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RESEARCH ARTICLE

HOW DO SUPPLIERS BENEFIT FROM INFORMATION TECHNOLOGY USE IN SUPPLY CHAIN RELATIONSHIPS?[1]

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Abstract

Supply chain management systems (SCMS) championed by network leaders in their supplier networks are now ubiquitous. While prior studies have examined the benefits to network leaders from these systems, little attention has been paid to the benefits to supplier firms. This study draws from organizational theories of learning and action and transaction cost theory to propose a model relating suppliers' use of SCMS to benefits. It proposes that two patterns of SCMS use by suppliers—exploitation and exploration—create contexts for suppliers to make relationship-specific investments in business processes and domain knowledge. These, in turn, enable suppliers to both create value and retain a portion of the value created by the use of these systems in interfirm relationships.

Data from 131 suppliers using an SCMS implemented by one large retailer support hypotheses that relationship-specific intangible investments play a mediating role linking SCMS use to benefits. Evidence that patterns of information technology use are significant determinants of relationship-specific investments in business processes and domain expertise provides a finer-grained explanation of the logic of IT-enabled electronic integration. The results support the vendors-to-partners *thesis that IT deployments in supply chains lead to closer buyer-supplier relationships (Bakos and Brynjyolfsson 1993). The results also suggest the complementarity of the transaction-cost and resource-based views, elaborating the logic by which* specialized assets *can also be* strategic assets.

Keywords: Buyer-supplier relationships, inter-organizational systems (IOS), EDI, supply chain management systems (SCMS), transaction cost economics, intangible asset specificity, IT use, exploration, exploitation

[1]Ron Weber was the accepting senior editor for this paper.

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Introduction

Early forms of interorganizational systems (IOS) primarily supported the automation of manual processes such as ordering and settling accounts. A range of new features for information sharing, communication, and collaboration has subsequently enhanced these systems (Icasati-Johanson and Fleck 2003). Estimates suggest that over 30,000 IOS are currently in use, supporting a large proportion of business-to-business transactions (Harris 2001).

In recent years, network leaders such as Chrysler, Dell, Ford, and Wal-Mart have made significant efforts to derive the benefits of coordination and collaboration with their suppliers by using a particular form of IOS: supply chain management systems (SCMS[2]). A greater understanding of the benefits that these systems provide to supplier firms is therefore an issue of interest to both researchers and practitioners. Nonetheless, despite their significance, research on SCMS has been scant and fragmented. Prior work has focused largely on the benefits derived from SCMS by network leaders. Little attention has been paid to the benefits derived from SCMS by suppliers and mechanisms that enable suppliers to realize benefits.

Supplier networks are characterized by a large number of supplier firms working with a dominant network leader. Relationships between suppliers and network leaders are largely asymmetric. Network leaders play a central role in orchestrating suppliers. They often champion the introduction of SCMS in their supplier networks. Benefits from these information technologies are distributed unevenly and skewed in favor of the network leader (Riggins and Mukhopadhyay 1994). Although supplier participation is necessary for network leaders to derive benefits, supplier firms appear unlikely to benefit from networks. Instead, network leaders seem to benefit at the expense of supplier firms (Carter 1990; Clemons and Row 1993), often by shifting activities and costs to them. For instance, the move to vendor-managed inventories shifts tasks related to monitoring and managing retail inventories to suppliers, creating benefits for network leaders while adding to the tasks performed by suppliers. Similarly, quick-response programs create benefits for auto manufacturers and retailers while burdening suppliers with making more frequent deliveries and incurring higher inventory holding costs (Mukhopadhyay et al. 1995). Network leaders can also use their superior bargaining power to appropriate supplier benefits from streamlining interfirm processes. For instance, they may specify annual cost reduction targets in supply contracts (Ghosh and John 1999). SCMS can thus be an unfortunate strategic necessity for suppliers (Barua and Lee 1997).

The few studies that have examined supplier benefits from interorganizational systems (e.g., Lee et al. 1999; Mukhopadhyay and Kekre 2002) focus on systems developed by large supplier firms. We know little of benefits in the more prevalent instance of suppliers adopting SCMS championed by a dominant network leader. This situation is troubling because the rollout of SCMS by network leaders has gained momentum in a wide range of industries. The question confronting suppliers is often not *whether* they should use SCMS but *how* they can take advantage of these systems and benefit from their use.

This paper draws on organizational theories and transaction cost economics to examine supplier benefits from SCMS use. This work contributes to the literature in three ways. First, it focuses on the supplier perspective in IT-mediated supplier-retailer interactions and highlights the benefits to suppliers from IT use. Second, it theorizes two patterns of use of supply chain technologies—for exploitation and for exploration—and highlights the implications of these appropriation choices for relationship-specific supplier investments and supplier benefits. Third, it theorizes the role of relationship-specific intangible investments in enabling suppliers to both generate value and obtain benefits from SCMS use. Theory building

[2]In this paper, SCMS are viewed as instances of information technologies employed in interorganizational contexts to mediate buyer-supplier transactions.

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and theory testing in this paper are grounded in the context of supplier-retailer relationships in a retail distribution channel. Specific features of the context, such as asymmetric relationships of suppliers with the network leader and characteristics of supplier-retailer interactions, are used to articulate the relationships between SCMS use, specialized investments, and benefits.

Theoretical Background

Figure 1 presents the model examined in this research. For suppliers in an SCMS, it shows relationships that are hypothesized to exist among patterns of IT use, relationship-specific investments, and benefits.

Patterns of SCMS Use

Prior examinations of IOS reveal multiple goals motivating their use: providing management support, reducing operational costs, improving customer service, and gaining competitive advantages (El Sawy et al. 1999; Premkumar et al. 1997). However, prior conceptualizations fail to articulate patterns of IOS use that help explain diverse outcomes. Prior research has highlighted volume, diversity, breadth, depth, scope, and intensity as dimensions of IOS use (Bensaou and Venkatraman 1995; Massetti and Zmud 1996). Such descriptive features are of limited value in relating system use to variations in outcomes because the use of IOS in different contexts—even if similar in breadth, depth, or intensity—clearly can be motivated by different goals. A conceptualization of IOS use that reflects intentionality of use is missing.

In this regard, the concept of *appropriation* proposed by DeSanctis and Poole (1994) provides useful insights. The term appropriation refers to patterns of IT use. Differing appropriations can lead to diverse outcomes, even when the context of use and underlying technologies are similar (DeSanctis and Poole 1994). While this construct has been useful as a means of understanding how group decision support systems (GDSS) are used, it has not been applied in the context of SCMS use. Appropriations of SCMS can reveal intentionality and help relate SCMS use to outcomes.

To this end, the paper draws from a theory of learning and action that suggests actions in organizations can be categorized as either *exploitation* or *exploration* (March 1991). Exploitation is the extension or elaboration of old certainties. It is the class of actions whose goal is to improve operational efficiencies (e.g., through increased standardization, tighter process controls, and reduced manual intervention). In contrast, exploration is the pursuit of new possibilities. It is the class of activities whose goal is to learn about the environment and discover novel ways of creating value or solving old problems. These two classes of action also incorporate differing task orientations. Exploitation involves the application of variance-reducing strategies to streamline activities, perform them efficiently with a high level of consistency, and achieve greater control over process execution. In contrast, exploration involves the application of variance-seeking strategies to reassess current approaches to problems and to develop novel solutions. Exploration reflects risk taking, experimentation, and innovation. Inherently, it involves activities where the immediate payoffs are less certain but which, over multiple periods, can help build a firm's ability to devise superior solutions to problems.

Consistent with this view, *SCMS use for exploitation* and *SCMS use for exploration* are conceptualized as two complementary patterns of appropriation of supply chain technologies. The distinction between exploitation and exploration in the use of supply chain technologies has considerable appeal. It parallels the fundamental differences between *automating* and *informating*, which are two broad motives for using information systems. These patterns of SCMS use are expected to explain variations in benefits to suppliers using identical supply chain technologies. Table 1 lists activities comprising SCMS use for exploitation and for exploration.

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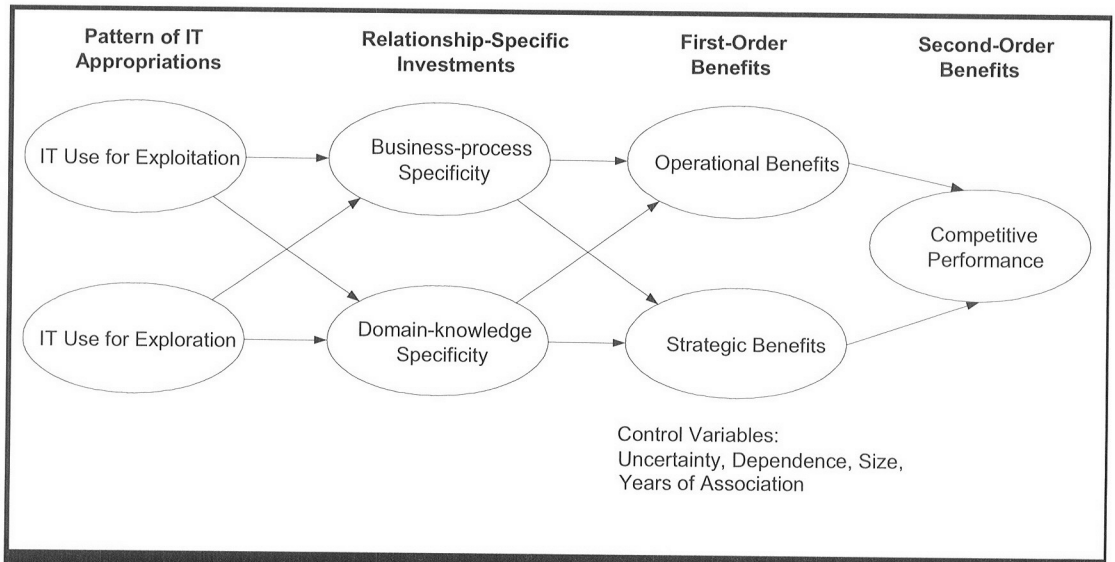

Figure 1. IT Use, Relationship-Specific Investments, and Supplier Benefits

Relationship-Specific Intangible Assets

Transaction cost economics suggests that relationship-specific investments are important sources of value creation in interfirm exchanges (Williamson 1995). Such supplier investments include customized business processes catering to the requirements of a particular buyer and the development of expertise unique to an exchange (such as a detailed understanding of an automaker's engineering practices). Within the context of an exchange, specialized, relationship-specific assets create more value than non-specialized, generic assets.[3] They are an important source of interorganizational competitive advantage (Dyer and Singh 1998). Subramani and Venkatraman (2003) highlight that enhanced value creation enabled by intangible relationship-specific investments confers supplier firms with advantages over competitors operating without such assets.[4] They represent a powerful means for suppliers to create value and to position themselves strategically to claim an equitable proportion of the value created. The use of relationship-specific investments by suppliers can create exit barriers for the retailer. They enhance the bargaining power of suppliers, thus becoming part of the *strategizing calculus* in relationships (Ghosh and John 1999).

The focus in this paper is on supplier investments that create two types of intangible asset specificity: *business-process specificity* and *domain-knowledge specificity*. Business-process specificity arises from the development of relationship-specific routines or standard operating procedures for efficient task execution. Domain-knowledge specificity arises

[3]Relationship-specific assets are commonly viewed as assets that are of lesser value when redeployed in alternative exchanges. An alternative perspective emphasizing their constructive role is that specialized assets deliver greater value than non-specialized, generic assets in the context of a particular relationship (Ghosh and John 1999).

[4]The paper focuses on the role of intangible assets that are characterized by greater causal ambiguity than physical assets and are thus less amenable to imitation by competing suppliers. The arguments indicate that intangible, relationship-specific investments by suppliers can create *lock-in* effects, even without reciprocal asset commitments by retailers.

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Table 1. Patterns of IT Use by Suppliers

IT Use for Exploitation: Execution of Structured Interfirm Processes	IT Use for Exploration: Execution of Unstructured Interfirm Processes
Goals: Improving, applying, and incrementally refining firm capabilities. **Outcomes**: Clearly definable benefits (e.g., cost reduction, process consistency, process efficiency).	**Goals:** Creating new capabilities, devising novel solutions to current problems. **Outcomes**: Soft benefits that are difficult to evaluate in advance (e.g., shared understanding, clearer picture of cause-effect relationships, greater understanding of operating environment).
Examples of IT Use for Exploitation	**Examples of IT Use for Exploration**
Request for Quotation (RFQ) received electronically by suppliers. Support documents such as detailed part drawings and quality specifications accessed online.	Analysis of *point-of-sale* data to understand patterns in customer preferences, patterns in the sale of complementary products. Analysis of product-return data to detect issues to be addressed at retail store level (e.g., problems in handling, displaying products).
Electronic Transmission of Purchase Orders, Electronic Transmission of Advanced Shipment Notification (ASN). Scheduling delivery windows at warehouse loading docks.	Communicating with repair and service personnel of retailer to diagnose problems encountered in the field. Interactions between supplier's engineering group and retailer's service division on diagnosing component failures to inform product redesign, new product design.
Electronic Payment Settlement Advice, issued in predefined intervals after material receipt.	Communicating with retail documentation group to improve service manuals and customer manuals.
Transmission of order status reports (e.g., to alert retailer about unanticipated delays, ability to advance-ship hot items).	Communication between product designers and retail buyers related to new features to be incorporated to improve product's appeal
Electronic notification of changes (e.g., product specifications, changes to packaging and shipping procedures, specification of purchase order quantities).	Interaction between retail planners and supplier's managers to decide stocking levels for different products, size allocations to different stores.
Inventory alerts based on preset triggers to communicate stocking levels of products in warehouses.	*Ad hoc* communications between supplier and retailers' buying and merchandising groups (e.g., to signal competitive activity such as special promotions or to respond to stock-outs from unanticipated product demand).

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from the development of a context-sensitive understanding of cause-effect relationships that facilitate effective action and resolution of ambiguities in task planning and execution.

Business-Process Specificity

Business-process specificity is the *degree to which a supplier's key business processes such as operating processes, administrative processes, and quality-control processes are particular to the requirements of the focal firm*[5] *in the relationship* (Subramani and Venkatraman 2003). Business-process specificity is an important factor linked to performance in interfirm relationships (Dyer 1996b; Mukhopadhyay and Kekre 2002; Zaheer and Venkatraman 1994). The fieldwork conducted for this study provides an example. A mattress supplier made significant changes to manufacturing processes in multiple plants to develop a customized *make-to-order* process that enabled a retailer to discontinue the relatively inefficient practice of maintaining mattress inventories. The supplier assigned one primary manufacturing plant and one backup plant in each region to local clusters of retail stores. Orders placed by customers in the retailer's stores were transmitted to the designated plants. The plants manufactured the mattresses within 12 hours and delivered them directly to customers by the next day. The move to a make-to-order system involved many changes to the supplier's planning, manufacturing, and shipping processes. These intangible investments were useful only in the relationship with the particular retailer.[6] They created exit barriers for the retailer because relationship termination involved foregoing benefits created by them as well as incurring the costs of reestablishing the discontinued warehouse stocking and customer delivery processes. Business-process specificity thus enhances the retailer's dependence on the supplier and increases the supplier's bargaining power in the relationship (Subramani and Venkatraman 2003).

Domain-Knowledge Specificity

Domain-knowledge specificity is the *degree to which a supplier's critical expertise such as competitive analysis and strategy formulation and new-product development are particular to the requirement of the focal firm in the relationship* (Subramani and Venkatraman 2003). Domain-knowledge specificity is reflected in instances of firms relying on suppliers for innovations and for inputs in critical decisions (Dyer and Singh 1998). Interviews with suppliers in the distribution channel revealed several manifestations of domain-knowledge specificity. For example, managers at a supplier of designer women's clothing indicated that their analysis of a retailer's sales helped them better understand regional variations in size and color preferences. This understanding of the retailer's customers enabled them to work with the retailer to create region-level size profiles and even store-level merchandise forecasts for their products. As a result, the retailer reduced the level of markdowns, improved their margins on the product line, and reinforced the high-end image of the supplier's products. Managers at the supplier firm also used their knowledge to plan new design collections customized for different geographic areas such as French-speaking Canada, the Pacific Northwest, and the far North. This example reflects the value-creating potential of *relationship-specific* domain knowledge such as an intimate understanding of the preferences and tastes of customer segments addressed by the retailer.[7] Because these benefits are unavailable to the retailer if they switch to an alternative supplier, domain-knowledge specificity enhances the retailer's reliance on the supplier.

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[5]The network leader, viewed from the perspective of supplier firms, is termed the *focal firm*.

[6]The physical assets—the machinery used to make the mattress—were general purpose and not particular to the retailer. In this paper, the focus is primarily on intangible investments by suppliers that Bakos and Brynjolfsson (1993) highlight as being *non-contractible* and thus contributing to contact incompleteness in IT-mediated supply relationships.

[7]Takeishi (2002) describes similar instances of relationship-specific expertise investments by suppliers in the auto industry.

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Linking SCMS Use to Relationship-Specific Intangible Assets

The following section discusses the patterns of association of SCMS use by suppliers and their relationship-specific intangible asset investments.

Business-Process Specificity and SCMS Use for Exploitation

Greater levels of SCMS use for exploitation (ITExploit)—using the system to perform structured, repetitive tasks—are accompanied by changes to interorganizational business processes. These changes (e.g., to manufacturing, quality control, and shipment processes) are both prompted and facilitated by SCMS use. For instance, making direct-to-store deliveries (rather than warehouse deliveries) involves use of the SCMS to facilitate the complex but structured task of disaggregating the retailer's order into multiple storewise orders and creation of storewise shipment and billing documents. As a result, suppliers have an opportunity to enhance their benefits by making complementary changes to their production and inventory management processes. They can thus more efficiently execute high-variety, low-volume store-level orders. The value of such retailer-specific process reconfigurations often becomes evident to suppliers in the course of SCMS use. These changes occur subsequent to the basic set of process changes involved in adopting and using the SCMS.

Similarly, use of the SCMS in the structured task of tracking retail warehouse inventories creates the opportunity for suppliers to redesign their planning and manufacturing processes to derive efficiency benefits (e.g., by linking material procurement processes to retailer orders or by incorporating information on retailer promotions in their production planning processes). Even though none of these changes are mandated or required to work with the retailer, suppliers choosing to make them derive greater benefits than those operating without specialized processes. These arguments suggest that ITExploit is an enabler of change in a manner that customizes suppliers' process to a specific exchange. Higher levels of SCMS use for exploitation (ITExploit) are therefore likely to be associated with higher levels of business-process specificity:

> *H1: The higher the level of SCMS use for exploitation, the greater the level of business-process specificity in the exchange.*

Domain-Knowledge Specificity and SCMS Use for Exploration

SCMS use for exploration (ITExplore) occurs via the reporting and messaging features of the SCMS. Greater levels of ITExplore reflect increasing reliance on an SCMS for unstructured tasks by suppliers. For instance, ITexplore enables suppliers to understand patterns in customer preferences, develop new perspectives through IT-mediated interactions with retailer personnel, and develop novel approaches to field-service problems. Greater levels of ITExplore are likely to develop and refine a supplier's understanding of the retailer's market and the retailier's customers and their preferences, leading to suppliers developing greater levels of relationship-specific domain knowledge.

Buyer-supplier relationships in the distribution channel and the auto industry comprise ongoing supply relationships between the network leader and a set of supplier firms selected after screening and verification by the network leader. SCMS provide features to allow network leaders to provide suppliers with an array of reports on a regular basis. The level of ITExplore reflects the use of such information by suppliers in unstructured tasks. For instance, suppliers can use retail sales and return reports to infer regional patterns in customer tastes (e.g., style preferences and color preferences of women's swimsuits) as well as product and market characteristics (e.g., sensitivities of products to promotions).

ITExplore thus enhances a supplier firm's domain knowledge in a manner that is particular to the

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relationship. It also reflects use of the messaging and collaboration features in SCMS. By enhancing the level of supplier-retailer interaction beyond that possible in non-IT-mediated settings, it helps supplier firms become sensitive to idiosyncratic features of the retailer's requirements. For instance, in the auto industry, supplier firms use SCMS features such as e-mail and discussion forums to understand details of the automaker's requirements not completely conveyed in formal documentation (Takeishi 2002). In the distribution channel, engineers in a supplier firm can use the SCMS to interact with a retailer's field service group providing after-sales services. These interactions help them learn how customers use their products and how the service group handles field failures. These arguments suggest that ITExplore influences the development of a supplier's domain knowledge and makes it more attuned to the nuances of a particular exchange. Higher levels of SCMS use for exploration (ITExplore) are therefore likely to be associated with higher levels of domain-knowledge specificity:

> *H2: The higher the level of SCMS use for exploration, the greater the level of domain-knowledge specificity in the exchange.*

Relative Influence of SCMS Use on Relationship-Specific Investments

H1 and H2 highlight the association of ITExploit with business-process specificity and ITExplore with domain-knowledge specificity. The following subsections discuss the relative influence of the two patterns of SCMS use on business-process specificity and domain-knowledge specificity.

Relative influence on business-process specificity: ITExplore enables suppliers to learn about a variety of issues in the relationship that can influence the level of business-process specificity. For instance, higher levels of ITExplore (e.g., greater communication with the merchandising group or the quality-control group) allow suppliers to become aware of shortcomings in their business processes and learn about the advantageous business practices adopted by other suppliers (Dyer and Nobeoka 2000; Dyer and Singh 1998). Suppliers thereby recognize opportunities for improving their current processes or for creating new processes. Higher levels of ITExplore can thus lead to greater levels of business-process specificity. Because the link between ITExplore and business-process specificity is indirect and often serendipitous, however, the association between ITExplore and business-process specificity is likely to be weaker than the association between ITExploit and business-process specificity. ITExploit is likely to be more strongly associated with suppliers' business-process specificity:

> *H3a: The association of ITExploit with business-process specificity is stronger than the association of ITExplore with business-process specificity.*

Relative influence on domain-knowledge specificity: Higher levels of ITExploit can have informational benefits and positively influence the level of domain-knowledge specificity. For instance, ITExploit can reveal information about retailer processes that are articulated and formalized in implementing the SCMS. Even in routine use of SCMS for structured interorganizational processes (e.g., to transmit quality-control reports), suppliers may become aware over time of the retailer's internal processes for formulating quality standards, subjective judgments involved in quality-control procedures, preferences of individuals charged with making these judgments, and the discretion to permit exceptions possessed by individuals in the quality-management group. Higher levels of ITExploit thus enable suppliers to develop higher levels of relationship-specific domain knowledge in the exchange. However, this association is likely to be constrained by gaps in communication and knowledge sharing among functions within supplier firms (e.g., personnel in the manufacturing function and designers involved in creating products) and differences in their interpretation of information. Consequently, of the two patterns of SCMS use, ITExplore is likely to be more strongly associated with domain-knowledge specificity than ITExploit:

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H3b: The association of ITExplore with domain-knowledge specificity is stronger than the association of ITExploit with domain-knowledge specificity.

Overall, these hypotheses highlight the different consequences of suppliers' SCMS appropriation choices for the profile of their relationship-specific, intangible investments. These hypotheses represent a context-specific elaboration of the link between SCMS use by suppliers and their development of intangible, IT-enabled resources and capabilities (Bharadwaj 2000).

First-Order and Second-Order Benefits

This work draws upon a two-stage model of benefits (Barua et al. 1995; Mukhopadhyay and Kekre 2002) in which information technologies are viewed as creating direct, first-order benefits, which in turn generate indirect, second-order benefits. First-order benefits are related to firm actions and can be influenced directly by firms. In contrast, second-order benefits are competitive outcomes and incorporate the influence of external factors such as competitors' moves and environmental changes that are beyond the control of an individual firm.

Operational benefits and strategic benefits are two first-order benefits of SCMS use (Mukhopadhyay and Kekre 2002). Operational benefits arise from lowered transaction and production costs through SCMS use. Examples include faster invoicing and payment settlement, more-efficient inventory management, and automating and rationalizing business processes. In contrast, strategic benefits arise through firms positioning themselves to take advantage of opportunities arising in the relationship. These include the development of new products and services, a richer understanding of the partner and nuances of the exchange (Mukhopadhyay and Kekre 2002), and the ability to recognize and respond to changes in the relationship. This parallels the distinction between outcomes linked to cost reduction and to end-product enhancement in interfirm relationships (Ghosh and John 1999).

A supplier's competitive performance—reflecting the supplier's success relative to competitors—is viewed here as a second-order benefit influenced by operational and strategic benefits created by information technologies. This view is consistent with the suggestion that competitive performance is a long-term strategic benefit of SCMS use (Mukhopadhyay and Kekre 2002).

Linking SCMS Use to Benefits: Mediation by Relationship-Specific Intangible Investments

The logic of benefits from IT use proposed here is that patterns of SCMS use by suppliers influence the nature of relationship-specific assets, which lead to supplier benefits. This mediating role for relationship-specific investments is suggested from the perspective of both value creation and value retention. The value-creation perspective—that value creation by firms through information technologies is linked to complementary changes in organizational processes and business strategies—has been examined in prior work (Duliba et al. 2001; Sabherwal and Chan 2001).

In contrast, the value-retention perspective has received less attention in the IS literature. The ability of suppliers to claim benefits from IT use *ex post* and prevent benefits from being appropriated by the other party is an important consideration in asymmetric interfirm relationships (Ghosh and John 1999).[8] In this respect, relationship-specific, intangible investments represent an important source of advantage (Subramani and Venkatraman 2003). For instance, a supplier's IT-enabled business processes that enable them to manage offshore garment manufacturers and their IT-enabled domain knowledge that builds on industry knowledge possessed by firm employees are manifested as complex capabilities that

[8]The *strategizing calculus* through which firms contend for a share of benefits is a key distinction between IT use in interorganizational contexts and IT deployments within firms.

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present barriers to imitation, emulation, and substitution by competitors. As a result, a supplier firm can both constrain the focal firm's ability to switch to alternative suppliers and benefit from the value created by relationship-specific assets (Dyer 1996a, 1996b; Subramani and Venkatraman 2003). Williamson (1995, p. 230) terms this outcome a *fundamental transformation*: "the transformation of what had been a large numbers bidding competition at the outset into one of bilateral exchange during contract execution and at contract renewal intervals." Relationship-specific investments, therefore, enhance a supplier's ability to retain an equitable proportion of the value generated by IT use—value that the focal firm could otherwise appropriate by the credible threat of switching to alternative suppliers. This logic is consistent with observations that interfirm relationships involve a complex interplay of *ex ante* cooperation to jointly create value and *ex post* self-interested bargaining to claim value (Ghosh and John 1999). It is also consistent with research suggesting that the prospect of adversely affecting the value created by idiosyncratic and intangible supplier assets in future periods attenuates *ex post* opportunistic behavior by focal retailers (Subramani and Venkatraman 2003).

Overall, these arguments, from the value-creation and value-retention perspectives suggest that supplier benefits are positively related to the level of relationship-specific intangible investments (which, in turn, are related to patterns of SCMS use). The roles of business-process specificity and domain-knowledge specificity in creating and retaining benefits are not differentiated because prior theory on this issue is limited. In conjunction with the arguments for H1, H2, and H3, this analysis leads to

H4: The higher the level of SCMS use for exploitation, the higher the levels of operational and strategic benefits achieved through the leverage of relationship-specific business processes.

H5: The higher the level of SCMS use for exploration, the higher the levels of operational and strategic benefits achieved through the leverage of relationship-specific domain knowledge.

Consistent with the two-stage model of benefits, higher levels of operational and strategic benefits are likely to lead to higher levels of competitive performance:

H6: Higher levels of operational benefits in the exchange are associated with higher levels of competitive performance.

H7: Higher levels of strategic benefits in the exchange are associated with higher levels of competitive performance.

Control Variables

To discount rival hypotheses, the model incorporates four variables influencing supplier benefits: product uncertainty, retailer replaceability, supplier size, and length of association between firms. Hypotheses related to these variables are not proposed because the paper does not attempt to develop theory related to their effects. However, they are included in the model to assess the effects of the model's independent variables on dependent variables, beyond those attributable to these control variables.

Uncertainty arising from shorter product life cycles increases information processing demands in relationships (Bensaou and Venkatraman 1995). It also increases the likelihood of a supplier encountering unanticipated contingencies. For example, unexpected product improvements by competitors can catch a supplier by surprise and adversely affect its sales. Therefore, product uncertainty is expected to be negatively related to supplier benefits.

The level of retailer replaceability reflects the ease with which a supplier can make the transition to working with other customers for their goods in the event they are not able to sell to the focal retailer. The level of retailer replaceability is inversely related to the level of dependence of the supplier on the focal retailer. Low levels of retailer replace-

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ability can reflect a cooperative climate in the relationship and therefore be positively related to supplier benefits (Dyer and Singh 1998). Yet low levels of retailer replaceability can also make the supplier more vulnerable to exercises of power by the retailer (Hart and Saunders 1997) and adversely affect its performance. Including retailer replaceability in the model helps control for these effects of dependence on supplier benefits.

Including firm size in the model controls for factors such as relative bargaining power and size of the resource base that can affect supplier benefits (Zaheer and Venkatraman 1994). Larger suppliers may be more willing to make investments in training personnel. They may also have more experience in information systems use. Benefits to larger suppliers may therefore be systematically higher than those to smaller suppliers (Lee et al. 1999). However, larger suppliers may have existing IT and manufacturing operations that need considerable redesign to integrate with the retailer's processes (an issue likely to be less problematic for smaller suppliers). Incorporating size in the model controls for these extraneous effects.

Including the length of association as a control variable has two advantages. First, it helps control for the potential effects of relationship duration on supplier benefits. Second, it controls for recursive relationships, if any, between dependent and independent variables (Subramani and Venkatraman 2003). For instance, greater supplier benefits in one period might lead to higher levels of IT use and investments in specialized intangible assets in subsequent periods. Including length of association in the model helps control for such temporal patterns that may otherwise confound the results.

Methods

This section presents details about the context of the study, the procedures used to develop the survey items, and the procedures used for data collection.

Data

This study was conducted in Canada with the cooperation of Alpha, a leading Canadian retailer that pioneered the use of information technologies in their supply chain. Alpha has a reputation for carrying high-quality products and using rigorous supplier qualification and audit processes. Being a supplier to Alpha is recognized as a mark of distinction and provides reputational benefits. Alpha's relationships with suppliers were asymmetric with Alpha being more powerful, which is a characteristic typical of buyer-supplier relationships in the retail distribution channel. The data collected for this study were part of a larger data collection effort aimed at examining the management of buyer-supplier relationships.

In the first phase of fieldwork, eight day-long strategy sessions in which senior Alpha managers and selected suppliers shared information about market developments and discussed their short- and long-term plans were observed. Then 27 semi-structured interviews were conducted with Alpha and supplier managers on the nature of interactions in their relationship. Some of these interviews were conducted at supplier premises, which allowed observation of suppliers' use of the SCMS.

The SCMS was a proprietary system developed by Alpha. The application was based on electronic data interchange (EDI) technologies. It interfaced with Alpha's internal merchandising, quality control, retail operations, logistics, and accounting systems. In addition to supporting standard functional processes, the SCMS provided a range of status reporting and messaging facilities. The supplier module of the SCMS ran on PCs. Suppliers signed up with value-added network service providers for communications facilities. The system let Alpha provide suppliers with a range of periodic reports including district and region-wide sales, product forecasts, store returns, markdowns, promotion calendars, and inventory alerts. The SCMS interfaced with the databases of Alpha's large post-sale service

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organization and allowed suppliers access to field-service records for their products. The SCMS was used to ensure coordinated supplier interactions by Alpha's merchandising, quality-control, accounting, and after-sales service groups. Suppliers were assigned e-mail IDs and provided messaging facilities through the SCMS. The messaging module interfaced with Alpha's internal e-mail systems. Suppliers could send e-mail messages to individuals in Alpha listed in the address book. The features of this SCMS are typical of systems currently in use. Although systems based on Internet technologies are currently available, recent evidence suggests that 90 percent of firms still use EDI-based systems (Shah et al. 2002). These latter systems are expected to continue to play a key role in mediating supply relationships (Chwelos et al. 2001).

A structured questionnaire was developed based on the fieldwork and a review of prior studies. The instrument was refined in pretests with five senior buyers in Alpha and five senior managers in supplier firms. The sampling frame was the set of 640 supplier firms that had provided more than 0.5 percent of the annual requirement of any of Alpha's departments during the prior calendar year. Over 90 percent of the retailer's purchases in the prior year were made from this set.

The strategy of collecting data from one focal retailer's population of suppliers, all of which use the same SCMS technology, reduces extraneous variations that might otherwise confound results. Features of the technology and implementation, like the variety of processes supported and the degree of integration with the retailer's business processes, are similar across suppliers sampled. This also minimizes variations in retailer attributes, such as supplier involvement in decision making, the level of retailer assistance to supplier firms, and differences in incentives for SCMS adoption. Furthermore, survey data could be supplemented with information from Alpha's supplier databases. Although sampling a specific supply network introduces limitations (discussed later), the advantages in this case outweigh the disadvantages.

Response Rate and Nonresponse Bias

The final survey instrument was mailed to managers in the 640 supplier firms. The response rate was 33 percent (211 valid responses). A comparison of early and late respondents using a *t* test ($p < 0.10$) revealed no significant differences between the two groups. They also did not differ in their average annual sales to Alpha, years of association with the retailer, or the number of stock-keeping units (SKUs) supplied. The groups using Alpha's supplier database were also compared. There were no significant differences in dollar volume of purchases in the prior year by Alpha or the number of purchase-order infractions. In addition, 5 percent of the nonrespondents, picked at random, were called. Their responses alleviated the concern that systematic factors might underlie nonresponse. Of the 211 respondents, 131 (62 percent) had been using the SCMS for interaction with Alpha for at least 24 months. The analyses reported here are based on the responses of this set.[9]

To avoid common-methods bias, independent assessments of suppliers' competitive performance were obtained through a survey of Alpha's buying group.

Measures

For most constructs, measures validated in previous studies were adapted. For constructs unique to the model, multiple operational measures based on field interviews were developed. Details of the measures and their sources are in Appendix A.

[9]Supplier interviews suggest that it took about six months for SCMS implementation and usage to stabilize. This set of 131 firms thus comprises firms using the system for retailer interactions routinely for at least 18 months, thus enabling valid assessments of patterns of SCMS use, relationship-specific investments, and benefits.

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SCMS Use

The format of items for SCMS use was adapted from Boynton and Zmud (1994). The content of items was based on details of SCMS use collected in supplier interviews.

SCMS use for exploitation (ITExploit): The SCMS supported transaction processing activities by suppliers such as electronic order receipt and invoicing, management of packaging, and shipping. The most prominent features in the system were order management involving electronic order receipt, order acknowledgement, and invoice generation. Suppliers needed to use these functions for basic EDI compliance. The system also provided facilities for suppliers to maintain quality-inspection data, create advance-shipment notices (ASN), and reserve delivery windows for supplier trucks at warehouses. It also supported manufacturing planning and procurement activities and allowed suppliers to manage their warehouse stocks, in-process inventories, and in-transit inventories. Suppliers' use of these features reflects increasing degrees of the incorporation of the SCMS in structured tasks. The items for ITExploit tapped the extent of SCMS use for order processing, invoicing, settling accounts, managing inventories, and exchanging shipment and delivery information.

SCMS use for exploration (ITExplore): The items for ITExplore assessed the level of SCMS use to support nonroutine, unstructured tasks. The broad array of information regularly available through the system made it possible for suppliers to understand market trends and customer preferences and to use that knowledge in various ways. Field-service reports made it possible for suppliers to evaluate the performance of their products after they were sold and gain insights for product modifications and new product design. Retail sales and merchandise-return reports provided information that suppliers could use to understand the distribution of customer preferences and reasons for product returns. The summary information in retail sales reports allows suppliers learn about sales of related products. For example, a manufacturer of stationary exercise bicycles had access to sales summaries for treadmills. Similarly, a supplier of men's garments had access to data on sales of men's accessories. The SCMS messaging facilities allowed suppliers to contact individuals and groups within Alpha directly. For example, a supplier could e-mail a regional field-service group to have defective parts returned for examination. The items for ITExplore assessed the extent to which suppliers used the SCMS for the unstructured tasks highlighted in field interviews as being important for supplier performance. One item assessed the extent of its use for understanding product and market trends and customer preferences. A second item assessed SCMS use for field service information and the extent to which suppliers used inputs from Alpha's post-sale service organization to improve design and manufacturing functions.[10] A third item pertained to the extent of SCMS use to support the creation of new business opportunities to extend the scope of the relationship with Alpha.

Relationship-Specific Investments

The format of items for business-process specificity and domain-knowledge specificity was adapted from Zaheer and Venkatraman (1994) and Bensaou and Venkatraman (1995). Subramani and Venkatraman (2003) also used these items.

Business-process specificity: Alpha represented the SCMS as a system that suppliers could use to interact not only with it but also with other retailers. Consequently, the relationship specificity of supplier investments depends on the extent to which the SCMS and related applications (e.g., converters to interface existing stock-keeping systems to the SCMS) were used exclusively to interact with Alpha as opposed to being used uniformly across other retailers with which the supplier worked. Such overlap between Alpha

[10]Technicians in Alpha's service group had a reputation for devising innovative solutions to field problems. This division also maintained detailed data on part failure and part replacement gathered from field service calls and carry-in repairs.

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and other retailers occurred largely in billing and inventory management, and one item focused on the relationship specificity of these processes. A second item captured the relationship-specific nature of supplier investments in vendor selection, cost accounting procedures, and other administrative procedures. Relationship-specific changes to operating procedures in manufacturing and shipping functions were highlighted as another source of business-process specificity. For instance, the mattress manufacturer using the SCMS to support the move to a make-to-order system introduced a variety of changes in its manufacturing, packaging, and shipping processes. These supplier investments were useful only in working with Alpha. The third item captured the extent of such relationship-specific investments in operating procedures.

Domain-knowledge specificity: The items captured the specialized intangible investments by suppliers in understanding Alpha's requirements and the unique context of the interaction. They focus on the specificity of both component and architectural knowledge and cover expertise developed for new-product planning, product conception and design, and pricing. These three areas reflect a supplier's understanding and knowledge of Alpha's market positioning and customer expectations.

Supplier Benefits

The items focused on benefits highlighted in supplier interviews and in prior literature. Because Alpha was expected to favor vendors adopting the SCMS, suppliers were likely to derive cost efficiencies from higher sales volumes. This argument is consistent with the observation by Mukhopadhyay and Kekre (2002, p. 1312) that suppliers adopting business-to-business systems championed by customer firms are "rewarded with higher sales volumes." Suppliers were unlikely to derive benefits in the form of price increases because Alpha negotiated price reductions in supply contracts, which is a pattern also observed in other studies (Dyer and Nobeoka 2000). Suppliers could also benefit from process improvements and the creation of new processes. For example, online ordering could help eliminate order-entry errors, electronic booking of delivery slots could reduce trucks' idle times at Alpha's warehouses, and submitting invoices electronically could enable timely payments by customers. Suppliers could also increase their overall profitability through efficiencies created by SCMS use and use of information made available by the system. The three items for operational benefits tapped the extent to which suppliers derived benefits from these sources.

Measures of strategic benefits assessed outcomes that positioned suppliers more advantageously in their relationship with Alpha. These included learning about Alpha's customer segments and their preferences, the extent to which suppliers were able to create new products or enhancements for Alpha, and the extent to which suppliers developed new business opportunities in the exchange. Alpha's merchandising groups used these three criteria to nominate firms for "Supplier of the Year" awards.

Suppliers' competitive performance was measured using two items focusing on trends in sales to Alpha and trends in the suppliers' market share with Alpha. Managers in Alpha's merchandising group provided assessments of suppliers' performance[11] with respect to competing suppliers in the product category (e.g., small appliances, footwear, and luggage). Because none of the suppliers were sole providers, there was always a comparison set available.

Control Variables

Measures of uncertainty, retailer replaceability, length of association, and size were adapted from prior studies. Appendix A lists the items used and their sources.

[11]Obtaining independent assessments from informants in Alpha guards against common-methods bias that can arise when an informant provides assessments of both dependent and independent variables.

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Data Analysis

Structural equation modeling procedures implemented in PLS Graph were used to perform a simultaneous evaluation of both the quality of measurement (the measurement model) and construct interrelationships (the structural model). PLS Graph provides the ability to model latent constructs even under conditions of non-normality and small- to medium-size samples (Chin et al. 1996). The sample of 132 cases is adequate for PLS analysis. It satisfies the heuristic that the sample size be at least 10 times the largest number of structural paths directed at any one construct.[12]

Testing Direct Effects

Hypotheses postulating direct effects between constructs (H1, H2, H6, and H7) were tested based on the magnitude and significance of paths computed by PLS Graph. Hypotheses regarding difference in the strengths of multiple paths (H3a, H3b) were tested by comparing the path magnitudes calculated by PLS.

Testing Mediated Effects

The mediation hypotheses (H4, H5) were tested in two ways. The first approach compares the research model (with mediated paths from SCMS use to benefits) to a competing model (incorporating a direct link between the constructs). Because the two models are nested, model-comparison procedures using PLS results enable statistical conclusions to be reached regarding model fit. The second approach uses mediation-analysis techniques (Hoyle and Kenny 1999) to calculate the magnitude and significance of individual mediated paths based on values of standardized direct paths computed in PLS. Appendix B describes the two complementary approaches to test mediated effects.

Results

This section presents the measurement properties, sample demographics, and results of hypothesis testing.

Measurement Properties

Internal consistency was assessed by examining ρ_c, a measure of composite reliability. The ρ_c values for constructs are all above the suggested threshold of 0.7, indicating reliable measurement[13] (Appendix A). The values of average variance extracted (AVE)—the ratio of the construct variance to the total variance among indicators—are all above the recommended threshold of 0.50. The measures exhibit satisfactory convergent and discriminant validity. The values of the square root of the AVE (reported on the diagonal in Table 2) are all greater than the inter-construct correlations (the off-diagonal entries in Table 2).

Informant and Sample Demographics

Of the informants, 78 percent were senior managers (titles such as general manager, vice president, or CEO) with an average tenure of 14 years. The sample consists of well-established firms with an average of 32 years of operation and 260 employees in a range of industries, such as garments, fashion accessories, luggage, furniture, lighting, sports equipment, and hardware. The firms had longstanding associations with Alpha (mean of 19 years), consistent with prior supplier samples in the distribution channel (Heide 1994). The suppliers were predominantly small firms.

[12]The largest number of paths to any construct in the research model is six. This count includes the paths from the four control variables that are not shown in Figure 2.

[13]All the loadings of items on constructs used to calculate ρ_c were significant at $p < .01$ and were uniformly high. Twenty-one of the 27 loadings were above 0.8, with the lowest loading being 0.71.

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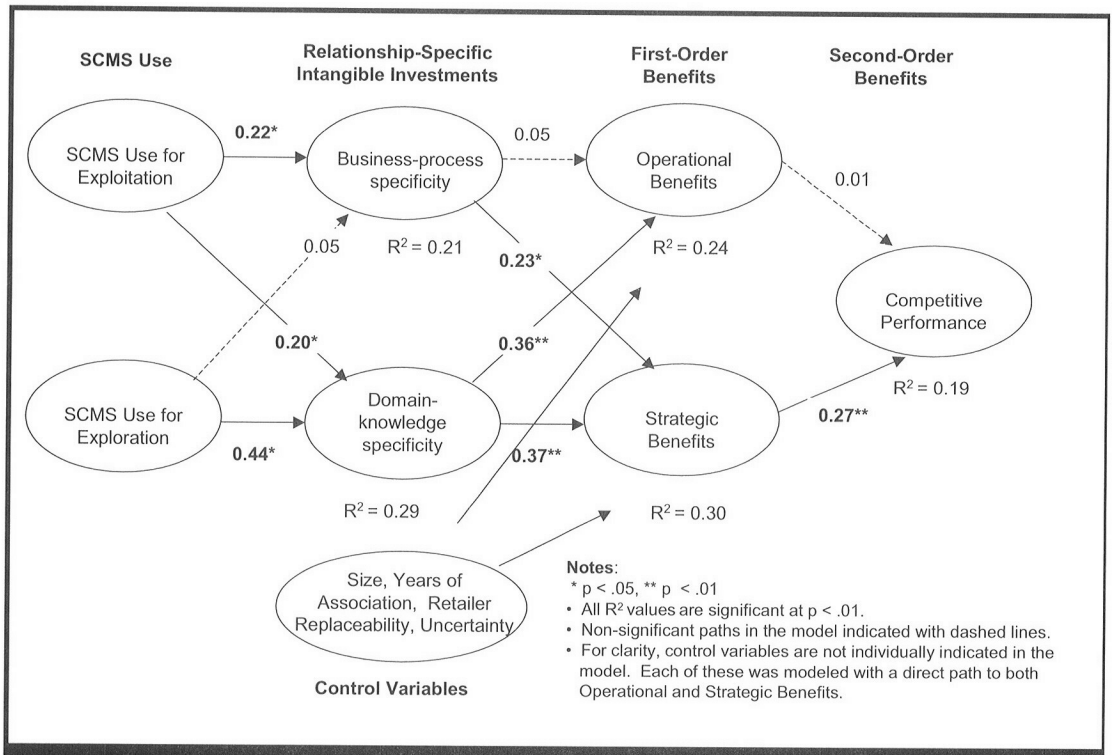

Figure 2. Research Model Linking SCMS Use, Relationship-Specific Investments and Supplier Benefits

Over 55 percent had annual sales between $11 and $50 million. On average, Alpha accounted for 18 percent of the annual sales of firms in the sample. Only 6 percent indicated that Alpha accounted for over 50 percent of their sales. Over 80 percent of the annual sales to Alpha were made under Alpha's home brands and private labels. This statistic is interesting, considering that most firms (55 percent) indicated that their products were among the top three brands in their categories.[14] On average, the firms supplied 235 different SKUs.[15] The retail prices of the items ranged from $20 to $75. The products involved little customization for Alpha (median of 2 on a seven-point scale), were relatively complex (median of 4 on a seven-point scale), and were more fashion and style-driven than utilitarian (median of 3 on a seven-point scale).

The means, standard deviations, and correlation of constructs are in Table 2. The significance levels of paths in the research model were determined using PLS's bootstrap resampling procedures. Overall, the results suggest a satisfactory fit of the model to the data. The R^2 values for the dependent constructs range from 0.19 to 0.30. They are all significant at $p < .01$. The results of the PLS analysis are in Table 3 and Figure 2. The results of the mediation analyses are in Tables 4 and 5.

Table 3 and Figure 2 provide the magnitude and significance of inter-construct relationships. Retailer replaceability is inversely related to both

[14]This high figure suggests that Alpha was successful in leveraging the expertise of leading suppliers in supplying Alpha's house brands. House brands in general are associated with higher margins than supplier brands.

[15]In many instances, this number does not necessarily reflect a diversity of products. Supplying dress shirts of one style in four different sizes and seven different pattern/color combinations amounts to 28 SKUs. With two styles, the number rises to 56.

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Table 2. Means, SD, Inter-Construct Correlations and Average Variance Extracted (n = 131)

	Mean (SD)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
IT Use fo Exploitation (1)	5.12 (1.61)	0.93										
IT Use for Exploration (2)	2.13 (1.53)	0.188	0.82									
Business Process Specificity (3)	5.68 (1.15)	0.321*	0.039	0.82								
Domain-knowledge specificity (4)	2.91 (1.35)	0.329*	0.468*	0.200	0.88							
Operational Benefits (5)	2.80 (1.57)	0.179*	0.343*	0.163	0.550*	0.81						
Strategic Benefits (6)	2.85 (1.80)	0.258*	0.352*	0.257*	0.410*	0.489*	0.84					
Competitive performance (7)	4.33 (1.48)	0.086	0.005	0.013	0.158	0.173	0.274*	0.93				
Uncertainty (8)	3.38 (1.37)	0.049	0.198	0.077	0.197	-0.028	-0.044	0.131	0.79			
Retailer Replaceability (9)	3.82 (1.59)	0.028	0.07	-0.10	-0.111	-0.23**	-0.31**	-0.67**	0.13	0.89		
Size (10)	3.44 (1.30)	0.132	0.165	-0.152	0.205*	-0.019	-0.015	-0.01	0.328**	0.19*	1.00	
Yrs of Association (11)	18.98 (12.75)	0.137	0.117	-0.187*	0.097	-0.002	0.055	0.007	0.133	-0.069	0.32**	1.00

Notes: a) Figures in shaded diagonal are values of square root of the AVE
b) * = p < .05, ** = p < .01

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Table 3. Path Coefficients

Path/Hypothesis	Path Coefficient	*t* Value
ITExploit → Business-process specificity (H1)	0.22	2.42**
ITExploit → Domain-knowledge specificity	0.20	2.13*
ITExplore → Business-process specificity	0.05	0.071
ITExplore → Domain-knowledge specificity (H2)	0.44	5.77**
Business-process specificity → Operational Benefits	0.05	0.71
Business-process specificity → Strategic Benefits	0.23	2.54**
Domain-knowledge specificity → Operational Benefits	0.36	4.77**
Domain-knowledge specificity → Strategic Benefits	0.37	4.63**
Operational Benefits → Competitive performance (H6)	0.01	0.18
Strategic Benefits → Competitive performance (H7)	0.27	3.29**
Uncertainty → Operational Benefits	-0.15	0.60
Uncertainty → Strategic Benefits	-0.11	1.64
Retailer Replaceability → Operational Benefits	0.17	1.77*
Retailer Replaceability → Strategic Benefits	0.21	2.79**
Size → Operational Benefits	-0.10	0.98
Size → Strategic Benefits	-0.08	0.20
Years of Association → Operational Benefits	-0.09	0.54
Years of Association → Strategic Benefits	0.08	0.58

Note: 1. * = $p < .05$, ** = $p < .01$ in one-tailed tests
2. Only the hypotheses tested based on individual path magnitudes (H1, H2, H6, H7) are listed here.

Table 4. Nested Model Comparison

Direct Path	R^2 in Mediated Model (no direct path)	R^2 with Direct Path	f^2 Value	Pseudo F F(1,130)	Conclusion
ITExploit → Operational Benefits	0.238	0.244	0.008	1.000	Not significant
ITExploit → Strategic Benefits	0.300	0.305	0.007	0.913	Not significant
ITExplore → Operational Benefits	0.238	0.246	0.011	1.323	Not significant
ITExplore → Strategic Benefits	0.300	0.317	0.025	3.109	Not significant

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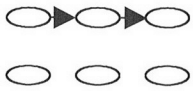
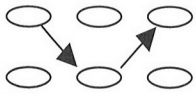
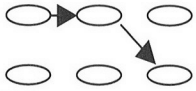
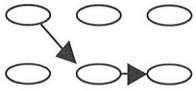
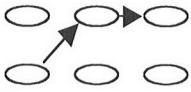
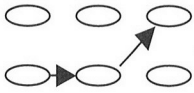
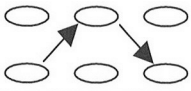
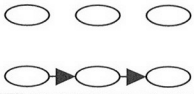
Table 5. Significance of Mediated Paths from IT Use to Benefits (n = 131)

Indirect Effect	Row	Mediated Paths	Graphical Representation	Path[a]	z stat
ITExploit → OpBen	a	ITExploit → BPS → OpBen		0.011	0.680
	b	ITExploit → DKSpec → OpBen		0.073	2.435*
ITExploit → StrBen	c	ITExploit → BPS → StrBen		0.050	1.962*
	d	ITExploit → DKSpec → StrBen		0.075	2.417*
ITExplore → OpBen	e	ITExplore → BPS → OpBen		0.003	0.443
	f	ITExplore → DKSpec → OpBen		0.161	3.674**
ITExplore → StrBen	g	ITExplore → BPS → StrBen		0.012	0.560
	h	ITExplore → DKSpec → StrBen		0.165	3.613**

Note: * = p < .05, ** = p < .01 in one-tailed tests
a: Standardized path magnitude

operational benefits (path = -0.17) and strategic benefits (path = -0.21). This negative relationship between retailer replaceability and supplier benefits (or expressed differently, the positive relationship between supplier dependence and supplier benefits) is consistent with the sampling of a set of longstanding, ongoing supplier-retailer relationships. Uncertainty, size, and years of association are not significantly related to either of the dependent variables. The results of hypothesis testing are summarized below.

Hypothesis 1, Supported: The path from ITExploit to business-process specificity (path = 0.22, t = 2.42, p < .01) is positive and significant (Table 3).

Hypothesis 2, Supported: The path from ITExplore to domain-knowledge specificity (path = 0.44, t = 5.77, p < .01) is positive and significant (Table 3).

Hypothesis 3a, Supported: The path from ITExploit to business-process specificity (path =

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0.22, t = 2.42, p < .01) is positive and significant, but that from ITExplore to business-process specificity (path = 0.05, t = 0.71) is positive but not significant. A one-sided test of this directional hypothesis indicates that the magnitude of the path from ITExploit to business-process specificity is greater than that from ITExplore to business-process specificity (difference = 0.173, t = 1.86, p < .05).

Hypothesis 3b, Supported: The path from ITExplore to domain-knowledge specificity (path = 0.44, t = 5.77, p < .01) is positive and significant, as is the path from ITExploit to domain-knowledge specificity (path = 0.20, t = 2.13, p < .05). A one-sided test for the directional hypothesis indicates that the magnitude of the path between ITExplore and domain-knowledge specificity is greater than that between ITExploit and domain-knowledge specificity (difference = 0.243, t = 3.30, p < .01).

Overall, all hypotheses relating patterns of suppliers' SCMS use to relationship-specific intangible investments are supported by the data.

Hypothesis 4, Supported: The results of nested-model comparison (Table 4) indicate that the effect of ITExploit on benefits is completely mediated by relationship-specific assets. The research model incorporating mediated paths is preferred to competing models that include direct paths from ITExploit to operational benefits (Table 4, row 1) and strategic benefits (Table 4, row 2). The analysis of individual mediated paths (Table 5) indicates that three of the four mediated paths from ITExploit to benefits are positive and significant (Table 5, rows b, c, and d).

Domain-knowledge specificity mediates the link between ITExploit and both operational benefits and strategic benefits. Both the indirect paths are positive and significant (Table 5, rows b and d). Business-process specificity mediates the link between ITExploit and strategic benefits. The indirect path is positive and significant (Table 5, row c). However, the indirect path from ITExploit to operational benefits through business-process specificity is positive but not significant (Table 5, row a).

Hypothesis 5, Supported: The nested model comparison (Table 4) indicates that the effect of ITExplore on benefits is completely mediated by relationship-specific assets. The research model incorporating mediated paths is preferred to competing models including direct paths to operational benefits (Table 4, row 3) and to strategic benefits (Table 4, row 4). The analysis of individual mediated paths indicates that two of the four mediated paths from ITExplore to benefits are positive and significant (Table 5, rows f and h).

Domain-knowledge specificity mediates the effect of ITExplore on both operational and strategic benefits. The indirect paths are positive and significant (Table 5, rows f and h). The indirect paths to operational and strategic benefits through business-process specificity are both positive but not significant (Table 5, rows e and g).

Overall, the hypothesized mediated effects of ITExploit and ITExplore on benefits are supported.

Hypothesis 6, Not Supported: The path between operational benefits and competitive performance (Table 3) is not significant (path = 0.010, t = 0.1, *ns*).

Hypothesis 7, Supported: The path between strategic benefits and competitive performance (Table 3) is positive and significant (path = 0.265, t = 3.291, p < .01).

Discussion and Conclusions

This paper develops and tests theory relating supplier firms' use of information technologies in supply chains to the profile of their relationship-specific intangible investments and outcomes for these firms. The study contributes to the literature by providing evidence that (1) suppliers can benefit by participating in supply chain management initiatives of network leaders, (2) benefits from SCMS use are mediated by suppliers' deployment of relationship-specific business processes and domain knowledge in the exchange,

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and (3) the profile of relationship-specific investments by suppliers is linked to their patterns of SCMS use. These results highlight the importance of recognizing variations in patterns of appropriation of supply chain technologies—for exploitation and exploration—to articulate benefits to suppliers from these systems.

The study contributes to theory by highlighting the role of relationship-specific assets in the dynamics of value creation and value retention in contexts of IT-mediated buyer-supplier interactions. While prior research has largely emphasized the part played by relationship-specific assets in enabling value creation by suppliers (Dyer 1996a, 1996b), this study extends current theory by highlighting their complementary role in value retention. This role is particularly salient in the context of SCMS use where both suppliers and a dominant buyer contend for the benefits created by the use of information systems. As patterns of SCMS use that create value are recognized and adopted by competing suppliers and become standard practice in supplier networks, the benefits created by such uses of SCMS are bargained away by suppliers in negotiations or appropriated by focal firms (Bakos and Brynjyolfsson 1993). This logic may explain why prior studies found few benefits to suppliers from systems championed by focal firms and cast the adoption of these systems as an unfortunate strategic necessity for suppliers (Barua and Lee 1997). When suppliers combine SCMS use with investments in relationship-specific intangible assets, however, the causal ambiguity of the combination raises barriers to imitation and enables system use to become a lever for differentiation. In effect, relationship-specific intangible investments that cloak SCMS use in idiosyncratic features prevent competing suppliers and the retailer from unpacking the complex causal structure contributing to supplier performance in the exchange. This causal ambiguity enables suppliers to offset the asymmetry in bargaining power in the exchange, which in turn allows them to retain some of the benefits created by SCMS use.

The strategic combination of SCMS use and relationship-specific investments thus enhances suppliers' ability to benefit from SCMS use. It also illustrates how suppliers can create negative externalities for competitors in IT-mediated relationships to improve their own relative advantage. This logic of IT-enabled competitive advantage in interfirm contexts thus reflects an interesting instance of the complementarity of the prescriptions of transactions-cost and resource-based views, providing a context-based explanation of how *relationship-specific assets* can also be *strategic assets*. In this respect, the data suggest that domain-knowledge specificity is more potent than business-process specificity as a basis for deriving strategic advantage.

The results provide empirical support for Bakos and Brynjolfsson's (1993) *vendors-to-partners* thesis whereby IT use in buyer-supplier exchanges leads to closer cooperative relationships. The results further refine this insight, indicating that the nature of intangible, relationship-specific investments is influenced by patterns of appropriations of SCMS by suppliers. SCMS use for exploitation, which focuses on achieving exchange efficiency, is dominant in enabling the creation and deployment of co-specialized business processes. SCMS use for exploration, involving the exchange of unstructured information, collaborative interactions, and analysis of data to infer cause-effect relationships, is dominant in enabling the development and use of specialized domain knowledge.

This view is consistent with suggestions that information technologies are complex artifacts providing multiple *affordances* to users. These technologies can be interpreted and used in different ways by different actors (Pentland 1992). The results of the current research indicate that the affordances introduced by SCMS can pertain both to structures of interfirm interaction incorporated in routines (business processes) and to competence structures underlying action (domain knowledge). In the context of suppliers' SCMS use, the results demonstrate that different appropriations of SCMS direct attention to differing sets of issues in the interaction, thereby leading to different choices of intangible investments and ultimately to different outcomes.

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This study has several limitations. The data were collected from the supplier network of one large retailer. While this sampling choice minimizes confounds by holding focal-firm characteristics constant, it limits the generalizability of the results. Reliance on the report of a single informant within each supplier firm is also a limitation. Furthermore, while the theory linking SCMS use, relationship-specific assets, and benefits is causal, and path analysis represents relationships between constructs as causal links, the paper uses cross-sectional data to empirically assess these relationships. The results thus reflect associations rather than causal links between constructs. Moreover, while the paper draws on prior theory and evidence to model SCMS use as a precursor to relationship-specific investments, rival arguments that suppliers may make relationship-specific investments in advance of SCMS use cannot be discounted. Biases from omitted variables and the possibility of mutual influence among constructs in the model are also limitations.

The constructs in the model and their interrelationships are independent of the technology underlying the SCMS examined in this study. The findings are therefore likely to be generalizable to other contexts with different underlying technologies. For instance, the emergence of the Internet as a medium for business-to-business transactions has led to the development of *private exchanges*—SCMS implementations based on open standards and Web technologies—where network leaders control supplier participation (Harris 2001). Recent work suggests that system features and business dynamics in Internet-based private exchanges are similar to those in the SCMS studied here (Icasati-Johanson and Fleck 2003). The results are generalizable to such contexts. The results need to be applied with caution, however, as developments in information technologies continue to expand the variety and sophistication of SCMS features. Exchanges providing richer transactional and collaborative features may exhibit characteristics different from the system studied here. Furthermore, the results apply only to settings in which the fundamental assumption of this study holds: that relationship-specific intangible assets developed in ongoing interactions create more value than generic, nonspecific assets available in spot markets. This situation may not be the case in *public exchanges* or electronic markets (Choudhury et al. 1998) in which firms can aggressively seek suppliers offering the lowest price each time they need to buy goods or services (Harris 2001). When buyers and sellers engage in *plug-and-play* interactions and history effects are unimportant, modularity and flexibility are more valuable than relationship specificity (Lee 2002). Nonetheless, the constructs developed in this paper can serve as a useful point of departure to examine value creation in these contexts.

This study highlights a variety of issues for future investigation. The finding that the path from ITExploit to operational benefits mediated by business-process specificity is not significant warrants further scrutiny. Moves toward standardization and modularization of business processes in contexts of IT mediation possibly make them less viable as a source of benefits. Organizational process reconfigurations and expertise development are time- and resource-intensive. The cost-effectiveness of such investments needs further study. The finding in this study that operational benefits are not linked to competitive benefits in the form of enhanced revenues and market share also deserves further examination. While this result may reflect the value Alpha placed on cultivating suppliers that emphasized new product development and innovation, it may also indicate that having suppliers focus exclusively on operational benefits from SCMS use may be counterproductive. Future research on the role of SCMS in enabling expertise coordination (Faraj and Sproull 2000), strategic learning (Thomas et al. 2001), and developing functional capabilities (Dutta et al. 2003) at the team and organizational levels within supplier firms can also yield useful insights. Evolving a richer conceptualization of domain knowledge specificity incorporating the influence of constructs such as social capital and functional expertise (Subramaniam and Youndt 2003) is yet another promising direction for future work.

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The results have several implications for practice. Suppliers can anticipate the relationship-specific investments in adopting SCMS and their links to patterns of SCMS use. They can recognize the advantages of deploying co-specialized intangible assets in IT-mediated exchanges and the possibility of employing such assets strategically to lock larger customers into bilateral relationships. In this way, they can enhance their ability to appropriate an equitable share of the value created in the exchange. For focal firms pursuing the goal of leveraging the resource endowments of their supplier networks, the results suggest that influencing patterns of SCMS use by suppliers is an important means to achieve their objective. The results highlight the opportunity for network leaders to leverage supplier capabilities through policies that encourage non-contractible, relationship-specific supplier investments. They also suggest that advantages accrue from managing their dependence upon suppliers through relational rather than contractual processes.

The contribution of information technologies to the creation and deployment of capabilities in organizational networks is an important theme in IS research. This study highlights that patterns of IT use in interfirm relationships are antecedents of co-specialized supplier investments in business processes and domain knowledge (resources that create competitive advantages for supply chains). For suppliers in asymmetric relationships with a network leader, these investments, which complement IT use, play an important part. They are central to value creation. They are also key elements of the strategic calculus of claiming value *post hoc* in the relationship. As firms increasingly rely on IT-mediated interfirm relationships to develop and deploy capabilities, recognizing the complex interplay of contextual features, appropriations of technology, and firm strategies is important in explicating the role played by information technologies.

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About the Author

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Appendix A

Details of Measures

Strategic Benefits (ρ_c = 0.87)

Please indicate the extent to which you are receiving the following benefits as a result of your relationship with Alpha:

- *Learning about customers and markets for our products*
- *Creation of new products, product enhancements*
- *Development of new business opportunities*

Scale: Little or none of this benefit — Some Level of this benefit — High level of this benefit (1-7 Scale)

Operational Benefits (ρ_c = 0.85)

Please indicate the extent to which you are receiving the following benefits as a result of your relationship with Alpha:

- *Cost Efficiencies from higher sales volumes*
- *Improvements to current processes or creation of new processes*
- *Increased profitability*

Scale: Little or none of this benefit — Some Level of this benefit — High level of this benefit (1-7 Scale)

Business-Process Specificity (ρ_c = 0.86)

The extent to which the *software and applications* used (e.g., billing, inventory management, EDI, etc.) in supplying *Alpha* are relatively similar or are significantly different from what you use with other retailers.

The extent to which the *administrative procedures* used (e.g., vendor selection, cost accounting procedures etc.) in supplying *Alpha* are relatively similar or are significantly different from what you use with other retailers.

The extent to which the *operating procedures* used (e.g., manufacturing, bar-coding, packaging, shipping procedures etc.) in supplying *Alpha* are relatively similar or are significantly different from what you use with other retailers.

Scale: Relatively Similar as with other Retailers — Moderately Customized — Significantly Customized for Alpha (1-7 Scale)

(Zaheer and Venkatraman 1994; Bensaou and Venkatraman 1995)

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Domain-Knowledge Specificity (ρ_c = 0.91)

The extent to which the knowledge and understanding used in *planning for new products, programs for Alpha* is significantly specific to the relationship (i.e., customized for Alpha) or is relatively similar to what you use with other retailers.

The extent to which the knowledge and understanding used in *product conception and design for Alpha* is significantly specific to the relationship (i.e., customized for Alpha) or is relatively similar to what you use with other retailers.

The extent to which the knowledge and understanding used in *determining product pricing for Alpha* is significantly specific to the relationship (i.e., customized for Alpha) or is relatively similar to what you use with other retailers.

Scale: Relatively Similar as with other Retailers — Moderately Customized — Significantly Customized for Alpha (1-7 Scale)

(Zaheer and Venkatraman 1994; Bensaou and Venkatraman 1995)

IT Use for Exploitation (ρ_c = 0.94)

Please indicate the extent to which you use specific Information Technology based support for the following in your relationship with Alpha:

- The extent to which you use specific IT based support for *order Processing, invoicing and settling accounts*
- The extent to which you use specific IT based support for *exchange of shipment and delivery information*
- The extent to which you use specific IT based support for *managing warehouse stock and inventories*

Scale: Minimal Use — Some Use — Significant Use (1-7 Scale)

(Boynton and Zmud 1994)

IT Use for Exploration (ρ_c = 0.86)

Please indicate the extent to which you use specific Information Technology based support for the following in your relationship with Alpha:

- *Understanding trends in sales and customer preferences with Alpha*
- *Integrating your functions (e.g. design and manufacturing) with Alpha's service organization*
- *Leveraging your firm's expertise to create new business opportunities*

Scale: Minimal Use — Some Use — Significant Use (1-7 Scale)

(Boynton and Zmud 1994)

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Uncertainty (ρ_c = 0.83)

What is the likelihood of major changes occurring in this product category over the next 12 months?

- *Extensive Style Changes*
- *Major Product Innovations*
- *Key Manufacturing/Quality Innovations*

Scale: Very Unlikely — Likely — Very Likely (1-7 Scale)

(Subramani and Venkatraman 2003)

Retailer Replaceability (ρ_c = 0.93)

- *We could easily find other customers who would offer as much supplier assistance as provided by Alpha.*
- *We could easily find other customers to replace the margin levels with Alpha.*
- *We could easily substitute for the loss of reputational effects of being a Alpha supplier.*

Scale: Strongly Disagree — Neither Agree nor Disagree — Strongly Agree (1-7 Scale)

(Subramani and Venkatraman 2003)

Size

What is the annual sales revenue of your firm?

Years of Association

For how many years has your firm been associated with Alpha in Canada? _____ years

Product Characteristics (7-point semantic differential scale anchored at bipolar endpoints)

Please indicate the position on the following scale that best describes this product category:

- *Standard (low customization for Alpha) … Specialized (highly customized for Alpha)*
- *Simple … Complex*
- *Fashion oriented and style driven … Utility oriented, not style driven*

(Bensaou and Venkatraman 1995)

Competitive Performance (α = 0.79)

- The trends in your purchases from SuppCo (retail and catalog) over the last 18 months
- The trends in SuppCo's market share in the category over the last 18 months

Scale: Significant reduction — No Change — Significantly Increase (1-7 Scale)

Note: Assessments of suppliers' competitive performance were obtained in an independent survey of Alpha's buying group.

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Appendix 2

Tests of Mediation

Comparing Nested Models

The PLS analysis was run for the research model (proposing that the relationship between IT use and outcomes is completely mediated) and for a set of competing models (each of which incorporated a direct link between one type of IT use and one of the benefits). The two models are nested, and competing models have one path more than the research model (e.g., a direct link between ITExploit use and operational benefits). The magnitude and significance of the difference in the R^2 statistics of the two models (e.g., the R^2 values for operational benefits are 0.238 for the research model and 0.244 for the competing model with a direct link between ITExploit and operational benefits) reflect the increased explanation of the dependent variable (operational benefits) by the inclusion of the direct link. The significance of the extra path is assessed using a procedure similar to that employed to test nested models in stepwise linear regression. The f^2 statistic is computed based on the R^2 difference; the significance of the f^2 is assessed based on a pseudo *F* test[16] (Chin et al. 1996). The results of these tests are presented in Table 4.

Analyses of Individual Mediated Paths

The results of the PLS analysis—the magnitudes and the variance of the direct paths among independent variable, mediator, and dependent variable—are used to calculate the extent to which a construct mediates the relationship between the independent variable and the dependent variable (Hoyle and Kenny 1999). For instance, the magnitude of the mediation effect between ITExplore (variable x) and Strategic Benefits (variable y) mediated by Domain-knowledge specificity (variable M) is the product of the standardized paths between x and M and between M and y. The standard deviation of the mediated path can be computed based on the magnitudes and the variance of the paths among x, M, and y.[17] The results of the analyses of paths in the model are in Table 5.

The two tests for mediation are complementary. The comparison of nested models highlights the utility of incorporating a direct path in addition to the indirect paths between constructs. It provides no information, however, about individual mediated paths through which the indirect effect may be occurring. The analysis of individual mediated paths provides detailed information on the magnitude and significance of individual indirect paths underlying the overall indirect effect. However, it does not indicate if incorporating a direct path in addition to the indirect paths would improve explanation of the dependent variable.

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[16] f^2 is calculated as (R^2full - R^2excluded)/(1 - R^2full). The *pseudo F* statistic is calculated as $f^2 * (n - k - 1)$, with 1, (n – k) degrees of freedom where n is the sample size and k is the number of constructs in the model.

[17] The standard error of the mediated path is approximated as $\text{sqrt}(b^2 s_a^2 + a^2 s_b^2 + s_a^2 s_b^2)$, where a and b and are the magnitudes of the paths between x, M, and y, and s_a and s_b are the standard deviations of a and b.

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