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RESEARCH ARTICLE

AN EMPIRICAL INVESTIGATION OF NET-ENABLED BUSINESS VALUE[1]

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Abstract

Many traditional organizations have undertaken major initiatives to leverage the Internet to transform how they coordinate value activities with customers, suppliers, and other business partners with the objective of improving firm performance. This paper addresses processes through which business value is created through such Internet-enabled value chain activities. Relying on the resource-based view of the firm, we propose a model positing that a firm's abilities to coordinate and exploit firm resources (processes, information technology, and readiness of customers and suppliers) create online informational capabilities (a higher order resource) which then leads to improved operational and financial performance. The outcome of a firm's online informational capabilities is reflected in superior operational performance through customer and supplier-side digitization efforts, which reflect the extent to which *transactions and external interactions occur electronically. We also hypothesize that increased customer and supplier-side digitization leads to better financial performance. The model is tested with data from over 1,000 firms in the manufacturing, retail, and wholesale sectors. The analysis suggests that while most firms are lagging in their supplier-side initiatives relative to the customer-side, supplier-side digitization has a strong positive impact on customer-side digitization, which, in turn, leads to better financial performance. Further, both customer and supplier readiness to engage in digital interactions are shown to be as important as a firm's internal digitization initiatives, implying that a firm's transformation-related decisions should include its customers' and suppliers' resources and incentives.*

Keywords: Business value of IT, net-enabled business transformation, digitization, resource-based view, online informational capability, business process alignment

Introduction

The Internet and related technologies have enabled firms to change the way they interact and coordinate value chain activities with customers and suppliers with the objective of improving operational and financial performance. These changes, referred to as Net-enabled business transformation (NBT) (Straub and Watson 2001), involve substitution of everyday business activities involving paper, telephone, and fax-based communication with electronic transaction and information exchange, and significant redesign of processes, incentives and information technology to enable tighter coordination with customers and suppliers. Such changes may enable firms to enhance customer satisfaction, understand customer preferences, reduce inventory, increase inventory turnover, decrease stock-out situations, and improve response time and time-to-market, which may eventually lead to financial benefits. Despite the potential for improved firm performance through NBT, there is a lack of systematic evidence regarding the process through which value is created, and how firm resources are exploited to create this value.

We use the resource-based view (RBV) (Barney 1991) of the firm, a dominant theory in the strategic management literature, as the underlying theoretical basis to study firms' abilities to deploy technological (e.g., IT infrastructure), organizational (e.g., business processes), and environmental (e.g., partner readiness) resources in the context of NBT to create business value. We argue that the effective combination of these resources enables a firm to develop online informational capabilities (OIC), a higher-order or intermediate resource (Amit and Schoemaker 1993), with their customers and suppliers, which then leads to improved operational and financial performance. OIC addresses specific problems resulting from lack of information access, information asymmetry, and uncertainty discussed in supply chain management (e.g., bullwhip effect; see Lee et al. 1997; Milgrom and Roberts 1988) and customer relationship management (e.g., customization, customer preferences). OIC not only allows a firm to share tactical and strategic information with business partners, but also enables low-cost execution of customized transactions.

IS researchers have adopted the theory of RBV to study how IT helps firms gain business value (e.g., Bharadwaj 2000; Mata et al. 1995; Ross et al. 1996) by treating certain IT and IT-related resources (e.g., IT skills, IT human resources, IT knowledge, IT capability) as rare and valuable. Wade and Hulland (2004) provide an overview of the literature on IT-related resources and their impact on firm strategy and performance. They rely on the definition of resources from Sanchez et al. (1996) that resources are a set of assets and capabilities available for a firm that is useful in detecting and responding to market opportunities or threats. Assets, both tangible and intangible, are defined as those resources available for a firm to "use in its processes for creating, producing, and/or offering its products (goods/services) to a market," whereas "capabilities are repeatable patterns of actions in the use of [IT] assets" (Wade and Hulland 2004). Some resources, particularly certain IT assets, are easily available (e.g., IT hardware, the Internet, etc.) or transferable (e.g., patents) compared with capabilities (e.g., market responsiveness, managing external relationships) that are firm-specific and deeply embedded within an organization and its processes that are not easily transferable (e.g., Amit and Schoemaker 1993; Makadok 2001; Teece et al. 1997). That is, capabilities are higher-order resources that involve the ability of a firm to deploy resources (Wade and Hulland refer to these resources as assets) in combination with organizational processes to obtain desired outcomes (Amit and Schoemaker 1993; Grant 1991; Makadok 2001).

Not all firms possess the ability to create OIC, even when they have access to the same IT assets such as the Internet. For instance, channel conflicts can preclude a firm's ability to develop OIC (see Willcocks and Plant 2001; Zettelmeyer et al. 2001). Likewise, a firm's intangible or tacit resources such as the extent of trust and relationships with customers and suppliers that are deeply rooted in the organizational history—history-dependent state variables (Cool et al. 1989)—impact the ability to build OIC. Thus, OIC cannot be easily replicated and copied as they develop over time and, therefore, may result in strategic value for firms (Amit and Schoemaker 1993).

Mata et al. (1995) have argued that physical systems such as the Internet and related technologies by themselves are not a source of value; rather, it is the ability to combine, coordinate, and exploit IT resources with other organizational and environmental resources to address business problems that is difficult to conceive and implement. Bharadwaj (2000) identifies customer orientation, synergy between different units, and knowledge as key IT-related resources since they enable the effective use of information available through IT. Consistent with IT-related RBV literature, this study models the process through which firms create OIC that lead to business value by modeling interactions of IT with other organizational and interorganizational resources including business processes, incentives, and intangible resources such as trust and relationship with business partners.

Although the past literature in RBV does not explicitly identify environmental resources such as partner readiness for improved firm performance, a related resource—external relationship management—has been frequently cited (Feeny and Willcocks 1998; Wade and Hulland 2004). This resource is critical for NBT, since the primary focus is to leverage the Internet for value creation in interactions with external entities such as customers and suppliers. The OIC of a firm relies on its partners' ability to exploit its own technological and organizational resources.

OIC enables firms to achieve a higher level of digitization of their business activities (the extent to which every day value-chain activities are performed electronically) which is likely to improve operational and financial performance. Past literature in electronic data interchange (EDI) has shown that information sharing capabilities improve operational performance including reduced cycle time and improved quality (e.g., Clemons et al. 1993; Mukhopadhyay et al. 1997b; Srinivasan et al. 1994). Likewise, the marketing literature suggests that improved informational capabilities have a direct impact on customer satisfaction, buying experience, and loyalty (see Alba et al. 1997; Burke 1997). Therefore, OIC entails operational benefits on both customer and suppler sides. The improved operational benefits from customer and supplier interactions can be linked to financial performance in order to assess business value (DeLone and McLean 1992). This approach of tracing value creation involving operational and financial measures has been used in the IT business value literature (see Kauffman and Kriebel 1988; Weill 1992) and performance measurement research based on the balanced scorecard (Kaplan and Norton 1992).

Based on the above discussion, we develop a model of NBT with OIC as a mediating factor that relies on a firm's IT, business process, and partner readiness resources. OIC enables firms to improve all types of interactions with customers and suppliers, which then have a positive impact on operational and financial performance. Digital interactions with suppliers are seen as an important enabler of customer-side interactions, underscoring the need for developing OIC on both customer- and supplier-facing sides of a business. The model is tested with survey data from over a thousand firms in manufacturing, wholesale, distribution, and retailing. The empirical results provide strong support for the theoretical model. The total effect of customer and supplier-side digitization on financial performance is significantly positive. Firms with higher levels of supplier-side digitization are likely to have higher levels of customer-side digitization and enjoy better financial performance. This indicates that firms that strategize to serve customers better online must also focus on supplier-side online capabilities. The empirical analysis also supports the view that OIC depends on resources such as business process alignment, partner readiness, and IT related factors.

The contributions of this research are threefold. First, we propose a theory of Net-enabled business transformation based on the RBV of the firm. We identify key resources for NBT and a process through which value is created via OIC, a higher-order resource. Second, this study highlights the differences as well as the synergy between customer- and supplier-side initiatives. Third, from a metrics standpoint, we add to the emerging empirical literature on business value measurement specific to NBT. Finally, from a practitioner point of view, if a firm is contemplating the allocation of resources for IT assimilation and process alignment, our results suggest that it is imperative that the firm considers the (1) readiness of other players in the value network, and perhaps even allocate resources to increase such readiness when deemed necessary, and the (2) importance of supplier-side interactions in improving customer-side interactions.

The balance of the paper is organized as follows. The next section describes the research model, provides theoretical justification, and develops hypotheses. Next, we discuss the details of operationalization of the constructs, survey instrument, and data collection. This is followed by data analysis, discussion of the results, limitations, and concluding remarks.

Research Model

The conceptual model of NBT and value assessment is shown in Figure 1. The definitions of various constructs in the model are summarized in Table 1.

As discussed earlier, our model of NBT relies on three resources (assets, as referred to in Wade and Hulland, 2004)—IT resource, processes, and readiness—to create OIC, a higher-order resource or an intermediate resource (Eisenhardt and Martin 2000; Teece et al. 1997) that enables a firm to seamlessly exchange strategic and tactical information with customers and suppliers. The OIC of a firm determines the digitization levels, the extent to which a firm conducts its transaction and coordination activities with customers and suppliers using Net-enabled systems (Armstrong and Sambamurthy 1999). NBT is finally judged by the improvement in the firm's financial performance, which results from digitization levels facing customers and suppliers. Our model also suggests that supplier-side digitization has both direct and indirect impacts on financial performance, and that the indirect impact is mediated by the extent of customer-side digitization.

We make a distinction between customer and supplier-side digitization, OIC, process alignment, and readiness, since there are fundamental differences in the dynamics of a firm's interactions with these two external constituencies. Such differences include strategic implications (see Day 1994; Srivastava et al. 1999), the control and power of the firm (see Hart and Saunders 1998) over its suppliers vis-à-vis customers, the frequency of interactions, the asset-specific investments needed to enable relationships, and the extent of uncertainty in the operating environment. Hart and Saunders (1998) suggest that firms usually have different bargaining power on suppliers than they do on customers, resulting in different types of information exchanged. Likewise, in the context of EDI, Holland et al. (1992) and Premkumar et al. (1994) argue that firms have different EDI strategies facing customers and suppliers because of the differences in the types of information flow and the power over suppliers and

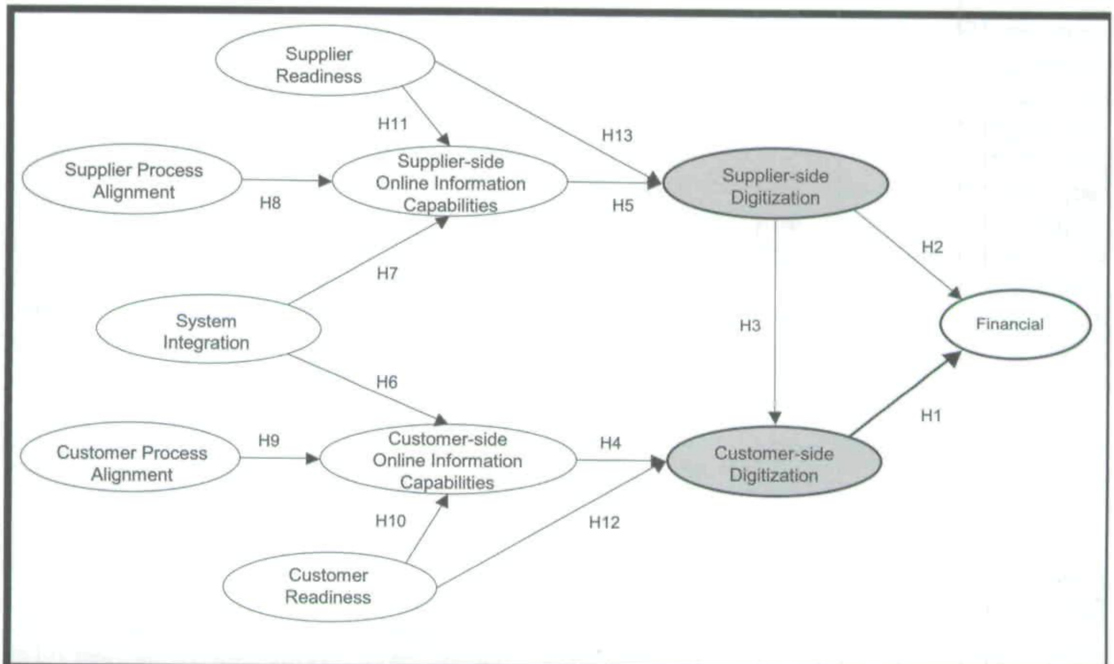

Figure 1. Conceptual Model

Table 1. Definitions and Constructs in the Model

Construct	Definitions
System integration	The extent to which a firm integrates its IT systems to provide visibility to customer and supplier data and to allow online information sharing and transaction execution across the value chain
Process alignment	The degree of fit between business processes and the underlying technology to facilitate online transactions and information sharing
Partner readiness	The degree to which a firm's customers and suppliers are willing and ready to conduct business activities electronically
Online informational capabilities (OIC)	The ability of a firm to exchange strategic and tactical information with customers and suppliers on-demand
Digitization level	The extent to which a firm accomplishes day-to-day business activities electronically including transactions and information exchange facing customers (e.g., sales, customer service, new customer acquisition) and suppliers (e.g., procurement)
Financial performance	Improvement in financial performance attributable to NBT

customers. For instance, it is difficult for a firm to assess customer demand and to seek information from customers to reduce uncertainty, while a firm can simply plan ahead its procurement activities. Similarly, supplier-side digitization needs more cooperation and asset-specific investments from suppliers relative to customer-side digitization. By separating the dynamics involved between customers and suppliers, the model is able to extract the specific nature of impact of a firm's choices.

Next, we discuss the theoretical considerations and definition of the various constructs and the rationale behind the hypotheses.

Financial Performance and Digitization

A firm engages in NBT with the goal of improving performance. The main thesis in the IT productivity and business value literature has been that IT investments lead to improved firm performance measures such as return on assets (ROA), market share, and gross margin (Hitt and Brynjolfsson 1996). The literature also recognizes that better financial performance is the result of improvements in intermediate operational measures (e.g., Mukhopadhyay et al. 1995; Mukhopadhyay et al. 1997b).

In our model, financial performance attributable to NBT is driven by digitization level, which is the extent to which a firm accomplishes day-to-day business activities electronically including transactions and information exchange with customers (e.g., sales, customer service) and suppliers (e.g., procurement). The digitization level reflects the effective application of the Net-enabled systems not only to support the regular value-chain activities within the firm, but also to enhance relationships with customers and suppliers (Armstrong and Sambamurthy 1999; Sabherwal and King 1991).

The digitization levels reflect (1) the cost of coordination of activities with customers and suppliers, (2) the extent to which information is shared to lower uncertainty in the value system (e.g., to reduce bullwhip effect), and (3) the ability to reach customers efficiently and effectively to increase revenue. These have a direct bearing on a firm's cost structure (see Porter and Millar 1985). A firm that can substitute expensive human labor with IT to execute day-to-day activities is likely to have a lower cost structure, which then impacts its financial performance. Case studies of firms such as Cisco Systems and Dell Inc. have established that the cost of online interactions including sales, customer service, and procurement is much lower than that in traditional practices (Magretta 1998).

Higher levels of digitization indicate that a firm can better coordinate procurement processes and material movement (Srinivasan et al. 1994) that can reduce inventory, obsolescence, and transportation costs (Mukhopadhyay et al. 1995). A firm is likely to lower its cash conversion cycle with improved supply-side digitization (Magretta 1998), which has a direct influence on a firm's profitability. Tight coordination with suppliers can reduce transaction cost and improve the bottom line by reducing stock-out situations, lowering lead times, reducing order fulfillment errors, and increasing inventory turnover rates (Clemons et al. 1993; Mukhopadhyay et al. 1995; Mukhopadhyay et al. 1997a; Srinivasan et al. 1994; Straub et al. 2002). Web-based supply chain management applications enable firms to reduce uncertainty about demand, quality, and inventory, which have a direct impact on financial performance.

Digitization of interactions with customers may lead to a smaller sales force, less paperwork, and fewer data input errors, while shifting the responsibility of product information search, order entry, and tracking to customers (Johnston and Vitale 1988; Weill and Vitale 2001). For example, selling an air ticket online costs a carrier only about $6 compared with more than $20 if the ticket is sold via telephone (Wagner 2002). The reduced sales cost will lead to improved financial performance. Online interaction usually puts a customer in control of the content, order, and duration of the flow of information, which may increase customer satisfaction due to higher decision quality, memory, knowledge, and confidence (Ariely 2000). The marketing literature has argued that online service provision leads to better service experience and less disconfirmation with expectations, resulting in better service encounter and overall satisfaction (Balasubramanian et al. 2003; Shankar et al. 2003; Zeithaml et al. 2002). Increased customer satisfaction will lead to increased sales and customer loyalty (Rust and Zahorik 1993). Finally, online presence also allows a firm to expand its market by reaching out to new customer bases and segments without the limitations of geography and time (Evans and Wurster 1997). Thus a firm that has successfully digitized its customer-side initiatives is likely to have higher productivity and revenue per employee. Hence,

H1: *Higher levels of customer-side digitization will be positively associated with greater gains in financial performance attributable to NBT.*

H2: *Higher levels of supplier-side digitization will be positively associated with greater gains in financial performance attributable to NBT.*

The strategy and operations management literature has long recognized the interdependencies of dyadic relationships between the firm and its customers and the firm and its suppliers in the value chain (Lee et al. 1997; Porter and Millar 1985). For instance, a firm focusing on meeting customer demand using just-in-time (JIT) manufacturing critically depends upon the level of electronic communication and coordination with suppliers (e.g., Lee and Whang 2000). In the context of value creation through business processes, Srivastava et al. (1999) suggest that customer solutions necessitate, among other initiatives, efficient supply chain management processes to obtain physical and informational inputs. For example, consider the automotive sector that is in pursuit of increased customer-side digitization. Schwartz (2001) notes:

> In order to allow the customer on the front end to order any combination of options and take delivery within 14 days—the stated goal of all the automakers—the industry must make changes to the entire back-end operation.

Digitization on the supplier side serves as a prerequisite for digitization on the customer-side. Without increasing supplier-side digitization, a firm may over-promise customers and then fail to deliver, leading to lower customer satisfaction and loyalty. The case of online customization or product configuration illustrates this point. While online customization creates value for customers (see Srivastava et al. 1999), without supplier-side digitization, a firm is likely to fail to fulfill this order in a cost-efficient and timely manner, leading to customer dissatisfaction (Day 1994). Many online retailers, including Amazon.com, that initially rushed to provide services without effective supply-side digitization failed to deliver goods and services as promised, resulting in some firms closing their operations (e.g., Living.com). Fingar (2000) argues that firms experimenting with online customer service (a key component of customer-side digitization) can respond to online customer requests in a timely and accurate manner only when they have capabilities to interact and retrieve information electronically from suppliers. Hence,

H3: *Higher levels of supplier-side digitization will be positively associated with greater levels of customer-side digitization.*

Customer- and Supplier-Side Online Informational Capabilities

OIC is defined as the ability of a firm to exchange strategic and tactical information online with customers and suppliers on-demand. A firm with high levels of OIC is likely to lower the uncertainty of product or service requirements, improve coordination, and enhance satisfaction associated with the online channel, which will encourage value-chain activities to be conducted electronically. Thus the outcome of developing better OIC is reflected in higher levels of digitization.

In the early stages of NBT, firms may experiment through small-scale initiatives with limited OIC, which may have a positive impact on digitization levels and financial performance. This success, coupled with new knowledge of customers' and suppliers' needs gathered through electronic interactions, may prompt the firm to commit resources to further improve its OIC. Thus, when analyzed over time, there may be a feedback loop from digitization to OIC. However, analyzing such temporal aspects is beyond the scope of the current model.

On the customer side, OIC enables a firm's customers to manage all activities before, during, and after the purchase, including online information search, order customization, transaction execution, and customer service (Johnston and Vitale 1988; Weill and Vitale 2001). Recent research in MIS and Marketing supports the notion that higher levels of OIC increase customers' willingness to transact online, customer satisfaction, and shopping experience (e.g., Alba et al. 1997; Burke 1997). Informational capabilities using Web technologies provide opportunities to enhance the impression of a firm's existing and potential customers (Chatterjee et al. 2002), and to lower product search cost that is identified as a key reason why online shopping is more appealing than offline shopping (Alba et al. 1997; Ariely 2000; Lynch and Ariely 2000). Some have argued that online customization provides an economical way to empower customers to participate in the product design and to create products that better fit their needs (Alba et al. 1997; Wind and Rangaswamy 2001). Thus, a firm with higher levels of OIC may not only observe existing customers switch to online interactions, but also attract new customers and retain existing customers due to higher empowerment, satisfaction, and loyalty.

Zeithaml et al. (2002) posit that the capability to provide online customer service enables a firm to customize services to individuals in a cost-efficient way while enhancing convenience. Furthermore, online transactions provide convenience to both buyers and sellers without the limitations of time and space (Konana and Balasubramanian 2005). The more effective the system is in supporting these activities, the more day-to-day interactions with customers will be conducted through the online channel. For instance, the online channel enables both synchronous (e.g., chat-based) and asynchronous (e.g., e-mail-based) interactions for customer service, which may be desirable in situations where it is difficult to communicate only through interactive voice response systems or with limited human services. A firm with low levels of OIC has to rely on expensive traditional methods such as face-to-face or telephone interactions. Hence,

H4: *Higher levels of customer-side online informational capabilities will be positively associated with greater levels of customer-side digitization.*

On the supplier side, the ability to exchange rich and timely information facilitates the shifting of a firm's interaction with suppliers from the offline to the online channel. Supply chain management involves not only the movement of physical products and services but also the flow of information in both directions. Coordination and collaboration between a firm and its suppliers depend on the extent to which they share critical information such as inventory levels, demand, and quality feedback. Visibility across the supply chain through information sharing helps reduce uncertainty—a key determinant of transaction costs (see Williamson 1979, 1989)—inventory (see Milgrom and Roberts 1988) and bullwhip effect (see Lee et al. 1997). Milgrom and Roberts (1988) argue that information lowers uncertainty arising from cost, change-orders, demand, quality, resource availability (e.g., machine, labor, contacts), lead-time, shipment, technology (e.g., product roadmap), and volume (Davis 1993; Lee and Billington 1992; Lee et al. 1997; Lovejoy 1990, 1995) and, therefore, acts as a substitute for inventory. Firms that create supplier-side OIC are, therefore, likely to share such critical information and shift procurement activities and transactions online. For example, Dell Inc. has developed extensive capabilities to share information related to quality, relationship management, design, daily production requirements, and inventory levels even on an hourly basis with suppliers. This has enabled Dell to perform all supply chain activities online in real-time (Magretta 1998). In the absence of such OIC, firms rely on conventional methods including face-to-face, phone, and fax for pre-procurement activities and transaction execution. Hence,

> H5: *Higher levels of supplier-side online informational capabilities will be positively associated with greater levels of supplier-side digitization.*

Systems Integration

Systems integration refers to the extent to which a firm integrates its various IT systems to provide visibility to customer and supplier data and to allow online information sharing and transaction execution across the value chain. It is achieved by resolving data type and semantic differences among multiple databases and integrating various hardware platforms, communication technologies, and applications to work seamlessly (Broadbent et al. 1999; Turnbull 1991).

An organization with a high level of systems integration is able to transmit, combine, and process data from customers and suppliers or vendors. Its external and internal systems are able to monitor order status at various stages in the process (e.g., manufacturing, shipment) and automatically reflect order changes in downstream processes or systems (e.g., inventory and manufacturing systems). Further, it should be easy to share data among various internal systems (e.g., forecasting, production, shipment, accounting, etc.) and to retrieve information from various databases for decision support (e.g., cost information, reporting tools) (Sikora and Shaw 1998). All of these factors directly contribute to the capability to exchange information online. Hence,

> H6: *Higher levels of systems integration within a firm will be positively associated with greater levels of customer-side online informational capabilities.*

> H7: *Higher levels of systems integration within a firm will be positively associated with greater levels of supplier-side online informational capabilities.*

Customer and Supplier Related Processes

Process alignment is defined as the degree of fit between business processes and underlying technology assets to facilitate online transactions and sharing of, and access to, strategic and tactical information. That is, process alignment leads to OIC, a higher-order resource, which then leads to improved operational and firm performance. For instance, providing online access to real-time demand or inventory information to suppliers is an informational capability that requires both integrated information systems and appropriate processes that incorporate how, what, and when such information can be shared. In the absence of such processes, sharing sensitive demand information can lead to unintended consequences (e.g., moral hazard problem; see Narayanan and Raman 2000).

Research shows that IT and business process redesign are natural partners (Jarvenpaa and Stoddard 1998; Kettinger and Grover 1995). New processes can lead to improved informational and coordination capabilities; such capabilities result in lower costs and improved services that affect revenues (e.g., better customer service) (Hammer and Champy 1993). For example, the EDI literature has shown that a firm is able to share information at the right time and improve performance when business processes are changed along with (EDI) technology implementation (Clark and Stoddard 1996; Riggins and Mukhopadhyay 1994).

The realization of capabilities to exchange information online with suppliers depends on aligning supplier-related processes and incentives to encourage suppliers to participate in online relationships and to share information. Firms must implement a supplier selection strategy that provides incentives to the right suppliers to participate in online information sharing (Bakos and Brynjolfsson 1993; Srinivasan et al. 1994). Firms also need processes that reduce approval steps, paperwork, and exception handling for all purchasing decisions. Furthermore, firms have to redefine processes that consolidate fragmented ordering within the organization to allow negotiation for better overall prices. When processes to address the issues discussed above (e.g., incentives, exception handling, and approval process) are aligned with the underlying technology, a firm is likely to create effective OIC.

In order to use Net-enabled systems for better customer relationship and service, firms must re-evaluate customer processes (El Sawy and Bowles 1997). Customers in need of services should be able to connect online and communicate their needs effectively through a single point of contact. Further, once a customer service request is received, ideally, there should be no *coordination gaps* (Rathnam et al. 1995), which are caused by the lack of fit between customer support processes and the attributes of IT used. Therefore, customer processes must be designed such that the use of IT fits the task (see Jarvenpaa and Stoddard 1998).

Therefore, in order to facilitate online transaction and information sharing with customers and suppliers, firms need to accomplish an alignment or *fit* between the underlying technology and related business processes. The extent to which this fit is achieved has a direct effect on a firm's capability to exchange information online. Hence,

H9: *Higher levels of customer processes alignment will be positively associated with greater levels of the customer-side online informational capabilities.*

H8: *Higher levels of supplier processes alignment will be positively associated with greater levels of the supplier-side online informational capabilities.*

Electronic Business Readiness of Customers and Suppliers

Although the resources available to a firm's business partners have not been explicitly linked to the firm itself, such resources are critical in the context of NBT. A firm has at least partial control over its partners' resources, since a firm can spend its own resources to help its partners gain certain resources. A firm can also use its power to influence its partners' resource configuration. The ability of a firm to influence its business partners is firm specific, since it is based on history-dependent state variables (see Cool et al. 1989; Dierickx et al. 1989) and acquired over the long run. A firm's power over its suppliers is not replicable and imitated since it comes from firm size, supplier selection policies, and dependence (Boyle and Dwyer 1995).

A successful NBT of a firm depends not only on its own efforts to incorporate IT in its operations, but also on the readiness of its customers, suppliers, and trading partners to engage in electronic interactions and transactions. Lack of organizational (internal) readiness has been shown to inhibit IT adoption in organizations where readiness is defined as the availability of needed organizational resources (Crook and Kumar 1998; Grover 1993; Iacovou et al. 1995; Premkumar and Ramamurthy 1995; Premkumar et al. 1994; Saunders and Clark 1992; Swatman and Swatman 1992). However, in this study we are concerned with the readiness of customers and suppliers, since the success of a firm's Net initiatives is likely to be influenced by its partners' ability to conduct business electronically (Chwelos et al. 2001; Crook and Kumar 1998; Hart and Saunders 1997).

The readiness of all partners in the value chain allows information flows that reduce information asymmetry and uncertainty, while enhancing coordination. While it is intuitive to think of this readiness as external to an organization, it is best considered as an enabler that requires a proactive commitment of a firm's resources. Firms can design certain incentive mechanisms such as subsidy or guaranteed business to encourage business partners to get connected. Firms can also invest in resources to help increase the capability of their partners to do business electronically, such as providing training (Crook and Kumar 1998; Riggins et al. 1994; Wang and

Seidmann 1995). Even if a firm has the necessary IT applications to do business online with customers and suppliers, a lack of readiness on the part of customers or suppliers will impede the adoption of the technology. General Electric realized that its electronic business goals were not achievable since a significant fraction of its suppliers were not ready to do business online for lack of incentives to share information and concerns of lock-in, security, integration costs, and loss of bargaining power (Murray and Sapsford 2001; Strassmann 2001). Hence,

H10: *Higher levels of the electronic business readiness of customers will be positively associated with greater levels of the customer-side online informational capabilities.*

H11: *Higher levels of the electronic business readiness of suppliers will be positively associated with greater levels of the supplier-side online informational capabilities.*

Unlike the system integration and process constructs, the readiness of customers and suppliers has a direct impact on the digitization level on the customer and the supplier sides, respectively. A firm still needs to rely on its partners' readiness to actively adopt and assimilate its online initiatives. The earlier example of General Electric illustrates this potential gap between a firm's and partners' readiness levels. While integration and process alignment reflect a firm's internal efforts to enable online informational capabilities, these may not directly influence its partners (i.e., customers and suppliers) to participate actively. Therefore, integration and process alignment do not have a direct impact on digitization level. Hence,

H12: *Higher levels of the electronic business readiness of customers will be positively associated with greater levels of the customer-side digitization.*

H13: *Higher levels of the electronic business readiness of suppliers will be positively associated with greater levels of the supplier-side digitization.*

Research Design

Operationalization of Constructs

Financial Performance

We employed four financial performance measures: percentage increase in (1) revenue per employee (RPE), (2) gross profit margin (GPM), (3) return on assets (ROA), and (4) return on invested capital (ROIC) attributable to NBT initiatives. There is evidence that firms have begun to monitor and track some of these measures through internal cost-benefit analyses and activity-based costing (Moozakis 2000; Slater 1997).

While measures such as ROA have been used extensively in previous IT productivity and business value literature (e.g., Barua et al. 1995; Hitt and Brynjolfsson 1996; Strassman 1990; Weill 1992), RPE and GPM are also critical in assessing the impact of NBT. Francalanci and Galal (1998) used "premium income per employee," which is analogous to sales per employee in the current context, as one of the indicators of productivity in the life insurance industry. Gross profit is a measure of value added used in previous research (Hitt and Brynjolfsson 1996).

Since all four items are measured as percentage increases, the lower bound is 0 when there is no increase in the related financial measure that can be attributed to NBT. All four measures are self-reported by the respondents. Note that these measures do not reflect the overall performance of the firm, but only the improvements that can be traced to NBT.

Digitization Level

We consider six measures of digitization: the percentage of (1) total business transacted online, (2) existing customers conducting business online, (3) new customers acquired online, (4) customer service provided online, (5) maintenance, repair, and operations (MRO) items purchased online, and (6) production goods procured online. The first four metrics are used to measure the level of customer-side digitization (CSD), while the last two are used to measure the level of supplier-side digitization (SSD). These measures reflect the outcome of leveraging the Internet for coordination with customers and suppliers, which is a key focus of NBT. Since the measure of the outcome of OIC is digitization, it subsumes other measures such as frequency of information exchange or extent of information exchange with suppliers and customers.

Online Informational Capability

Both supplier- and customer-side OIC constructs are measured by items based on a seven-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). The customer-side online informational capabilities (OICC) construct is operationalized by five items related to the capability of providing product information, product customization, website personalization, service, and order management online. The items are selected based on multiple research streams. Zaheer and Venkatraman (1994) state that the capability to search and retrieve product-related information, and to monitor and enforce contract execution is the main source of transaction cost. Peterson et al. (1997) suggest that a characteristic of the Internet is to enable mass customization. Online customer service has been identified as one of the weak links in the online shopping experience that drives a customer away (Burke 2002; Zeithaml et al. 2002). The extent to which the information related to these customer-facing activities is exchanged between a firm and its customers is used to measure the overall online informational capability of the firm on the customer side.

Supplier-side online informational capabilities (OICS) have three sub-constructs, each captured by three items, that measure the capabilities of information exchange related to quality (OICS-QL), resource availability (OICS-RS), and relationship management (OICS-RL) with suppliers. These three conceptually distinct sub-constructs are combined into a second-order construct to measure the overall level of supplier-side online informational capabilities. They reduce uncertainty through better information sharing and coordination. The items have been generated based on discussions with managers in Fortune 50 firms, operations management literature (Lee and Billington 1992; Lee et al. 1997; Lovejoy 1995), and business practice literature (e.g., Magretta 1998). Our discussions with senior managers of large firms indicated that they are devoting increased attention to customer quality feedback and to incorporate design changes in the products and parts through the extended value chain including the suppliers. Further, these firms have implemented incentives to share quality information at the suppliers' site so decisions involving whether to accept or reject certain batches are made proactively and not after the parts are assembled and shipped to customers.

Supplier-side OIC regarding resource availability relates to the uncertainty due to non-availability of demand, inventory, and capacity (e.g., machine capacity, manpower) information. The need for sharing such information is well documented in the literature (e.g., Davis 1993; Lee and Billington 1992; Lee et al. 1997; Lovejoy 1990, 1995; Magretta 1998) and is consistent with the conclusions reached by the managers we interviewed. Three scale items measure the extent of information sharing to reduce uncertainty.

The Internet has been an effective and cost efficient channel for buyers and suppliers to (1) share knowledge (e.g., frequently asked questions), (2) enhance community interactions (e.g., discussion forums), and (3) provide feedback irrespective of the location and time. The role of information sharing (e.g., know-how and patents) in buyer-supplier relationships is discussed extensively in the literature (e.g., Cannon and Perreault 1999; Dyer and Chu 2003). Stuart et al. (1998) have argued the importance of community interaction, such as supplier association, in developing supplier relationship in the Japanese auto industry. A continuous supplier evaluation and performance feedback program is also critical to buyer-supplier relationship management (Handfield et al. 2000). The Internet enables firms to develop the capabilities to share such relationship-enhancing information. Therefore, the above three issues form the items that measure supplier-side OIC regarding relationship management.

Process Alignment, Readiness, and Integration Constructs

All constructs related to process alignment, readiness, and systems integration constructs are based on a seven-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). Systems integration (SYS) is measured by items focusing on the ease with which data in different systems and organizational functions can be shared (Goodhue et al. 1992), the ability to update information to reflect changes in the downstream processes (Bhatt 2000; Rundensteiner et al. 2000), and the visibility of customer orders throughout the organization (Hasselbring 2000).

The supplier process alignment (PRCS) construct includes five items about whether a firm has well-defined procedures, metrics, and methods to guide its procurement activities (Lee and Billington 1992). The items measure the extent to which formal supplier selection policies, evaluation metrics, and monitoring processes are institutionalized. The items are generated from discussions with managers and support from the operations management literature, such as information exchange policy (Lee and Whang 2000), supplier evaluation policy, and sharing product roadmap and demand information sharing (Lee and Billington 1992; Magretta 1998).

The marketing literature has identified required changes in customer-related processes for efficient customer relationship management. These changes involve redesigning transaction-oriented processes into a process that learns and satisfies customer needs (Srivastava et al. 1999). Therefore, our customer process alignment (PRCC) construct consists of questions related to how well the process facilitates customer interaction, complaint resolution, and the dissemination of customer feedback.

Finally, the two readiness constructs are operationalized by measuring a firm's perception of the beliefs and motivation of customers and suppliers toward Net-enabled business (Chwelos et al. 2001; Iacovou et al. 1995; Parasuraman 2000).

Instrument Design and Refinement

The initial structured questionnaire was generated based on interviews with managers involved in NBT, and academic and practitioner-oriented literature. The questionnaire was pretested by multiple faculty members, doctoral students, and managers in a large manufacturing organization. Each item was reviewed for content, scope, and purpose (content validity). A seven-point Likert scale was used to collect most responses, while some questions involved absolute numbers, percentages or binary variables. The final questionnaire consisted of 39 items for 10 constructs, 13 operational performance measures related to customers and suppliers, 4 financial performance measures, 8 items related to transactional capabilities, and 10 questions pertaining to industry, number of employees, estimated revenue, type of Internet business related software used, and the number of months and years since the inception of NBT initiatives.

Data Collection

The data collection involved traditional manufacturing firms, distributors, wholesalers, and retailers engaged in NBT that had the ability to interact with customers over the Web. Further, the targeted firms included a mix of small, medium, and large organizations to reflect their presence in the overall economy. The survey was conducted in early 2000.

Given the difficulties in collecting data of this level of complexity, we employed a professional research organization that has extensive expertise and contacts to collect data from multiple managers within individual firms. We stipulated a number of conditions on this agency to induce transparency in data collection. Firms were selected from a universe of websites (compiled through a combination of searches using specialized bots, specific Internet searches, and InterNIC information). Any specific requirements to include in the data sample were handled through telephone-based screening. After firms were screened for a number of days, service firms were eliminated, and only manufacturers, retailers, distributors, and wholesalers were retained. Over 4,500 potential respondents were contacted via telephone. Of those, approximately 25 percent agreed to participate in the survey. The respondents were provided a choice to complete the survey over the phone or on a special website containing the questionnaire.

To minimize potential biases, the respondents were assured that their responses and identity would remain confidential, and that only aggregate information would be published. Respondents were allowed to specify ranges of values for operational and financial performance when they were unable to provide point estimates. Further, a "don't know" response category was added to each question to minimize the risk of obtaining inaccurate responses from participants who may not know the answers to certain questions. This would enable a respondent to avoid feeling pressured to respond to a question about which they did not feel confident. This is especially critical in collecting financial data since such data are self-reported by the respondents in our survey. For instance, in a binary question (yes/no) involving improvements in financial performance through electronic business initiatives, many respondents responded in the affirmative, but chose the "don't know" response when asked to provide percentage gains in specific financial measures. Given the large scale of the study and the anecdotal evidence that firms are increasingly focusing on cost-benefit analyses of their e-business initiatives (Moozakis 2000), we did not expect any potential problems involving too many missing data points.

The titles of the individuals who completed the questionnaire differed widely across firms. In smaller organizations (e.g., those with annual revenues less than $10 million), owners and principals were able to respond on behalf of an entire organization. In larger companies, the required information was dispersed throughout the firm. Many of the questions were oriented toward an IT or business process specialist, while others were financial in nature. Multiple individuals were contacted inside each large firm over multiple calls. In a number of instances, the interview began with one individual, and if that person was unable to answer some of the questions, s/he was then asked for a referral for someone else inside the organization. Typically, over one hour was required to identify appropriate respondents inside qualified organizations.

Telephone surveys were monitored for data quality, and several steps were taken to minimize any possible transcription errors. The data collection agency had validation screens programmed into the interviewing software to verify revenue and other figures that may be publicly available (e.g., number of employees, industry type). After the data collection was complete, all responses were checked for validity and compared to industry norms and third-party sources, where available. The respondents were contacted again when specific responses raised questions that could not be verified though external sources. If the recontact attempt was unsuccessful, the case was deleted from further analysis. At the end of the data collection process, 1,076 data points were retained.[2] Summary information regarding the size and industry distribution of the sample is presented in Table 2.

After receiving the raw data from the agency, we completed an independent cross-validation of responses. For example, we randomly chose 36 publicly traded companies in our sample and compared the revenue reported in our survey to the revenue figures obtained from Compustat. The correlation between the two measures is close to 0.8. We also randomly checked the reported increase in revenue per employee by collecting data from Compustat for publicly traded companies in our sample. Although we asked for the e-business related change in revenue per em-

[2]Although there are missing data, all 1,076 data points were used in estimating the measurement model and structural model by using full information maximum likelihood method when computing the correlation matrix.

Table 2. Summary of Firms in the Sample

Employee	Number of Firms	Percentage
< 50	555	51.6%
50–100	79	7.3%
101–400	102	9.5%
> 400	323	30.0%
Missing	17	1.6%
Sales (Millions)	**Number of Firms**	**Percentage**
< 10	501	46.6%
10–100	67	6.2%
100–500	127	11.8%
500–1000	37	3.4%
> 1000	54	5.0%
Missing	290	27.0%
Industry	**Number of Firms**	**Percentage**
Retailer	443	58.3%
Manufacturer	349	32.4%
Distributor	111	10.3%
Wholesaler	90	8.4%
Missing	83	7.8%

ployee in our survey, and while the data from Compustat only reflect the overall change in revenue per employee, we found that for most of the cases, the reported numbers were less than those from Compustat. For example, many firms that experienced an overall increase in revenue per employee did not attribute such increases to electronic business initiatives. This suggests that respondents may have been conservative when reporting the financial performance attributable to NBT.

The validity of the responses regarding the supplier-side digitization is difficult to check directly since these features are not accessible to external observers. However, we compared our results at an aggregate level to those from industry surveys and found the averages to be consistent. For example, according to our data, firms purchased 17 percent of production goods and 19 percent of MRO goods online, while a report by ActivMedia showed that the percentage of purchases made online ranged from 20 percent to 22 percent in 2000 (*CIO Magazine* 2000). A January 2001 NAPM/Forrester research report stated that 61 percent of large firms bought indirect goods online during the last quarter of 2000 with a median amount of 1 percent, while 39 percent of firms bought direct goods online with a median amount of less than 1 percent (NAPM 2001). The corresponding figures from our data are 60 percent, 2 percent, 48 percent, and less than 1 percent, respectively.

The Harmon's one-factor test was conducted to investigate the common method variance (Podsakoff and Organ 1986) since all the data are self-reported. The items that are used to measure the dependent and independent variables were entered into a single exploratory factor analysis. Thirteen factors were retained using the proportion criterion. The first factor accounted for 33.4

percent of the total variance. Moreover, the items measuring the enabler constructs and those measuring performance constructs tended to load on different factors. Therefore, a substantial common method variance problem is not evident in our data.

Data Analysis

The Measurement Model

Exploratory factor analysis (EFA) was first conducted to check if the proposed factor structures are indeed consistent with the actual data. The factor structures suggested by the EFA match the one proposed in the research model. The various loadings are shown in Table 3.

Next, confirmatory factor analysis (CFA) was conducted to check the reliability and validity of the measurement model. In this measurement model, no unidirectional path was specified between any latent variables. Instead, a covariance is estimated to connect each latent variable with every other latent variable. This measurement model was estimated using AMOS 4.0. The properties of the measurement model are summarized in Table 4.

Instrument Reliability and Validity

The items were tested for scale reliability (Cronbach 1951). The Cronbach alpha ranges from 0.74 to 0.93 for the 13 constructs, indicating a high internal consistency. Except for one item in the customer-related online information exchange capability construct, all the items were retained. Various reliability test results are shown in Table 5. The construct validity is also tested for convergent and discriminant validity. Convergent validity is assessed by reviewing the *t* tests for the factor loadings (Thong et al. 1996). The discriminant validity is tested by confidence interval method (Anderson and Gerbing 1988). The discriminant validity is also tested by comparing the variance extracted (VE) (Fornell and Larcker 1981) of each latent construct to the square of correlations between this construct and every other construct, which has been used by some IS studies (e.g., Segars and Grover 1998; Thong et al. 1996; Vandenbosch and Higgins 1996). The validity of all constructs and their indicators is also supported by the above tests. The details are provided in Tables 6 and 7.

The Structural Model

The structural model tested in the present study is shown in Figure 1. All enabler constructs except the two online information exchange capability constructs are allowed to covary with each other. This model was estimated using AMOS 4.0. The χ^2 statistic of 2.850 is within the acceptable limit (Byrne 1989; Carmines and McIver 1981; Marsh and Hocevar 1985; Wheaton et al. 1977). Several goodness of fit indices of the measurement model have been widely used in IS research and are presented in Table 8. The Tucker-Lewis index, also known as the non-normed fit index (NNFI) (Bentler and Bonett 1980), and the comparative fit index (CFI) (Bentler 1990) are all close to 1, suggesting an excellent fit between the structural model and the data. RMSEA is well below the suggested threshold value of 0.08 (Browne and Cudeck 1992). The parsimony-adjusted NFI (James et al. 1982) of the revised model is 0.863, which is significantly above the suggested value of .60 (Netemeyer et al. 1990; Williams and Hazer 1986), indicating highly acceptable levels of parsimony and fit of the overall model. All of these fit indices are acceptable, suggesting that the overall structural model provides a good fit with the data.

The results of estimating the structural model are presented in Figure 2. The squared multiple correlation (SMC) values, which are similar to R^2 in regression analysis, show that this model accounts for 47 percent of the variance in customer-side digitization, 12 percent of the variance in supplier-side digitization, and 45 percent of the variance in the financial performance construct. Customer process alignment, customer readiness, and system integration account for 45 percent of the vari-

Table 3. Exploratory Factor Analysis Loading

Content	Label	System Integration	Customer-side online information capabilities	Supplier-side online information capabilities (quality)	Supplier-side online information capabilities (resource)	Supplier-side online information capabilities (relation)	Supplier Process Alignment	Customer Process Alignment	Customer Readiness	Supplier Readiness
Data can be shared easily among various internal systems (e.g., forecasting, production, manufacturing, shipment, finance, accounting, etc).	SYS1	**.80**	-.06	-.02	.01	.01	-.03	.05	-.01	-.01
Order changes are automatically reflected in downstream processes or systems (e.g., inventory, manufacturing resource planning and manufacturing systems).	SYS2	**.65**	-.08	.15	.01	-.09	.05	-.06	.00	.00
Our systems can easily transmit, integrate and process data from suppliers/vendors and customers.	SYS3	**.52**	.11	.03	.04	.04	.02	-.04	.04	.07
Our systems allow continuous monitoring of order status at various stages in the process (e.g., manufacturing, shipping).	SYS4	**.66**	.11	.00	-.02	-.03	.05	-.05	-.01	.00
Employees can easily retrieve information from various databases for decision support (e.g., cost information, reporting tools).	SYS5	**.76**	.00	-.10	-.02	.05	-.01	.08	.01	-.03
All product-related information is available online (e.g., catalog, product description, detailed specifications, price, discount, etc.).	OICC1	-.01	**.68**	-.04	.02	-.02	-.05	.02	.03	-.03
Customers can customize their orders online without phone/fax or face-to-face interactions	OICC2	-.02	**.65**	.04	-.04	-.04	-.02	-.01	12	-.07
A comprehensive Frequently Asked Questions section on our company, our products/services, contact information, etc. is available on online.	OICC3	.02	**.44**	-.07	.00	.17	.08	.00	-.06	.03
Customers can conveniently contact service representatives or seek service online.	OICC4	.00	**.60**	.04	-.02	-.06	.02	.10	.03	.01

Table 3. Exploratory Factor Analysis Loading (Continued)

Content	Label	System Integration	Customer-side online information capabilities	Supplier-side online information capabilities (quality)	Supplier-side online information capabilities (resource)	Supplier-side online information capabilities (relation)	Supplier Process Alignment	Customer Process Alignment	Customer Readiness	Supplier Readiness
Customers see personalized content (e.g., products, prices, order history, order status, etc.) when they log onto our web site	OICC5	.04	**.51**	.07	.06	.06	-.01	-.07	-.03	.04
Customer feedback and field incidence reports (e.g., product failures, defects) are shared with suppliers/vendors in real-time.	OICS-QL1	-.04	.07	**.59**	.07	.05	.08	.07	-.03	.00
Process quality information (e.g., line rejection rates, yields) is shared electronically with relevant trading partners in real-time.	OICS-QL2	.05	-.02	**.77**	.04	.01	.00	-.01	-.04	.02
Changes (e.g., order changes, product design changes, etc.) are communicated to trading partners electronically in real-time.	OICS-QL3	.00	.00	**.78**	.01	.03	.02	.00	.04	.00
Continuously updated inventory information is shared with trading partners online.	OICS-RS1	-.03	.04	-.02	**.77**	.01	-.04	.02	.02	.04
Continuously updated production schedules and capacity (e.g., machine downtime, manpower availability) information is shared online with trading partners.	OICS-RS2	.00	-.07	.09	**.75**	.01	.04	.03	.03	-.05
Continuously updated product demand information (e.g., actual and forecasted) is shared online.	OICS-RS3	.05	.04	.02	**.73**	-.02	.02	-.05	-.03	.00
We provide online communities (e.g., discussion forms, online chat rooms) to our suppliers/vendors.	OICS-RL1	-.05	.03	.04	.04	**.68**	-.01	.00	.03	.01
We make available a comprehensive online Frequently Asked Questions section (e.g., contact information, glossary, events, etc.) to our trading partners online.	OICS-RL2	.04	.11	-.07	.03	**.66**	.03	.06	-.10	.08
We make frequently updated supplier/vendor evaluation reports available online.	OICS-RL3	.03	-.01	.09	.03	**.68**	.03	-.02	.00	-.01
The method for sharing product roadmap and demand forecast with our suppliers is well defined.	PRS1	.03	.06	.03	.06	.07	**.61**	-.02	-.12	.05

Table 3. Exploratory Factor Analysis Loading (Continued)

Content	Label	System Integration	Customer-side online information capabilities	Supplier-side online information capabilities (quality)	Supplier-side online information capabilities (resource)	Supplier-side online information capabilities (relation)	Supplier Process Alignment	Customer Process Alignment	Customer Readiness	Supplier Readiness
Information exchange policies with our suppliers (i.e., frequency, precision, real-time or delayed, format and channel) are well defined.	PRS2	.05	-.04	.18	-.08	-.05	**.66**	-.04	-.01	.02
The standard operating procedures cover all procurement scenarios (e.g., well-defined rules for large versus small procurement).	PRS3	.01	-.02	-.01	-.03	.01	**.78**	.05	.01	.02
Supplier/vendor selection criteria are well documented.	PRS4	-.02	.08	-.01	.01	-.06	**.74**	.02	.04	.03
Supplier/vendor evaluation metrics are well defined.	PRS5	.01	-.03	-.04	.02	.05	**.84**	-.04	.04	-.03
The vendor/supplier quality monitoring process is well defined.	PRS6	-.02	-.04	-.05	.02	-.01	**.87**	.03	.05	-.05
Customers generally have one contact point for all service needs.	PRC1	.00	-.07	.03	-.02	.02	-.03	**.70**	.07	-.03
There are only a small number of steps in resolving customer complaints.	PRC2	-.04	.05	.00	.01	-.04	-.02	**.75**	-.08	.04
Customer feedback is quickly disseminated into organizational processes.	PRC3	.05	.07	.02	.01	.00	.07	**.65**	.02	.00
Our customers feel comfortable regarding security and privacy in electronic commerce with our company.	RDC1	.04	.12	-.06	.02	.05	.04	.06	**.57**	.03
Our customers consider it important to engage in electronic commerce.	RDC2	-.03	.16	.04	.01	-.03	.01	-.04	**.53**	.15
Our suppliers/vendors have Internet-based systems to engage in electronic business.	RDS1	-.01	.03	.02	-.01	.05	-.08	.02	-.02	**.76**
Our suppliers/vendors feel comfortable (regarding security, privacy, etc.) engaging in electronic business.	RDS2	.02	-.11	.03	-.01	.00	-.02	.06	.17	**.66**
Our suppliers/vendors are willing to share information electronically with us.	RDS3	.04	.03	-.06	.02	.02	.04	.05	-.06	**.72**
Our suppliers/vendors consider it important to engage in electronic business.	RDS4	-.03	-.01	.06	-.01	-.02	-.04	-.07	.10	**.73**
Our suppliers/vendors consider it important to improve coordination and collaboration with us.	RDS5	-.01	.01	-.04	.02	-.07	.15	-.03	-.09	**.65**

Table 3. Exploratory Factor Analysis Loading (Continued)

Content	Label	Digitization level – Customer-side	Digitization level – Customer-side	Financial Performance						
What percent of your company's revenue is generated online, that is, revenue earned directly from Internet-related sales or transactions? Your best estimate will be fine?	CSD1	**.89**	.03	.01						
What percent of service requests received by your company are resolved electronically?	CSD2	**.51**	.11	.05						
What percent of your company's existing customers do business with your company online?	CSD3	**.86**	-.06	.10						
What percent of your company's new customers in the past year were acquired online?	CSD4	**.73**	.07	.07						
What percent of your company's procurement of maintenance, repair and operations (MRO) items (e.g., supplies, maintenance, etc.) is done online?	SSD1	.10	**.69**	.01						
What percent of your company's production goods (e.g., raw materials or components from manufacturers, or finished goods for distributors and retailers) is procured online?	SSD2	.00	**.70**	-.01						
Has your company experienced an increase in revenue per employee since it began its electronic business initiatives? What is the percentage increase in revenue per employee?	FIN1	.13	-.02	**.70**						
Has your company experienced an increase in gross profit margin since it began its electronic business initiatives? What is the percentage increase in gross profit margin?	FIN2	.11	-.02	**.83**						
Has your company experienced an increase in return on assets since it began its electronic business initiatives? What is the percentage increase in return on assets?	FIN3	-.01	.00	**.96**						
Has your company experienced an increase in return on invested capital since it began its electronic business initiatives? What is the percentage increase in return on invested capital?	FIN4	-.03	.03	**.91**						

Table 4. Summary of Constructs

Construct Name	Construct Identifier	Initial Number of Items	Number of Items carried Forward to the Analysis	Cronbach Alpha	Number of data points
Systems Integration	SYS	5	5	.83	1021
Customer-side online information capabilities	OICC	6	5	.76	1023
Supplier-side online information capabilities – Quality	OICS-QL	3	3	.84	1020
Supplier-side online information capabilities – Resource availability	OICS-RS	3	3	.84	1009
Supplier-side online information capabilities – Relationship mgmt.	OICS-RL	3	3	.74	1026
Supplier process alignment	PRCS	6	6	.90	953
Customer process alignment	PRCC	3	3	.78	1007
Customer readiness	RDYC	2	2	-	1026
Supplier readiness	RDYS	5	5	.81	1016
Supplier-side digitization					
Customer-side digitization					
Financial measure improvement					

Table 5. Summary of the Measurement Model

Latent Construct	Indicator	Standard Loading	Composite Reliability	Variance Extracted Estimate	Latent Construct	Indicator	Standard Loading	Composite Reliability	Variance Extracted Estimate
SYS	SYSIT1	0.778	0.83	0.50	PRCS	PRCS1	0.685	0.90	0.59
	SYSIT2	0.652				PRCS2	0.684		
	SYSIT3	0.644				PRCS3	0.789		
	SYSIT4	0.691				PRCS4	0.728		
	SYSIT5	0.750				PRCS5	0.854		
OICC	OICC1	0.661	0.75	0.38		PRCS6	0.859		
	OICC2	0.675			PRCC	PRCC1	0.738	0.79	0.55
	OICC3	0.504				PRCC2	0.781		
	OICC4	0.637				PRCC3	0.703		
	OICC5	0.572			RDYC	RDYC1	0.729	0.69	0.53
OICS-QL	OICS-QL1	0.723	0.85	0.65		RDYC2	0.725		
	OICS-QL2	0.830			RDYS	RDYS1	0.749	0.81	0.47
	OICS-QL3	0.859				RDYS2	0.722		
OICS-RS	OICS-RS1	0.770	0.84	0.64		RDYS3	0.672		
	OICS-RS2	0.831				RDYS4	0.722		
	OICS-RS3	0.795				RDYS5	0.544		
OICS-RL	OICS-RL1	0.753	0.76	0.52	SSD	MRO%	0.815	0.79	0.65
	OICS-RL2	0.599				PRO%	0.802		
	OICS-RL3	0.798			CSD	REV%	0.890	0.90	0.69
OICS	OICS-QL	0.769	0.82	0.60		SVC%	0.702		
	OICS-RS	0.778				NEW%	0.839		
	OICS-RL	0.785				EXS%	0.886		
					FIN	RPE%	0.745	0.93	0.77
						GMG%	0.841		
						ROA%	0.983		
						ROI%	0.927		

OICC: Customer-side OIC OICS: Supplier-side OIC

Table 6. Confidence Interval of Estimated Correlation Among Constructs

			Corr. Estimate	Confidence Interval					Corr. Estimate	Confidence Interval	
SYS	↔	OICC	0.378	0.308	0.448	PRCC	↔	RDYC	0.366	0.288	0.444
SYS	↔	PRCS	0.432	0.372	0.492	PRCC	↔	RDYS	0.217	0.143	0.291
SYS	↔	PRCC	0.207	0.133	0.281	PRCC	↔	SSD	0.156	0.074	0.238
SYS	↔	RDYC	0.294	0.218	0.370	PRCC	↔	FIN	0.206	0.120	0.292
SYS	↔	RDYS	0.314	0.244	0.384	PRCC	↔	CSD	0.271	0.199	0.343
SYS	↔	SSD	0.199	0.119	0.279	PRCC	↔	OICS	0.107	0.027	0.187
SYS	↔	FIN	0.094	0.008	0.180	RDYC	↔	RDYS	0.609	0.547	0.671
SYS	↔	CSD	0.168	0.096	0.240	RDYC	↔	SSD	0.369	0.287	0.451
SYS	↔	OICS	0.475	0.409	0.541	RDYC	↔	FIN	0.333	0.245	0.421
OICC	↔	PRCS	0.270	0.198	0.342	RDYC	↔	CSD	0.552	0.488	0.616
OICC	↔	PRCC	0.372	0.300	0.444	RDYC	↔	OICS	0.393	0.315	0.471
OICC	↔	RDYC	0.648	0.584	0.712	RDYS	↔	SSD	0.427	0.355	0.499
OICC	↔	RDYS	0.321	0.249	0.393	RDYS	↔	FIN	0.120	0.034	0.206
OICC	↔	SSD	0.363	0.285	0.441	RDYS	↔	CSD	0.273	0.203	0.343
OICC	↔	FIN	0.311	0.227	0.395	RDYS	↔	OICS	0.455	0.387	0.523
OICC	↔	CSD	0.572	0.514	0.630	SSD	↔	FIN	0.355	0.271	0.439
OICC	↔	OICS	0.553	0.487	0.619	SSD	↔	CSD	0.631	0.577	0.685
PRCS	↔	PRCC	0.171	0.099	0.243	SSD	↔	OICS	0.350	0.270	0.430
PRCS	↔	RDYC	0.285	0.211	0.359	FIN	↔	CSD	0.657	0.603	0.711
PRCS	↔	RDYS	0.293	0.225	0.361	FIN	↔	OICS	0.125	0.035	0.215
PRCS	↔	SSD	0.154	0.076	0.232	CSD	↔	OICS	0.297	0.225	0.369
PRCS	↔	FIN	0.096	0.014	0.178						
PRCS	↔	CSD	0.161	0.091	0.231						
PRCS	↔	OICS	0.520	0.460	0.580						

OICC: Customer-side OIC

OICS: Supplier-side OIC

Table 7. Comparison of VE and Squared Correlations

Var.		SYS	OICC	OICS	PRCS	PRCC	RDYC	RDYS	SSD	CSD	FIN
2.244	SYS	**0.497**									
1.650	OICC	0.143	**0.376**								
1.221	OICS	0.226	0.306	**0.604**							
1.546	PRCS	0.187	0.073	0.270	**0.593**						
1.725	PRCC	0.043	0.138	0.011	0.029	**0.549**					
1.251	RDYC	0.086	0.420	0.154	0.081	0.134	**0.529**				
1.650	RDYS	0.099	0.103	0.207	0.086	0.047	0.371	**0.470**			
405.1	SSD	0.040	0.132	0.123	0.024	0.024	0.136	0.182	**0.654**		
956.1	CSD	0.028	0.327	0.088	0.026	0.073	0.305	0.075	0.398	**0.693**	
351.6	FIN	0.009	0.097	0.016	0.009	0.042	0.111	0.014	0.126	0.432	**0.772**

*VEs are on the diagonal; squared correlations are off-diagonal.

OICC: customer-side OIC　　OICS: Supplier-side OIC

Table 8. Fit Indices of Structural Model

χ^2	2619
Df	919
χ^2/df	2.850
Normed fit index (NFI)	0.97
Tucker-Lewis index	0.98
Comparative fit index (CFI)	0.98
RMSEA	0.041
Lower bound	0.040
Upper bound	0.043
Parsimony-adjusted NFI	0.86

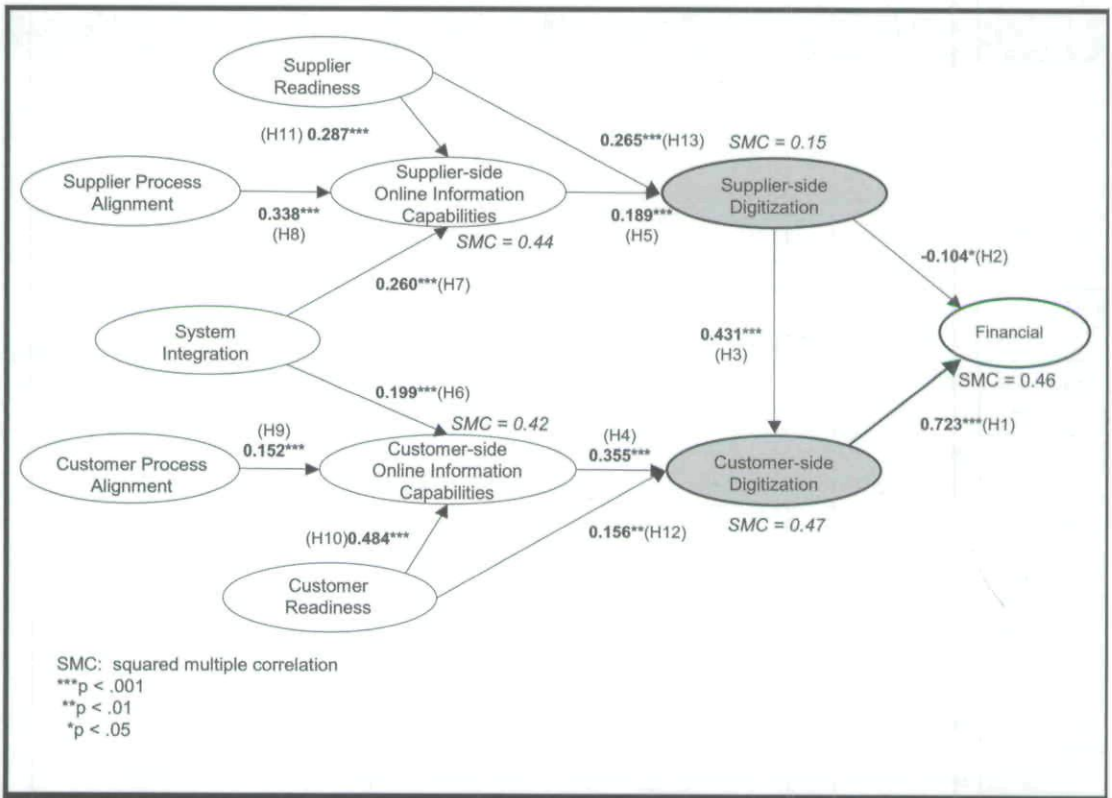

Figure 2. Structural Model Results

ance in the customer-side online information exchange capability construct. In all, 44 percent of the variance in the supplier-side online information exchange capability construct is explained by supplier process alignment, supplier readiness, and system integration. All of the paths, except the marginally significant and negative path linking supplier-side digitization directly to financial performance, are significant and positive, supporting the corresponding hypotheses. These findings are discussed below. A summary of the hypotheses test results is provided in Table 9.

Discussion of Results

With 12 out of 13 hypotheses supported, the empirical results provided strong overall validation for the NBT model. Hypothesis 1 is strongly supported ($p < 0.001$), demonstrating that the digitization of customer-side operations involving the conduct of online business, the acquisition of new customers, the migration of existing customers online, and the provision of online customer service leads to improved financial performance. This result can be interpreted both in terms of new revenues and cost efficiencies generated through NBT. For example, the extended reach and increased richness of electronic interactions may enable firms to acquire new customers, retain existing customers through improved customer satisfaction, and to up-sell and cross-sell through better and timely customer knowledge (Alba et al. 1997; Burke 1997; Evans and Wurster 1997; Krishnan et al. 1999; Peterson et al. 1997). Cost efficiency is attributable to lower communication and coordination cost, leaner sales force and customer service operations, and fewer errors and delays than in paper based systems (see Burke 1997).

Table 9. Summary of the Structural Model

Hypothesis	Path Coeff.	Supported?
H1: The higher the level of customer-side digitization, the higher the financial performance attributable to electronic business	.723	Yes
H2: The higher the level of supplier-side digitization, the higher the financial performance attributable to electronic business.	-.104	No*
H3: The higher the level of supplier-side digitization, the higher the level of customer-side digitization.	.431	Yes
H4: The higher the level of customer-side online informational capabilities, the higher the level of customer-side digitization.	.355	Yes
H5: The higher the level of supplier-side online informational capabilities, the higher the level of supplier-side digitization.	.189	Yes
H6: The higher the level of systems integration within a firm, the higher the level of customer-side online informational capabilities.	.199	Yes
H7: The higher the level of systems integration within a firm, the higher the level of supplier-side online informational capabilities.	.260	Yes
H8: The higher the level of supplier processes alignment, the higher the level of supplier-side online informational capabilities.	.338	Yes
H9: The higher the level of customer processes alignment, the higher the level of customer-side online informational capabilities.	.152	Yes
H10: The higher the electronic business readiness of customers, the higher the level of customer-side online informational capabilities.	.484	Yes
H11: The higher the electronic business readiness of suppliers, the higher the level of supplier-side online informational capabilities.	.287	Yes
H12: The higher the electronic business readiness of customers, the higher the level of customer-side digitization.	.156	Yes
H13: The higher the electronic business readiness of suppliers, the higher the level of supplier-side digitization.	.265	Yes

*Direct effect is not supported but overall effect (.207) is supported.

Contrary to our expectation in hypothesis 2, the direct impact of SSD on financial performance is found to be small but significantly negative ($p < 0.1$). To explain this unexpected result, we note that SSD is a complex undertaking involving large-scale changes in deeply entrenched interorganizational processes and systems (see Davis 1993). The unique challenges of digitizing a supply chain include changes that a firm's suppliers have to make in their business processes, perceived threats by suppliers, and the firm's own internal resistance to change. Furthermore, complete digitization may not be achieved rapidly since firms often run parallel online and offline transactions, duplicating efforts similar to those found in the early phase of EDI adoption. In fact, in our sample, even among firms with supplier-side OIC, the average online procurement is only 17 percent to 19 percent, which indicates the presence of dual processes and systems. In the early phases of NBT, the cost may be higher due to dual systems and the associated learning curve. In addition, our measures of financial performance placed more emphasis on the revenue side than on the cost side. It is possible that SSD has a stronger direct impact on the cost structure than on revenue.

We find strong support for hypothesis 3, indicating that SSD is an enabler of CSD. Along these lines, it is interesting to note that the indirect impact of SSD on financial performance through CSD ($0.43 \cdot 0.72 = .31$) strongly dominates the small and weakly significant direct negative impact (-0.104, $p < 0.1$). In other words, the pay-off from SSD is partly realized through enabling CSD. In fact, SSD is the most significant antecedent of CSD. In other words, in addition to developing customer-side OIC (i.e., OICC) to enable electronic interactions with customers, firms also need to tackle the difficult task of improving OIC on the supplier side (i.e., OICS). However, do firms place as much emphasis on enhancing supplier-side capabilities as they do on the customer side? Our dataset shows that while more than 50 percent of the firms have customer-oriented IT applications, less than 25 percent have similar applications for interactions with suppliers. In the absence of electronic interaction capabilities on the supplier side, the impact of isolated initiatives on the customer-facing side of the business may prove to be elusive. This phenomenon can be explained in the context of online customization, which introduces uncertainty in the upstream value network, and which can be successfully managed through information flows from customers to suppliers (Day 1994; Srivastava et al. 1999). The real source of the value of online customization is the ability to deliver the customized product within a reasonable time frame and at reasonable cost through efficient online supply-chain management.

Our analysis strongly supports hypotheses 4 and 5 ($p < .001$), implying that that OIC is an important antecedent of key electronic business activities such as online transactions with customers and suppliers, acquisition of new customers online, and the provision of online customer service. In a recent article, Carr (2003) questions the strategic significance of IT resources. He argues that since IT is widely available to most firms today, it cannot lead to competitive advantage. While we do not address the issue of competitive advantage directly in this paper, we demonstrate that when firms are able to develop a higher order resource such as OIC from the raw IT infrastructure (which is indeed available to most firms), there is a positive impact on both operational and financial performance. The acquisition of technologies such as hardware, software, and network infrastructure is just a necessary step in the development of OIC and appropriate business processes. IT managers must pay special attention to how these technologies, in conjunction with suitable business processes and high levels of partner readiness, can enable all aspects of electronic interactions between the firm and its external constituencies.

As noted in the model development section, this paper does not address a potential long-term feedback loop between digitization levels and OIC. This loop involves interesting questions of how firms choose to allocate resources to improve OIC based on prior success with NBT. Future research can analyze how such a feedback loop influences NBT resource allocation and impacts the linkages in the model.

A firm's decision to develop OIC for NBT depends upon the readiness of its value-chain partners to acquire complementary capabilities to enable seamless information flow and processing across firms. Hypotheses 10 and 11, linking partner readiness to OIC, are strongly supported ($p < 0.001$), underscoring the importance of considering partners' electronic business capabilities and attitude toward digital interactions in the development of a firm's own OIC. In addition to influencing a firm's IT decisions, partner readiness directly affects a firm's ability to engage in digital interactions. Hypotheses 12 and 13, involving direct relationships between partner readiness and digitization, are also validated ($p < 0.001$). While a firm may decide to undertake a NBT initiative regardless of the digital capabilities of its business partners, hypotheses 12 and 13 suggest that when the firm has partners who are technically and organizationally capable of engaging in electronic interactions, the firm can expect higher levels of digitization. When business partners have a low level of readiness, a firm planning on a NBT initiative may also want to consider how to increase the partner readiness levels. Improving such readiness may take the form of education and training (Crook and Kumar 1998; Wang and Seidmann 1995), sharing of knowledge and IT resources (Magretta 1998), and incentives (Crook and Kumar 1998). Taken together, hypotheses 10 through 13 illustrate the important role played by partner readiness in a firm's NBT initiatives.

New IT requires concurrent changes to existing technologies and business processes (see Brynjolfsson and Hitt 1998; Chatterjee et al. 2002; Cooper and Zmud 1990; Venkatraman 1994). More specifically, processes and IT have to be aligned with each other to create certain capabilities for better communication and coordination across value chain members. Hypotheses 8 and 9, which deal with the alignment between business processes and IT for suppliers and customers respectively, are strongly supported ($p < 0.001$). Given the importance of process–technology alignment, how do firms in our sample measure in terms of their process initiatives? As in the case of customer- and supplier-side digitization, firms in our sample have made higher levels of customer-related process alignment relative to the supplier side. For example, between 71 percent and 81 percent of firms have undertaken initiatives to simplify customer service and feedback sharing processes, while only 27 percent to 48 percent of the firms have engaged in various supplier-side processes such as information sharing, and supplier selection and evaluation. Hypothesis 8 makes it imperative for firms to improve supplier-side process alignment for both operational and financial gains.

While resources such as hardware, software, and networking are widely available to most firms today, our empirical analysis confirms that not all firms have the same OIC, and that such capabilities lead to better operational and financial performance. Based on the premise of RBV, we argue that process related shortcomings, lack of readiness of partners, and the inability to combine these resources properly contribute to lower OIC in many organizations. For example, without a high level of trust between a firm and its business partners, the latter are unlikely to consider electronic interactions beneficial or necessary. In such a situation, the firm is unable to take advantage of the ubiquity of the Internet and the abundance of low-cost software applications in improving its OIC.

There is evidence in the literature that fragmented systems across the value chain create informational inefficiencies (Hammer and Champy 1993; Lee and Billington 1992). The positive and negative impacts of integrated and fragmented systems are also observed in the examples of Toys "R" Us and Home Depot respectively. Our empirical results (hypotheses 6 and 7; $p < 0.001$) confirm that system integration plays an important role in building OIC, which, in turn, relate strongly to business performance measures. Many firms invest in enterprise resource planning systems to achieve, among other things, systems integration across the organization (see Worthen 2003), which, our results suggest, is an antecedent of OIC on both customer and supplier sides.

Limitations and Conclusion

This study developed and validated a model of NBT of traditional firms. Drawing upon the RBV literature, we provided theoretical support for how resources such as IT, business process alignment, and partner readiness can be combined to create higher-order resources such as OIC, and how such capabilities have a positive impact on operational and financial performance measures. Some key features of the model include the important role of the ability and the willingness of business partners to engage in electronic interactions in a firm's own NBT initiative. Another highlight of the study is the significantly positive effect of doing business electronically with suppliers upon the operational and financial performance on the customer side. The study provides strong empirical support for end-to-end digitization of the entire value chain from customers to the suppliers for enhanced business performance. The results also underscore the need for improving online supply chain management for better performance in a firm's interaction with its customers.

The results also raise an interesting issue related to metrics for practitioners. While firms tend to focus on IT investments and performance metrics such as return on investment (ROI) and return on assets (ROA), they also need to relate such performance to online informational capabilities. The IT business value literature (e.g., Weill 1992) suggests that IT investment dollars may not directly translate into efficient systems. Arguing along similar lines that IT investments do not necessarily translate into useful systems functionality, Barua and Mukhopadhyay (2000) call for linking IT characteristics to performance measures. Given that NBT involves new online technologies, it is possible that many investments do not lead to desired OIC. Therefore, it would be interesting to investigate a more holistic model to trace the entire path from the investment through OIC to operational and financial performance. This will help bridge an existing gap in our understanding of expected and actual benefits of IT investments.

While this study explored the impact of process alignment, OIC, and partner readiness on operational and financial performance, we did not focus on the potential complementarity among these factors. A preliminary investigation of such complementarity, not reported in this paper for the sake of brevity, by incorporating interaction terms in the regression model suggests the presence of such effects. Future research should analyze the extent and the nature of complementarity among processes, IT, and readiness constructs using appropriate econometric approaches (see Athey and Stern 2002).

The impact of digitization on financial performance could be mediated by factors such as customer satisfaction, up-sell and cross-sell, shorter order cycles, and lower inventory levels. Since this is an early study on the impact of NBT on firm performance, we did not incorporate such richness for the sake of simplicity and tractability. It should also be noted that our results are applicable at the firm level rather than at the industry or business sector level. The ultimate impact of NBT on industry profitability depends on various factors such as channel conflict, price transparency, and customer lock-in (Grover and Ramanlal 1999), which are outside the scope of the current study.

This research is also subject to some data-related limitations. First, firm performance data attributed to NBT initiatives are self-reported and could potentially induce certain biases. However, several checks and balances within the data collection process and the fact that multiple responses were used in data collection should work to reduce such biases. Most importantly, the survey was designed such that respondents could choose "don't know" in the event they did not have NBT specific performance data. Second, the existence of certain missing values in performance measures restricted the range of statistical analyses that could be performed. By using the full information maximum likelihood (FIML) method, we could estimate the structural model in spite of missing values; however, the structural modeling does not allow testing possible interactions between different enabler constructs.

The sizes of the firms in our sample ranged from small to large. It is possible that firms of different sizes have different NBT-related challenges. For example, while large firms have more resources and expertise than small firms to carry out NBT, the former may be constrained by a large base of existing systems and complex supplier-side processes, which make it difficult to implement large-scale change projects such as NBT. Studying systematic differences in NBT across small and large firms poses an interesting research issue that is not addressed in this research.

Firms that have initiated NBT earlier may have certain advantages (as well as disadvantages) over those starting later. For example, starting early may have the advantages of higher visibility among business partners as well as a favorable position on the organizational learning curve; however, followers may be able to acquire better technologies and learn from the mistakes of the pioneers. While analyzing the impacts of these factors is beyond the scope of the present study, they provide fruitful avenues for future research.

Firms are making major commitments to large-scale technology-based organizational initiatives to take advantage of the opportunities and to cope with challenges posed by the Internet. However, the evidence of positive impacts from these transformation projects is not abundant in the research literature. By developing and testing a model linking technology and organizational factors to NBT-related performance, this research contributes to a nascent body of knowledge investigating the impacts of organizational transformation enabled by the Internet.

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References

Alba, J., Lynch, J., Weitz, B., Janiszewski, C., Lutz, R., Sawyer, A., and Wood, S. "Interactive Home Shopping: Consumer, Retailer, and Manufacturer Incentives to Participate in Electronic Marketplaces," *Journal of Marketing* (61:3), July 1997, pp. 38-53.

Amit, R., and Schoemaker, P. J. H. "Strategic Assets and Organizational Rent," *Strategic Management Journal* (14:1), January 1993, pp. 33-46.

Anderson, J. C., and Gerbing, D. W. "Structural Equation Modeling in Practice—A Review and Recommended 2-Step Approach," *Psychological Bulletin* (103:3), May 1988, pp. 411-423.

Ariely, D. "Controlling the Information Flow: Effects on Consumers' Decision Making and Preferences," *Journal of Consumer Research* (27:2), September 2000, pp. 233-248.

Armstrong, C. P., and Sambamurthy, V. "Information Technology Assimilation in Firms: The Influence of Senior Leadership and IT Infrastructure," *Information Systems Research* (10:4), December 1999, pp. 304-327.

Athey, S., and Stern, S. "The Impact of Information Technology on Emergency Health Care Outcomes," *The Rand journal of Economics* (33:3), Autumn 2002, pp. 399-432.

Bakos, J. Y., and Brynjolfsson, E. "Information Technology, Incentives, and the Optimal Number of Suppliers," *Journal of Management Information Systems* (10:2), Fall 1993, pp. 36-53.

Balasubramanian, S., Konana, P., and Menon, N. M. "Customer Satisfaction in Virtual Environments: A Study of Online Investing," *Management Science* (49:7), July 2003, p 871.

Barney, J. "Firm Resources and Sustained Competitive Advantage," *Journal of Management* (17:1), Mar 1991, pp. 99-120.

Barua, A., Kriebel, C. H., and Mukhopadhyay, T. "Information Technologies and Business Value - an Analytic and Empirical-Investigation," *Information Systems Research* (6:1), March 1995, pp. 3-23.

Barua, A., and Mukhopadhyay, T. "Business Value of Information Technologies: Past, Present and Future," in *Framing the Domains of IT Management: Glimpsing the Future through the Past,* R. Zmud (Ed.), 2000, pp. 65-84.

Bentler, P. M. "Comparative Fit Indexes in Structural Models," *Psychological Bulletin* (107:2), March 1990, pp. 238-246.

Bentler, P. M., and Bonett, D. G. "Significance Tests and Goodness of Fit in the Analysis of Covariance-Structures," *Psychological Bulletin* (88:3) 1980, pp. 588-606.

Bharadwaj, A. S. "A Resource-Based Perspective on Information Technology Capability and Firm Performance: An Empirical Investigation," *MIS Quarterly* (24:1), March 2000, pp. 169-196.

Bhatt, G. D. "An Empirical Examination of the Effects of Information Systems Integration on Business Process Improvement," *International Journal of Operations & Production Management* (20:11), 2000, pp. 1331-1359.

Boyle, B. A., and Dwyer, F. R. "Power, Bureaucracy, Influence, and Performance: Their Relationships in Industrial Distribution Channels," *Journal of Business Research* (32:3), March 1995, pp. 189-200.

Broadbent, M., Weill, P., and Neo, B. S. "Strategic Context and Patterns of IT Infrastructure Capability," *Journal of Strategic Information Systems* (8:2), June 1999, pp. 157-187.

Browne, M. W., and Cudeck, R. "Alternative Ways of Assessing Model Fit," *Sociological Methods & Research* (21:2), November 1992, pp. 230-258.

Brynjolfsson, E., and Hitt, L. M. "Beyond the Productivity Paradox," *Communications of the ACM* (41:8), August 1998, pp. 49-55.

Burke, R. "Do You See What I See? The Future of Virtual Shopping," *Journal of the Academy of Marketing Science* (25), Fall 1997, pp. 352-360.

Burke, R. R. "Technology and the Customer Interface: What Consumers Want in the Physical and Virtual Store," *Academy of Marketing Science Journal* (30:4), Fall 2002, pp. 411-432.

Byrne, B. M. *A Primer of LISREL: Basic Applications and Programming for Confirmatory Factor Analytic Models*, Springer-Verlag, New York, 1989.

Cannon, J. P., and Perreault, W. D. "Buyer-Seller Relationships in Business Markets," *Journal of Marketing Research* (36:4), November 1999, pp. 439-460.

Carmines, E. G., and McIver, J. P. "Analyzing Models with Unobserved Variables," in *Social Measurement: Current Issues*, G. W. Bohrnstedt and E. F. Borgatta (Eds.), Sage, Beverly Hills, CA, 1981, pp. 65-115.

Carr, N. G. "IT Doesn't Matter," *Harvard Business Review* (81:5), May 2003, pp. 41-49.

Chatterjee, D., Grewal, R., and Sambamurthy, V. "Shaping Up for E-Commerce: Institutional Enablers of the Organizational Assimilation of Web Technologies," *MIS Quarterly* (26:2), June 2002, pp. 65-89.

Chwelos, P., Benbasat, I., and Dexter, A. S. "Empirical Test of an EDI Adoption Model," *Information Systems Research* (12:3), September 2001, pp. 304-321.

CIO Magazine. "Half of E-Commerce Businesses Buy Online," November 30, 2000 (available online at http://www2.cio.com/metrics/2000/metric144.html?CATEGORY=113&NAME=Supply%20Chain).

Clark, T. H., and Stoddard, D. B. "Interorganizational Business Process Redesign: Merging Technological and Process Innovation," *Journal of Management Information Systems* (13:2), 1996, pp. 9-28.

Clemons, E. K., Reddi, S. P., and Row, M. C. "The Impact of Information Technology on the Organization of Economic Activity: The 'Move to the Middle' Hypothesis," *Journal of Management Information Systems* (10:2), Fall 1993, pp. 9-35.

Cool, K., Dierickx, I., and Jemison, D. "Business Strategy, Market Structure and Risk-Return Relationship: A Structural Approach," *Strategic Management Journal* (10:6), November/December 1989, p 507.

Cooper, R. B., and Zmud, R. W. "Information Technology Implementation Research: A Technological Diffusion Approach," *Management Science* (36:2), February 1990, pp. 123-139.

Cronbach, L. J. "Coefficient Alpha and the Internal Structure of Tests," *Psychometrika* (16), 1951, pp. 297-334.

Crook, C. W., and Kumar, R. L. "Electronic Data Interchange: A Multi-Industry Investigation Using Grounded Theory," *Information & Management* (34:2), September 1998, pp. 75-89.

Davis, T. "Effective Supply Chain Management," *Sloan Management Review* (34:4), Summer 1993, pp. 35-46.

Day, G. S. "The Capabilities of Market-Driven Organizations," *Journal of Marketing* (58), October 1994, pp. 37-52.

DeLone, W. H., and McLean, E. R. "Information Systems Success: The Quest for the Dependent Variable," *Information Systems Research* (3:1), March 1992, pp. 60-95.

Dierickx, I., Cool, K., and Barney, J. B. "Asset Stock Accumulation and Sustainability of Competitive Advantage," *Management Science* (35:12), December 1989, pp. 1504-1511.

Dyer, J. H., and Chu, W. "The Role of Trustworthiness in Reducing Transaction Costs and Improving Performance: Empirical Evidence from the United States, Japan, and Korea," *Organization Science* (14:1), January/February 2003, pp. 57-68.

Eisenhardt, K. M., and Martin, J. A. "Dynamic Capabilities: What Are They?," *Strategic Management Journal* (21:10/11), October/November 2000, pp. 1105-1121.

El Sawy, O., and Bowles, G. "Redesigning the Customer Support Process for the Electronic Economy: Insights from Storage Dimensions," *MIS Quarterly* (21:4), December 1997, pp. 457-483.

Evans, P. B., and Wurster, T. S. "Strategy and the New Economics of Information," *Harvard Business Review* (75:5), September/October 1997, pp. 70-83.

Feeny, D. F., and Willcocks, L. P. "Core IS Capabilities for Exploiting Information Technology," *Sloan Management Review* (39:3), Spring 1998, pp. 9-21.

Fingar, P. "Transforming the Supply Chain," *Logistics Management & Distribution Report*, April 1, 2000 (available online at http://home1.gte.net/pfingar/logisticsmag04-00.htm).

Fornell, C., and Larcker, D. F. "Evaluating Structural Equation Models with Unobservable Variables and Measurement Error," *Journal of Marketing Research* (18:1), 1981, pp. 39-50.

Francalanci, C., and Galal, H. "Information Technology and Worker Composition: Determinants of Productivity in the Life Insurance Industry," *MIS Quarterly* (22:2), June 1998, pp. 227-241.

Goodhue, D. L., Wybo, M. D., and Kirsch, L. J. "The Impact of Data Integration on the Costs and Benefits of Information Systems," *MIS Quarterly* (16:3), September 1992, pp. 293-311.

Grant, R. M. "The Resource-Based Theory of Competitive Advantage: Implications for Strategy Formulation," California Management Review), Spring 1991, pp. 114-135.

Grover, V. "An Empirically Derived Model for the Adoption of Customer-Based Interorganizational Systems," *Decision Sciences* (24:3), May/June 1993, pp. 603-640.

Grover, V., and Ramanlal, P. "Six Myths of Information and Markets: Information Technology Networks, Electronic Commerce, and the Battle for Consumer Surplus," *MIS Quarterly* (23:4), December 1999, pp. 465-495.

Hammer, M., and Champy, J. *Reengineering the Corporation: A Manifesto for Business Revolution*, Harper Business, New York, 1993.

Handfield, R. B., Krause, D. R., Scannell, T. V., and Monczka, R. M. "Avoid the Pitfalls in Supplier Development," *Sloan Management Review* (41:2), Winter 2000, pp. 37-49.

Hart, P., and Saunders, C. "Power and Trust: Critical Factors in the Adoption and Use of Electronic Data Interchange," *Organization Science* (8:1), January/February 1997, pp. 23-42.

Hart, P. J., and Saunders, C. S. "Emerging Electronic Partnerships: Antecedents and Dimensions of EDI Use from the Supplier's Perspective," *Journal of Management Information Systems* (14:4), Spring 1998, pp. 87-111.

Hasselbring, W. "Information system integration," *Communications of the ACM* (43:6), June 2000, pp. 32-38.

Hitt, L. M., and Brynjolfsson, E. "Productivity, Business Profitability, and Consumer Surplus: Three Different Measures of Information Technology Value," *MIS Quarterly* (20:2), June 1996, pp. 121-142.

Holland, C., Lockett, G., and Blackman, I. "Planning for Electronic Data Interchange," *Strategic Management Journal* (13:7), October 1992, pp. 539-550.

Iacovou, C. L., Benbasat, I., and Dexter, A. S. "Electronic Data Interchange and Small Organizations: Adoption and Impact of Technology," *MIS Quarterly* (19:4), December 1995, pp. 465-485.

James, L. R., Mulaik, S. A., and Brett, J. M. *Causal Analysis: Assumptions, Models, and Data*, Sage Publications, Beverly Hills, CA, 1982.

Jarvenpaa, S. L., and Stoddard, D. B. "Business Process Redesign: Radical and Evolutionary Change," *Journal of Business Research* (41:1), January 1998, pp. 15-27.

Johnston, H. R., and Vitale, M. R. "Creating Competitive Advantage with Interorganizational Information Systems," *MIS Quarterly* (12:2), June 1988, pp. 153-165.

Kaplan, R. S., and Norton, D. P. "The Balanced Scorecard—Measures That Drive Performance," *Harvard Business Review* (70:1), January/February 1992, pp. 71-79.

Kauffman, R. J., and Kriebel, C. H. "Modeling and Measuring the Business Value of Information

Technologies," in *Measuring Business Value of Information Technologies,* P.A. Strassman, P. Berger, E. B. Swanson, C. H. Kriebel, and R. J. Kauffman (Eds.), International Center for Information Technologies, Washington, DC, 1988, pp. 93-120.

Kettinger, W. J., and Grover, V. "Toward a Theory of Business Process Change Management," *Journal of Management Information Systems* (12:1), 1995, pp. 9-30.

Konana, K., and Balasubramanian, S. "The Social-Economic-Psychological (SEP) Model of Technology Adoption and Usage: An Application to Online Investing," *Decision Support Systems*, Forthcoming, 2005.

Krishnan, M. S., Ramaswamy, V., Meyer, M. C., and Damien, P. "Customer Satisfaction for Financial Services: The Role of Products, Services, and Information Technology," *Management Science* (45:9), September 1999, pp. 1194-1209.

Lee, H. L., and Billington, C. "Managing Supply Chain Inventory—Pitfalls and Opportunities," *Sloan Management Review* (33:3), Spring 1992, pp. 65-73.

Lee, H. L., Padmanabhan, V., and Whang, S. J. "Information Distortion in a Supply Chain: The Bullwhip Effect," *Management Science* (43:4), April 1997, pp. 546-558.

Lee, H. L., and Whang, S. "Information Sharing in a Supply Chain," *International Journal of Technology Management* (20:3/4) 2000, pp. 373-387.

Lovejoy, W. S. "Myopic Policies for Some Inventory Models with Uncertain Demand Distributions," *Management Science* (36:6), June 1990, pp. 724-738.

Lovejoy, W. S. "Response-Time Design in Integrated Order Processing Production Systems," *Operations Research* (43:5), September/October 1995, pp. 851-861.

Lynch, J. G., and Ariely, D. "Wine Online: Search Costs Affect Competition on Price, Quality, and Distribution," *Marketing Science* (19:1), Winter 2000, pp. 83-103.

Magretta, J. "The Power of Virtual Integration: An Interview with Dell Computer's Michael Dell," *Harvard Business Review* (76:2), March/April 1998, pp. 72-83.

Makadok, R. "Toward a Synthesis of the Resource-Based and Dynamic-Capability Views of Rent Creation," *Strategic Management Journal* (22:5), May 2001, pp. 387-401.

Marsh, H. W., and Hocevar, D. "Application of Confirmatory Factor-Analysis to the Study of Self-Concept : First- and Higher-Order Factor Models and Their Invariance across Groups," *Psychological Bulletin* (97:3) 1985, pp. 562-582.

Mata, F. J., Fuerst, W. L., and Barney, J. B. "Information Technology and Sustained Competitive Advantage: A Resource-Based Analysis," *MIS Quarterly* (19:4), December 1995, pp. 487-505.

Milgrom, P., and Roberts, J. "Communication and Inventory as Substitutes in Organizing Production," *Scandinavian Journal of Economics* (90:3), 1988, pp. 275-289.

Moozakis, C. "Services Calculate Net ROI," *InternetWeek* (827), August 28, 2000, pp. 62-64.

Mukhopadhyay, T., Kekre, S., and Kalathur, S. "Business Value of Information Technology: A Study of Electronic Data Interchange," *MIS Quarterly* (19:2), June 1995, pp. 137-156.

Mukhopadhyay, T., Lerch, F. J., and Mangal, V. "Assessing the Impact of Information Technology on Labor Productivity—A Field Study," *Decision Support Systems* (19:2), February 1997a, pp. 109-122.

Mukhopadhyay, T., Rajiv, S., and Srinivasan, K. "Information Technology Impact on Process Output and Quality," *Management Science* (43:12), December 1997b, pp. 1645-1659.

Murray, M., and Sapsford, J. "GE Reshuffles Its Dot-Com Strategy to Focus on Internal `Digitizing'," *Wall Street Journal*, May 4, 2001.

NAPM. "NAPM/Forrester Research Report on eBusiness," January 2001 (available online at http://www.ism.ws/ISMReport/Forrester/FROB012001.cfm).

Narayanan, V. G., and Raman, A. "Aligning Incentives for Supply Chain Efficiency," Harvard Business School Case 9-600-110, 2000.

Netemeyer, R. G., Johnston, M. W., and Burton, S. "Analysis of Role-Conflict and Role Ambiguity in a Structural Equations Framework," *Journal of Applied Psychology* (75:2), April 1990, pp. 148-157.

Parasuraman, A. "Technology Readiness Index (TRI): A Multiple-Item Scale to Measure Readiness to Embrace New Technologies," *Journal of Service Research* (2:4), May 2000, pp. 307-320.

Peterson, R. A., Balasubramanian, S., and Bronnenberg, B. J. "Exploring the Implications of the Internet for Consumer Marketing," *Academy of Marketing Science Journal* (25:4), Fall 1997, pp. 329-346.

Podsakoff, P. M., and Organ, D. W. "Self-Reports in Organizational Research: Problems and Prospects," *Journal of Management* (12:4), 1986, pp. 531-544.

Porter, M. E., and Millar, V. E. "How Information Gives You Competitive Aadvantage," *Harvard Business Review* (63:4), 1985, pp. 149-160.

Premkumar, G., and Ramamurthy, K. "The Role of Interorganizational and Organizational Factors on the Decision Mode for Adoption of Interorganizational Systems," *Decision Sciences* (26:3), May-June 1995, pp. 303-336.

Premkumar, G., Ramamurthy, K., and Nilakanta, S. "Implementation of Electronic Data Interchange: An Innovation Diffusion Perspective," *Journal of Management Information Systems* (11:2), Fall 1994, pp. 157-186.

Rathnam, S., Mahajan, V., and Whinston, A. B. "Facilitating Coordination in Customer Support Teams: A Framework and its Implications for the Design of Information Technology," *Management Science* (41:12), December 1995, pp. 1900-1921.

Riggins, F. J., Kriebel, C. H., and Mukhopadhyay, T. "The Growth of Interorganizational Systems in the Presence of Network Externalities," *Management Science* (40:8), August 1994, pp. 984-998.

Riggins, F. J., and Mukhopadhyay, T. "Interdependent Benefits from Interorganizational Systems: Opportunities for Business Partner Reengineering," *Journal of Management Information Systems* (11:2), Fall 1994, pp. 37-57.

Ross, J. W., Beath, C. M., and Goodhue, D. L. "Develop Long-Term Competitiveness through IT Assets," *Sloan Management Review* (38:1), Fall 1996, pp. 31-42.

Rundensteiner, E. A., Koeller, A., and Zhang, X. "Maintaining Data Warehouses over Changing Information Sources," *Communications of the ACM* (43:6), June 2000, pp. 57-62.

Rust, R. T., and Zahorik, A. J. "Customer Satisfaction, Customer Retention, and Market Share," *Journal of Retailing* (69:2), Summer 1993, pp. 193-215.

Sabherwal, R., and King, W. R. "Towards a Theory of Strategic Use of Information Resources: An Inductive Approach," *Information & Management* (20:3), March 1991, pp. 191-212.

Sanchez, R., Heene, A., and Thomas, H. *Introduction: Towards the Theory and Practice of Competence-Based Competition*, Pergamon Press, Oxford, 1996.

Saunders, C., and Clark, S. "EDI Adoption and Implementation: A Focus on Interorganizational Linkages," *Information Resources Management Journal* (5:1), 1992, pp. 9-19.

Schwartz, E. "Auto Industry Geared for E-Customization," *InfoWorld*, March 23, 2001 (available online at http://archive.infoworld.com/articles/su/xml/01/03/26/010326suauto. xml).

Segars, A. H., and Grover, V. "Strategic Information Systems Planning Success: An Investigation of the Construct and its Measurement," *MIS Quarterly* (22:2), June 1998, pp. 139-163.

Shankar, V., Smith, A. K., and Rangaswamy, A. "Customer Satisfaction and Loyalty in Online and Offline Environments," *International Journal of Research in Marketing* (20:2), July 2003, pp. 153-175.

Sikora, R., and Shaw, M. J. "A Multi-Agent Framework for the Coordination and Integration of Information Systems," *Management Science* (44:11), November 1998, pp. S65-S78.

Slater, D. "Go Figure," *WebMaster Magazine*, April 1997 (available online at http://www.cio.com/archive/webbusiness/040197_roi.html).

Srinivasan, K., Kekre, S., and Mukhopadhyay, T. "Impact of Electronic Data Interchange Technology on JIT Shipments," *Management Science* (40:10), October 1994, pp. 1291-1304.

Srivastava, R. K., Shervani, T. A., and Fahey, L. "Marketing, Business Processes, and Shareholder Value: An Organizationally Embedded View of Marketing Activities and the Discipline of Marketing," *Journal of Marketing* (63), 1999, pp. 168-179.

Strassmann, P. A. *The Business Value of Computers*, Information Economics Press, New Canaan, CT, 1990.

Strassmann, P. A. "GE's B2B Retreat," *Computerworld* (35:27), July 2, 2001, p. 27.

Straub, D. W., Hoffman, D. L., Weber, B. W., and Steinfield, C. "Toward New Metrics for Net-Enhanced Organizations," *Information Systems Research* (13:3), September 2002, pp. 227-238.

Straub, D. W., and Watson, R. T. "Research Commentary: Transformational Issues in Researching IS and Net-Enabled Organizations," *Information Systems Research* (12:4), December 2001, pp. 337-345.

Stuart, I., Deckert, P., McCutcheon, D., and Kunst, R. "Case Study: A Leveraged Learning Network," *Sloan Management Review* (39:4), Summer 1998, pp. 81-93.

Swatman, P. M. C., and Swatman, P. A. "EDI System Integration: A Definition and Literature Survey," *Information Society* (8:3), 1992, pp. 169-205.

Teece, D. J., Pisano, G., and Shuen, A. "Dynamic Capabilities and Strategic Management," *Strategic Management Journal* (18:7), 1997, pp. 509-533.

Thong, J. Y. L., Yap, C. S., and Raman, K. S. "Top Management Support, External Eexpertise and Information Systems Implementation in Small Businesses," *Information Systems Research* (7:2), June 1996, pp. 248-267.

Turnbull, P. D. "Effective Investment in Information Infrastructures," *Information and Software Technology* (33:3), April 1991, pp. 191-199.

Vandenbosch, B., and Higgins, C. "Information Acquisition and Mental Models: An Investigation into the Relationship Between Behavior and Learning," *Information Systems Research* (7:2), June 1996, pp. 198-214.

Venkatraman, N. "IT-Enabled Business Transformation—from Automation to Business Scope Redefinition," *Sloan Management Review* (35:2), Winter 1994, pp. 73-87.

Wade, M., and Hulland, J. "The Resource-Based View And Information Systems Research: Review, Extension, and Suggestions for Future Research," *MIS Quarterly* (28:1), March 2004, pp. 107-142.

Wagner, M. "Online Services Keep Airlines Aloft," *B to B* (5), May 6, 2002, p. 14.

Wang, E. T. G., and Seidmann, A. "Electronic Data Interchange—Competitive Externalities and Strategic Implementation Policies," *Management Science* (41:3), March 1995, pp. 401-418.

Weill, P. "The Relationship Between Investment in Information Technology and Firm Performance: A Study of the Valve Manufacturing Sector," *Information Systems Research* (3:4), 1992, pp. 307-333.

Weill, P., and Vitale, M. R. *Place to Space: Migrating to eBusiness Models*, Harvard Business School Press, Boston, 2001.

Wheaton, B., Muthen, B., Alwin, D. F., and Summers, G. F. "Assessing Reliability and Stability in Panel Models," in *Sociological Methodology,* D. R. Heise (Ed.), Jossey-Bass, San Francisco, 1977, pp. 84-136.

Willcocks, L. P., and Plant, R. "Pathways to E-Business Leadership: Getting from Bricks to Clicks," *MIT Sloan Management Review* (42:3), Spring 2001, pp. 50-59.

Williams, L. J., and Hazer, J. T. "Antecedents and Consequences of Satisfaction and Commitment in Turnover Models—A Reanalysis Using Latent Variable Structural Equation Methods," *Journal of Applied Psychology* (71:2), May 1986, pp. 219-231.

Williamson, O. E. "Transaction-Cost Economics: The Governance of Contractual Relations," *Journal of Law and Economics* (22:2), 1979, pp. 233-261.

Williamson, O. E. "Transaction Cost Economics," in *Handbook of Industrial Organization,* R. Schamlensee and R. D. Willig (Eds.), Elsevier Science, Amsterdam, 1989, pp. 135-182.

Wind, J., and Rangaswamy, A. "Customerization: The Next Revolution in Mass Customization," *Journal of Interactive Marketing* (15:1), Winter 2001, pp. 13-32.

Worthen, B. "Extreme ERP Makeover," *CIO* (4), November 15, 2003, pp. 1-5.

Zaheer, A., and Venkatraman, N. "Determinants of Electronic Integration in the Insurance Industry—An Empirical Test," *Management Science* (40:5), May 1994, pp. 549-566.

Zeithaml, V. A., Parasuraman, A., and Malhotra, A. "Service Quality Delivery through Web Sites: A Critical Review of Extant Knowledge," *Academy of Marketing Science Journal* (30:4), Fall 2002, pp. 362-375.

Zettelmeyer, F., Anderson, E., and Simester, D. "Internet Channel Conflict: Problems and Solutions," Working Paper, Haas School of Business, University of California, Berkeley, 2001.

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