*/.
COMPUTE PRED=a0+ax*zrflexibility+az*ugroup+axz*uzr
flexibility+ax1*zlflexibility+ax2*uzlflexibility /*Coefficients and
independent variables*/.
CNLR zservice /*CNLR procedure, dependent variable*/
/OUTFILE='c:\documents and settings\ rflexibility_service.sav' /*file
for bootstrap coefficient estimates*/
/BOOTSTRAP=1000 /*Number of boostrap samples*/.

* CNLR syntax to produce bootstrap estimates for Equation 2.
SET RNG=MT MTINDEX=54321 /*Merseene Twister random
number generator, seed set at 54321*/.
MODEL PROGRAM b0=-.026 bx=.342bm=.298 bz=.018
bxz=.163 bmz=-.155 bx1=.214 bx2=.079 /*Starting values for co-
efficients*/.
COMPUTE PRED=b0+bx*zrflexibility+bm*zservice+bz*
ugroup+bxz*uzrflexibility+bmz*uzservice+bx1*zlflexibility+bx2*
uzlfexibility /*Coefficients and independent variables*/.
CNLR zsatisfaction /*CNLR procedure, dependent variable*/
/OUTFILE='c:\documents and settings\ rflexibility_satisf.sav' /*file
for bootstrap coefficient estimates*/
/BOOTSTRAP=1000 /*Number of boostrap samples*/.
```

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