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Are logistics outsourcing partners more integrated in a more volatile environment?

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ABSTRACT

This study examines how integration, an emerging innovative approach in inter-firm relationship management, between the vendor and the client in logistics outsourcing relationships is influenced by environmental uncertainties. Building on transaction cost theory, we develop the hypothesis that integration decreases to cope with supply volatility and technology uncertainty, and increases to cope with demand volatility and legal unenforceability. These four interrelated yet distinct characteristics jointly describe environmental uncertainties in a logistics outsourcing relationship. Our analysis of 264 such relationships suggests that integration does decrease with supply volatility and technology uncertainty and increase with demand volatility and legal unenforceability. By enhancing operational performance, integration improves outsourcing performance in terms of both financial performance and overall satisfaction. Lastly, operational performance also contributes to financial performance.

1. Introduction

Companies generally outsource their logistics to external service providers in order to improve the efficiency of their core functions. How to manage their relationships with service providers is critical to the success of these outsourcing activities due to the loosely coupled nature of outsourcing relationships. Except for the widely acknowledged control mechanisms like contract, monitoring, relational norms, or personal ties, recent studies propose that, integration, an innovative approach in inter-firm collaboration, can also work as an effective mean in inter-firm relationship management that help to guarantee task fulfillment and improve the collaboration outcome (Stank et al., 2001; Flynn et al., 2010). In addition, innovative practices of information sharing, coordinated planning and process improvement through the use of internet and other information and communications technologies inherent in integration also help to reduce costs and improve speed of responses in the supply chain (Lee, 2002). Many studies have already addressed integration from several perspectives, including type and dimension (e.g., Chen et al., 2009; Flynn et al., 2010; Kannan and Tan, 2010; Swafford et al., 2008), power relationship commitment (e.g., Yeung et al., 2009; Zhao et al., 2011), IT implementation and adoption of e-business (e.g., Li et al., 2009, Nurmilaakso, 2009; Prajogo and Olhager, 2012; Thun, 2010), institutional forces and governance choices (e.g., Cai et al., 2010; Richey et al., 2010; Wong and Boon-itt, 2008), and collaborative design (e.g., Soosay et al., 2008; Trappey and Hsiao, 2008). These studies are based on economic and relational exchange theories and share a similar focus on how to increase integration through exchange attributes and collaboration arrangements either to reduce the cost of transactions induced by institutional constraints, information asymmetry and opportunistic behavior (Li et al., 2006; Flynn et al., 2010), or to create an affective attached relationship leading to repeated transactions and shared values (Chen and Paulraj, 2004; Fawcett et al., 2007).

Although the studies cited above have focused on strategies and means that encourage integration, the effect of the external environment on integration has received inadequate attention in prior research (Wong and Boon-itt, 2008). Addressing environmental influences is important because the aim of integration is to achieve maximum value for firms by reducing transaction costs through strategic collaboration with partners (Flynn et al., 2010), and transaction cost is typically a function of environmental uncertainty as predicted by transaction cost economics. As a strategic choice in inter-firm exchanges, integration is not fixed, and its strength is largely determined by a firm's anticipation of the net value (returns minus costs) it will gain through full

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collaboration with partners, which is often influenced by market uncertainty (Luo, 2007).

We use logistics outsourcing relationships established by a client firm (a manufacturer or a retailer) and a vendor firm (a logistics service provider) in an emerging market to develop our theory and empirical verification. An emerging market is a good setting for the investigation of environmental uncertainty because this type of market is characterized by rapid growth, a dynamic structure and a volatile environment (Luo, 2007). Specifically, we use four distinct yet interrelated constructs to jointly describe environmental uncertainty in a logistics outsourcing relationship: *demand volatility*, *supply volatility*, *technology uncertainty and legal unenforceability* . Building on transaction cost theory, we develop the logic that integration may decrease to cope with supply volatility and technology uncertainty but increase to deal with demand volatility and legal unenforceability. Our analysis of 264 logistics outsourcing relationships in China generally supports these hypotheses.

2. Theoretical background and research hypotheses

2.1. Theoretical background

It is essential to investigate the issue of uncertainty and integration in outsourcing relationships. Unlike other forms of inter-firm collaboration, such as joint equity ventures, franchising, alliances and buyer–supplier relationships, outsourcing is regarded by firms as a powerful vehicle to reduce costs, avoid risks and improve the efficiency of core functions by allocating part of a product value-adding function to external sources (McIvor, 2009). Thus, outsourcing relationships are much more loosely coupled, mainly rely on contractual agreements, and have less or even no risk- or resource-sharing activities. Such relationships are vulnerable to external uncertainties, as fewer complementary resources are pooled to solidify collaborative competitive advantages (Khanna et al., 1998); fewer commitment and risk sharing structures are triggered (Osborn and Baughn, 1990); and fewer mechanisms are arranged for joint problem-solving and crisis management. Thus, integration is important for outsourcing relationships. In recent years, due to standardized delivery systems and the rapidly changing technologies used in logistics, professional logistics providers have been able to perform much more efficiently and at lower costs than firms can achieve in house (Logan, 2000). More and more firms are contracting out their logistics operations to outside service providers. Logistics outsourcing possesses huge market value and is increasingly viewed as a key promoter of a nation's business activities (Chen et al., 2010). Thus, investigating how partners integrate to respond to external uncertainties in logistics outsourcing setting will deliver various benefits both in theory and in practice.

“Integration” is generally defined as “the extent to which separate parties work together in a cooperative manner to arrive at mutually acceptable outcomes” (Jayaram and Tan, 2009). In a logistics outsourcing setting, we define “integration” as the degree to which a client firm and a vendor firm strategically collaborate and manage their inter-organizational processes to achieve mutually efficient and timely flows of information, services, capital and decisions, with the objective of obtaining maximum value for both sides. Within the framework of this definition, integration contains components of information sharing, coordinating, joint planning, and joint problem-solving (Flynn et al., 2010). In inter-firm exchanges, integration induces partners' specific investments of time, information, commitment, employees, and other organizational resources into their mutual relationship (Power, 2005; Flynn et al., 2010) and serves as effective relationship governance that defines partners' behaviors and coupling mechanisms, leading to the fulfillment of joint objectives (Frohlich and Westbrook, 2001; Stank et al., 2001). As illustrated by both theoretical arguments and empirical demonstrations (Liu et al., 2009; Luo et al., 2009) in terms of transaction cost theory, specific investments and relationship governance are basic tools for curbing transaction costs, and transaction costs are principally a function of uncertainty, which is determined in part by environmental factors.

Environmental uncertainty typically reflects the rate of change, the degree of instability, or the dynamism of factors in the environment (Luo, 2007). Logically, in situations of high environmental uncertainty, the process of inter-firm exchange will become much more complex, as it is hard to get complete and accurate information to assess market conditions, predict market changes, evaluate partner qualifications and capabilities, and ensure the protection of institutional systems (Krishnan et al., 2006). Each party needs to spend more time and resources on bargaining and negotiation, monitoring partners' behavior to guarantee their fulfillment of obligations, and making remedies when communication and coordination failures emerge. These requirements lead to increased costs related to bargaining, monitoring, and mal-adaption, which are the basic sources of transaction costs (Dahlstrom and Nygaard, 1999). When such costs increase beyond a party's tolerable level or exceed its expected revenue from the exchange relationship, that party will lose its passion to maintain the relationship, and will behave opportunistically or even abandon the relationship (Hill, 1990). Thus, when firms anticipate high environmental uncertainty and the consequential transaction costs, they usually tend to impose certain governance mechanisms on their exchange relationships to reduce uncertainty, constrain transaction costs, and enhance performance (Joshi and Campbell, 2003; Li et al., 2010; Poppo and Zenger, 2002; Ryu and Eyuboglu, 2007).

Environmental uncertainty is a multidimensional concept. It usually involves the variability, unverifiability, and unpredictability of various elements related to both the macro (general environment) and micro (partner or business) dimensions of the business environment (Huo et al., 2014; Luo, 2007). Based on a review of existing studies of environmental uncertainty, we use four distinct yet interrelated constructs to jointly profile environmental uncertainty in a logistics outsourcing relationship: (a) demand volatility, (b) supply volatility, (c) technology uncertainty, and (d) legal unenforceability. Following Lee's (2002) typology, demand volatility and supply volatility are indicators from the business level. They represent the rate of change of market participants within a logistics outsourcing relationship, including changes in demand type, quantity, and specific requirements on the client side and changes in price, capability, and quality on the vendor side (Mohr, 2001). Technology uncertainty and legal unenforceability are indicators related to general environment. Logistics is a technology intensive industry. Such industries tend to compete fiercely and generate competitive turbulence due to the rapidly evolving nature of technology (Hills and Sarin, 2003). In the past 30 years of economic reform and opening up, the Chinese government has been developing a new legal system to regulate its social and economic activities. Nevertheless, due to the uneven levels of development between cities or industries and the strong political ties between top executives and government officials, lawsuits enforced in a totally consistent manner and not influenced by particular circumstances still cannot be guaranteed in China (Luo, 2007; Zhou and Poppo, 2010). The perception of a lack of adequate and consistent legal protection leads firms to consider legal unenforceability to be an important issue in this market. These four dimensions (*demand volatility*, *supply volatility*, *technology uncertainty*, and *legal unenforceability*) each affect integration. Collectively, they describe environmental uncertainty in a logistics outsourcing relationship.

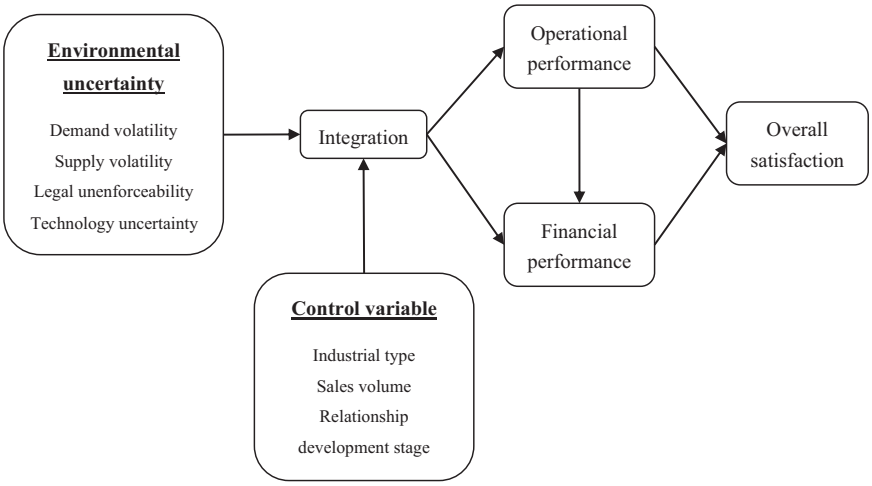

Fig. 1. Integration in logistics outsourcing relationships.

Fig. 1 depicts the unified model of this study, whose elements are detailed below.

2.2. Environmental uncertainty and integration

2.2.1. Demand volatility and integration

In a logistics outsourcing relationship, demand volatility indicates that the volume, type, and requirement of the client's logistics demands fluctuate or change frequently. As indicated by Lee (2002), only through information sharing and tight coordination can firms regain control of relationship efficiency in present of demand uncertainty. Outsourcing is typically regarded as a powerful vehicle to reduce costs and improve efficiency for the client firm (McIvor, 2009). When a client firm's demands change frequently, it may require the vendor to support its logistics strategy by quickly noticing and responding to its new needs. Thus, the client is likely to communicate and cooperate closely with its vendor to give the vendor more time and information to make adjustments in response to the changes in demand. As a service provider, the top priorities for the vendor are providing customized services and maintaining customer loyalty. Full cooperation and communication give the vendor more opportunities to better understand exactly what the client wants, why client demand requirements change, and how to best meet the demand changes. Thus, in the presence of demand volatility, both the client and the vendor want to work collaboratively and exchange timely information, which is beneficial to integration. Hence, we propose:

Hypothesis 1. Logistics outsourcing partners are more integrated in response to increased demand volatility in which they participate, ceteris paribus.

2.2.2. Supply volatility and integration

Supply volatility means that the price, capability, and quality of the vendor's logistics services are highly unstable. Unlike demand volatility, the level of integration between logistics outsourcing partners will decrease in response to supply volatility because, due to supply uncertainty, it is impossible for the client to predict to what extent its logistics requirements can be met or how much it will pay for logistics outsourcing, and it cannot evaluate the impact of logistics outsourcing on firm performance (Luo, 2007). Accordingly, the vendor is also uncertain about what kind of work it will be able to accommodate in the future and so it cannot guarantee services to the client. This means that both the client firm and the vendor firm have only a little or even no control over the outcome of their logistics outsourcing relationship. Both sides will thus hesitate to invest in the relationship and be unwilling to share information with their counterparts because such behavior will expose their organizational resources and strategies to highly disruptive external forces, such as market turbulence and partner opportunism. Accordingly, firms may display low commitment to the outsourcing relationship, shirk obligations, reduce resource and information exposure to partners, and adopt a cautious "wait and see" approach to decision-making (Luo, 2007), factors which are harmful to the formation of integration. Thus, we predict:

Hypothesis 2. Logistics outsourcing partners are less integrated in response to increased supply volatility in which they participate, ceteris paribus.

2.2.3. Technology uncertainty and integration

Technology uncertainty is the inability to accurately predict the technical requirements and trends in a relationship (Walker and Weber, 1984). Logistics outsourcing is a technology intensive industry due to its need for up-to-date logistics-facilitating software and hardware to effectively manage operations. Technology intensive industries tend to compete fiercely and generate competitive turbulence due to their rapid evolving technologies (Hills and Sarin, 2003). Firms in logistics industry are thus likely to encounter a high degree of technology uncertainty, which makes it hard to predict general technological developments and determine changes in the standards or specifications of products or services (Geyskens et al., 2006). Firms have to continuously adapt their products/services to the specific technology uncertainty they perceive to stay in business (Oosterhuis et al., 2011). Neither side wants to be locked into a relationship with a fixed partner in case the demand or supply disappears due to technology change. Each side wants to maintain the flexibility to terminate the relationship and switch to a new partner with more appropriate technical capabilities when technology standards or trends change (Balakrishnan and Wernerfeit, 1986). Thus, in the presence of technology uncertainty, partners are likely to maintain an arm's length relationship with less integration. We therefore postulate:

Hypothesis 3. Logistics outsourcing partners are less integrated in response to increased technology uncertainty in which they participate, ceteris paribus.

2.2.4. Legal unenforceability and integration

Legal unenforceability is a key issue for firms doing business in emerging markets (Hoskisson et al., 2000). Typically, it means that lawsuits regarding business activities cannot be enforced in a consistent manner (Peng, 2003) or that legal regulations and

industry standards in a certain area are poorly defined or incomplete. Legal unenforceability makes it impossible for firms to obtain reliable, stable, and certain arbitration results from the legal system because the judgments of business disputes are likely to be contingent on particular circumstances or even have no laws to refer to (Peng, 2003). To better solve problems and mitigate exchange hazards, apart from the legal system, firms have a great need for informal controls, such as information sharing, personal ties, joint planning, and joint problem-solving, which are all key indicators of integration of their business relationships.

Moreover, legal unenforceability implies weak external protection for firms' properties (Zhou and Poppo, 2010). Due to the rationality of economic entities, firms tend to be risk-averse and will try to obtain security through internal mechanisms within their exchange relationships. Accordingly, they are prone to monitor partner behavior and market changes continuously and modify their strategies accordingly (Fynes et al., 2005). In so doing, firms have to establish smooth communication, information diffusion, and joint decision-making channels with partners, which also contribute to inter-firm integration. Taking these factors into account, we propose:

Hypothesis 4. Logistics outsourcing partners are more integrated in response to increased legal unenforceability in which they participate, ceteris paribus.

2.2.5. Performance implications of integration

Integration has positive consequences for logistics outsourcing development. When integration is particularly high, information sharing, coordination, and joint planning are prevalent. Mutual information exchange in demand, supply, operational processes, capabilities, and plans helps vendor firms have a better understanding of client needs, make accurate service designs, avoid resource and capability waste, and be more responsive to unexpected events (Flynn et al., 2010). Coordination and joint planning enable vendor firms to deliver services on time, help client firms to undertake whole process quality monitoring of vendor firms, and give both sides strategic flexibility (Wong et al., 2011; Swink and Nair, 2007). Such seamless logistics connections facilitate client firms to adopt lean production and reduce their order cycle and inventory level, leading to improved operational performance (Prajogo and Olhager, 2012; Schonberger, 2007).

Qualified, timely, and flexible logistics services provided by the vendor firms provide the client firms with cost and responsiveness advantages in the market by reducing logistics costs, lead time, and risks (Liu et al., 2005). These advantages enable them to devote more organizational resources to core business, attract more customers, and upgrade service levels (Droge et al., 2004; Seidmann and Sundararajan, 1997). Lower costs, more customers, and higher profit margins lead to better financial performance. Through information sharing, coordination, and joint planning inherent in integration exchange, partners become more familiar and synchronously attached to each other. This leads to high communication and collaboration efficiency (Cousins and Menguc, 2006), which can save on negotiation, process monitoring, and maladaption costs. Such cost reduction also contributes to improved financial performance.

With superior operation and financial performance, firms' expectations of partner behavior and organizational goals can easily be met. A client firm's satisfaction perception that their logistics outsourcing partners are trying their best to accomplish assumed behavior, and the logistics outsourcing relationships are fulfilling, gratifying, and facile will naturally form (Homburg and Stock, 2004; Kim, 2009). Thus, we state:

Hypothesis 5a. Operational performance contributes to financial performance in logistics outsourcing relationships, ceteris paribus.

Hypothesis 5b. Through improved operational performance, integration provokes improved logistics outsourcing performance in terms of (a) financial performance and (b) overall satisfaction.

3. Research methods

3.1. Sample and data collection

The hypotheses were tested using data from five selected districts in the Bohai Rim region of China, including Hebei province, Liaoning province, Shandong province, Tianjin city and Beijing city. The Bohai Economic Zone is one of China's three major economic zones. It accounts for 28.2% of China's GDP and with more than 40 ports it is the most concentrated business seaports area in China. At present, the Bohai Rim region is a primary hub for shipping, railways, highways, aviation and communications. Data collected within this region can well represent the logistics activities in China.

Guided by theoretical considerations and field interviews, we developed a survey to collect data. When possible, we used or adapted existing measures that have been validated by previous studies. If no relevant measures could be found, we developed new items based on our definitions of the construct, observations from company interviews, and feedback from practitioners. The English version was developed first, translated into Chinese, and then back-translated into English. The back-translated English version was compared against the original English version for cross validation. Some items were re-worded for more accurate translation. Then, we conducted a pilot test using semi-structured in-depth interviews with logistics managers from a random sample of 50 enterprises located in Tianjin City in July 2010. A research team was sent out to ensure that the participants had understood the questions correctly. Some final refinements were made based on the team's feedback.

The formal data collection was conducted from September 2010 through March 2011. This process was supported by the Tianjin Federation of Industry and Commerce, Tianjin Communication and Logistics Association, Tianjin Logistics Managers Club, Beijing Logistics Managers Club and the Baoding Development and Reform Commission. We first sent the questionnaires to 850 logistics managers from a range of manufacturing companies, commercial enterprises, and supporting associations or clubs. To improve participation, a confidentiality agreement was included in the letter of the questionnaire. A total of 295 (34.7%) managers responded. After excluding the unusable responses and any non-3PL customers from the original sample, we were left with 264 valid responses from 3PL customers, an effective response rate of 31.1%.

As the questionnaire data were collected from one informant from a single firm, the risk of common method bias may be present. We thus used several techniques to assess the potential for common method bias. First, as guided by Huo et al. (2014) and Podsakoff et al. (2003), we created different versions of the questionnaire by rearranging the order of the sections and giving different instructions for different constructs to reduce the respondents' consistency in self-reporting. Second, as recommended by Podsakoff and Organ (1986), the Harman's one-factor test was conducted. An un-rotated factor analysis revealed eight different factors that together accounted for 72% of the variance, and the first factor captured only 12% of the variance. No single factor accounted for most of the variance, which indicated the absence of common method bias. Third, a confirmatory factor

analysis with a single factor was performed, and the fit in dex (χ^2=526, df=438, GFI=0.895, CFI=0.978, IFI=0.979, RMSEA=0.028) indicated that the model fit deteriorated. This suggested that common method variance bias was unlikely in this study (Sanchez and Brock, 1996). As a last test, we compared the fit index of two measurement models. One model included traits only, and the other included both traits and a method factor (Huo et al., 2014; Paulraj et al., 2008). The fit index of the method factor model was only marginally better than the fit of the traits model (GFI by 0.014; CFI by 0.011, NFI by 0.010; RMSEA by 0.008). These indicated that the common method factor accounted for only a very small variance. We therefore concluded that common method variance bias was not present in this study.

To ensure that the respondents were capable of answering the survey questions, we requested that the contact persons be senior managers who were fully responsible for the logistics activities of their firms. These senior managers were typically top executives, general office directors, or directors who supervised their firms' logistics activities (58% of the total sample). Thus, these respondents were deemed able to answer questions related to their firms' logistics outsourcing relationships. Respondents came from a wide range of industries (see Table 1). The highest proportion of companies were in the retail (10.2%), chemicals and petrochemicals (9.8%), and metals, mechanical, and engineering (8.7%) industries, followed by the food, beverages, alcohol and cigars (8.0%), and the machinery and manufacturing (8.0%) industries. The median number of employees was around 500, and firms with fewer than 100 employees accounted for the highest proportion (36.0%, see Table 2). The median sales volume of the sample firms was around HK$ 100 million, and firms with sales volumes of more than HK$ 300 million were the highest proportion of all of the reporting firms (34.8%). Generally, the sample was evenly divided between small (fewer than 100 employees) medium size (100–999 employees), and large firms (1000 or more employees). Our sample can be taken as representative of Chinese firms.

To check for non-response bias, the assumption that subjects who respond less readily are more like non-respondents (Armstrong and Overton, 1977), we randomly selected 50 companies each from the early and late response samples and compared both sets of samples in terms of demographics and the key constructs in our model. No differences were found, which excluded the presence of non-response bias.

Table 1
Industry profile.

Industry	Total (N=264)
Retail	27(10.2%)
Chemicals and petrochemicals	26(9.8%)
Metals, mechanical and engineering	23(8.7%)
Food, beverages, alcohol and cigars	21(8.0%)
Machinery and manufacturing	21(8.0%)
Business and trade	19(7.2%)
Textiles, apparel and leather	16(6.1%)
Transportation equipment	16(6.1%)
Pharmaceutical and medical	15(5.7%)
Logistics and warehousing	12(4.5%)
Metallurgy	11(4.2%)
Electric machinery/equipment manufacturing	10(3.8%)
Electronics and electrical	8(3%)
Printing and publishing	7(2.7%)
Water, electricity and energy	6(2.3%)
Rubber and plastics	5(1.9%)
Building materials	3(1.1%)
Other	18(6.8%)

Table 2
Number of employees and annual sales.

Employees	Total (N=264)	Sales	Total (N=264)
Fewer than 100	95(36.0%)	Less than HK$ 1 m	21(8.0%)
100–499	71(26.9%)	HK$ 1 m – HK$ 4.99 m	37(14.0%)
500–999	35(13.3%)	HK$ 5 m – HK$ 9.99 m	22(8.3%)
1000–4999	44(16.7%)	HK$ 10 m – HK$ 49.99 m	41(15.5%)
5000 or more	19(7.2%)	HK$ 50 m – HK$ 99.99 m	22(8.3%)
		HK$ 100 m – HK$ 300 m	29(11.0%)
		More than HK$ 300 m	92(34.8%)

3.2. Measurement and validity

Multi-item scales were used to operationalize all the key constructs and a 7-point Likert scale with end points of “strongly disagree” and “strongly agree” was used to measure them (see Table 3). Concerning the specific measurements of five external uncertainty indicators, four items, three items, and two items adapted from Kohli and Jaworski (1990), Jaworski, Kohli and Sahay (2000), and Huo et al. (2014) respectively were used to capture demand volatility, supply volatility, and technology uncertainty. Three items were created to represent legal unenforceability based on Luo's (2007) definition and Zhou and Poppo's (2010) description. Integration was measured by five items similar to those of Flynn et al. (2010), who used several items to measure both integration with customers and integration with suppliers. For the outcome constructs, operational performance was measured by five items borrowed from Zhao et al. (2002), financial performance was measured by another five items recommended by Narasimhan and Kim (2002), and lastly, based on measures initially developed by Geyskens and Steenkamp (2000), five items were used to capture satisfaction.

In addition to the key constructs, another three constructs (industry type, sales volume and relationship development stage) were included as control variables. Industry type refers to the specific industrial classification of a firm based on its organizational structure and business operation mode. Sales volume was represented by the net income of total sales within a year in HK$. Relationship development stage measured the specific stage of the focal logistics relationship in the inter-firm relationship lifecycle. Unlike key constructs, which were measured by multiple items, each of these four control variables was measured by a single choice question.

We made several efforts to check the reliability and validity of all constructs used for this study (see Table 3). First, as suggested by Anderson and Gerbing (1988), an item-to-total correlation examination indicated that there were no deviations from the external consistency (all >0.4). Second, Cronbach's alpha was calculated to assess internal consistency. The results for all constructs were greater than 0.7 (with the exception of 0.67 for legal unenforceability, because it has only three items), which confirmed high internal consistency. Third, the composite reliability (CR) values were calculated based on methods from Bagozzi and Yi (1988), and demonstrated high construct reliability (all >0.732). Fourth, all items were subjected to exploratory factor analysis using principal component analysis with a varimax rotation. As noted by Jambulingam et al. (2005), if an item is loaded on more than one factor and the difference between factor loadings is less than 0.10 across the factors, then it is considered to have cross-loadings. The results successfully came out of nine eigenvalues that were larger than 1 and exclude the possibility of cross-loadings (see Table 4). The total variance explained by these eight factors was 72%.

Then, we continued to estimate the content, convergent, and discriminant validity separately. By virtue of our thorough

Table 3
Construct reliability and validity.

	Cronbach's α	Factor loading	CR	AVE
Demand volatility	0.789		0.801	0.503
DV1: Our demand for logistics service type changes frequently.		0.73		
DV2: Our demand for logistics service quantity is highly fluctuating.		0.77		
DV3: Our requirements for logistics services are hard to predict.		0.63		
DV4: Major 3PL providers are often surprised by our activities.		0.70		
Supply volatility	0.864		0.868	0.689
SV1: The price of major 3PL providers' services changes frequently.		0.72		
SV2: The capability of major 3PL providers is unstable.		0.91		
SV3: The quality of major 3PL providers' services changes frequently.		0.85		
Technology uncertainty	0.798		0.826	0.711
TU1: It is very difficult for us to predict whether the required logistics technology is outdated.		0.98		
TU2: It is very difficult for us to predict and keep up with the latest development of logistics technology.		0.68		
Legal unenforceability	0.670		0.732	0.477
LN1: Relevant laws and regulations concerning dispute resolution in inter-firm cooperation need to be improved.		0.69		
LN2: The cost of solving disputes through legal means is relatively high.		0.65		
LN3: Domestic legal services such as arbitration and law firms are yet to be perfected.		0.73		
Integration	0.853		0.859	0.551
IN1: We have high level information exchange with key 3PL service providers.		0.64		
IN2: We conduct joint planning with key 3PL service providers to better predict and solve operational problems.		0.77		
IN3: We and key 3PL service providers are mutually aware of each other's responsibilities.		0.70		
IN4: We conduct joint planning with key 3PL service providers to improve overall cost-effectiveness.		0.80		
IN5: We design customized processes with key 3PL service providers.		0.79		
Operational performance	0.886		0.882	0.601
OP1: We have higher delivery reliability.		0.74		
OP2: We have higher customer satisfaction.		0.84		
OP3: We can respond to changes in customer demand in a timely way.		0.81		
OP4: We have more flexibility in dealing with customers' special requirements.		0.70		
OP5 We are capable of meeting customers' urgent orders.		0.78		
Financial performance	0.927		0.926	0.758
FP1: Growth in sales volume.		0.90		
FP2: Growth in profit.		0.90		
FP3: Growth in market share.		0.86		
FP4: Growth in return on sales.		0.82		
Satisfaction	0.867		0.870	0.629
SA1: Key 3PL providers are our good business partners.		0.76		
SA2: We expect that we can use more services from key 3PL providers in the future.		0.75		
SA3: I will recommend my successor to continue to use these key 3PL providers' services.		0.91		
SA4: We are willing to recommend our key 3PL providers to our business partners.		0.74		
Industry type: (1) Manufacturing (2) Retailing (3) Others				
Sales volume (HK$): (1) Less than 1 million (2) 1–4.99 million (3) 5–9.99 million (4) 10–49.99 million (5) 40 million–0.1 billion (6) 0.1–0.3 billion (7) More than 0.3 billion				
Relationship development stage: (1) Initiation phase (2) Development phase (3) Stabilization phase (4) Decline phase (5) Termination phase				

literature review, firm interviews, and the pilot test, content validity was easily ensured. A confirmatory factor analysis was conducted to assess convergent validity, with the result showing a good fit for the data (χ^2=526, df=438, GFI=0.895, CFI=0.978, IFI=0.979, RMSEA=0.028). In addition, the average variance extracted (*AVE*) values for all of the constructs exceeded 0.5 (with the exception of 0.477 for legal unenforceability), also demonstrating good convergent validity. Finally, the discriminant validity was checked using complementary methods. We first compared the fit between the one-factor and the two-factor CFA models, as suggested by Dabholkar and Bagozzi (2002). The results of the analysis showed that the chi-square difference tests for each pair of constructs (with one degree of freedom) were statistically significant ($\Delta\chi^2_{(1)} > 3.84$), demonstrating satisfactory discriminant validity. As an alternative test, as recommended by Anderson and Gerbing (1988), we went on to check the 95% confidence interval of the correlations between two randomly selected factors and found that 1.0 did not exist at any interval, also demonstrating good discriminant validity. The issue of multicollinearity was addressed by calculating the tolerance, variance inflation factor (VIF), and the condition index of each independent variable. The results (tolerance $>$ 60%, VIF $<$ 2, condition index $<$ 30) successfully prove that multicollinearity is not present in this study.

4. Results and analysis

Table 5 reports the Pearson correlation coefficients for all variables involved in this study. Results of the Structural Equation Modeling are shown in Table 6. Significant positive relationships were found between demand volatility (β=0.363, $p < 0.01$) and integration, and between legal unenforceability (β=0.139, $p < 0.1$) and integration. On the contrary, supply volatility ($\beta = -0.298$, $p < 0.01$) and technology uncertainty ($\beta = -0.159$, $p < 0.05$) exert significant negative effect on integration. These results lend support toH1-H4.

Then, operational performance is found to positively affect financial performance (β=0.377, $p < 0.01$), which support H5a. Typically, a mediating effect exists when three requirements are met: (1) the predictor (integration) is significantly related to the mediator (operational performance), (2) the mediator is significantly related to the dependent variable (financial performance or overall satisfaction) and (3) the previously significant relationship between the predictor and the dependent variable is eliminated or substantially reduced when the mediator is included (Baron and Kenny, 1986). As shown in Table 6, the first condition is met as integration is positively significantly related to operational performance (β=0.354, $p < 0.01$). The significant positive effect of operational performance on financial performance (β=0.377,

Table 4
Exploratory factor analysis results.

Item[a]	Factor loadings							
	DV	SV	TU	LN	IN	OP	FP	SA
DV1	0.029	0.063	0.028	0.100	**0.858**	0.063	0.056	−0.001
DV2	0.041	0.099	0.057	0.087	**0.751**	0.264	0.069	0.071
DV3	0.048	−0.069	−0.017	−0.065	**0.659**	0.162	0.025	0.203
DV4	0.049	0.007	0.007	−0.053	**0.688**	0.332	−0.079	0.130
SV1	0.007	−0.059	−0.082	0.004	0.214	**0.809**	0.042	0.044
SV2	0.029	−0.059	−0.006	−0.024	0.322	**0.845**	0.037	0.094
SV3	0.049	−0.130	−0.014	−0.069	0.228	**0.835**	−0.006	0.166
TU1	−0.053	−0.100	0.038	0.090	0.242	0.174	0.063	**0.832**
TU2	−0.048	−0.017	0.022	−0.019	0.128	0.108	0.055	**0.894**
LN1	0.078	0.069	0.003	−0.035	0.099	−0.112	**0.787**	0.076
LN2	0.117	−0.117	0.011	−0.014	−0.072	0.186	**0.730**	0.000
LN3	0.139	0.081	0.027	0.143	0.046	0.000	**0.775**	0.033
IN1	0.079	**0.646**	−0.017	0.262	0.109	−0.050	−0.015	−0.150
IN2	0.032	**0.847**	0.113	0.008	−0.028	−0.027	−0.037	−0.040
IN3	0.190	**0.711**	0.049	0.252	−0.095	−0.040	0.034	0.014
IN4	0.119	**0.817**	0.115	0.108	0.004	−0.117	0.003	0.110
IN5	0.045	**0.797**	0.133	0.166	0.100	−0.025	0.074	−0.085
OP1	**0.725**	0.140	0.137	0.172	−0.048	0.010	0.130	−0.054
OP2	**0.810**	0.069	0.134	0.147	−0.023	0.076	0.201	−0.082
OP3	**0.794**	0.181	0.101	0.203	0.065	−0.061	0.076	−0.003
OP4	**0.815**	0.045	0.082	0.079	0.120	0.066	0.012	0.112
OP5	**0.823**	0.039	0.161	0.159	0.063	0.003	0.032	−0.095
FP1	0.142	0.093	**0.879**	0.193	0.049	−0.057	0.032	−0.014
FP2	0.149	0.080	**0.898**	0.114	−0.012	−0.012	−0.006	0.082
FP3	0.141	0.095	**0.880**	0.130	0.021	0.044	−0.010	−0.013
FP4	0.138	0.116	**0.855**	0.082	0.015	−0.081	0.038	0.010
SA1	0.209	0.342	0.125	**0.697**	0.037	−0.079	0.031	0.136
SA2	0.210	0.099	0.151	**0.792**	−0.038	0.001	0.054	0.007
SA3	0.210	0.234	0.129	**0.837**	0.045	−0.080	0.004	0.079
SA4	0.161	0.179	0.167	**0.775**	0.046	0.043	0.032	−0.108

[a] See Table 1 for the survey questions on the measurement items.

Table 5
Construct correlation matrix and descriptive statistics ($N=264$).

Construct	Mean	S.D.	Construct correlations										
			1	2	3	4	5	6	7	8	9	10	11
1. Demand volatility	3.574	1.266	1										
2. Supply volatility	0529	1.335	0.515**	1									
3. Technology uncertainty	4.367	1.374	0.343**	0.307**	1								
4. Legal unenforceability	5.430	.969	0.077	0.072	0.108	1							
5. Integration	4.245	1.092	0.047	−0.157*	−0.092	0.047	1						
6. Operational performance	4.890	0.956	0.107	0.043	−0.051	0.250**	0.271**	1					
7. Financial performance	4.630	1.071	0.052	−0.064	0.040	0.060	0.247**	0.333**	1				
8. Overall satisfaction	4.865	0.917	0.071	−0.071	0.034	0.111	0.465**	0.446**	0.360**	1			
9. Industry type	1.393	0.721	0.112	0.126*	0.034	−0.145*	−0.025	0.060	0.084	−0.059	1		
11. Sales volume	4.746	2.116	−0.251**	−0.314**	−0.112	0.053	0.183**	0.066	0.166**	0.173**	−0.079	1	
12. Relationship development stage	2.337	0.806	−0.149**	−0.139*	−0.136*	−0.060	0.137*	0.083	0.045	0.085	−0.040	0.197**	1

** $p < 0.01$
* $p < 0.05$; two-tailed test.

$p < 0.01$) and overall satisfaction ($\beta=0.433$, $p < 0.01$) validated the second condition for financial performance and overall satisfaction. Lastly, when operational performance is accounted for, the originally significant effects of integration on financial performance ($\beta=0.281$, $p < 0.01$) and overall satisfaction ($\beta=0.433$, $p < 0.01$) are reduced ($\beta=0.181$, $\beta=0.358$ respectively), which satisfies the final condition of mediation. As integration also exerts some effect on financial performance and overall satisfaction, the mediating effect is partial in nature. These results generally support H5b.

5. Discussion and conclusion

5.1. Results summary

Focusing on logistics outsourcing relationships, this study explores how the degree of integration between vendor and client firms varies in response to the external uncertainties of demand volatility, supply volatility, technology uncertainty, and legal unenforceability. We treat these four indicators as distinct, each representing a different aspect, yet jointly capturing the overall

Table 6
Hypotheses testing: Structural Equation Modeling ($N=264$).

Uncertainty antecedents → integration	β	t-Value	Integration → outcome implications	β	t-Value
Control Variables			**Mediation test: operational performance- overall satisfaction**		
Industrial type → integration	0.009	0.128	Integration → overall satisfaction (direct)	0.433	6.162***
Sales volume → integration	0.146	2.057**	Integration → operational performance	0.354	4.921***
Relationship development stage → integration	0.119	1.786*	Operational performance → overall satisfaction	0.433	5.839***
Uncertainty indicators			Integration → overall satisfaction (indirect)	0.358	5.333***
Demand volatility → integration	0.363	2.898***	**Mediation test: operational performance-financial performance**		
Supply volatility → integration	−0.298	−2.768***	Integration → financial performance (direct)	0.281	4.132***
Legal unenforceability → integration	0.139	1.702*	Integration → operational performance	0.354	4.921***
Technology uncertainty → integration	−0.159	−2.018**	Operational performance → financial performance	0.377	5.520***
			Integration → financial performance (indirect)	0.181	2.631***
			Path effect		
			Operational performance → financial performance	0.311	4.407***

Model fit: $\chi^2=572$, df=459, GFI=0.887, CFI=0.972, IFI=0.972, RMSEA=0.031.

The entries in this table are standardized β s.

* $p<0.05$
** $p<0.01$
*** $p<0.001$.

external uncertainty. External uncertainty increases the transaction complexity and information-processing difficulty of the outsourcing relationship, which gives rise to high transaction costs (Luo, 2007). A key feature of transaction cost theory is that governance structures for coping with transaction uncertainty should exert a minimal transaction cost. In light of transaction complexity, information-processing difficulty, and the threat of opportunism and high transaction costs, firms in logistics outsourcing relationships are likely to demonstrate some degree of integration with their counterpart in response to risks arising from external uncertainties.

Overall, the results of this study demonstrate four major findings. First, supply volatility and technology uncertainty inhibit integration between the client and the vendor in a logistics outsourcing relationship whereas demand volatility and legal unenforceability promotes it. Second, integration between the client and the vendor significantly improves performance, in terms of operational performance, financial performance, and overall satisfaction. Third, operational performance also contributes to financial performance. Lastly, operational performance exerts a mediating effect between integration and the two fundam ental performance indicators, financial performance and overall satisfaction.

5.2. Theoretical implications

The main findings of this study extend transaction cost theory and demonstrate the theory's relevance to explicating partner integration in response to external uncertainty in logistics outsourcing relationships. Transaction cost theory suggests that firms will design their transaction structures based on the frequency, asset specificity, and uncertainty of their transactions (Williamson, 1991). Among these three factors, uncertainty is the most complex and thus the most important. The literature in this discipline reports that, in the presence of high uncertainty, firms will implement control mechanisms (e.g., contract, transaction specific investment, trust, personal ties) into their transactions to increase control over transaction attributes and reduce risks and transaction costs accordingly (Zhou and Poppo, 2010). Contracts and transaction specific investments are transactional in nature and are effective for behavior control but are likely to induce resentment between partners and require a large amount of prior input of time, money, and manpower (Liu et al., 2009). Trust and personal ties are relational in nature and are flexible in changing environments but need a relatively long time to form (Liu et al., 2009). Each control mechanism has its own advantages and shortcomings. Are there any new strategies or mechanisms that are more comprehensive and integrative to better deal with uncertainty? Integration, a new form of strategic collaboration between partners that manages intra- and inter-organizational processes to achieve effective and efficient flows of products, services, information, money and decisions, with the objective of providing maximum value for both sides, is becoming ever more popular in inter-firm relationship management (Zhao et al., 2011). The results of this study confirm that the integration does work as an effective governance mechanism in response to different uncertainty indicators with different levels, and thus enriches transaction structure research within the framework of transaction cost theory and represents an innovation in inter-firm relationship management.

Second, this study may be among the first initiatives to test the effects of integration on three logistics outsourcing performance indicators in a single model. Previous studies have separately verified the positive effects of integration on operational performance, financial performance (Flynn et al., 2010), and overall satisfaction (Homburg and Stock, 2004; Kim, 2009). However, an empirical investigation of the effect of integration on all three performance indicators at the same time is still lacking. Examining the effects of integration on different performance indicators in a unified model helps firms to compare the relative effectiveness of the promoting effects of integration on different performance indicators. This enables firms to design accurate levels of integration and resource allocation based on the type and extent of performance they expect to achieve.

Finally, this study also examines the sequencing of different performance indicators. Classifying mid-range and ultimate performance is useful because doing so helps to identify the specific paths via which integration exerts its effects on the overall relationship. Our results indicate that, in a logistics outsourcing relationship, it is through operational performance that integration affects financial performance and overall satisfaction. Further, operational performance generates a mediating effect between integration and financial performance/overall satisfaction. And lastly operational performance directly contributes to financial performance.

5.3. Managerial implications

As the fundamental motivation for firms to outsource their logistics activities is to reduce costs and better focus on their core business, relationship building with vendor firms becomes

increasingly critical. Superior relationships with vendor firms provide the client firm with competitive advantages in the marketplace through faster delivery speeds, shorter lead times, and better customer evaluations. However, like any other relationship, logistics outsourcing relationships face numerous external uncertainties. Governing such relationships is a key task for executives on both sides, and especially for the client firm. One lesson learned from this study is that integration and different indicators of external uncertainty are aligned. If the external uncertainties a client firm in a logistics outsourcing relationship faces come from supply volatility or technology uncertainty, the firm should decrease integration with its vendor to avoid resource exposure and resource waste. In contrast, if high uncertainty in demand volatility or legal unenforceability is perceived, the firm should increase its integration with its vendor.

The results of this study also provide practitioners with an understanding of various effects that integration incurs. The positive relationships between integration and all three types of performance demonstrate the importance of integration in logistics outsourcing relationships. If improvement in any one type, two, or all three types of performance is the ultimate goal, integration would be a good choice. In addition, the sequencing of these three performance indicators and the mediating role of operational performance shows managers that the three types of performance are not all achieved at once when integration is implemented. Operational performance is the first to be achieved and it will then contribute to the achievement of financial performance and overall satisfaction.

5.4. Limitations and future research

This study has several limitations that need to be addressed in future endeavors. First, integration is not always the best solution for responding to volatility. This study only investigates integration between client and vendor firms in a logistics outsourcing relationship as a governance structure in response to external uncertainties, leaving other governance mechanisms, such as contracts, specific investments, monitoring, relational norms, and personal ties unexplored. Future research could take up these issues, offering both theoretical and empirical insights into how the extent of these additional governance mechanisms varies, individually or interactively, in response to external uncertainties.

Second, although we followed Lee's (2002) typology of demand and supply volatility in designing our measures for environmental uncertainty in the business level, we did not develop a model that illustrates how the degree of integration varies to fit into each of the four situations with varying degrees of demand and supply uncertainty. Instead, this study investigated how the extent of integration between the client and the vendor varies in response to demand volatility, supply volatility, and two more other uncertainty indicators separately. It will be interesting and fruitful to examine the role and importance of integration in implementing each of the four strategies that Lee (2002) proposed in dealing with the four situations with the different levels of demand and supply volatility.

Third, logistics outsourcing relationships are dyadic interactive processes between vendor firms and client firms. However, the control variables included in this study reflect characteristics at the organization level, overlooking characteristics at the relationship and national levels, which may affect integration between the vendor and the client. For example, one dyadic relationship control variable is power asymmetry—whether the vendor and the client possess equal or differentiated power in their relationship may influence their integration levels. Furthermore, future studies may also consider both symmetric and asymmetric power structures, to examine whether the proposed model holds under different power structures (e.g., vendor power > client power, vendor power = client power, vendor power < client power).

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