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MUTUAL COMMITMENT TO SUPPORT EXCHANGE: RELATION-SPECIFIC IT SYSTEM AS A SUBSTITUTE FOR MANAGERIAL HIERARCHY

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This paper examines the effects of information technology (IT) on the governance of vertically related firms. We propose that a highly relation-specific IT system in inter-firm transactions plays a key role in the resulting inter-firm governance as a mutual sunk-cost commitment, in terms of leading to both less vertical integration (i.e., a change in governance mode as a first-order effect) and a smaller number of suppliers (i.e., a change within a governance mode as a second-order effect). As a result, this highly relation-specific IT system (bilateral investment) can be an alternative governance mode of electronic integration that acts as a substitute for managerial hierarchy and vertical financial ownership. From a strategic management perspective, this paper provides transaction costs and resource-based explanations on IT systems' impact on the organizational boundary decision and its impact on the likelihood of the firm achieving sustainable competitive advantage. Copyright © 2006 John Wiley & Sons, Ltd.

> 'Flawed' modes of economic organization for which no superior feasible mode can be described are, until something better comes along, winners nonetheless. (Williamson, 1985: 408)

> Even though technology advances breathlessly, the economic principles we rely on are durable. The examples may change, but the ideas will not go out of date. (Shapiro and Varian, 1999: x)

INTRODUCTION

This paper examines the impact of information technology (IT) on changing the governance of vertically related firms that are applying IT systems in search of sustainable competitive advantage via superior economic efficiency. More specifically, this paper analyzes the effects of information attributes that characterize vertical relationships, and the governance effects of different types of IT systems that are being used to complete transactions efficiently by substituting for managerial hierarchy through '*electronic integration*.'[1]

Although there has been considerable discussion of the relationship between IT systems and organization structures in the organization science and communication science research literatures (McPhee and Poole, 2001; Rice and Gattiker, 2001), the governance mechanisms by which IT systems affect vertical relationships have not been

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[1] Zaheer and Venkatraman define *electronic integration* as 'a specific form of vertical quasi-integration achieved through the deployment of proprietary information systems between relevant actors in adjacent stages of the value chain' (Zaheer and Venkatraman, 1994: 549). Similarly, in the current paper, electronic integration is defined as a vertical relationship through a highly relation-specific IT system that constitutes one type of hybrid governance mode (see also Macher, Mowery, and Simcoe, 2002; Mukhopadhyay and Kekre, 2002).

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fully developed (Fulk and DeSanctis, 1995; Henderson and Venkatraman, 1994). Even with the widespread recognition of the importance of IT systems on organization structures, little research attention focuses on the specificity and heterogeneity of IT systems that are currently in use. As a result, the extant research literature presents seemingly contradictory empirical results, and research studies have produced few clear and reliable generalizations (Attewell and Rule, 1984; Brynjolfsson *et al*., 1994). Thus, in order to analyze the relationships between IT systems and governance, the characteristics of IT systems and the characteristics of transactions need to be examined simultaneously in a systematic way.[2] Our primary objective in the current paper is to develop theoretically grounded propositions concerning the strategic importance of firm-specific IT (unilateral investment) systems, and relation-specific IT (bilateral investment) systems and their governance effects on the boundary of the firm.

By adopting contractual economic perspectives on IT systems and governance, the current paper examines the role of information attributes and the role of IT systems in changing firm boundaries and inter-firm relationships. For this purpose, the current paper draws from research literatures on *information economics, transaction costs theory*, and *dynamic resource-based theory*. First, information economics considers the economy as a system of structured information flows and provides the relative economic efficiency of the firm in terms of information searching, information transferring, and information processing (Arrow, 1974). Second, transaction costs theory, which focuses on the degree of various types of asset specificity (Williamson, 1996) and coordination costs (Malone, 1987), provides governance implications for the role of IT systems in changing both efficient firm boundaries and contractual relationships. Third, dynamic resource-based theory extends static cross-sectional explanations of the sources of competitive advantage into dynamic longitudinal explanations of the sources of 'sustainable' competitive advantage (Ghemawat and Levinthal, 2000; Mahoney and Pandian, 1992; Teece, Pisano, and Shuen, 1997).

From these theoretical perspectives, the central strategic question addressed in the current paper is how firm-specific and relation-specific IT systems influence vertical relationships with adjacent value-chain members in search of improved governance and sustainable competitive advantages via superior economic efficiency.[3] This research question is related to the fundamental strategic issue of why and how two independent organizations can effectively coordinate across organizational boundaries in their value-chain activities for economic value creation.

In the current paper, an IT system of a business organization[4] is defined as a computer-based network of information that is needed to create, control, and maintain the organization's transactions efficiently, either within a firm or between firms.[5] An IT system differs in its asset specificity concerning information and technology, and depending on the relative economic costs of switching, IT systems can be categorized into two types: a 'general IT system' or a 'specific IT system' (e.g., firm-specific and relation-specific IT system). Accordingly, it is argued here that when the cost of switching the IT system is high, the investment in either a firm-specific (intra-firm use) IT system or a relation-specific (inter-firm use) IT system constitutes a high sunk-cost commitment—i.e., there is high asset specificity.[6]

[2] In the communication science research literature, Sutcliffe (2001) also provides an integrative framework of 'sense-making' and 'sense-giving' approaches that accounts for outward as well as inward information flows in organization–environment relations.

[3] This economic efficiency approach that is maintained in the current paper (Mahoney, 2005; Peteraf, 1993) contrasts with an alternative 'market power' explanation (Scherer and Ross, 1990), which emphasizes the role of the firm's monopoly power over price.

[4] Current developments of IT systems offer firms access to the following types of information: (1) product: specifications and prices in e-catalogs, and sales history in the data warehouse; (2) customer, sales, and marketing: sales history, forecasts, and promotion for customer relationship management; (3) suppliers and supply chain: contractors, product line and lead times, quality, performance, inventory, and scheduling for supply chain management; (4) production process: capacities, commitments, and product plans for virtual corporations; (5) transportation: carriers, lead times, and costs for just-in-time (JIT) delivery management; and (6) competitors: benchmarking, competitive product offerings, and market share (Lee, 2003: 82).

[5] Rice and Gattiker (2001: 567–571) survey diverse research literatures on the impacts of a computer-mediated communication and information system on 'intra-organizational structures' and 'inter-organizational structures.' In the current paper we adopt a similar approach and examine the governance effects of an *intra-firm IT system* and the governance effects of an *inter-firm IT system*, respectively.

[6] For example, a relation-specific IT system is observed as an exclusive IT-supported network with its proprietary computer software and database system, such as Saturn's real-time automotive management IT system with its member dealerships.

Transaction costs theory views alternative modes of governance—e.g., markets, hybrids, and hierarchies—as clusters of related attributes, on which account governance structures differ from one another in discrete structural ways that are reinforced by distinct institutional arrangements. In a '*discrete structural analysis*' of alternative governance modes, Williamson (1991) emphasizes the difference between first-order economizing—i.e., getting the governance mode right—and second-order refinements—i.e., adjusting at the margins within a governance mode. In a similar vein, the use of an IT system may leverage a firm's capability to do business differently and create new ways to coordinate and influence inter-firm relationships through a *first-order effect* (i.e., a change in governance mode) and *second-order effects* (i.e., changes within a governance mode).

Table 1 shows the definitions of four governance outcomes that are examined in the current paper along with the four corresponding research propositions. Suppose t_1 represents the time of the IT system implementation and the time period of observation is set from t_1 to t_2. Vertical integration is defined as the change of governance mode from the market at t_1 to the firm at t_2, and outsourcing is defined as the change from the firm at t_1 to the market at t_2. Following Williamson's (1991) terminology, these changes are defined as *first-order governance effects* (Proposition 1 and Proposition 3). When the governance modes remain the same, we examine to what extent IT changes the number of employees or the number of suppliers at t_2. Once again, following Williamson's (1991) terminology, these changes are defined as *second-order governance effects* (Proposition 2 and Proposition 4).

Markets and other governance mechanisms provide different information-processing capabilities to the exchange parties (Kambil and van Heck, 1998), and different types of information in the exchange have different governance implications (Jensen and Meckling, 1992). General information, such as the inventory level in retail stores, is characterized as easily codifiable and separable from the information producer. However, it is relatively more difficult or costly to codify or to transfer specific information, such as R&D activities and tacit organizational capabilities (Nelson and Winter, 1982). In the case of general information, due to low switching costs between exchange partners, the market will appear as a dominant governance mode that has often been observed, for example, in the vertical relationship between retailers and commodity manufactures. In the case of specific information, however, the efforts to minimize transaction costs lead to the use of managerial hierarchy as a dominant governance mode that has been witnessed, for example, in vertically integrated automobile manufacturers in the United States (Monteverde and Teece, 1982). In this respect, the *ex post* organization structure of vertically related firms represents an adaptive response to the information attribute of *information specificity*, which characterizes the transactions in question.[7]

[7] Prior research on the effects of IT systems on exchange organizations and processes have focused on the reduction of transaction costs to take advantage of production economies available in markets without consideration for differences in market organization (Bakos and Brynjolfsson, 1993a; Gurbaxani and Whang, 1991; Hitt, 1999). More recent research studies in information systems and finance have examined the impact of IT systems on market institutions (Lee, 1993; Madhavan, 1992, 1995; Kambil and van Heck, 1998; Grover, Ramanlal, and Segars, 1999). For example, Kambil and van Heck (1998) examine successes and failures in the introduction of new IT-based trading mechanisms in the Dutch flower auctions. These research studies have begun to consider the importance of different market types and institutional histories while analyzing how market structure and information flow lead either to fragmentation or to integration. While the outcome characterizations of different market institutions are important, they are not easily generalizable across governance mechanisms. Market organizations, like other governance modes, are information-processing systems that serve to generate or organize information, and to reduce uncertainties and mitigate opportunism risks in the exchange. In the current paper, we consider the information attributes in the exchange as

Table 1. Definitions of vertical integration and outsourcing

	Firm at t_2	Market at t_2
Firm at t_1	Number of employees [Proposition 2]	**Outsourcing** [Proposition 1]
Market at t_1	**Vertical integration** [Proposition 3]	Number of suppliers [Proposition 4]

t_1: IT systems are implemented at t_1.
t_2: Governance effects are observed at t_2.

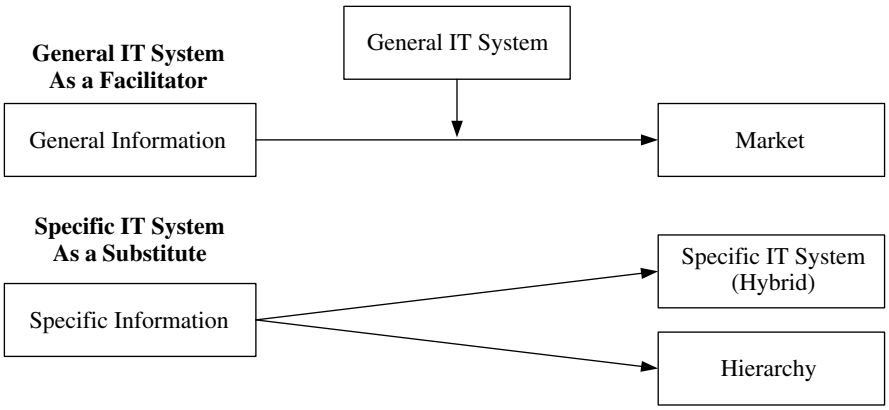

Figure 1. Hypothetical relationships between IT and governance modes

According to Williamson's (1991) *discriminating alignment hypothesis*, governance modes that are between market and hierarchy, such as franchising and equity joint ventures, are often referred to as hybrids. In this respect, electronic integration through a relation-specific IT system can be considered as one type of hybrid governance mode. As presented in Figure 1, it is proposed here that a relation-specific IT system *substitutes* for managerial hierarchy since it changes the current governance mode of market to hybrid (through electronic integration) rather than managerial hierarchy (through vertical integration). Accordingly, *a relation-specific IT system is considered a distinctive governance mode* and thus is viewed here as a task of first-order economizing (i.e., change in governance mode from market to hybrid).[8]

The current paper proceeds as follows. The next section provides a review of related research studies in organizational economics and strategic management. In the following section, theoretical propositions are developed from information economics, resource-based theory, and transaction costs theory. The final section provides discussion and conclusions.

REVIEW OF THE LITERATURE

Information technology is believed to change the method and the capability to search, capture, store, and transfer information, and thereby fundamentally affects the management system and the organization structure (Rockart and Scott Morton, 1984; Sambamurthy, Bharadwaj, and Grover, 2003). With this important change, managing information can be viewed as a critical source of firm capabilities in inter-firm relationships, and, as a result, there has been extensive research in this strategic area.[9]

Coordination costs and vertical integration

Several research studies on IT systems and governance structures in organizational economics and strategic management adopt a coordination costs perspective. Some of these research studies focus on the *information costs* of transacting in terms of search and communications costs

a key construct reflecting the characteristics of different types of transactions.

[8] Compared to previous research studies on the role of a general IT system (Bakos and Brynjolfsson, 1993b; Brynjolfsson *et al*., 1994; Hitt, 1999; Malone, Yates, and Benjamin, 1987), the current paper focuses on the governance implications of a specific IT system when viewed as a sunk-cost commitment—i.e., when viewed as an investment with high asset specificity. Empirical findings in Subramani and Venkatraman (2003) corroborate the importance of relationship-specific investments influencing governance choice.

[9] To be clear, since the current paper focuses on the role of a relation-specific IT system for the strategic intent of attenuating opportunism as a mutual sunk-cost commitment, rather than the role of an IT system on improving information processing between firms, the research literature review here covers and builds on the research studies from this organization economics tradition (Williamson, 1985). Monge and Contractor (2001) point out that the traditional transaction costs approach fails to account for communication and other processes encountered in the exchange, and Zajac and Olsen (1993) propose an alternative three-stage process model that incorporates the communication aspects of exchange relations. These issues, while clearly important, are well beyond the scope of the current paper, which emphasizes the mutual economic hostage attribute of a relation-specific IT system that supports economic exchange and mutual cooperation.

(e.g., Malone *et al*., 1987), while other research studies emphasize the economic *incentive costs* in terms of economic moral hazards and opportunistic behaviors (e.g., Clemons, Reddi, and Row, 1993; Clemons and Row, 1992; Gurbaxani and Whang, 1991).[10] For instance, Malone *et al*. (1987) argue that because IT systems lead to an overall decline in coordination costs in terms of searching and communicating with transacting parties, a reduction in coordination costs without sacrificing potential economic efficiency in production costs will generally favor external procurement over vertical integration. Both Gurbaxani and Whang (1991) and Clemons *et al*. (1993) propose that an IT system reduces transaction risks such as the contractual hazards of shirking and opportunism through improved monitoring and reduced specificity in coordination.

In order to relate these research studies to the research questions of the current paper, it is useful to divide the costs of coordination into two distinct categories: *internal* coordination costs and *external* coordination costs. Internal coordination costs represent the economic costs incurred for communications, data transfer, and other economic expenditures on managing dependencies between activities within a firm. External coordination costs represent the economic costs of locating suppliers, writing contracts, and other economic costs of maintaining market procurement.

An IT system can reduce the economic costs of internal coordination within the firm by improving the quality and speed of information processing and management's decision making, leading to more centralized management. At the same time, an IT system can also provide management with the ability to reduce agency costs through improved monitoring capabilities and evaluation schemes, inducing decentralization of decision making. With respect to external coordination costs, an IT system can directly reduce market transaction costs by providing cost-effective means to access and process market information. An IT system also has the potential to reduce market transaction costs, since it facilitates closer inter-firm links through information sharing and mutual monitoring. Therefore, the efficient boundary of the firm is determined by trading off external coordination costs and internal coordination costs. A cost-effective IT system can reduce external coordination costs and can lead a firm to increase its use of markets. However, an IT system can also reduce internal coordination costs and provide management with the capability to manage a large organization more effectively. Thus, Gurbaxani and Whang correctly note that: 'the net effect of IT on firm size varies from situation to situation, depending on the cost structure of the firm and the modes of synergy generated by integration' (Gurbaxani and Whang, 1991: 71).

Clemons *et al*. (1993) emphasize that an IT system has the capability to lower external coordination costs without increasing the contractual risks associated with market transactions, thus leading to more outsourcing and a less vertically integrated firm (Ang and Straub, 1998; Loh and Venkatraman, 1992). More specifically, lower asset specificity of IT investments and better monitoring capabilities imply that these firms can more safely invest in an IT system for inter-firm coordination than in traditional investments for vertical coordination such as co-located facilities or specialized human resources. Firms are therefore more likely to coordinate with suppliers rather than vertically integrate to reduce the transactional risks. This IT-based coordination also enables these firms to benefit substantially from production economies of large specialized suppliers. In this respect, an IT system as a general-purpose investment has a disproportionate economic effect on reducing the external coordination costs, thereby favoring market procurement.

In sum, the impact of an IT system on vertical integration is determined by the degree to which an IT system changes the economic costs of internal coordination, external coordination, and production. Since production costs are generally believed to be lower for external procurement because of economies of scale and/or specialization, a more vertically integrated firm can be viewed as having accepted higher production costs and internal coordination costs in return for lower external coordination costs. Similarly, a less vertically integrated firm economizes on production and internal coordination costs, but incurs higher external coordination costs.

A related issue in the coordination costs approach is how an IT system affects the number of

[10] In the current paper, we hold that coordination costs consist of information costs (i.e., searching and processing information on suppliers) and economic incentive costs (i.e., managing supplier relations to mitigate the contractual hazards of opportunism).

contractual relationships in the value chain without changing the governance mode of transactions. Conventional economic wisdom suggests that a firm would benefit financially by increasing the number of its suppliers and thereby broadening the range of its choice set. The optimal number of suppliers, however, is limited by organizational and technological considerations,[11] such as the economic costs of searching, setting up, and maintaining the vertical relationship.

Thus, the optimal number of suppliers is determined by trading off the economic costs of further searching against the expected economic benefits from identifying a better supplier. When a buyer can select among many suppliers, as in a spot market, the buyer can secure a low production cost because of production efficiencies and competition, but the buyer must incur relatively high coordination costs in the process. However, a single-supplier relationship restricts the buyer's choice, and the resulting long-term relationship reduces information costs by eliminating the need to search and process information about many suppliers. Consistent with this economic logic, Malone *et al*. (1987) suggest that an IT system will facilitate a move from a single-supplier arrangement to multiple-supplier arrangements, because it reduces the economic costs of external coordination with suppliers.

Several empirical studies have examined these vertical relationships using various statistical approaches. Brynjolfsson *et al*. (1994) find empirical evidence that increased IT investment is associated with decreasing firm size when measured by employees per firm, sales per firm, and value added per firm. Dewan, Michael, and Min (1998) also find that less vertically integrated firms have a higher level of IT investment. Dewan *et al*. (1998) report that the level of IT investment is positively related to the degree of firm diversification, reflecting the greater need for coordination of resources within diversified firms. Hitt (1999) observes that an increased use of IT systems is associated with a substantial decrease in vertical integration, and suggests that the empirical evidence corroborates that the effect of an IT system on lower external coordination costs is greater than the effect of an IT system on lower internal coordination costs.

Previous research studies in the coordination costs approach, however, assume away the asset specificity of IT systems in inter-firm relationships, and thereby ignore the potential economic costs of market transactions that are due to the contractual hazards of economic holdup. Bringing these potential contractual holdup hazards to the foreground of theory, which attempts to explain and predict the relationship between IT investment commitment and the firm's organizational boundary decision, is the purpose of the current paper and we discuss these contractual issues next.

Holdup problems and mutual commitment

Given the prohibitively high economic costs of specifying, monitoring, and enforcing all the elements of economic performance for all possible contingencies, the contracting parties resort to an incomplete contract (Bakos and Brynjolfsson, 1993b; Grossman and Hart, 1986; Kim and Mahoney, 2005). Because *ex ante* difficulties in contracting tend to reduce the completeness of any contract reached, such incompleteness of contracts often forms part of the reason for *ex post* difficulties in managing the resultant contractual relationship (Kim and Mahoney, 2002; Williamson, 1975). Thus, coordination of these *ex ante* noncontractible aspects requires frequent joint decision making through *ex post* renegotiations between the contracting parties.

Previous research studies on the economic costs of renegotiations associated with joint decision making have recognized a specific set of economic conditions under which *ex post* bargaining costs increase. Specifically, at least three sources of bargaining costs have been identified in the organizational economics research literature: a mismatch of negotiation strategies, asymmetric information about contingencies, and uncertainty about each other's preferences (Milgrom and Roberts, 1990). These asymmetries give rise to bargaining behavior that is intended to improve one's own economic position at the expense of the other party's economic position but often erodes the total size of the economic wealth that is to be divided. In particular, coordination between firms involved in the transactions of rare and idiosyncratic resources can be severely hampered by the contractual hazards of

[11] Orlikowski (1992) refers to such considerations as *the duality of technology*, which involves four major research propositions: (1) technology is the product of human action; (2) technology is the medium of human action; (3) institutional conditions provide the context for interaction with technology; and (4) there are institutional consequences of interaction with technology (see also Orlikowski and Barley, 2001).

holdup and can often end up with market failure (i.e., no market exchange).

The potential economic remedies for the contractual hazards of holdup can be classified into two types. The first type of economic remedies intends to achieve a unified control, and the second type of economic remedies intends to build effective economic deterrence to contractual holdup. When specialized assets are required due to interdependency with an adjacent stage of the value-chain, the economic remedy called for is to integrate into the next vertical stage to attain unified control over economically interdependent resources. Such vertical integration, however, is often very costly and is thus likely to be a suboptimal economic solution when the (strategic) resources that the firm wants to acquire are subject to high mobility barriers (Chi, 1994).[12]

When it is too costly to vertically integrate or to eliminate the conditions of interdependency, a firm involved in the transaction of specialized assets might try to build effective economic deterrence to contractual holdup. The key to effective economic deterrence is to give each contractual party sufficient means to respond to any opportunistic behavior by the other contractual party (Williamson, 1985). There will be insufficient economic deterrence, however, if the economic gain that one contractual party can get from opportunistic behavior more than offsets the economic penalty the other can possibly impose. Such an economic situation can be remedied if the favorably positioned contractual party provides the vulnerable contractual party with an economic bond to support exchange (Williamson, 1983).[13] For example, Klein and Leffler (1981) argue that franchisees may be required to make sunk-cost investments in transaction-specific capital as a way to safeguard the franchise system against free-riding and consequent quality shading, which can damage the entire franchise system.

Reciprocity transforms a unilateral relation into a bilateral relationship, where both contractual parties understand that the transaction will be continued only if economic reciprocity is observed. In other words, one way to avoid contractual holdup and to thereby support economic exchange is for the buyer and supplier to devise a mutual reliance relationship. For example, an equity joint venture in which both contractual parties provide substantial amounts of sunk-cost investment can be considered as a mutual sunk-cost commitment. Thus, a mutual commitment can serve to equalize the risk exposure of the contractual parties, and thereby reduce the economic incentive of any contractual party to behave opportunistically in the exchange process *ex post*.

In sum, Williamson's (1983) economic '*hostage model*' examines a market transaction in which self-enforcing contracts (Klein, 1985; Telser, 1980) involve credible mutual (sunk-cost) commitments. One way to avoid market imperfections is to expand the contractual relationship by devising a mutual reliance relationship, in which the potentially opportunistic contractual parties reciprocally invest in relation-specific assets that have economic value only in the market exchange in question. If the non-salvageable economic value of the (sunk-cost) commitment is substantial for both the buyer and the supplier, an efficient exchange outcome is to be (justifiably) expected.[14]

The key theoretical proposition offered in the current paper is that *ex ante mutual sunk-cost investments in a relation-specific IT system undertaken by vertically-related firms result in an improved governance mode to complete the transaction efficiently as an economic remedy for the ex post contractual hazards of holdup*. In other words, reciprocal exposure to commit credibly to the contractual agreement is accomplished through sunk-cost investments in a relation-specific IT system in which high switching costs are strategically incurred if any attempt is made to change contracting parties or to renegotiate contracts opportunistically.

Property rights and co-location

The modern property rights approach elaborated by Grossman and Hart (1986) and Hart and Moore

[12] The economic benefit of unified control may still be partially attained through quasi-integration—i.e., the extension of a firm's control rights to a subset rather than all of the assets employed in a vertically related operation (Monteverde and Teece, 1982). However, when there still exists significant asset interdependency between the two contractual parties under such an arrangement, quasi-integration can only reduce but cannot completely eliminate the contractual hazards of holdup.

[13] Contrary to legal centralism, Williamson (1983) refers to such a contract as a 'private ordering' where reliance on third-party enforcement is minimal.

[14] We provide a game-theoretic illustration of Williamson's (1983) mutual economic hostage model in the Appendix to the current paper.

(1990)—sometimes referred to as 'GHM models'—provides a formal framework for analyzing the distribution of control rights (Kim and Mahoney, 2002). As in transaction costs theory, GHM models assume that contracts are necessarily incomplete in the sense that the allocation of control rights cannot be specified *ex ante* for all future states of the world. In the presence of positive transaction costs, control over the productive assets cannot be affected through contractual stipulation alone, and economic efficiency depends on the ownership of the asset.[15] According to GHM models, it is the control rights that determine the boundary of the firm, where a firm is defined as a jointly determined bundle of property rights.

In GHM models, the distinction between an inter-firm contract and an intra-firm contract turns on who owns the physical assets that are necessary for the transaction. An independent contractor typically owns his physical assets that are alienable while an employee within a firm typically does not own the physical assets. The economic importance of asset ownership derives from the fact that the willingness of an agent to undertake a non-contractible investment in human capital that is specific to the asset depends on who owns the asset. The economic allocation of the residual rights of control also has an important economic effect on the bargaining position to the contract since a contractual party that owns the essential asset will be in a favorable bargaining position to capture the economic benefit from the transaction by threatening to withhold the asset. According to Hart and Moore (1990), in order to avoid under-investment problems, the contractual party who is to make the most economically important non-contractible and asset-specific investment in human capital should own the asset.

Complementing research studies in the transaction costs approach (Williamson, 1985), modern property rights theory provides a clear definition of the boundary of the firm in terms of asset ownership, and provides a theoretical direction for answering the question of who should integrate with whom. From the property rights perspective, integration, quasi-integration, and deterrence-building activities all aim to achieve an economically efficient assignment of control rights. Economic efficiency depends on ownership and/or ready-access to the relevant assets.[16]

Importantly, for the purposes of the current paper, the GHM models have been extended to the study of information assets (Brynjolfsson, 1994). Brynjolfsson (1994) examines a setting where production requires the use of physical and information assets, focusing on optimal allocation and ownership of these assets. This approach enables us to examine how different levels of the alienability and contractibility of the information assets affect the investment of other assets, thereby influencing inter-firm governance.[17]

When we consider two complementary assets of production—information assets and physical assets—economic incentive considerations prescribe that it is optimal to give the informed party ownership of the physical assets of the firm necessary to the production activity. If the information is not completely essential to the productivity of the physical assets, then giving the informed party ownership of the physical assets will reduce the economic incentives of the other party. Whether this reduced economic incentive is outweighed by the improved economic incentives to the informed party will be a function of how necessary the information is to the productivity of the firm, and how important it is to maximize the economic incentives of the informed contractual party relative to those of the other contractual party.[18]

When we treat information as an alienable asset, and thus the ownership of the information can be separated from the current owner, we can consider

[15] Following legal convention, ownership is defined as the possession of residual rights of control, which are the rights to decide the uses of assets under contingencies that are not specified precisely in the contract. In other words, all residual rights to an asset not expressly assigned in the contract accrue to the party who owns the asset.

[16] This property rights interpretation is similar to the effect of residual rights of control over valuable assets, where the concept of residual control rights incorporates not only an ownership title but also effective *decision rights* that each contractual party holds in making and implementing strategic decisions for economic value creation from the relevant resources (Kim and Mahoney, 2002).

[17] For example, Wal-Mart generates and possesses exclusive data on customers and sales via its point-of-sales (POS) scanning system. This information is separable from Wal-Mart in a digital format, and can be shared with the vendors who use the information for improved production scheduling and inventory replenishment.

[18] This interpretation is consistent with the propositions by Hart and Moore (1990) that an agent who is indispensable to an asset should own that asset, and that the same agent should own the complementary assets when writing a complete contract is not feasible.

an alternative of giving the other contractual party ownership of both the physical assets and the information. *If the economic value created under this alternative ownership structure is quite large, economic incentives for IT investments in ways to make information alienable will be strong, leading to new approaches to the organizational challenge of co-locating information and decision rights.*

Jensen and Meckling (1992) provide a useful framework for studying the complementarities between information assets, decision rights, and economic incentive structures in organizations. According to Jensen and Meckling (1992), informational variables are key to the structure of organizations because the quality of decisions is determined by the quality of information available to the decision maker, and therefore the co-location of pertinent information and decision rights enables the decision maker to make optimal economic decisions. The co-location of pertinent information and decision rights is achieved because markets function on the basis of alienable rights. Thus, alienability assures the maximization of economic values from the assets, and lack of co-location between decision rights and pertinent information yields decisions that are hampered by poor information.

Jensen and Meckling (1992) propose that there are two ways to bring information and decision rights together: *the IT solution*, which transfers the information required for the decision to the decision maker, using the IT systems, or *the organizational redesign solution*, which redesigns the organizational structure so that the decision-making authority is where the pertinent information is located.[19] The implementation of this co-location depends on the nature of the pertinent information. By definition, general knowledge that is useful for a decision, calls for the IT solution because it can be transferred at low cost. In contrast, when specific knowledge plays a key role in a decision, the best solution calls for restructuring decision rights so as to provide the decision authority to the one who possesses or has access to the pertinent information since the transfer of specific knowledge is too costly. All the other things being equal, we can represent the structure of organizations as an efficient response to the structure of their information costs. In particular, if an IT system changes the costs of processing and transferring certain types of information, then an IT system can change the structure of organizations by facilitating certain information flows as well as by turning knowledge that used to be specific into general knowledge.

To sum up, the GHM approach to identifying the determinants of vertical financial ownership emphasizes the central role of non-human assets. Brynjolfsson (1994) treats information assets, specifically the productive information of the agents, on an equal footing. An IT system affects the organizational structure of vertical relationship by changing the distribution of information across organizations and the nature of information assets. Making necessary information alienable improves economic incentives by making new ownership patterns feasible. In order to achieve co-location of pertinent information and decision rights, the IT solution and the organization redesign solution interact with each other. However, co-location has the potential for creating an economic incentive problem, since the economic interests of the informed contractual party are seldom served in ways that correspond perfectly with the economic interests of the other contractual party in its entirety. Hence, the organization of firms can be understood as an attempt to locate decision rights so as to minimize the sum of the economic costs arising from poor information and economic incentive problems. To understand the impact of IT systems on governance, the economic incentives of management and the contents of information should be examined simultaneously.

Resource complementarity and co-specialization

One of the challenges to the earlier optimism concerning an IT system's potential for creating sustainable competitive advantage is developed in resource-based theory (Barney, 1991; Mahoney and Pandian, 1992; Mata, Fuerst, and Barney, 1995). Whereas strategy research in the industrial organization (IO) tradition has focused on advantages derived from industry and competitive positioning, the resource-based approach has focused on competitive advantages stemming from firm-specific, intangible resources (Hall, 1993; Itami and Roehl, 1987). According to resource-based theory, unlike product attributes and strategic positions, which competitors can often replicate, or

[19] The IT solution is usually associated with centralization of decision rights, while the organization redesign solution has earlier roots and usually favors some forms of decentralization.

render obsolete, unique resources tend to be protected by isolating mechanisms such as resource complementarity and causal ambiguity, offering sustainable competitive advantage (Rumelt, 1984; Wernerfelt, 1984). Focusing on the relationships between firm-specific resources and sustainable competitive advantage, resource-based theory advances two key premises. First, firms are heterogeneous with respect to their resources and organizational capabilities on which they base their strategies. Second, the resources and organizational capabilities are not perfectly imitable across firms, resulting in sustained heterogeneity (Peteraf, 1993).

In the early resource-based contributions, there was little explicit distinction between resources and capabilities,[20] although Amit and Schoemaker (1993) suggest that resources are assets that either are owned or controlled by a firm, while capabilities refer to the firm's ability to utilize and combine resources through organizational routines in order to accomplish its objectives. Teece *et al*. (1997) offer a comprehensive framework of the concept of dynamic capabilities that reflects a firm's capabilities to achieve new and innovative forms of competitive advantage. These dynamic capabilities include organizational and managerial processes, specific asset positions, and path dependencies, 'that which is distinctive cannot be bought and sold short of buying the firm itself, or one or more of its subunits' (Teece *et al*., 1997: 518).

In a resource-based analysis of an IT system and firm economic performance, Clemons and Row (1991) advance *a commodity view of an IT system*, arguing that competitive imitation eventually erodes most IT-based advantages, and that above-normal returns to the IT investment eventually vanish. Clemons and Row conclude: 'Examples of using information technology to achieve sustainable advantage through either barriers to imitation or first mover advantages do exist, but they are far less common than a trusting first scan of the MIS literature would imply' (Clemons and Row, 1991: 278).

[20] The earlier resource-based approach is often called the *Ricardian resource-based view*, emphasizing heterogeneity of resources that have differential productivity (Peteraf, 1993). As Mahoney (1995) points out, this Ricardian perspective has been complemented by the Schumpeterian perspective that is often called the *dynamic-capabilities view*, emphasizing the importance of capabilities embedded in the organization and its processes.

The notion that IT systems *per se* do not generate sustainable competitive advantages has received increasing support in recent IT research, and has produced a perspective known as *the strategic necessity hypothesis* (Kettinger *et al*., 1994; Powell and Dent-Micallef, 1997; Tippins and Sohi, 2003). This hypothesis consists of two research propositions: (1) IT systems provide economic value to the firm by increasing coordinating efficiencies, and thus firms that do not adopt IT systems will have higher cost structures; and (2) firms cannot expect IT systems to produce sustainable competitive advantages because most IT systems are readily available to all competitors in competitive factor markets.

According to this strategic view, firms would appear to have only three feasible paths to IT-based competitive advantage: (1) reinvent IT advantages perpetually through continuous, leading-edge IT innovation; (2) move first and develop isolating mechanisms for first-mover advantages; and/or (3) embed IT systems in organizations in such a way as to produce valuable resource complementarity (Bharadwaj, 2000; Powell and Dent-Micallef, 1997; Santhanam and Hartono, 2003). The first two paths, however, have proven insecure. Perpetual innovation may hypothetically produce sustainable competitive advantages, but these advantages confront ever-shortening IT development cycles. Efforts to achieve first-mover IT advantages seem more promising, particularly those involving proprietary systems to utilize firm-specific strengths or opportunities. However, as the case studies illustrate (Westland and Clark (1999) for example), IT systems developed and deployed only within a single firm often become liabilities over time and generally provide temporary advantages to the firm. But IT systems that create linkages and interdependencies outside of a single organization can become difficult for competitors to duplicate as a whole. Furthermore, if the adopted inter-organizational IT system is incompatible with alternative contracting parties, it is even more difficult to duplicate and the competitive advantage achieved from the IT system could be sustained. Thus, resource-based theory focuses on resource complementarity as the most likely path for achieving an IT system advantage (Keen, 1993).

In sum, the 'resource-based' strategic necessity hypothesis does appear to fit the emerging empirical evidence (Levy and Murnane, 1996;

Powell and Dent-Micallef, 1997), and its resource-based origins provide a solid theoretical foundation for investigating the conditions under which an IT system may produce sustainable competitive advantage. Particularly, the resource-based theory points toward a co-specialization perspective (Teece, 1986) that emphasizes the possibility of sustainable competitive advantages arising from strategically combining firm-specific IT systems with other complementary firm-specific resources within the firm.

THEORY AND PROPOSITIONS

Intra-firm use of IT and governance effects

One of the traditional assumptions of neoclassical microeconomic theory is that of perfect information—i.e., information that is equally available to all market participants at zero transaction costs. Much of the early work done in information economics challenged this neoclassical economics assumption by considering the economic costs of attaining information, and by exploring the economic problems concerning information asymmetries among market participants (Alchian and Demsetz, 1972; Spence, 1973). Alchian and Demsetz (1972: 793), for instance, suggest that internal organization possesses informational advantages over market interactions: 'the firm serves as a highly specialized surrogate market. ... The employer, by virtue of monitoring many inputs, acquires special superior information about their productive talents ... Opportunities for profitable team production by inputs already within the firm may be ascertained more economically and accurately than for resources outside the firm. Superior combinations of inputs can be more economically identified and formed from resources already used in the organization than by obtaining new resources (and knowledge of them) from the outside.' [21]

Arrow (1974) considers the uncertainty of information as a fundamental driver of market frictions and one of the driving economic forces behind the formation of managerial organizations: 'Organizations are a means of achieving the benefits of collective action in situations in which the price system fails ... There is one particular failure of the price system to which I want to stress, one that is absolutely central to the understanding of organizations. I refer to the presence of uncertainty' (Arrow, 1974: 33) and 'the organization as a processor of information ... the scarcity of information-handling ability is an essential feature for the understanding of both individual and organizational behavior.' (Arrow, 1974: 37).

Coupled with Coase's (1937) transaction costs theory,[22] Malmgren (1961) extends the earlier information-costs view in order to examine the economic rationale of decentralized decision making in a market economy. In the information-costs view, the transaction costs of using the price mechanism are mostly costs of searching, acquiring, and processing information on relevant sets of events. If there are non-trivial transaction costs of searching, acquiring, and processing information on the events, particularly in a market where transactions are heterogeneous and the search for a buyer or seller may be lengthy, there may be an economic incentive to combine a number of events or activities into one bundle by arranging long-term contracts. Malmgren notes that: 'As a result, events would be made to behave according to plan, in the sense that closely allied activities are isolated from the market and balanced one against another in a planned system' (Malmgren, 1961: 402).

Malmgren's (1961) focus centers on the interaction between information and uncertainty concerning the current and future states of events and that the task of management is to achieve '*converging expectations.*' The firm predicts the costs of production of its commodities better than the market could over its set of economic activities by eliminating the divergence of expectations that may arise when interdependent decisions are taken by independent decision makers. It is because of the lack of information on a range of events that firms

[21] Williamson (1985) also argues that information about production costs is more reliably obtained within the rubric of authority than in communication between autonomous market agents, and that, by comparison with the firm, markets lack a rich and common rating language. Similar language and communication issues are discussed by Nelson and Winter (1982), and in research studies in the communication science literature (Fulk and Collins-Jarvis, 2001; Rice and Gattiker, 2001).

[22] Coase (1937) emphasizes the transaction costs of using the price system—in particular, that of discovering the relevant prices—and argues that transactions can sometimes be undertaken more cheaply by replacing a set of separately negotiated economic exchanges with a long-term contract in which one party is given the right to determine the use of the resources of the others without repeated renegotiation of the terms of the exchange.

are put together, where long-term contracts and regulated markets for clearly defined services can be developed. Therefore, multi-person and multi-process firms arise in a market economy for a number of reasons corollary to the existence of information costs. This organizational choice of the firm, in turn, provides a large amount of '*controlled information*'—not only are a number of events predictable over the duration of the entire production plan, but also less information is required to describe that set of events for coordination and control purposes.

More recently, Putterman (1995) argues that firms often have a comparative advantage both in recognizing and in eliciting differentiation of input characteristics, and that these informational advantages of firms are a product of their capability to support long-term association by providing for mutually beneficial sharing of the information and the economic rents of joint production by suppliers of co-specialized resources. Putterman (1995) points out that, when detailed resource characteristics cannot be ascertained except through prolonged use, resource owners will be unable to represent themselves credibly in the market as possessors of specialized resources. In this economic situation, market trade will tend to be restricted to resources with easily ascertained qualities, and to uses in which the precise type is unimportant. For these economic and strategic reasons of resource specificity and information asymmetry, the firm will typically be associated with richer resource knowledge than the market under such business circumstances.

The logic of the information advantage of the firm over the market is sustained when it is applied to explain the role of an IT system on governance choice. As suggested in the information economics literature, when the use of a firm-specific IT system can successfully reduce the information costs for its internal transactions within a firm, it further facilitates the firm's creation of converging expectations and controlled information internally. In this case, in order to utilize and enhance its information advantage through developing converging expectations and controlled information, firms will not pursue outsourcing but rather will increase internal transactions based on the use of a firm-specific IT system.

Proposition 1a: (Controlling for the initial governance mode being the firm) Increases in information specificity in intra-firm transactions encourage the use of a firm-specific IT system.

Proposition 1b: (Controlling for the initial governance mode being the firm) The use of a firm-specific IT system within a firm is negatively related to the degree of outsourcing.

In its treatment of IT-based advantages, resource-based theory emphasizes sustainability protected by resource complementarity and co-specialization (Teece, 1986). Resource complementarity represents an enhancement of resource value that arises when a resource produces greater economic returns in the presence of another resource than the resource does in isolation. Complementary resources are co-specialized if one resource has little or no economic value without the other bilaterally.

The current paper extends the idea of complementary resources to the development of dynamic capabilities of the firm through co-specialization of an IT system and unique resources. Accordingly, we propose that in order to be a source of sustainable competitive advantage, a firm-specific IT system requires complementary investments for co-specialization with other firm-specific resources, such as IT trained employees or IT-supported distribution networks, leading to an increase in the scale of operation conducted within the firm.

According to resource-based theory, a complementary interaction between firm resources typically enhances the economic value for both complementary resources. For example, an Electronic Data Interchange (EDI) system may enable a firm to enhance its procurement activities, while the pre-existing routines maximize EDI's inherent information-sharing capabilities.[23] Thus, even a commodity resource such as an off-the-shelf EDI system, if combined with management processes, can become an embedded, mutually reinforcing rent-generating resource (i.e., property rights) bundle. Therefore, a firm-specific IT system, as a result of a sunk-cost investment to develop a co-specialized IT system with critical complementary

[23] Electronic Data Interchange (EDI) is the inter-organizational exchange of business documents in structured, machine-readable form, typically between independent application systems. 'An EDI implementation consists of at least the following components: (1) An on-line network for communication of messages; (2) Standards for message format; (3) Software for translating to and from the EDI formats; and (4) An interface with other information systems' (Benbasat *et al*., 2003: 50–51).

resources, satisfies resource-based criteria for sustained competitive advantage—i.e., firm-specific, tacit, idiosyncratic, and embedded in the organization—and thereby constitutes a dynamic capability of the firm (Teece *et al*., 1997).

In the information systems research literature, Zaheer and Venkatraman (1994) provide a comparative analysis of the impact of general vs. specific inter-organizational information systems (IOS) on performance. Zaheer and Venkatraman (1994) point out that the impact of an IT system in a setting characterized by a common IOS infrastructure is significantly different from a setting characterized by one or more proprietary IOS. In the case of proprietary IOS, individual firms commit resources to create firm-specific IT-based capabilities, and such dynamic capabilities provide enhanced opportunities for restructuring their relationships with chosen business partners. However, within a common IOS, since all firms have the opportunity to use the same IOS capabilities, the extent of technology-generated competitive benefits is limited.

From the empirical investigation of the role of IT systems in the retail industry, Powell and Dent-Micallef (1997: 395) conclude that: (1) an IT system (as a commodity product) has become pervasive and relatively easy to acquire in competitive factor markets; (2) most retailers have not merged IT systems with the requisite human and business complementary resources; (3) IT systems do not merge themselves automatically with human and business resources; and (4) the more economically valuable the resource complementarity, the more difficult it is to achieve. Although the industry has invested sufficiently in IT systems, only those firms that merged IT systems with complementary resources, particularly firm-specific resources, could gain IT-related advantages. In a similar vein, Kettinger *et al*. state that: 'the information resources of a firm must be driven by business strategy and integrated into the product and process dimensions of the enterprise based on an understanding of core competencies' (Kettinger *et al*., 1994: 50).

Levy and Murnane (1996) support the strategic necessity hypothesis by examining the impact of computers on skill demands in the banking business in two channels, changes in the numbers of different occupations and changes in the content of individual occupations. The empirical evidence shows that computerization has increased the bank's demand for college graduates. Levy and Murnane (1996) note that an increased demand for skilled labor means redesigning the jobs themselves to maintain the interest of higher-skilled workers, and that simply computerizing a job does not redesign it automatically.[24]

In sum, sustainable IT-based competitive advantage depends on utilizing *relationships among complementary resources* to create a co-specialized firm-specific IT system as a dynamic capability of the firm. Thus, if an IT system alone is not enough and should be supplemented with complementary assets for a co-specialized IT system to achieve sustainable competitive advantages, we can expect to observe an increase in the complementary assets—particularly human resources—with an increased use of IT systems.[25] This prediction is also consistent with the prediction based on transaction costs theory, since an internal IT system can facilitate the use of the firm (first-order economizing) if the IT system is highly specific to its internal use, favoring disproportionately internal coordination over external coordination. This economic efficiency gain occurs when a highly firm-specific IT system is embedded in the organizational process through a co-specialization investment with other firm-specific complementary resources, such as human resources. In this business case, this firm-specific IT system contributes to an increased scale of operations, in terms of the number of employees (a second-order refinement). This theoretical development leads to the following proposition:

> *Proposition 2: (Controlling for the initial governance mode being the firm) The use of a firm-specific IT system within a firm is positively related to the number of employees of the firm.*

[24] Advocating a more 'human-centered information management' in practice, Davenport also recommends that IT systems need people to make them productive because 'Most of the information in organizations—and most of information people really care about—isn't on computers. Managers prefer to get information from people; people add value to raw information by interpreting and adding context' (Davenport, 1994: 122).

[25] For example, if GM's CAD system is highly specific to GM's own product line with its skilled employees but it can not be extended efficiently into the parts production of outside suppliers, GM may increase its internal production of required parts without relying on independent suppliers in order to maximize the potential economic benefits of co-specialization of GM-specific CAD systems with its skilled employees.

Inter-firm use of IT and governance effects

Following Brynjolfsson (1994), we treat the information as an economic asset that the contracting parties own but that can be alienable at different costs. Depending on its alienability, information can be embodied either in employees, like knowledge and skills, or codified like documents and files. In addition, some information, such as inventory and shipment data in the retail industry, is fairly contractible. Advancement in IT systems has led to the creation of numerous alienable and contractible information assets, allowing new economic and strategic approaches to the organizational problem of co-locating pertinent information and decision rights for superior decision making.

When the information can be made alienable, it is natural to consider single ownership of both the physical assets and the information. In certain business situations, it may be more economically efficient to move the information asset than to shift ownership of all the physical assets to the informed contractual party. Sometimes, however, it may be difficult or costly to transfer the critical information to the other contractual party, not only because of difficulties in codifying and transmitting this information, but also because of economic incentive problems in trading this information (Arrow, 1974). However, economic incentives for advancing an IT system in ways that make information alienable will be strongest if the economic value of alienability is high.[26]

Many early applications of computers have focused on internal systems rather than inter-organizational systems. If the IT system reduces the economic costs of external coordination more than that of internal coordination, however, we would expect to see firms buying more items externally. In this case, the degree of vertical integration should decrease (Dewan *et al*., 1998; Hitt, 1999). Therefore, without considering the characteristics of the IT system in the business context, we cannot predict which effect predominates and whether a resulting shift is of an economically substantive magnitude. In other words, the efficient boundary implication of an IT investment depends on the characteristics of the information and the technology in question.

In the case of a standardized general IT system, once a firm implements an IT system, it can extend its economic benefit by reproducing the IT system in another transaction at marginal costs.[27] There could be even more potential to reproducing it with another contracting party in market transactions at marginal costs, especially in the case of a standardized general IT system with wide use. In addition, the firm is able to access alternative contracting parties with a superior production system, thereby reducing its production costs. Therefore, due to more applicability of a general IT system along with positive network externalities, mostly through standardization, we expect that an accelerated decrease of external coordination costs leads to less vertical integration. In other words, with a general IT system, the lowered external coordination costs will outweigh the lowered internal coordination costs, leading to more extensive use of the market, which is consistent with the coordination costs explanations.

However, the contribution of the current paper is to make clear that when the IT system used in the market transaction is highly relation-specific to the contractual parties, the coordination costs logic with a general IT system no longer applies. The dilemma of providing economic incentives to the contractual parties when the contract is incomplete can be mitigated if those contractual parties are assured a significant share of the output they produce by providing them with the *ex post* bargaining power inherent in asset ownership in terms of the residual rights of control. As shown by Holmstrom and Milgrom (1994), efficient contracting requires the removal of certain decision-making discretion from an agent when it is too expensive to provide the right economic incentive via residual claimancy for the agent to refrain from costly opportunism.

[26] If information can be made fully contractible, then there are no residual rights and thus the ownership approach of the information is economically irrelevant. The same party who owns physical assets does not need to control the complementary information because there is no longer a potential contractual holdup problem. Thus, making information alienable improves economic incentives by making a new ownership pattern feasible, but it still falls short of the best economic solution since any contractual party not getting control of the alienable information asset is potentially subject to contractual holdup (Brynjolfsson, 1994).

[27] As Shapiro and Varian (1999: 21) point out, one of the key characteristics of information is that 'information is costly to produce but cheap to reproduce.'

Masten (1988) suggests that the economic problem of optimal contracting in the case of contractual holdup can be formulated as one of minimizing the expected economic value dissipation resulting from the two parties' contractual holdup activities. Since the two contracting parties in general both have the potential to engage in *ex post* opportunism, the assignment of residual control needs to balance the economic holdup hazards posed by both contractual parties. Since a given contractual holdup hazard can often be lowered by removing or reducing the potential offender's control over certain decisions, we can expect that a contractual party will be given less residual control when that contractual party could pose a particular contractual holdup hazard.

From the property rights perspective, an IT system affects the efficient boundary choice of the firm both through its impact on the distribution of asset ownership and the nature of the information. In principle, the best economic incentives can be achieved either through the centralization of information and asset ownership by one party when the information is alienable without any potential holdup problems, or through decentralization of information and economic assets when the information can be made contractible. As the information becomes well specified and understood by both contractual parties with precise terms based on a relation-specific IT system, which is superior to a general IT system in its contractibility, we can expect improved economic incentives and consequently improved economic value creation. In other words, with improved contractibility from using this relation-specific IT system, contractual parties can achieve superior vertical coordination efficiently without acquiring full control over the whole operation through vertical integration. This economic outcome is possible because firms can access critical information through information sharing based on a relation-specific IT system, such as a Vendor Managed Inventory (VMI) system between Wal-Mart and P&G. Without resorting to vertical integration, electronic integration based on a relation-specific IT system provides an alternative governance mode as a distinctive hybrid organizational form. This logic leads to our *substitution hypothesis*:

> *Proposition 3: (Controlling for the initial governance mode being the market) The use of a relation-specific IT system between firms is negatively related to the degree of vertical integration.*

As far as the number of contractual relationships is concerned, the coordination costs approach suggests that the optimal number of suppliers is determined by trading off economic costs of further searching and managing new suppliers against expected economic benefits from identifying a better supplier, and that the 'make vs. buy' decision can be seen as an economic trade-off between production and coordination costs (Bakos and Brynjolfsson, 1993a). Controlling for the specificity of the IT systems to be low universally, Malone *et al*. (1987) argue that an IT system will facilitate a move from a single-supplier arrangement to multiple supplier arrangements, because it reduces the economic costs of coordination with suppliers, especially by lowering the economic costs of acquiring information. However, there has been empirical evidence that firms tend to rely on fewer suppliers (Johnston and Lawrence, 1988). In addition, one empirical study found that the average number of suppliers in the automobile industry decreased by 25 percent between 1983 and 1988 (Helper, 1991). These 'anomalies' are both explained and predicted by the revised theory of the current paper that considers the role of IT systems as mutual sunk-cost commitments.

Many scholars suggest that the governance of inter-firm exchanges involves more than formal contracts. Inter-firm exchanges are typically repeated exchanges embedded in social relationships, and governance emerges from the values and agreed-upon processes found in those relationships that may minimize transaction costs as compared to formal contracts (Dyer and Singh, 1998; Poppo and Zenger, 2002). For such relational contracting, the enforcement of obligations, promises, and expectations occurs through social processes that promote norms of flexibility and information exchange. Flexibility facilitates adaptation to unforeseeable events while information exchange facilitates coordination and problem solving because both the supplier and buyer are willing to share proprietary information with one another, including short-term and long-term plans and goals.

However, transaction costs theory suggests that a potential contractual hazard of working with few suppliers with highly specific assets is the higher

contractual risk that these suppliers will behave opportunistically and hold up the buyer. If the IT investment is not likely to be relationship-specific, the risk of opportunistic behavior inherent in this interdependency situation can be alleviated, and this difference enables firms to work with fewer suppliers since the IT system reduces the information costs but does not increase the economic incentive costs. In other words, if the IT investment is *ex post* transferable to other equally valuable uses or can be contractually specified *ex ante*, the appropriate number of suppliers is determined by production costs. On the other hand, if the IT investment is *ex post* specific and non-contractible, the firm will need to limit the number of suppliers employed in order to convince these suppliers that the economic return on their investments will not be expropriated in *ex post* bargaining.

When the investment is *ex post* specific, reciprocal efforts of economic remedies to build effective deterrence to holdup can enhance mutual economic benefits for both contractual parties. Telser (1980) describes this economic situation as a self-enforcing agreement while Williamson (1983) emphasizes the dyadic governance structure of the investment as mutual economic hostages to support economic exchange. Likewise, mitigating contractual hazards can be achieved if each contractual party invests in a relation-specific IT system jointly, thereby constituting a bilateral self-enforcing contract (i.e., a first-order effect), whereby commitment to a small number of core suppliers (i.e., a second-order effect) will be a superior governance choice leading to a long-term cooperative relationship.[28]

Proposition 4: (Controlling for the initial governance mode as the market) The use of a relation-specific IT system between firms is negatively related to the number of suppliers of the firm.

Table 2 summarizes the propositions developed in the current paper with respect to the relationships of IT systems and resulting governance effects.

DISCUSSION AND CONCLUSIONS

The development of effective cooperative relationships is becoming increasingly important for economic value creation, and the importance of

[28] As widely discussed in the management literature, norms of flexibility, information sharing, and mutual commitment thus help circumvent the potentially high costs of exchange hazards (Granovetter, 1985; Jones, Hesterly, and Borgatti, 1997). From the relational contracts perspective, mutual sunk-cost commitment to a relation-specific IT functions to mitigate the exchange hazards through the social processes and the resulting norms. The expectations of continuity that accompany relational governance generate economic incentives to invest in the relation-specific assets. These sunk-cost investments are protected by the mutually imposed costs of termination. Similarly, expectations of longevity minimize the need for precise performance measurement in the short run because the contractual parties expect that short-term inequities will be corrected in the long term. Finally, norms of cooperation and mutual adaptation developed through the use of the relation-specific IT system provide the flexibility to cope with inevitable uncertainties that arise in an economic exchange.

Table 2. Summary of the propositions

	Firm t_2	Market t_2
Firm t_1	Number of Employees ↑ **Proposition 2** (Co-specialization with firm-specific resources) Second-order effect (Changes within a governance mode)	**Outsourcing** ↓ **Propositions 1a and 1b** (Converging expectation and Controlled information) First-order effect (Change in governance mode)
Market t_1	**Vertical integration** ↓ **Proposition 3** (Electronic integration through a relation-specific IT system) First-order effect (Change in governance mode)	Number of suppliers ↓ **Proposition 4** (Mutual sunk-cost commitment to core suppliers) Second-order effect (Changes within a governance mode)

t_1: IT implementation observed.
t_2: Governance effects observed.
Proposition 1 and Proposition 3 indicate first-order effects.
Proposition 2 and Proposition 4 indicate second-order effects.

this business phenomenon is reflected in the growing academic research interest concerning cooperative relationships between vertically related firms. Previous research studies on vertical relationships have demonstrated that close supplier–buyer relationships can become valuable assets, and a central theme of this research concerns the interdependence of exchange partners seeking sustainable competitive advantage (Blankenburg Holm, Eriksson, and Johanson, 1999). The current paper emphasizes that to achieve effective cooperative relationships both suppliers and buyers must make substantial mutual sunk-cost commitments that require a long-term perspective for developing mutually advantageous business relationships. Furthermore, strategic sunk-cost investments for the development of long-term vertical relationships with exchange partners have organizational impacts concerning the resulting governance modes.

In the current paper, we examine the phenomenon of inter-firm cooperation that leverages IT capability—that has been previously described in the research literature as *electronic integration* (Zaheer and Venkatraman, 1994) within a broader continuum of electronic markets and electronic hierarchies (Malone *et al*., 1987). The current paper is believed to be timely and useful especially when we survey recent empirical findings directly related to this business phenomenon. For example, Bensaou (1997) tests the influence of the use of an IT system on buyer–supplier relationships in the context of the U.S. and Japanese automobile industries. According to Bensaou (1997), U.S. auto-manufacturers are believed to become the electronic coordinator of an IT-mediated production network, typically purchasing more core components from outside, thus reducing its level of vertical integration and at the same time reducing its total number of suppliers. The emerging strategic relationships involve higher levels of cooperation via electronic JIT, with a strategic intent to replicate the Japanese JIT system. As this new inter-firm relationship corresponds to more cooperative governance, Bensaou (1997) predicts that the use of an IT system supports greater inter-firm coordination by increasing information-processing capabilities and by reducing task uncertainty.

The empirical results, however, show that the use of a general IT system does not play the key role in cooperation across firm boundaries in the automobile industry. The association is not significant, especially in the U.S. sample, even though, in absolute terms, U.S. manufacturers rely more heavily on an IT system that is measured by the scope of general EDI use in six business functions. Bensaou concludes that: 'the findings of this study clearly indicate that this ambitious use of information technology has not yet translated into IT playing a major role in explaining cooperation between the two firms' (Bensaou, 1997: 119). This empirical result is, however, not the case for Japan, where the use of IT is significantly associated with cooperation. This empirical difference indicates that in contrast to U.S. policy to develop an electronic platform to support an 'electronic marketplace' for car components based on the use of a standardized IT platform, Japanese manufacturers are engaged in an 'electronic partnership' where a relation-specific IT system, co-specialized with other relation-specific practices, supports exchange with the close partners as a mutual (sunk-cost) commitment that supports economic exchange.

Dyer and Singh (1998: 662) define a relational rent as 'a supernormal profit jointly generated in an exchange relationship that cannot be generated by either firm in isolation and can only be created through the joint idiosyncratic contributions of the specific alliance partners,' and argue that alliances generate relational rents only as they move the relationship away from the attributes of market relationships. More specifically, Dyer and Singh (1998) provide four conditions for the competitive advantages of partnerships:

- investments in relation-specific assets;
- substantial knowledge exchange;
- the combining of complementary, but scarce, resources and/or capabilities; and
- lower transaction costs than competitor alliances, due to more effective governance mechanisms.

The four propositions developed in the current paper meet Dyer and Singh's (1998) four conditions since relational rents are possible when vertical partners invest in a relation-specific IT system and share strategic information. A long-term vertical partnership is achieved by employing a superior governance mode of electronic integration that lowers transaction costs and gains relational rents through mutual sunk-cost commitments.

From the perspective of strategic management, the current paper provides various research agendas, both for the existence and boundary of the

firm (Casson, 1997) and for sustainable competitive advantage (Mahoney, 1998).[29] Regarding the existence and boundary of the firm, information should be traded within the firm when it is less costly than other forms of market transactions. Information attributes and specificity of an IT system determine the economic efficiency of the coordination mechanisms for the given transaction and correspondingly the efficient boundary choice of the firm. With respect to sustainable competitive advantage, not all information is equally costly to trade, nor are all coordination mechanisms equally efficient for processing the information for the transaction. Sustainable competitive advantage rests on the comparative assessment of (imperfect) alternative governance modes in acquiring and handling information of uncertain quality at lower economic costs, while simultaneously managing economic incentive problems. The strategic intent of searching for improved governance in acquiring and processing information effectively continues to provide challenges for both strategic management theory and strategic management practice.

A relation-specific IT system, that entails substantial mutual sunk-cost commitments on the part of both buyer(s) and supplier(s), acts as a 'mutual strategic hostage to support economic exchange.' Such mutual sunk-cost commitments play the role of economic collateral that protects the contractual parties against possibilities of opportunistic contractual holdup problems. Therefore, a relation-specific IT system *substitutes* for managerial hierarchy in serving the joint functions of 'economizing on bounded rationality' (via better information processing between the buyer and supplier) and of 'attenuating opportunism' (since *ex ante* mutual sunk-cost investments better align mutual economic incentives and thereby reduce the likelihood of distributional conflicts whereby one or both contracting parties attempt to renegotiate contractual agreements *ex post*).

[29] The current paper also has implications for organizational theory and organizational design. For example, Huber (1990) early on noted that increasing availability and use of information technologies are leading to changes in organizational design and information accessibility, which typically improves effectiveness of decision making. We thank Associate Editor Rich Bettis for bringing this connection to our attention. To these ideas we add that Simon (1982) provides a number of essays that reflect a similar optimism to that of Huber (1990) concerning prospects for information-processing technology improving the effectiveness of decision making. Further, Child and McGrath (2001) comment on our increasingly information-intensive economy and provide examples of recent innovations of organizational design and organizational forms as adaptive responses to these changes.

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APPENDIX: COOPERATIVE GAME AND MUTUAL (SUNK-COST) COMMITMENT

Game theory is the analysis of rational behaviors in situations involving interdependent outcomes when the firm's payoff depends on what it does and what the other firm does (Schelling, 1960). Since many strategic decisions involve interdependent outcomes, game-theoretic analysis can be applied to the study of vertical supplier–buyer relationships. In game-theoretic models each firm's optimal action depends on what the focal firm believes its counterpart firm will do in response. In other words, the game-theoretic analysis requires assumptions about the counterpart's rationality and the counterpart's belief about the focal firm's own rationality.

The prisoners' dilemma game provides a powerful metaphor for a fundamental conflict that arises in business situations involving vertical interdependence (Saloner, 1991; Scherer and Ross, 1990). In the prisoners' dilemma what is best for the individual firm is to maximize its own economic profitability and this 'individual rationality' is detrimental to group-level economic performance. The 'collective rationality' is for both firms to cooperate and obtain a higher group-level payoff, but the 'individual rationality' is for each firm to play their dominant strategy, given the current payoff matrix. No matter how much they preach the importance of the group-level (common) benefits, there is always the possibility that the poor group-level outcome will be the dominant strategy equilibrium as predicted in the prisoners' dilemma game.

One way out of the prisoners' dilemma occurs when the players take steps that change the payoff matrix. Paradoxically, worsening some of one's own payoff possibilities may improve the likely outcome of the game (Schelling, 1960). Consider the case of an IT investment between Wal-Mart and P&G. The best strategies for the collective good are that both firms cooperate. While this is collectively rational, it is unfortunately not individually rational in terms of individual firm-level economic profitability. Thus, in Payoff Matrix 1 we have an example of the prisoners' dilemma situation where the Nash equilibrium point **(91, 91)** is predicted when each firm plays their dominant strategy of behaving opportunistically.

Payoff Matrix 1		Wal-Mart	
		Cooperation	Opportunism
P&G	Cooperation	(112, 112)	(58, 123)
	Opportunism	(123, 58)	**(91, 91)**

Let us suppose P&G posts an economic bond (e.g., volunteering to invest in a relation-specific IT system) that P&G would lose if P&G defects from the joint collaboration. In effect, this action unilaterally lowers the economic payoff associated with potential opportunistic behaviors by P&G (i.e., from 123 to −28, and from 91 to −51, respectively, below). Thus, P&G eliminates the economic attractiveness of defecting from the cooperative solution. Such a voluntary arrangement is considered self-enforcing because third-party enforcement is not relied upon. As a result, Cooperation is now P&G's dominant strategy.

Payoff Matrix 2		Wal-Mart	
		Cooperation	Opportunism
P&G	Cooperation	(112, 112)	**(58, 123)**
	Opportunism	(−28, 58)	(−51, 91)

Expecting greater economic gains from an ongoing relationship with P&G than short-term gains from defecting, if Wal-Mart emulates P&G's action (i.e., mutually commits to a relation-specific IT with P&G) then this action further transforms the situation to Payoff Matrix 3 (as we see below) to encourage mutual commitments to cooperation that increases both firms' economic payoffs to (**112, 112**). This business example illustrates that firms involved in interdependent outcomes should seek both to *give* and *receive* mutual (sunk-cost) commitments that facilitate ongoing relationships and adaptation (Williamson, 1985).

Payoff Matrix 3		Wal-Mart	
		Cooperation	Opportunism
P&G	Cooperation	**(112, 112)**	(58, −28)
	Opportunism	(−28, 58)	(−51, −51)

For the current research paper, this Appendix provides a reconstructed logic (Kaplan, 1964; Mahoney and Sanchez, 2004). A relation-specific IT system facilitates cooperation because it aligns the economic incentives of both contractual parties to engage in cooperative behaviors that support economic exchange. *These mutual economic commitments have enabled firms to substitute electronic integration to substitute for vertical financial ownership (Mahoney, 1992) in solving economic holdup problems.*