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EMPIRICAL RESEARCH

Interorganizational dependence, information transparency in interorganizational information systems, and supply chain performance

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Abstract

To explain the large disparity between the potential and practice of interorganizational information systems (IOSs), this study investigates asymmetric information transparency in an IOS from a dyadic perspective. When there is asymmetric dependency in a dyad, an IOS may not completely eliminate asymmetric information transparency between supply chain (SC) partners but may change the nature of information asymmetry. Consistent with resource dependence theory, this study includes joint dependence and dependence asymmetry as antecedents of information transparency in an IOS. The data used in this study were collected from 111 *matched pairs* of intermediate component manufacturers and their immediate suppliers in heavy manufacturing industries. The results show that asymmetric information transparency in an IOS is prevalent in SC relationships. Regarding the antecedents of information transparency in an IOS, both joint dependence and each partner's dependence advantage are significant. Furthermore, information transparency in an IOS positively influences SC performance measured by SC relationship quality and relationship-specific performance, whereas asymmetric information transparency negatively influences joint profit performance.
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Introduction

Information sharing among supply chain (SC) partners that is enabled by information technology (IT) is widely acknowledged to be a critical success factor for SC performance (Dedrick and Kraemer, 2010; Kang *et al*, 2010; Liu *et al*, 2013; Rai *et al*, 2012; Wei & Wang, 2010; Wong *et al*, 2011; Youn *et al*, 2014). However, few corporations have fully exploited their SC partners' information resources, and there is often a large disparity between the potential and practice of interorganizational information systems (IOSs) (Mentzer *et al*, 2000; Simatupang *et al*, 2004; Zhang *et al*, 2016). An IOS is a network-based system that transcends legal enterprise boundaries (Hong, 2002). Despite the clear benefits of information sharing among SC partners, why are only a few firms able to benefit from their partners' information? Part of the answer may lie in the asymmetric

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information transparency (AIT) in IOSs that undermines the plausibility of symmetrical information sharing among SC partners. Zhu (2004) defines information transparency as the degree of visibility and accessibility of information. Then, AIT in an IOS refers to the imbalance in the degree of visibility and accessibility of an SC partner's internal information that is required for SC cooperation through an IOS.

This study differentiates itself from existing studies on interorganizational information sharing through IOSs in two ways: (1) it challenges the implicit assumption that an IOS naturally decreases information asymmetry between SC partners and (2) it extends the analysis of interorganizational information transparency from a firm perspective to a dyadic perspective by collecting data from both sides of a supply channel.

Most IOS studies are based on the untested assumption that an IOS is a neutral technological input into an interorganizational relationship (Dedrick & Kraemer, 2010; Wang *et al*, 2013). Without considering the potential of asymmetric use of IOS, such studies assume that an IOS works as a channel for substantial information exchange, thereby decreasing information asymmetry between SC partners (Zhu, 2004). Although an IOS does not inherently favor any one party, either a supplier or a buyer, the IOS itself is not neutral in SC relationships (Giddens, 1979; Orlikowski & Baroudi, 1991). An IOS is the system manifestation of interorganizational relationships, and it institutionalizes asymmetric interdependence between organizations (Kumar & van Dissel, 1996). Then, owing to the power imbalances between SC partners, an IOS may not decrease relationship-specific information asymmetry, but it can change the nature of information asymmetry (Lamming *et al*, 2004). For example, when SC partners have their own information advantages but asymmetric interdependence exists between them, the information advantage of a dependent supplier may disappear owing to an IOS to favor the buyer who can maintain its information advantage (Lin *et al*, 2005). Thus, how the IOS is exploited determines whether it decreases information asymmetry between SC partners. Despite the significance of this phenomenon in SC performance, it has never been formally investigated in academic literature. Thus, the first objective of this paper is to investigate the impact of interorganizational dependence on information transparency in IOSs. Our results show that a high level of joint dependence contributes to a high level of SC information transparency through an IOS. However, under a low level of joint dependence, the logic of power significantly influences SC relationships, thus increasing AIT for those with relative power.

Regarding the second contribution, few empirical studies have investigated asymmetric SC relationships including AIT and their performance impacts (e.g., Casciaro & Piskorski, 2005; Klein *et al*, 2007). Furthermore, empirical tests of such relationships have primarily focused on the perspective of one party rather than examining the reciprocal relationship (for exceptions, see Klein & Rai, 2009; Kim *et al*, 2011). An asymmetric SC relationship is a property of an interorganizational dyad rather than an attribute of a single party (Emerson, 1962). This premise implies that investigations into the effect of asymmetry require simultaneous consideration of both partners' perspectives for a single construct (Casciaro & Piskorski, 2005). Furthermore, interorganizational information sharing has two components (Reinholt & Pedersen, 2011), i.e., the acquisition of information and the provision of information. Each SC participant's motivation and background for these information-sharing activities can differ. For example, each participant's risk assessment for engaging in the provision of information to a specific partner differs on the basis of the partner's characteristics, including the partner's opportunism, relative power, assets specific to the relationship, and other factors (Williamson, 1985). Thus, the second objective of this paper is to investigate the impact of interorganizational information transparency in IOSs on SC performance from both partners' perspectives. Our results show that overall SC information transparency is positively associated with joint profit performance. However, it turns out that AIT in an IOS significantly decreases joint profit performance.

Our research model was examined using a sample of 111 matched pairs of buyers and suppliers in heavy manufacturing industries. A matched pair consists of a first-tier manufacturer of intermediate components (buyer) and the immediate supplier (seller). The final outputs from the intermediate component manufacturer are sold to original equipment manufacturers (OEM) who integrate them into final products. The dyad's manufacturing activities need to be coordinated effectively because modular components must be assembled by following an integrated design. Thus, these upstream dyads provide a good context in which to study interorganizational information transparency in IOSs.

In the following sections, we briefly discuss the conceptual background for interorganizational information transparency in IOSs and present our research framework and hypotheses. We then describe the research methodology used in our study. We conclude the paper by discussing the contributions of this research.

Conceptual background

Interorganizational information transparency in IOS

Interorganizational information transparency in IOSs is related to information asymmetry in that the content that flows through an IOS is information, and AIT in IOSs can be considered to be a special case of information asymmetry. Information asymmetry refers to a situation in which one party in a transaction has more or better information regarding the products, characteristics, and selling practices than the other party (Pavlou *et al*, 2007). However, the general notion of information asymmetry

can take many different forms in terms of directions (e.g., sender advantage vs. receiver advantage), the amount of information (e.g., limited information related to a specific transaction vs. unrestricted information on an ongoing basis), and the quality of information (e.g., protected internal information vs. public information). Thus, to scrutinize the impact of information transparency in IOSs on SC relationships, we must clarify the concept of information asymmetry by explaining the unique aspects of AIT in IOSs.[1]

First, AIT in IOSs refers to asymmetry in *access privileges* to the SC partner's private *internal* information on an *ongoing* basis through an IOS, whereas general information asymmetry refers to the asymmetry of information regarding uncoupled events. The information assets (e.g., strategic and customer information) residing in an IOS are company-specific, and a firm would not reveal such assets to outsiders. Making protected internal information available to outside firms *instantly* in detail through an IOS may allow private information to become public, thereby decreasing the firm's competitive advantage (Kim *et al*, 2011). Furthermore, an IOS comprises mission critical systems, such as SC execution software, that are deeply intertwined with interorganizational processes. Therefore, AIT in an IOS may result in much higher business risk and enduring negative impacts on SC performance than general information asymmetry, in which the content, frequency, and nature of information exchange are relatively limited.

Second, interorganizational information transparency through an IOS expands the scope of information's empirical referents from that of general information asymmetry, which typically refers to asymmetry of information regarding the *same* empirical referent. As an example of general information asymmetry, a supplier may possess private information on the quality of a product that the buyer does not have. Conversely, in a manufacturer–supplier relationship with an IOS, each party needs to see information regarding the other's situation (i.e., *different* empirical referents) through the IOS. For example, the manufacturer requires access to the information on the supplier's (finished goods) inventory status, whereas the supplier requires the information on the manufacturer's (raw material) inventory status. The distinction between the two different empirical referents in a supply channel introduces two different types of information asymmetry (manufacturer-related and supplier-related) that must be investigated separately.

Distinguishing the direction of information asymmetry in a dyad, Lin *et al* (2005) introduced the dimension of *information structure* that describes a characteristic of the partner relationship in a dyad. They explored the impact of the differential properties of the information structure on knowledge transfer. In particular, in the *sender-advantage asymmetric information structure*, information asymmetry may lead to a malfunctioning, or even failed, knowledge market "because the receiver cannot distinguish between different types of senders and has to make the same offer to all … a knowledge seeker may fail to find a potential sender with high expected value of knowledge" (p. 16). In the *receiver-advantage asymmetric information structure,* the receiver can identify a sender with highly valuable knowledge, and as a result, the receiver can always choose the best source from which to acquire knowledge.

In an upstream manufacturer–supplier relationship, the manufacturer delegates work to the supplier, who performs the work according to a contract (Eisenhardt, 1989). Typically, there is a *supplier-advantage asymmetric information structure* because the supplier has more information on the product's quality and the internal operations related to the delivery of the promised quality. Here, an IOS can work as a mechanism to mitigate information asymmetry problems that are consequent to the supplier's information advantage (Kumar *et al*, 1998a). Exchanging information regarding the supplier's product design, manufacturing schedules, quality inspection, inventory status, and forecasting through an IOS may decrease information asymmetry, thereby lowering the incentive of a supplier to behave opportunistically (Weill & Vitale, 2002).

However, due to the imbalance of power among SC participants, an IOS may not completely eradicate the information asymmetry problems in a dyad. An IOS can only mitigate the information asymmetry that favors the party with relative dependence. In the context of manufacturer–supplier relationships, the more powerful party can assume the leadership position and introduce asymmetry in terms of the scope and depth of the partner information that can be seen through the IOS. For example, in the automobile manufacturing industry, a few manufacturers dominate the market (Maloni & Benton, 2000) and thus use their power to obtain internal information of the supplier as required while behaving opportunistically. Thus, in an asymmetric power relationship between upstream SC partners, the information advantage of the supplier may disappear, whereas the information required for SC collaboration may not flow from the manufacturer to the supplier. When the supplier has relative power, as in the case of Intel, the "supplier-advantage asymmetric information structure" persists and the necessary information does not flow from the supplier to the buyer. Recent research suggests that an IOS can be

[1]Theoretically, it is possible to compare interorganizational information sharing between two different channels, i.e., electronic (e.g., IOS) and non-electronic (e.g., face-to-face). However, in today's networked environments, SC firms of all sizes are interconnected through electronic channels in order to improve the efficiency and effectiveness of their business processes. Further, considering the sheer volume of information exchange between upstream SC partners in heavy manufacturing industries, it is practically impossible to maintain a close SC partnership without an IOS. Hence, we limit our discussion to environments where SC partners are interconnected via an IOS.

used by dominant parties in SCs to consolidate their dominance in the chain, which remains a key feature in real SC relationships. For example, in a study of cooperative positioning versus competitive positioning in business-to-business logistics relationships, Klein *et al* (2007) described how a logistics vendor occupying a central position within the industry uses its logistics systems to influence information flows between SC partners, thus giving rise to resource asymmetries. In particular, "centrality provides the vendor with the power to establish standards for services … clients are likely to assume a disproportionate amount of effort to integrate sourced services with their internal systems" (p. 613).

Research model and hypothesis development

Resource dependence theory

Resource dependence theory (RDT) views organizations "as open-system structures that seek to manage their levels of *dependence* on the environment" (Gulati & Sytch, 2007, p. 35) and focuses on understanding the power dynamics in interdependent exchange relationships. Because the central theme of RDT is interorganizational dependency and its consequences, it is an appropriate reference theory that can be used to identify the antecedents of interorganizational information transparency. A review of prior studies based on RDT reveals that their theoretical backgrounds are rooted in one of two different views of interorganizational relationships, i.e., the logic of power and the logic of embeddedness (Gulati & Sytch, 2007).

Logic of power According to the *logic of power*, sourcing inputs from outside a firm makes the firm dependent on other firms for critical resources. Pfeffer & Salancik (1978, p. 52) assert that "to the extent that the interests of one party cannot be achieved without other parties, concentration is necessary." The level of dependence on a partner is construed as a source of the partner's power. From this perspective, interdependence between actors is considered to be a *liability* that must be managed because unequal dependence would cause power imbalances (Pfeffer, 1972).

Human agents in SC transactions tend to behave opportunistically when there is asymmetric dependency between the parties (Williamson, 1975). Furthermore, the party that has relative power is more likely to exercise its power as the asymmetry increases (Lawler & Bacharach, 1987). The logic of power suggests the differences in their relative abilities to appropriate value; the dependence-advantaged firm will attempt to appropriate more value from the relationship at the expense of the weaker partner (Gulati & Sytch, 2007). In the context of an IOS, the powerful party attempts to have a formal IOS that guarantees as much access to the partner's internal information as it requires, while limiting the dependent party's access to its internal information.

In manufacturer–supplier relationships in heavy manufacturing industries, it is reasonable to expect most buyers (manufacturers) to have relative power (Gulati & Sytch, 2007). However, in the case of supply concentration (e.g., Intel), it is conceivable that the supplier holds the dependence advantage. Each SC partner's information-sharing behavior can differ depending upon which party has the dependence advantage. To capture the unique perspectives of buyers and suppliers who have power, each party's dependence advantage is hypothesized separately rather than taking the average of the buyer's and supplier's responses as is common in previous research on dependence asymmetry. Thus, we propose the following hypotheses:

H1a: *The manufacturer's dependence advantage increases information transparency in an IOS for the manufacturer.*

H1b: *The supplier's dependence advantage increases information transparency in an IOS for the supplier.*

Logic of embeddedness The existing literature on interorganizational dependence that is based on RDT (Kumar *et al*, 1998a; Pfeffer & Salancik, 1978) includes the other dimension of dependence, i.e., *joint dependence*, which refers to the sum of dependence between the actors in a relationship. Gulati & Sytch (2007) emphasize the importance of joint dependence in that "if two separate relationships are each perfectly balanced in terms of their actors' dependence levels, they may have different behavioral implications if they are balanced at different levels of dependence" (p. 37). In particular, under a high level of joint dependence, parties will pay significant attention to the responses and attitudes of the other such that the SC relationship produces desirable outcomes. In addition, a high level of mutual dependence may generate a high level of commitment to the relationship, thus leading to mutualistic orientation (Rusbult *et al*, 1991). Conversely, under a low level of joint dependence, firms can operate independently and do not need to pay much attention to each other's responses.

The logic of embeddedness suggests that higher levels of joint dependence necessarily increase the depth of economic interaction between SC partners (Zaheer & Venkatraman, 1995). The increased levels of joint action also result in a more advantageous information exchange in the dyad. Highly interdependent SC partners have little incentive to institute AIT in an IOS. A partner's opportunistic behavior may result in a short-term information advantage; however, this exploitation is likely to invite the other partner's opportunism (Park & Ungson, 2001). Thus, interdependent SC partners tend to develop a norm of information sharing through an IOS to secure the greatest benefit from the relationship (Lusch & Brown, 1996). Thus, we propose the following hypothesis:

H2: *Joint dependence increases overall SC information transparency through an IOS.*

Interorganizational information transparency through an IOS and SC performance

SC performance consists of the two dimensions of an SC relationship's outcome, i.e., relationship-specific performance and relationship quality (Jap & Anderson, 2003; Klein & Rai, 2009; Kumar *et al*, 1992). Making a firm's internal information available to SC partners is a significant effort that is made with the expectation that the information will be used for mutually beneficial outcomes (Kim *et al*, 2011). Thus, an SC relationship's outcome is an appropriate level of specificity for our research context.

Relationship quality refers to the extent of close working relationships that a firm maintains with its partners (Lages *et al*, 2005). By nature, relationship quality is not only a close proxy for the perceived effectiveness of an SC but may also be predictive of long-term ramifications (Anderson & Narus, 1990). Relationship quality is an important dimension of the outcome because it enables SC partners to engage in activities that do not give rapid and certain payoffs. When SC partners have on-demand access to the information required for SC cooperation, they would be willing to maintain close working relationships with their partners. Conversely, the relative withholding of information by a partner may discourage the focal firm from maintaining the SC partnership. Thus, we propose the following hypotheses:

H3a: *Information transparency in an IOS for the manufacturer increases the manufacturer's view of the relationship quality.*

H3b: *Information transparency in an IOS for the supplier increases the supplier's view of the relationship quality.*

Relationship-specific performance refers to the performance gains that are specifically attributable to relationship participation (Dyer & Singh, 1998). In particular, it represents the financial outcomes that each partner achieves from the interdependence of effort and investments residing within the dyad (Jap & Anderson, 2003). Relationship-specific performance is an appropriate dependent variable for this study because the unit of analysis is a dyad and the performance outcomes are directly attributable to participation in the relationship (Klein & Rai, 2009). When the information required for addressing environmental changes is readily visible and accessible to each SC partner, each partner in the dyad can adapt effectively to the changing environment and increase relationship-specific SC performance. Accordingly, we state two hypotheses related to outcomes from information transparency through an IOS that reflect each SC partner's perspectives:

H4a: *Information transparency in an IOS for the manufacturer increases the manufacturer's relationship-specific performance.*

H4b: *Information transparency in an IOS for the supplier increases the supplier's relationship-specific performance.*

Firms participating in an SC with a highly transparent IOS can have real-time access to the information required to support decision-making. In addition, when information regarding environmental changes is readily shared with SC partners through an IOS, the entire SC can be prepared to deal with environmental uncertainty effectively. Conversely, an SC relationship with AIT in an IOS can work to the disadvantage of both buyers and suppliers because the relevant information does not flow to upstream partners and all members throughout the SC cannot synchronize their operations. This may cause the SC participants to encounter increased overall SC inventory and costly duplicate practices, such as inaccurate forecasting by multiple participants, which decreases the joint profits of the SC participants. The expectation of better joint profits is considered to be a major motive for sharing internal information through an IOS (Jap & Anderson, 2003). Thus, the following hypothesis is proposed:

H5: *Overall SC information transparency in an IOS increases joint profit performance.*

Control variables: joint governance structure, interorganizational trust, and IOS integration

Because an IOS grants access privileges to the focal firm's up-to-the-minute internal information to the SC partner, the potential risk resulting from a partner's opportunism is much higher. Thus, the SC partners interconnected through an IOS require strong mechanisms to cope with opportunism. Dyer & Singh (1998) describe the two types of control mechanisms used by SC partners, i.e., formal safeguards, such as a joint governance structure (Williamson, 1975), and informal safeguards, such as interorganizational trust (Zaheer *et al*, 1998).

A joint governance structure refers to "the structures, processes, and associated arrangements that IOS management must have in place to fully account for the management of systems and the services delivered" (Lee *et al*, 2014, p. 287). A joint governance structure is necessary to keep opportunistic behavior under control so that ongoing information exchange through the IOS can be sustained. The primary motive for forming an IOS is the reduction of uncertainties in the SC, thereby gaining cost, cycle time, and quality advantages over competing SCs in the industry (Kumar & van Dissel, 1996). With an appropriate IOS governance structure in place, investments into relation-specific capital can benefit SC performance.

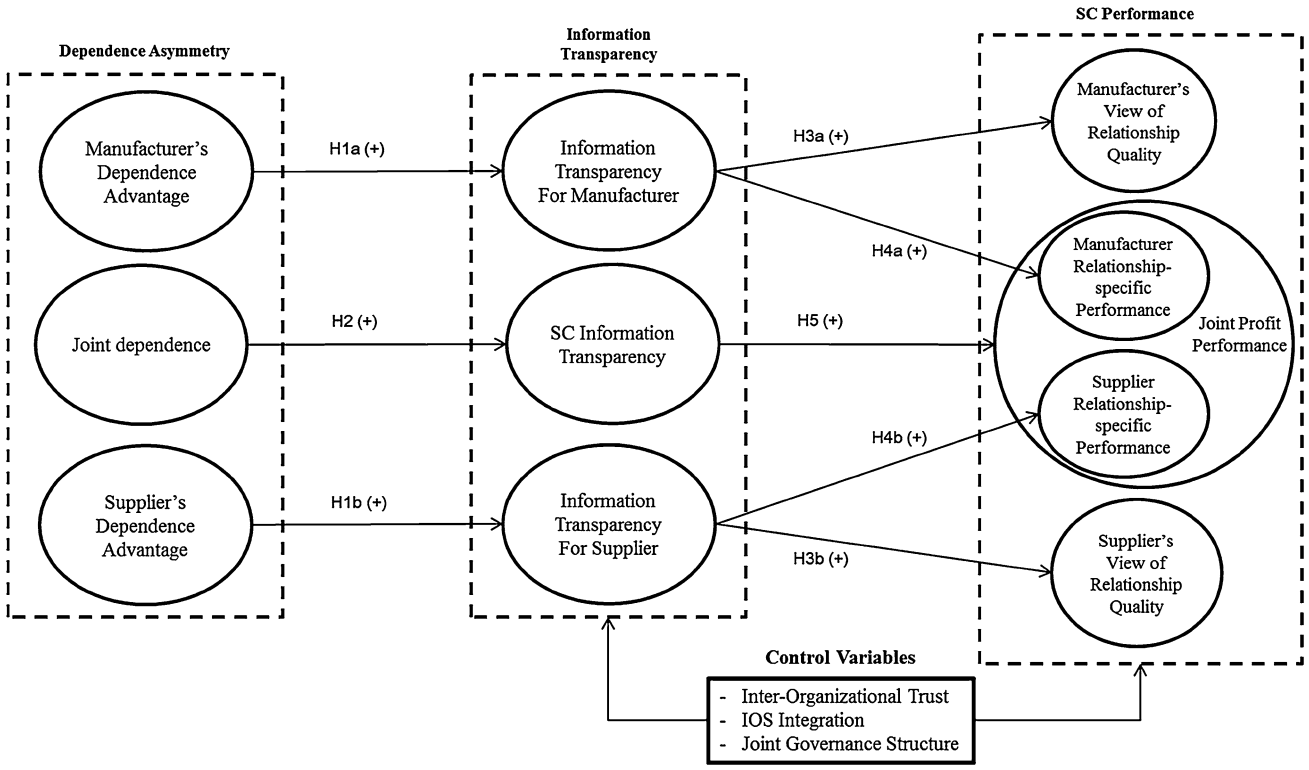

Figure 1 Research model.

With regard to interorganizational trust, Zaheer *et al* (1998) assert that interorganizational trust supplements formal controls and is "the most effective and least costly means of safeguarding specialized investments and facilitating complex exchange" (p. 669). Morgan & Hunt (1994) define interorganizational trust as conviction regarding the certainty and honesty of a trading partner. It decreases concerns on sharing internal information with trustworthy partners. Particularly, in high-trust relationships, organizations tend to be more open to the potential for value creation through the exchange and combination of information resources (Ryoo & Kim, 2009). Therefore, mutual IOS transparency is promoted spontaneously; thus, AIT should be decreased. Furthermore, interorganizational trust is necessary to easily dissolve potential conflicts related to an IOS (Anderson & Weitz, 1992) and reinforce long-term orientation with partners, thereby leading to high SC performance (Ryu *et al*, 2007).

IOS integration refers to "the extent to which the systems shared by two or more firms are integrated to facilitate access to information residing in either firm" (Grover & Saeed, 2007, p. 194). When the information systems for SC partners have compatible software and database structures, information can be exchanged efficiently without technical problems or major conversion processes. Thus, IOS integration works as an enabler for interorganizational information transparency. In addition, IOS integration creates the potential for an agile SC through the rapid exchange of information between SC participants (Weill & Vitale, 2002). For our empirical investigation, we propose the following research model (Figure 1).

Research methods

Sample and data collection

Because a supply channel is a dyadic environment, this research examines the phenomenon from the perspectives of both the manufacturer and its supplier in the dyad, i.e., a matched pair of a manufacturer and its supplier. The data required for this study were collected in three different industries (automobile manufacturing, shipbuilding, and electronics manufacturing) from two distinct sources, i.e., (1) the intermediate component manufacturers and (2) their immediate suppliers. The intermediate component manufacturers were identified from a major financial database of South Korean companies using (1) industry code and (2) size. Consequently, 220 manufacturers were identified in the sample. A questionnaire was administered to the respondents primarily via face-to-face meetings. If they preferred other methods, phone or email channels were used to collect the data. Of the 220 manufacturers contacted, data were collected from 159. For the selection of their suppliers, we adopted a "focal supplier" collection strategy (Klein & Rai, 2009), i.e., the intermediate component manufacturers (buyers) were asked to select an important part and a

Table 1 Respondent characteristics

Variables	*Category*	*Manufacturer (%)*	*Supplier (%)*
Respondent's years of work experience	1–4 years	43.2	44.1
	5–8 years	33.3	27.0
	9–12 years	12.6	17.1
	Over 13 years	10.8	11.7
Respondent's position	Executive level	4.5	8.1
	Director/General Manager	14.4	16.2
	Manager	50.5	44.1
	Sub-Manager	21.6	18.0
	Other position	9.0	13.5
Primary industry	Automotive	34.2	34.2
	Electronics	30.6	30.6
	Shipbuilding	35.1	35.1
Firm's 2009 annual sales	Less than US $10 million	17.1	17.1
	US $10–50 million	33.3	30.6
	US $51–100 million	29.7	36.9
	Over 100 million	19.8	15.3

major supplier for the part who was electronically connected to the buyer. The contact information of the chosen supplier was also solicited to collect data regarding the supplier's view of the relationship.

Then, of the 159 suppliers contacted, 111 suppliers participated in our survey, leaving a final sample of 111 matched pairs of manufacturer and supplier firms. Table 1 shows a profile of the respondents. To evaluate any systematic differences for nonresponses, analyses of variance (ANOVAs) were performed to compare the mean differences between early and late responses for all research variables in both samples. No statistically significant differences were found between the two groups in each sample at a 0.05 significance level. In addition, to check for any systematic differences among the subsamples of the three industries, ANOVAs were performed to compare mean differences. No statistically significant differences were found among the industries; thus, they were combined.

Measures

To measure our research variables, the existing scales were adapted to the context of the study; all of them were multi-item, seven-point Likert scales. The specific items for measuring the constructs are presented in Appendix A. Information transparency for the manufacturer refers to the extent to which the supplier's information required for effective SC cooperation is visible and accessible to the manufacturer through the IOS (Saeed *et al*, 2005). In an upstream SC context, the manufacturer typically requires the supplier's information in the following areas: order completion status, backorder status, production schedules, current production capacity, and demand planning information (Lee & Whang, 2000). We asked the purchasing managers at the intermediate component manufacturers to respond to the questionnaire. When the purchasing managers did not have sufficient knowledge to answer a specific question, they were encouraged to contact an appropriate expert inside the firm. Information transparency for the supplier refers to the extent to which the manufacturer's information required for effective SC cooperation is visible and accessible to the supplier through the IOS. The supplier typically requires the manufacturer's information in the following areas: inventory status, sales order status, production schedules, current production capacity, and demand forecast information. The suppliers' sales managers were asked to answer these questions. For questions outside their area of expertise, they were encouraged to contact appropriate experts inside the firm.

Following the existing literature on interorganizational dependence (Casciaro & Piskorski, 2005; Gulati & Sytch, 2007; Ryu & Eyuboglu, 2007), joint dependence and dependence asymmetry were derived from the buyer's and supplier's responses to the interorganizational dependence items developed by Morgan *et al* (2007). Joint dependence refers to the sum total of the two parties' dependence on each other (Ryu & Eyuboglu, 2007). Joint dependence for a dyad was calculated by taking the average of both the buyer's and its supplier's scores. Dependence asymmetry refers to the difference between the supplier's dependence on the buyer and the buyer's dependence on the supplier (Kumar *et al*, 1995; Zhou *et al*, 2007). For example, if a supplier is more dependent on its buyer, the buyer has the dependence advantage and more asymmetric power over the supplier. To calculate the buyer's and its supplier's dependence advantage scores, we used a spline specification (Kumar *et al*, 1998b).[2] Rather than using a single dependence

[2]Regression splines are piecewise regression functions between two variables. The basic logic of a regression spline is to allow the slope of the regression equation to change at certain points (known as *knots*, *nodes*, or *jointpoints*). Usually, one regression will approximate the negative tendency, while the other regression will approximate the upward tendency. In this instance, researchers can identify knots in the relationship between x and y, and then they can perform two piecewise linear estimates joined at the knots (Johnston, 1984).

Table 2 Procedures for data recoding

Measures	*Responses*		*Calculating*	*Recoding*	*Operationalized constructs*
	Manufacturer	*Supplier*			
Dependence	DP_M	DP_S	$DP_M - DP_S$	Let keep the original values, when ($DP_M > DP_S$); be 0 if otherwise	Manufacturer's dependence advantage
			$DP_M - DP_B$	Let keep the original values, when ($DP_S > DP_M$); be 0 if otherwise	Supplier's dependence advantage
			Mean (DP_M, DP_S)	–	Joint dependence
Information transparency in IOS	IT_M	–	–	–	Information transparency for manufacturer
	–	IT_S	–	–	Information transparency for supplier
	IT_M	IT_S	Sum (IT_M, IT_S)	–	SC information transparency
Relationship quality	RQ_M	–	–	–	Manufacturer's view of relationship quality
	–	RQ_S	–	–	Supplier's view of relationship quality
Relationship-specific performance	RP_M	–	–	–	Manufacturer's relationship-specific performance
	–	RP_S	–	–	Supplier's relationship-specific performance
	RP_M	RP_S	Mean (RP_M, RP_S)	–	Joint profit performance
Interorganizational trust	TR_M	TR_S	Mean (TR_M, TR_S)	–	Interorganizational trust
IOS integration	II_M	II_S	Mean (II_M, II_S)	–	IOS integration
Joint governance structure	JG_M	JG_S	Mean (JG_M, JG_S)	–	Joint governance structure

asymmetry variable, we differentiated between the manufacturer's and its supplier's dependence advantage. The spline estimation allowed us to investigate possible variations in the effects of each party's dependence advantage (Gulati & Sytch, 2007). In particular, to calculate the buyer's dependence advantage, we subtracted the buyer's dependence on the supplier from the supplier's dependence on the buyer. Then, we recoded the value to zero if it was negative. Similarly, to calculate the supplier's dependence advantage, we subtracted the supplier's dependence on the buyer from the buyer's dependence on the supplier. Then, we recoded the value to zero if it was negative (Table 2).

SC performance was operationalized as consisting of the following two dimensions, i.e., relationship quality and relationship-specific performance. The measures for these two dimensions were designed to reflect each partner's perception of how the two organizations were performing together. In particular, relationship quality entails a comparison of benefits against costs resulting from the involvement in a collaboration (Kumar *et al*, 1992), whereas relationship-specific performance refers to financial outcomes achieved from dyadic effort (Jap & Anderson, 2003). To calculate joint profit performance, responses to the relationship-specific performance measures from the manufacturer and supplier pair were averaged and the dyad score was obtained (Ryu & Eyuboglu, 2007; Zhou *et al*, 2007).[3]

We included interorganizational trust, IOS integration, and joint governance structure variables to control their effects on information transparency in IOS and SC performance. Interorganizational trust was measured on the basis of three dimensions – reliability, predictability, and fairness – using five items adopted from Poppo *et al* (2008), which were originally drawn from Zaheer *et al* (1998). IOS integration was measured using the following items developed by Grover & Saeed, (2007): database management systems, software, and file exchangeability. A joint governance structure refers to the structures, processes, and associated arrangements that IOS management must have in place to fully account for the use

[3]One concern may be regarding respondent knowledge of relationship-specific performance. Since the majority of our sample consists of small- and medium-sized companies (80.1% of the buyer sample and 84.6% of the supplier sample had revenues of less than $100 million in 2010) working in upstream SCs, respondents should know what proportion of their business is conducted with the SC partner and its profitability.

of resources, management of systems, and services delivered. For the joint governance structure, eight items were adopted from Luo (2008).

Analysis and results

We used partial least squares (PLS) Graph version 3.00 to conduct statistical analyses following the general procedures laid out by Gefen *et al* (2000). PLS is most suitable when the assumed cause-and-effect relationships are not sufficiently explored (Hair *et al*, 2011). The key theme of this paper, examining the relationships among dependence asymmetry, information transparency, and SC performance, has rarely been explored in the literature. Moreover, PLS is better suited when the model has complex relationships with many constructs and indicators (Hensler *et al*, 2009), which is a characteristic of this study.

Assessment of measurement model

All of the constructs in this study were modeled to be reflective because they are indicators that are influenced by latent variables (Gefen *et al*, 2000). To assess the measurement model, a two-step approach was necessary due to the special nature of the interorganizational dependence construct: (1) using the raw data in each sample and (2) using the calculated values for all constructs from the raw data (Ryu & Eyuboglu, 2007).

First, we tested the measurement model by examining individual item reliability, internal consistency, convergent validity, and discriminant validity for the items captured from each side of the dyad. Internal consistency and convergent validity were evaluated by examining item-construct-loading, composite reliability, and average variance extracted (AVE). All factor loadings in both samples, except for the two items measuring relationship quality, were each in an acceptable range, and the t values were all significant at the 0.01 level (see Tables B1, B2 in Appendix B). These two items of relationship quality were not considered further. The results also show that for both samples, the reliability coefficients were all greater than 0.70 and each AVE was greater than 0.50 (see Table B3 in Appendix B), which are the frequently cited threshold values. Discriminant validity was evaluated by examining (1) the extent to which each measure loaded more highly on their intended construct than on other constructs (see Tables B1, B2 in Appendix B) and (2) the extent to which the square root of AVE was greater than the interconstruct correlations (see Table B3 in Appendix B). In summary, confirmatory factor analysis and the results of the correlation matrix provide sufficient evidence for convergent and discriminant validity.

To assess the threat of common method bias resulting from the survey-based research design, we conducted Harman's one-factor test (Podsakoff *et al*, 2003). In this test, the emergence of a single factor that accounts for a large proportion of the variance in factor analysis suggests a common method bias. No such single factor emerged in either sample. Other evidence of common method bias includes exceptionally high correlations ($r > 0.90$) among research variables (Pavlou & El Sawy, 2006). The interconstruct correlation matrix (Table B3 in Appendix B) does not show any unusually high correlations in either sample (highest correlation among principal constructs is $r = 0.66$). Thus, we concluded that common method bias is not a significant threat to our data.[4]

Second, after calculating the scores for each party's dependence advantage, we reassessed the measurement model. The aforementioned tests were performed to assess the measurement model. As shown in Table 3, the loadings were each in an acceptable range, and their t values were all significant at the 0.01 level. All of the measures exceeded the recommended threshold value of 0.70 for composite reliability and the suggested 0.50 threshold value for AVEs, thereby supporting adequate convergent validity (Table 4). Furthermore, as shown in Table 3, all items were loaded more highly on their hypothesized constructs (all above 0.67) than they were on the other constructs. Table 5 shows that all AVEs were much greater than all of the cross-correlations. To address possible concerns related to multicollinearity, the variance inflation factor (VIF) values were examined. The resultant VIF values ranged from 1.17 to 2.18, far below the recommended threshold of 10 (Chatterjee & Price, 1991). Taken together, these results suggest good measurement properties for all indicators.

Hypothesis testing

The path coefficients and t values for the PLS structural model were computed using 5000 resamplings with bootstrapping (Chin *et al*, 2003). For SC performance, joint profit performance has an R^2 value of 0.34. Regarding relationship-specific performance, our structural model explains 37% of the variances for the manufacturer's view and 35% of the variances for the supplier's view. With regard to relationship quality, our structural model accounts for 10% of the variances for the supplier's view and 6% of the variances for the manufacturer's view (Figure 2).

In terms of the structural paths (Table 6), the manufacturer's dependence advantage showed a significantly positive relationship with information transparency for the manufacturer (H1a, $t = 4.47$, $p = 0.000$), whereas the supplier's dependence advantage showed a significantly positive relationship with information transparency for the supplier (H1b, $t = 4.59$, $p = 0.000$). In addition, joint dependence had a significantly positive relationship with the overall SC information transparency (H2, $t = 2.33$, $p = 0.011$).

[4]For our main analyses, common method variance was not a concern because the data were collected from two different sources: (1) intermediate component manufacturers and (2) their immediate suppliers.

Table 3 Confirmatory factor analysis results for the matched sample

	MDA	SDA	JDE	ITM	ITS	SIT	RQM	RQS	RPM	RPS	JPP	ITR	IOS	JGS
MDA1	0.769	−0.418	0.017	0.297	−0.235	−0.001	−0.175	−0.137	0.176	−0.248	−0.075	−0.188	0.060	0.030
MDA2	0.810	−0.471	−0.207	0.313	−0.289	0.021	−0.021	0.019	0.128	−0.379	−0.215	−0.201	−0.145	−0.074
MDA3	0.847	−0.431	−0.063	0.317	−0.259	0.043	−0.036	−0.100	0.172	−0.289	−0.110	−0.142	−0.181	−0.024
SDA1	−0.441	0.848	−0.061	−0.225	0.369	−0.041	0.160	0.156	0.089	0.362	0.358	0.168	−0.019	0.080
SDA2	−0.480	0.856	0.067	−0.209	0.374	−0.081	0.072	−0.001	0.040	0.309	0.280	0.139	0.131	0.180
SDA3	−0.486	0.881	−0.015	−0.276	0.400	−0.158	−0.058	0.043	−0.045	0.354	0.252	0.139	−0.007	0.166
JDE1	−0.079	−0.016	0.884	−0.424	0.431	0.250	−0.014	0.122	−0.110	0.505	0.331	0.357	0.298	0.270
JDE2	−0.116	0.028	0.906	−0.328	0.409	0.284	−0.045	0.083	0.002	0.449	0.365	0.370	0.315	0.311
JDE3	−0.094	−0.019	0.931	−0.376	0.442	0.348	−0.015	0.156	0.026	0.444	0.381	0.406	0.448	0.263
ITM1	0.352	−0.288	−0.423	0.870	−0.487	−0.037	−0.101	−0.137	0.107	−0.633	−0.436	−0.531	−0.258	−0.120
ITM2	0.377	−0.259	−0.371	0.896	−0.426	0.007	−0.058	−0.106	0.194	−0.654	−0.389	−0.461	−0.136	−0.067
ITM3	0.347	−0.253	−0.324	0.935	−0.496	0.098	−0.088	−0.174	0.282	−0.627	−0.304	−0.358	−0.189	−0.007
ITM4	0.334	−0.274	−0.377	0.914	−0.477	0.065	−0.053	−0.214	0.209	−0.662	−0.384	−0.303	−0.140	−0.080
ITM5	0.284	−0.150	−0.347	0.824	−0.428	0.040	−0.075	−0.227	0.215	−0.466	−0.223	−0.339	−0.186	0.022
ITS1	−0.344	0.453	0.376	−0.472	0.858	0.143	0.101	0.305	−0.150	0.622	0.400	0.305	0.242	0.283
ITS2	−0.262	0.463	0.342	−0.456	0.863	0.015	−0.015	0.184	−0.146	0.584	0.367	0.274	0.240	0.206
ITS3	−0.246	0.295	0.457	−0.478	0.917	0.160	0.063	0.254	−0.142	0.603	0.388	0.349	0.359	0.277
ITS4	−0.308	0.408	0.470	−0.451	0.939	0.120	0.072	0.232	−0.099	0.597	0.413	0.367	0.323	0.335
ITS5	−0.258	0.318	0.458	−0.451	0.860	0.120	0.061	0.210	−0.108	0.507	0.334	0.329	0.310	0.297
SIT1	0.043	−0.141	0.298	0.107	0.075	0.885	0.019	0.188	0.346	0.083	0.317	0.231	0.278	0.453
SIT2	0.060	−0.127	0.271	0.018	0.101	0.859	0.000	0.058	0.287	0.178	0.353	0.213	0.355	0.413
SIT3	0.068	−0.079	0.303	0.041	0.149	0.923	−0.081	0.139	0.253	0.134	0.292	0.222	0.274	0.458
SIT4	0.015	−0.121	0.337	−0.020	0.149	0.931	0.019	0.178	0.233	0.166	0.304	0.324	0.427	0.436
SIT5	−0.062	−0.028	0.271	0.055	0.090	0.903	0.041	0.152	0.346	0.115	0.344	0.319	0.366	0.404
RQM1	−0.121	0.066	−0.011	−0.100	0.098	−0.041	0.904	0.063	−0.169	0.070	−0.066	0.073	−0.014	−0.158
RQM2	−0.039	0.046	−0.038	−0.046	0.010	0.050	0.869	0.069	0.108	−0.032	0.051	0.135	0.097	−0.105
RQS1	−0.094	0.096	0.167	−0.209	0.297	0.164	0.064	0.928	0.053	0.291	0.276	0.165	0.134	0.076
RQS2	−0.055	0.022	0.048	−0.112	0.152	0.105	0.067	0.826	0.122	0.212	0.257	0.112	0.185	0.091
RPM1	0.216	0.042	−0.037	0.198	−0.104	0.283	−0.012	0.0–51	0.924	−0.111	0.578	0.044	0.188	0.301
RPM2	0.167	0.053	0.014	0.172	−0.072	0.329	−0.049	0.111	0.953	−0.110	0.602	0.156	0.249	0.329
RPM3	0.172	−0.005	−0.039	0.272	−0.225	0.298	−0.064	0.089	0.934	−0.196	0.508	0.119	0.189	0.388
RPS1	−0.331	0.378	0.484	−0.676	0.600	0.099	0.069	0.261	−0.183	0.913	0.603	0.450	0.270	0.284
RPS2	−0.373	0.319	0.501	−0.575	0.570	0.187	−0.020	0.282	−0.134	0.916	0.652	0.434	0.257	0.275
RPS3	−0.340	0.392	0.421	−0.634	0.644	0.135	0.020	0.265	−0.101	0.925	0.676	0.370	0.275	0.302
JPP1	−0.121	0.342	0.375	−0.420	0.423	0.283	0.049	0.252	0.504	0.677	0.910	0.404	0.357	0.449
JPP2	−0.169	0.282	0.395	−0.320	0.388	0.376	−0.050	0.295	0.570	0.627	0.927	0.444	0.374	0.444
JPP3	−0.164	0.324	0.324	−0.339	0.380	0.322	−0.028	0.285	0.571	0.636	0.922	0.393	0.363	0.525
ITR1	−0.176	0.099	0.379	−0.513	0.377	0.245	0.066	0.126	0.078	0.461	0.430	0.841	0.183	0.260
ITR2	−0.223	0.212	0.385	−0.419	0.343	0.295	0.103	0.143	0.155	0.444	0.470	0.926	0.229	0.336
ITR3	−0.134	0.118	0.328	−0.354	0.298	0.261	0.092	0.055	0.122	0.318	0.347	0.897	0.152	0.293
ITR4	−0.202	0.145	0.388	−0.341	0.288	0.268	0.090	0.146	0.089	0.370	0.364	0.904	0.185	0.236
ITR5	−0.206	0.164	0.373	−0.375	0.325	0.246	0.136	0.195	0.082	0.409	0.390	0.890	0.277	0.235
IOS1	−0.115	0.068	0.365	−0.218	0.350	0.292	0.114	0.196	0.150	0.296	0.348	0.225	0.921	0.200
IOS2	−0.096	0.078	0.380	−0.203	0.309	0.372	−0.010	0.135	0.208	0.303	0.396	0.272	0.950	0.231

Table 3 (Continued)

	MDA	SDA	JDE	ITM	ITS	SIT	RQM	RQS	RPM	RPS	JPP	ITR	IOS	JGS
IOS3	−0.107	−0.032	0.369	−0.150	0.267	0.396	0.026	0.161	0.257	0.217	0.361	0.179	0.924	0.237
JGS1	0.080	−0.050	0.180	0.089	0.080	0.444	−0.036	0.133	0.341	0.085	0.312	0.231	0.251	0.774
JGS2	−0.004	0.162	0.299	−0.073	0.299	0.389	−0.223	0.046	0.312	0.259	0.430	0.251	0.128	0.900
JGS3	−0.038	0.175	0.252	−0.069	0.279	0.401	−0.111	0.045	0.322	0.306	0.475	0.205	0.188	0.891
JGS4	−0.079	0.203	0.282	−0.109	0.350	0.367	−0.089	0.110	0.308	0.347	0.503	0.323	0.265	0.814
JGS5	−0.103	0.178	0.309	−0.022	0.345	0.473	−0.035	0.065	0.333	0.302	0.483	0.239	0.284	0.864
JGS6	−0.058	0.093	0.300	−0.070	0.296	0.370	0.099	0.029	0.447	0.177	0.464	0.252	0.288	0.673
JGS7	−0.156	0.195	0.324	−0.172	0.315	0.488	−0.032	−0.001	0.344	0.353	0.533	0.329	0.281	0.734
JGS8	−0.104	0.214	0.263	−0.062	0.269	0.393	0.048	0.063	0.443	0.276	0.541	0.311	0.227	0.671

MDA manufacturer's dependence advantage, *SDA* supplier's dependence advantage, *JDE* joint dependence, *ITM* information transparency for manufacturer, *ITS* information transparency for supplier, *SIT* SC information transparency, *RQM* manufacturer's view of relationship quality, *RQS*, supplier's view of relationship quality, *RPM* manufacturer's relationship-specific performance, *RPS* supplier's relationship-specific performance, *JPP* joint profit performance, *ITR* interorganizational trust, *IOS* IOS integration, *JGS* joint governance structure.

For the relationship between information transparency and SC performance, information transparency for the manufacturer had a significantly positive influence on the manufacturer's relationship-specific performance (H4a, $t = 3.34$, $p = 0.001$) as expected, whereas the manufacturer's view of relationship quality was not significantly related to information transparency for the manufacturer (H3a, $t = 0.19$, $p = 0.423$). Information transparency for the supplier had significantly positive effects on both dimensions of SC performance, i.e., the supplier's view of relationship quality (H3b, $t = 2.43$, $p = 0.008$) and the supplier's relationship-specific performance (H4b, $t = 11.35$, $p = 0.000$). In addition, the overall SC information transparency showed a significantly positive relationship with joint profit performance (H5, $t = 2.63$, $p = 0.005$).

With regard to the effects of control variables, Table 6 shows only the significant control paths at $p < 0.05$. The results show that interorganizational trust had a significantly positive effect on information transparency for the supplier ($t = 4.34$, $p = 0.000$) and the manufacturer's view of relationship quality ($t = 2.00$, $p = 0.024$). IOS integration had a significantly positive effect on overall SC information transparency ($t = 5.69$, $p = 0.000$). Joint governance structure had significantly positive effects on information transparency for the supplier's relationship-specific performance ($t = 2.05$, $p = 0.021$), the manufacturer's relationship-specific performance ($t = 6.30$, $p = 0.000$), and joint profit performance ($t = 4.98$, $p = 0.000$).

Supplementary analysis

Our analysis has so far focused on the positive effects of dependence advantage on the focal firm's information transparency and the firm's view of the two dimensions of SC performance. However, when AIT is present in an IOS, it can contribute to the disadvantage of both SC participants. The relative withholding of information by a powerful party may reduce the overall effectiveness of an SC. For example, the "bullwhip" effect is a core problem in SC management because it distorts the demand information transmitted upstream in the SC (e.g., Lee *et al*, 1997). This supposedly happens when a supplier's demand forecast is based on the order history of its immediate downstream partner (manufacturer) without any knowledge of the sales information with respect to the ultimate customers (Kim *et al*, 2012). A remedy for coping with the bullwhip effect is to share the ultimate sales information with the upstream SC partners through IOS. When the relevant information does not flow to the upstream partners because of AIT in an IOS, the SC performance may suffer from inefficiencies such as higher overall SC inventories.

In order to check the potentially negative impact of AIT in an IOS, we conducted a two-step analysis to examine the following issues: (1) whether dependence asymmetry leads to AIT in an IOS and (2) whether AIT in an IOS decreases SC performance. First, to examine the

Table 4 Results of construct measurement and validity assessment

Constructs	*Number of items*	*Mean (SD)*	*Average variance extracted*	*Composite reliability*
Manufacturer's dependence advantage	3	0.87 (0.93)	0.65	0.85
Supplier's dependence advantage	3	0.74 (1.02)	0.74	0.90
Joint dependence	3	4.25 (1.05)	0.82	0.93
Information transparency for manufacturer	5	3.61 (1.63)	0.79	0.95
Information transparency for supplier	5	3.70 (1.72)	0.79	0.95
SC information transparency	5	7.31 (2.43)	0.81	0.96
Manufacturer's view of relationship quality	2	4.36 (0.98)	0.79	0.88
Supplier's view of relationship quality	2	4.63 (1.08)	0.77	0.87
Manufacturer's relationship-specific performance	3	4.65 (1.16)	0.88	0.96
Supplier's relationship-specific performance	3	4.19 (1.31)	0.84	0.94
Joint profit performance	3	4.42 (0.81)	0.85	0.94
Interorganizational trust	5	5.03 (0.82)	0.80	0.95
IOS integration	3	3.49 (1.14)	0.87	0.95
Joint governance structure	8	3.61 (0.78)	0.63	0.93

Table 5 Correlation matrix and average variance extracted

	MDA	*SDA*	*JDE*	*ITM*	*ITS*	*SIT*	*RQM*	*RQS*	*RPM*	*RPS*	*JPP*	*ITR*	*IOS*	*JGS*
MDA	**0.81**[a]													
SDA	−0.54	**0.86**												
JDE	−0.11	0.00	**0.91**											
ITM	0.38	−0.28	−0.41	**0.89**										
ITS	−0.32	0.44	0.47	−0.52	**0.89**									
SIT	0.03	−0.11	0.33	0.04	0.13	**0.90**								
RQM	−0.09	0.06	−0.03	−0.08	0.06	0.00	**0.89**							
RQS	−0.09	0.08	0.13	−0.19	0.27	0.16	0.07	**0.88**						
RPM	0.20	0.03	−0.02	0.23	−0.15	0.32	−0.05	0.09	**0.94**					
RPS	−0.38	0.40	0.51	−0.69	0.66	0.15	0.03	0.29	−0.15	**0.92**				
JPP	−0.17	0.34	0.40	−0.39	0.43	0.36	−0.01	0.30	0.60	0.70	**0.92**			
ITR	−0.22	0.17	0.42	−0.45	0.37	0.29	0.11	0.16	0.12	0.45	0.45	**0.89**		
IOS	−0.11	0.04	0.40	−0.20	0.33	0.38	0.04	0.17	0.22	0.29	0.40	0.24	**0.93**	
JGS	−0.03	0.17	0.31	−0.05	0.31	0.48	−0.15	0.09	0.36	0.31	0.51	0.30	0.24	**0.79**

MDA manufacturer's dependence advantage, *SDA* supplier's dependence advantage, *JDE* joint dependence, *ITM* information transparency for manufacturer, *ITS* information transparency for supplier, *SIT* SC information transparency, *RQM* manufacturer's view of relationship quality, *RQS* supplier's view of relationship quality, *RPM* manufacturer's relationship-specific performance, *RPS* supplier's relationship-specific performance, *JPP* joint profit performance, *ITR* interorganizational trust, *IOS* IOS integration, *JGS* joint governance structure.

[a]Figures along diagonal in bold are values of the squared root of the AVE.

relationship between dependence asymmetry and AIT in an IOS, the latter was calculated by subtracting the partner's information transparency from that of the focal firm, following the methodology in the existing literature (Ryu & Eyuboglu, 2007; Zhou *et al*, 2007). For example, for the buyer-advantage (supplier-advantage) AIT in an IOS, we subtracted the supplier's (buyer's) information transparency from that of the buyer (supplier). Then, the buyer-advantage (supplier-advantage) AIT in an IOS was regressed on the buyer's (supplier's) dependence advantage.

The results show that the buyer's dependence advantage significantly influenced the buyer-advantage AIT ($b = 0.398$, $t = 4.531$, $p = 0.000$) and the supplier's dependence advantage also significantly influenced the supplier-advantage AIT ($b = 0.413$, $t = 4.740$, $p = 0.000$). These results imply that AIT in an IOS is prevalent when there is dependence asymmetry between SC partners, i.e., a powerful firm in a dyad attempts to benefit from information sharing from its partner without sharing its own information.

Second, to examine the relationship between AIT in an IOS and joint profit performance, we conducted a subgroup analysis by splitting the sample at the median values of the supplier's and buyer's information transparency, which resulted in four different types of buyer–supplier pairs (Table 7). In this analysis, we focused on cells 2 and 3, where AIT is present in an IOS. For cells 1 and 4, where information transparency is relatively balanced at high and low levels (no AIT), respectively, the SC performance impact of the overall SC information transparency was tested in H5. We found that high (low) overall SC transparency is associated with high (low) joint profit performance. Then, for the sample subjects in

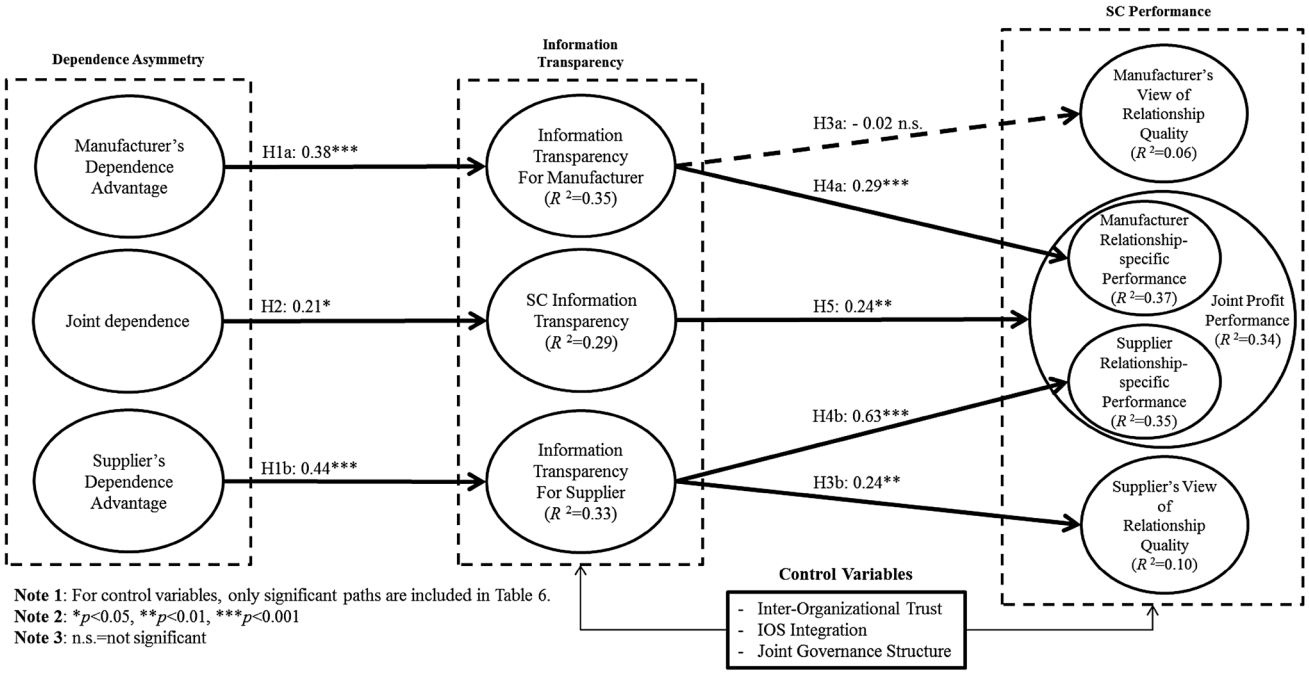

Figure 2 Results of partial least squares.

Table 6 Results of PLS analysis

	Hypothesis	*Path coefficient*	*t value*	*p value*	*Outcome*
Direct effects					
H1a	Manufacturer's dependence advantage → information transparency for manufacturer	0.38	4.47***	0.000	Supported
H1b	Supplier's dependence advantage → information transparency for supplier	0.44	4.59***	0.000	Supported
H2	Joint dependence → sc information transparency	0.21	2.33*	0.011	Supported
H3a	Information transparency for manufacturer → manufacturer's view of relationship quality	−0.02	0.19	0.423	Rejected
H3b	Information transparency for supplier → supplier's view of relationship quality	0.24	2.43**	0.008	Supported
H4a	Information transparency for manufacturer → manufacturer's relationship-specific performance	0.29	3.34***	0.001	Supported
H4b	Information transparency for supplier → supplier's relationship-specific performance	0.63	11.35***	0.000	Supported
H5	SC information transparency → joint profit performance	0.24	2.63**	0.005	Supported

Paths		*Path coefficient*	*t value*	*p value*	*Outcome*
From	*To*				
Control Paths					
Interorganizational Trust	Information Transparency for Supplier	0.32	4.34***	0.000	Significant
	Manufacturer's View of Relationship Quality	0.18	2.00*	0.024	Significant
IOS Integration	SC Information Transparency	0.47	5.69***	0.000	Significant
Joint Governance Structure	Information Transparency for Supplier	0.16	2.05*	0.021	Significant
	Manufacturer's Relationship-Specific Performance	0.53	6.30***	0.000	Significant
	Joint Profit Performance	0.53	4.98***	0.000	Significant

Note 1: $df = 110$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ in one-tailed tests.

Note 2: Only significant control paths are shown.

cells 2 and 3, joint profit performance was regressed on the AIT in an IOS. The results show that AIT in an IOS significantly decreases joint profit performance ($b = -0.590$, $t = -5.062$, $p = 0.000$), i.e., the greater the difference in information transparency in an IOS, the lower the level of joint profit performance.

Table 7 Results of subgroup analysis

		Supplier's information transparency	
		Low (≤3.4)	*High (>3.4)*
Buyer's information transparency	High (>4.0)	Cell 2 23[a]	Cell 1 33
	Low (≥4.0)	Cell 4 28	Cell 3 27

[a]Numbers represent the number of pairs in that category.

Discussion and conclusions

Theoretical implications and contributions

This study has attempted to make important contributions to the existing literature on information sharing in SC relationships. The first aim of this paper was to investigate the impact of dependence asymmetry on information transparency in an IOS. Results show that dependence advantage is a significant predictor of information transparency in an IOS. More importantly, this study challenges the untested assumption that an IOS facilitates active information sharing. With regard to information-sharing behavior of SC participants, Gulati & Sytch (2007) assert that they behave differently depending on the level of joint dependence. To predicate this argument, a split-sample test around the mean value of joint dependence was performed to compare the impact of dependence asymmetry on information transparency in an IOS between these two groups. The results show that in the high joint-dependence group ($N = 48$), neither of the dependence asymmetry variables (buyer dependence advantage or supplier dependence advantage) was a significant predictor of AIT in the IOS. However, in the low joint-dependence group ($N = 63$), both the buyer dependence advantage ($t = 3.04$, $p = 0.002$) and the supplier dependence advantage ($t = -2.73$, $p = 0.004$) were significant. The results suggest that under a high level of joint dependence, the logic of embeddedness, rather than the logic of power, underlies the information-sharing behavior of SC partners. In other words, a high level of joint dependence may bring unique advantages to dyadic relationships in the form of symmetrical information transparency (Rusbult *et al*, 1991). However, under a low level of joint dependence, the logic of power significantly influences SC relationships, thus increasing AIT for the party with relative power. This result supports our argument that necessary information does not flow through an IOS because in some situations, SC participants are unwilling to make their internal information visible and accessible to their SC partners. Thus, the argument in the existing literature that an IOS decreases information asymmetry naturally between SC partners must be modified by incorporating dyadic perspectives.

The second aim of this paper was to investigate the impact of interorganizational information transparency in an IOS on SC performance from both partners' perspectives. This research has extended the analysis of interorganizational information sharing from a firm perspective to a dyadic perspective to find meaningful results. Considering that AIT in an IOS is prevalent in SC relationships, SC performance can be suboptimal owing to the lack of bidirectional information flows (Ryu & Eyuboglu, 2007). An IOS decreases information asymmetry for both partners when symmetric information transparency is ensured. Indeed, bidirectional information sharing is a key component in advanced SC management programs, such as collaborative planning, forecasting, and replenishment, which allows continuous updating of inventory and upcoming requirements among SC participants. When this requirement for bidirectional information flow is satisfied, the SC-wide performance can be increased (Lee & Whang, 2000). In support of this argument, our results show that overall SC information transparency is positively associated with joint profit performance and that information transparency for each SC partner is positively associated with its view of the relationship-specific performance. However, it turns out that AIT in an IOS significantly decreases joint profit performance.

Contrary to our expectations, the results for relationship quality did not fully support our hypotheses. Information transparency for the supplier significantly increases the supplier's view of the relationship quality ($t = 2.43$, $p = 0.008$), whereas information transparency for the manufacturer does not increase the manufacturer's view of the relationship quality ($t = 0.19$, $p = 0.423$). A plausible explanation for this nonsignificant result can be provided with reference to the power imbalance between the manufacturer and its supplier in heavy manufacturing industries, in which the upstream SC is structured in multiple tiers around an OEM. In this structure, the manufacturer enjoys more power because it is typically larger and controls more critical resources (e.g., market information, order allocation, and collaborative relationship with OEMs) than the supplier. Such an environment puts the manufacturer in a better position to exploit the resource endowments of the supplier (Hitt *et al*, 2002). Thus, the manufacturer can use its superior

bargaining power to direct the supplier as it wishes (e.g., ensuring information transparency), and a close working relationship with the supplier may not matter.

Practical implications

This study offers some implications for practitioners. First, the results show that SC partners exhibit different information-sharing behaviors depending on the level of joint dependence. Furthermore, information transparency via an IOS positively influences SC performance. One tactic that SC partners can use to maximize the effects of information transparency in an IOS on SC performance would be to increase the level of joint dependence. As interdependence between a manufacturer and its supplier increases, SC partners are more likely to be committed and are less likely to behave opportunistically (Gulati & Sytch, 2007; Kumar *et al*, 1995). High levels of interdependence also signify that each party requires a lot of information from the other party to fulfill its own tasks in order to avoid any disruptions in upstream and downstream activities. By forming reciprocal, interdependent relationships, SC participants would benefit from bidirectional information sharing.

Second, an IOS should be used as a channel for bidirectional information exchange to achieve optimal SC performance. However, considering the focal firm's legitimate concerns regarding the partner's opportunism, there should be appropriate mechanisms that protect the focal firm's interests from the misuse of its private information by the partner. Opportunistic behavior by either party may jeopardize a difficult-to-replace relationship, which often outweighs possible short-term gains from opportunism (Kim *et al*, 2012). Our results show that a joint governance structure, interorganizational trust, and IOS integration are important promoting factors for bidirectional information transparency. When both partners have appropriate visibility and accessibility to each other's information required for SC cooperation, a partner's opportunism can be restrained. Thus, SC partners should use these formal and informal safeguards effectively.

Limitations and future research

Here, we discuss the limitations of our study. The first limitation of this research is related to the characteristics of our sample, which was a convenience sample. To accomplish successful data collection from a sufficient number of companies to test our research model, we selected companies (manufacturers) from a major database of South Korean companies on the basis of the likelihood of cooperation. Furthermore, manufacturers were asked to select a supplier of an important part depending on the importance of the relationship. This process might lead to a potential bias with regard to supplier selection because the same part can be supplied by multiple suppliers. Although this is not a random sample, gathering first-hand data from 270 companies required significant effort. Nevertheless, the results of this study should be interpreted with some caution.

The second limitation is related to the scale of measurement of relationship quality. With regard to the buyer sample, the empirical results show that two non-reversed items had very low loadings on its construct and that the loadings of reversed indicators exceeded the recommended threshold value of 0.70. However, with regard to the supplier sample, all measurement items were loaded on its own construct. Because this study adopted interfirm dyads as the unit of analysis, we dropped two non-reversed items of relationship quality from both samples. Thus, future studies should engage in further construct development and validation of the scale.

As an extension of this research, future research could investigate strategies to deal with AIT in an IOS. The existing literature has identified signals and incentives to be used as strategies to cope with the agency problems of information asymmetry. Generally, signals that reveal parties' private information may resolve adverse selection problems (Mishra *et al*, 1998). Moral hazard problems can be managed by incentives that align the agent's interests with those of the principal. However, these strategies are proposed for principals who are in disadvantaged positions. This paper asserts that an IOS can change the nature of information asymmetry from a supplier-advantage information structure to a manufacturer-advantage information structure. In that case, it is the supplier, rather than the manufacturer, who is in a disadvantaged position and must take action because of the IOS. Strategies for a dependent supplier to cope with information asymmetry problems may differ from those for a powerful principal. For example, SC participants may devise SC performance evaluation systems that tie the principal's interests to those of the agent. With the goal of relieving car dealers of the burden of managing service parts inventories, Saturn (a subsidiary of General Motors) holds its managers jointly accountable for the quality of service that the vehicle owners experience (Narayanan & Raman, 2004). In the future, it would be beneficial to examine SC partners' strategies for dealing with information asymmetry problems associated with an information structure with the manufacturer in a position of advantage.

Another area of investigation would be to expand the scope of the information shared between SC partners. Our measurement of information transparency via an IOS focuses mainly on the transparency of internal information that is directly related to daily operations (e.g., inventory status and available production capacity), and which resides within a traditional IOS. However, SC partners exchange information/knowledge for various purposes beyond that included in the daily operations we considered. Future research could be devoted to price transparency which may not reside in traditional IOS (Soh *et al*, 2006; De Corbière & Rowe, 2013). Currently, with the growth of the "Internet of Things," SC partners can use different types of information, including unstructured information (e.g., image, voice, natural language

sentences, etc.) and continuous flows of contextual information from an external environment (e.g., weather, traffic, social media, etc.). These new types of information can be strategic in nature; thus, SC partners may approach the sharing of information from different perspectives depending on their own positions in the SC. Future research could examine how each firm negotiates with its partner regarding the sharing of new contextual information, which has certain impacts on SC performance.

Finally, SC partners can be considered to be a type of meta-organization, a concept proposed by Gulati *et al* (2012), which refers to "networks of firms not bound by authority based on employment relationships but characterized by a system-level goal" (p. 573). Using the two dimensions of membership boundaries and stratification, they proposed a taxonomy comprising four types of meta-organizations, including a closed community, an open community, an extended enterprise, and a managed ecosystem. Upstream SC partners in heavy manufacturing industries, i.e., the research sample for this study, can be considered to be an extended enterprise in which, to enhance its own capacities, a firm contracts with upstream partners that possess complementary assets (Aron & Singh, 2005). As a meta-organization operates in turbulent environments, the lead firm in a managed ecosystem may change the nature of linkages among member firms that shapes information sharing and interorganizational learning. For example, Toyota, which is famous for encouraging its suppliers to exchange subassemblies and production plans, also stimulates its SC partners to share their knowledge of process improvements and system optimization (Dyer & Nobeoka, 2000). Thereby, under the lead firm's influence, information-sharing patterns and the distribution of power among member firms may change. Future research could investigate how changes in the choice of mechanisms for integrating member efforts in a meta-organization influence information asymmetry in upstream SC partners.

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Appendix A

Constructs and measures [seven-point (1–7) Likert scales]

* Item dropped due to poor loadings in a confirmatory factor analysis with PLS-SEM.

(R) Reverse coded item.

Dependence (Morgan *et al*, 2007)

The extent to which you agree or disagree with the following statements as it applies to your firm for this category:

1. This partner firm would be very difficult to replace.
2. We are dependent on this partner firm.
3. Losing this partner firm would be costly for us.

Information transparency in IOS (Saeed *et al*, 2005)

- Supplier's information transparency for the manufacturer: the extent to which the supplier's internal information in the following areas is visible and accessible to the manufacturer through the IOS:

  1. Order completion status
  2. Backorder status
  3. Production schedules
  4. Current production capacity
  5. Demand planning information

- Manufacturer's information transparency for the supplier: the extent to which the manufacturer's internal information in the following areas is visible and accessible to the supplier through the IOS:

  1. Inventory status
  2. Sales order status
  3. Production schedules
  4. Current production capacity
  5. Demand forecast information

Relationship quality (Kumar *et al*, 1992)

1. Our association with this partner has been a successful one. *
2. The partner leaves a lot to be desired from an overall performance standpoint. (R)
3. If we had to give the partner a performance appraisal, it would be outstanding. *
4. Overall, the results of our relationship with the partner have fallen short of expectations. (R)

Relationship-specific performance (Jap and Anderson 2003)
The degree to which financial outcomes result from the interdependence of effort and investments that reside within the dyad:

1. A high level of joint profits between them
2. A considerable amount of profits together
3. An increase in the joint profits shared between them

Interorganizational trust (Poppo *et al*, 2008)

1. The relationship with this partner firm can be characterized as mutually trusting.
2. This partner firm keeps the promises it makes to your company.
3. Your firm is sure that what this partner firm says is true.
4. This partner firm fulfills its commitments exactly as specified.
5. When making important decisions, this partner firm is concerned about your company's welfare.

IOS integration (Grover & Saeed, 2007)
The extent to which the systems shared by two or more firms are integrated to facilitate access to information residing in either firm in the following three dimensions:

1. Databases
2. Applications
3. File formats

Joint governance structure (Luo, 2008)

1. Both parties always work together on establishing and implementing new policies, rules, and procedures that govern alliance operations.
2. Both parties always work together formulating and executing budget control and investment control.
3. Both parties always work together building and exercising various information control systems (in accounting, sales, production, inventory, etc.).
4. Both parties are always dedicated to establishing a new corporate culture suitable for alliance growth, relinquishing its own corporate culture if necessary.
5. Both parties always work together setting forth alliance goals and objectives and annual plans, and monitoring and appraising middle level manager performance using some of these measures.
6. Whenever the alliance contract needs alternation or renewal, both parties always work together on all related terms and clauses and jointly monitor contract enforcement thereafter.
7. Contract terms on interparty cooperation, sharing, and exchange are clearly defined and well executed by both parties.
8. Contract terms on directing, monitoring, and governing the alliance's major activities are clearly defined and well executed by both parties.

Appendix B

Results of measurement models for the manufacturer and supplier samples.

Table B1 Confirmatory factor analysis results for the manufacturer sample

	DPM	*ITM*	*RQM*	*RPM*	*TRM*	*IIM*	*JGM*
DPM1	0.80	0.06	−0.13	−0.06	0.03	0.05	0.08
DPM2	0.88	0.17	−0.08	0.04	0.04	0.13	0.07
DPM3	0.92	0.19	0.02	0.10	0.16	0.07	0.15
ITM1	0.22	0.91	0.02	0.38	0.12	0.51	0.45
ITM2	0.22	0.89	0.04	0.35	0.05	0.58	0.47
ITM3	0.14	0.93	−0.07	0.36	0.10	0.56	0.40
ITM4	0.18	0.93	−0.01	0.30	0.15	0.58	0.41
ITM5	0.07	0.88	0.01	0.38	0.18	0.58	0.37
RQM1	−0.06	−0.11	0.67	−0.17	0.02	0.03	−0.07
RQM2	−0.04	0.02	0.99	0.11	0.22	0.11	0.15
RPM1	0.05	0.33	0.10	0.93	0.28	0.28	0.47
RPM2	0.07	0.34	0.07	0.95	0.34	0.26	0.53
RPM3	0.05	0.42	0.04	0.93	0.25	0.26	0.61
TRM1	0.14	0.05	0.21	0.28	0.78	0.13	0.15
TRM2	0.06	0.12	0.17	0.30	0.90	0.10	0.25
TRM3	0.04	0.10	0.17	0.22	0.85	0.11	0.16
TRM4	0.11	0.18	0.14	0.28	0.87	0.13	0.19
TRM5	0.07	0.07	0.14	0.15	0.67	0.04	0.08
IIM1	0.08	0.57	0.15	0.24	0.14	0.93	0.24
IIM2	0.08	0.53	0.07	0.26	0.11	0.92	0.28
IIM3	0.12	0.60	0.04	0.28	0.11	0.90	0.27
JGM1	0.16	0.39	0.07	0.39	0.19	0.13	0.81

Table B1 ***(Continued)***

	DPM	*ITM*	*RQM*	*RPM*	*TRM*	*IIM*	*JGM*
JGM2	0.16	0.33	−0.11	0.36	0.10	0.14	0.76
JGM3	0.05	0.44	−0.02	0.41	0.05	0.26	0.82
JGM4	0.08	0.30	0.06	0.37	0.02	0.10	0.77
JGM5	0.07	0.46	0.10	0.42	0.12	0.33	0.85
JGM6	0.15	0.35	0.24	0.55	0.24	0.35	0.84
JGM7	0.08	0.41	0.12	0.55	0.24	0.28	0.84
JGM8	0.05	0.35	0.17	0.57	0.32	0.18	0.80

DPM dependence on the supplier, *ITM* information transparency for the manufacturer, *RQM* relationship quality, *RPM* relationship-specific performance, *TRM* interorganizational trust, *IIM* IOS integration, *JGM* joint governance structure.

Table B2 Confirmatory factor analysis results for the supplier sample

	DPS	*ITS*	*RQS*	*RPS*	*TRS*	*IIS*	*JGS*
DPS1	0.88	0.55	0.21	0.64	0.44	0.35	0.47
DPS2	0.90	0.47	0.05	0.56	0.38	0.28	0.48
DPS3	0.91	0.55	0.17	0.58	0.48	0.38	0.48
ITS1	0.52	0.86	0.30	0.51	0.50	0.42	0.52
ITS2	0.50	0.86	0.16	0.61	0.49	0.43	0.55
ITS3	0.53	0.94	0.27	0.59	0.50	0.51	0.57
ITS4	0.57	0.94	0.29	0.60	0.50	0.54	0.60
ITS5	0.54	0.90	0.28	0.47	0.52	0.47	0.52
RQS1	0.20	0.31	0.92	0.29	0.20	0.30	0.14
RQS2	0.07	0.18	0.84	0.21	0.15	0.27	0.09
RPS1	0.62	0.55	0.26	0.92	0.54	0.43	0.54
RPS2	0.63	0.57	0.28	0.92	0.52	0.34	0.52
RPS3	0.58	0.58	0.26	0.92	0.49	0.34	0.52
TRS1	0.43	0.50	0.20	0.55	0.90	0.35	0.43
TRS2	0.46	0.53	0.16	0.52	0.93	0.33	0.46
TRS3	0.42	0.53	0.16	0.50	0.94	0.30	0.46
TRS4	0.49	0.52	0.24	0.53	0.93	0.33	0.45
TRS5	0.45	0.47	0.18	0.50	0.91	0.29	0.40
IIS1	0.34	0.50	0.33	0.38	0.32	0.95	0.30
IIS2	0.40	0.56	0.26	0.43	0.36	0.96	0.41
IIS3	0.33	0.43	0.34	0.34	0.29	0.91	0.32
JGS1	0.22	0.39	0.11	0.26	0.34	0.32	0.65
JGS2	0.44	0.51	0.07	0.48	0.37	0.34	0.85
JGS3	0.51	0.57	0.11	0.54	0.39	0.36	0.88
JGS4	0.50	0.56	0.15	0.49	0.45	0.27	0.86
JGS5	0.49	0.58	0.10	0.52	0.44	0.39	0.91
JGS6	0.48	0.47	0.13	0.47	0.31	0.26	0.85
JGS7	0.48	0.53	0.09	0.56	0.50	0.29	0.88
JGS8	0.44	0.54	0.14	0.51	0.43	0.24	0.87

DPS dependence on the manufacturer, *ITS* information transparency for the supplier, *RQS* relationship quality, *RPS* relationship-specific performance, *TRS* interorganizational trust, *IIS* IOS integration, *JGS* joint governance structure.

Table B3 Construct-level correlation matrix for the manufacturer and supplier samples

					Supplier sample constructs						
					1	*2*	*3*	*4*	*5*	*6*	*7*
				C.R.[b]	0.92	0.96	0.87	0.94	0.97	0.96	0.95
				AVE	0.80	0.81	0.77	0.84	0.85	0.89	0.72
Manufacturer sample constructs				Mean	4.19	3.70	4.63	4.19	4.94	3.56	4.18
	C.R.[b]	AVE	Mean	SD	1.39	1.72	1.08	1.31	1.33	1.71	1.34
1 Dependence	0.90	0.75	4.31	1.31	**0.87[a] (0.89)**	0.59	0.16	0.66	0.49	0.38	0.53
2 Information Transparency in IOS	0.96	0.82	3.91	1.63	0.18	**0.91 (0.90)**	0.29	0.62	0.56	0.53	0.62
3 Relationship Quality	0.83	0.72	4.36	0.98	−0.05	0.00	**0.85 (0.88)**	0.29	0.20	0.33	0.13
4 Relationship-Specific Performance	0.96	0.88	4.65	1.16	0.06	0.39	0.07	**0.94 (0.92)**	0.56	0.41	0.57
5 Interorganizational Trust	0.91	0.67	5.13	0.88	0.10	0.13	0.20	0.31	**0.82 (0.92)**	0.35	0.48
6 IOS Integration	0.94	0.84	3.41	1.67	0.10	0.62	0.10	0.28	0.13	**0.92 (0.94)**	0.36
7 Joint Governance Structure	0.94	0.66	4.15	1.20	0.12	0.47	0.12	0.57	0.21	0.29	**0.81 (0.85)**

[a]Bold diagonal values are the squared root of the AVE for the manufacturer sample (figures in parenthesis are those for the supplier sample).

[b]C.R. means composite reliability and AVE means average variance extracted.