A contingent view of e-collaboration and performance in manufacturing

Eve D. Rosenzweig*

The Goizueta Business School, Emory University, 1300 Clifton Road NE, Atlanta, GA 30322, United States

1. Introduction

In recent years, the practitioner and academic literatures have generated much excitement about Internet-enabled commerce, or the use of the Internet to conduct or support business activities across the supply chain (Boyer and Olson, 2002; Mullaney et al., 2003; Rosenzweig et al., 2009; Tsikriktsis et al., 2004; Zhu and Kraemer, 2002, 2005). One form of Internet-enabled commerce—e-collaboration, which “facilitates coordination of various decisions and activities beyond transactions among the supply chain partners...over the Internet” (Johnson and Whang, 2002, 414)—has garnered a great deal of attention. Frohlich and Westbrook (2002, 741), for example, conclude that

enhanced competitiveness requires that companies ceaselessly integrate within a network of organizations—[and] manufacturers...ignoring this new challenge are destined to fall hopelessly behind their more Internet-enabled rivals,

while Liker and Choi (2004, 104) assert that “partnerships are the supply chain’s blood” in today’s technology-intensive, global economy. But many manufacturers engaged in e-collaboration, particularly those conducting collaborative activities with business customers, have not reaped the expected performance benefits (Deveraj et al., 2007; Jap and Mohr, 2002; Mukhopadhyay and Kekre, 2002; Rosenzweig and Roth, 2007; Zhu, 2004).

In this study, we first hypothesize that e-collaboration with downstream business customers (hereafter e-collaboration) improves performance based on the emerging, yet fairly pervasive, view in practice and in the literature that the greater the supply chain connectivity, the better.
However, while the benefits of connectivity are widely touted, this view often fails to fully consider the substantial costs associated with e-collaboration (e.g., in information systems, administrative time, process changes, overhead, and human relationships) as well as the environment in which the firm competes (Barrett and Konsynski, 1982; Bensaou, 1999a,b; Clemons et al., 1993; Kumar and van Dissel, 1996; O'Leary-Kelly and Flores, 2002).

As an alternative to the developing conventional wisdom, we go on to hypothesize that there are likely to be conditions under which the benefits of e-collaboration— even when properly executed—do not exceed the costs. In doing so, we draw upon the notion that context matters with regard to the proposed relationship between e-collaboration and performance (Drazin and Van de Ven, 1985; Prescott, 1986; Venkatraman, 1989). That is, in addition to investigating the proposed main effect, we examine how various product (product complexity) and market characteristics (market variability, environmental munificence) moderate the form of the relationship between e-collaboration and performance using partial least squares (PLS) modeling.

The paper is intended to offer several key contributions to the emerging e-business literature. First, in contrast to the majority of empirical papers in this literature stream that adopt transaction cost economics or diffusion of innovation perspectives (Robey, 2006), we draw upon the relational view (Dyer and Hatch, 2006; Dyer and Singh, 1998; Jap, 1999; Malhotra et al., 2005)—and upon the operations strategy, information systems, and strategic management literatures and practice—to identify potential sources of advantage emanating from e-collaboration.

Second, using a sample of 50 U.S. manufacturers, we provide empirical evidence that e-collaboration is positively and significantly related to both operational and business performance. According to Zhu and Kraemer (2002, 276), “There has been much speculation but very little empirical data to gauge the scale and characteristics of the Internet-based initiatives and their impact on firm performance, especially of large manufacturing companies.” At the same time, much of the operations management (OM) literature on e-business focuses on supply-side, Internet-enabled commerce (Rosenzweig and Roth, 2007; Sanders, 2008), whereas we examine the performance effects of downstream supply chain operations with business customers.

And third, we show that while e-collaboration does matter, the strength of the effect is contingent upon the perceived level of environmental munificence. Ward and Duray (2000) conclude that the environment has long been identified as an important contingency in studies of manufacturing strategy. Yet empirical research in OM linking Internet-enabled commerce and environmental factors to performance is sparse, and as a result, a fruitful area of study (Saeed et al., 2005; Sanders, 2008). This study is one of the first in the manufacturing strategy literature to empirically investigate the ways in which various contextual factors moderate the relationship between e-collaboration and performance, thereby contributing important theoretical and managerial insights into the nature of supply chain relationships in the e-business arena.

In the next section, we elaborate upon our conceptualization of e-collaboration and provide theoretical arguments regarding its contingent linkages to performance. Section 3 describes the research sample, the reliability and validity of our measures, and the PLS analysis approach. We present and discuss the results in Sections 4 and 5, respectively, and in Section 6 we provide our concluding thoughts, the study limitations, and several opportunities for future research.

2. Theoretical development

The concept of e-collaboration is grounded in the literature that distinguishes business-to-business (B2B) marketspace-based competition from more traditional marketplace-based competition (Boyer and Olson, 2002; Frohlich and Westbrook, 2002; Johnson and Whang, 2002; Rayport and Sviokla, 1994; Rosenzweig and Roth, 2007; Tatsiopoulos et al., 2002; Zhu and Kraemer, 2002). Rayport and Sviokla (1994, 141–142) conclude,

> When buyer–seller transactions occur in an information-defined arena, information is accessed and absorbed more easily, and arranged and priced in different ways. Most important, the information about a product or service can be separated from the product or service itself... The traditional marketplace interaction between physical seller and physical buyer has been eliminated. In fact, everything about this new kind of transaction—what we call a marketspace transaction—is different than what happens in the marketplace... In an information-defined transaction space, customers learn about their products differently, buy them differently, and have them delivered differently.

Building on these studies, Rosenzweig and Roth (2007) use the term B2B marketspace to capture the new ways of doing business and corresponding business models made possible by the open standards, connectivity, and interactivity via the Internet. B2B marketspaces cover a wide spectrum, ranging from transaction-oriented Internet sites (e.g., ChemConnect) to more collaboratively oriented private trading networks (e.g., Cisco) (Jap and Mohr, 2002; Rosenzweig and Roth, 2007; Rosenzweig et al., 2009; Zhu and Kraemer, 2005). The context of this research, however, is on those marketspaces that facilitate e-collaboration.

Early work on interorganizational systems (IOS) highlights the important enabling role that technology—over and above more traditional, yet still effective, modes of collaboration (e.g., face-to-face meetings)—plays in creating and facilitating tightly coupled processes among supply chain partners (Barrett and Konsynski, 1982; Cash and Konsynski, 1985; Giffi et al., 1990; Johnston and Vitale, 1988; Malone et al., 1987; Srinivasan et al., 1994; Roth, 1996). Malone et al. (1987, 488) refer to this phenomena as the electronic integration effect, in which

> a supplier and a procurer use information technology to create joint, interpenetrating processes at the interface between value-added stages... This effect occurs when information technology is used not just to speed...
communication, but to change—and lead to tighter coupling of—the processes that create and use the information.

According to Malone et al. (1987), product development and distribution represent key processes to benefit from such electronic integration.

In keeping with this body of work, recent research calls attention to the role of the Internet in amplifying the sharing and dissemination of real-time information, decisions, processes, and resources among collaborating partners (Frohlich and Westbrook, 2002; Gosain and Palmer, 2004; Johnson and Whang, 2002; Konsynski and Tiwana, 2004; Rosenzweig et al., 2009). Such Internet-enabled relationships go beyond those made possible by more traditional IOS (e.g., traditional EDI), which, in many cases, simply automate current information flows and reinforce existing decision structures and roles (Rai, 2001; Rosenzweig and Roth, 2007; Sanders, 2007; Zhu and Kraemer, 2002, 2005).

Consistent with the e-business literature, our conceptualization of e-collaboration transcends basic buy/sell transactional activities like order entry and tracking to include activities that enhance ongoing manufacturer–customer relationships (Jap and Mohr, 2002; Johnson and Whang, 2002; Rosenzweig and Roth, 2007; Rosenzweig et al., 2009; Tsikriktsis et al., 2004; Zhu and Kraemer, 2002).

Our framing of e-collaboration consists of product development- and distribution-related activities in line with Malone et al. (1987), such as collaborative product design, forecasting and production planning, and logistics planning. We focus on these activities because they capture critical operational elements of downstream supply chain operations (Corbett et al., 1999; Frohlich and Westbrook, 2002; Goffin et al., 2006; Malhotra et al., 2005; Tatsiopoulos et al., 2002).

2.1. Linking e-collaboration and performance

The relational view of competitive advantage provides a valuable theoretical lens for investigating the ways in which e-collaboration influences performance. With its roots in the resource-based view (RBV) of the firm (see e.g., Barney, 1991), this theoretical perspective suggests that critical resources often span firm boundaries and may be embedded in interfirm routines and processes (Dyer and Hatch, 2006; Dyer and Singh, 1998; Jap, 1999; Malhotra et al., 2005). These resources have the potential to generate what Dyer and Singh (1998) refer to as a relational rent. We suggest that e-collaboration facilitates such rent generation by means of interfirm relation-specific assets and interfirm knowledge-sharing routines.

The first source of rent generation, interfirm relation-specific assets, refers to assets specialized to a particular customer relationship, which by definition have less value outside of that relationship. E-collaboration involves human asset specificity, in this case the accumulation of transaction-specific information, language, and know-how by supply chain partners over time (Dyer and Singh, 1998; Williamson, 1985). When engaged in e-collaboration, manufacturers and customers typically have rapid access to relevant historical and current information, which facilitates decision-making during task execution (Ben-saou and Venkatraman, 1995; Clemons et al., 1993; Closs et al., 2008; Corbett et al., 1999; Deveraj et al., 2007; Flynn and Flynn, 1999; Giffi et al., 1990; Gosain and Palmer, 2004; Jap and Mohr, 2002; Lee et al., 1997; Malone et al., 1987; Rosenzweig et al., 2003; Roth, 1996; Saeed et al., 2005; Zhu and Kraemer, 2002). For example, in the context of the apparel supply chain, Johnson (2002, 141, 143) concludes, "[E]nsuring that everyone in the supply chain has an accurate and up-to-date description of the product [design] is one of the biggest challenges... Reducing costs and speeding the design process are important benefits of Web-centric product management systems.”

Going beyond the improved flow of information, e-collaboration may also, over time, engender specialized routines and/or standard operating procedures, which enable manufacturers and their customers to work together more efficiently and effectively than their less-integrated counterparts (Cannon and Perreault, 1999; Gosain and Palmer, 2004; Jap, 1999; Mukhopadhyay and Kekre, 2002; Rosenzweig et al., 2003; Williamson, 1985).

We expect that as the volume and scope of the transactions between the manufacturer and customer increase, so too will the transaction-specific know-how and the resulting speed and quality of decision-making (Dyer and Singh, 1998).

A second avenue for rent generation involves interfirm systems and processes that facilitate the transfer, recombination, and/or creation of knowledge among collaborating supply chain partners (Dyer and Hatch, 2006; Dyer and Singh, 1998; Malhotra et al., 2005; Rosenzweig et al., 2003; Roth, 1996). By enhancing the connectivity between manufacturers and customers, e-collaboration offers new avenues for knowledge exchange and, in some cases, a reapportionment of decision roles, rights, and responsibilities (Konsynski and Tiwana, 2004).

For example, Procter & Gamble and Wal-Mart make use of the Internet to facilitate the synthesis of differing viewpoints as these partners synchronize plans, forecasts, and actual orders (Field, 2004). In this context, e-collaboration offers a forum for improvisation and joint learning, which in turn enables the quick, accurate, and efficient supply of products without relying on costly inventory (Corbett et al., 1999; Frohlich and Westbrook, 2002; Gosain and Palmer, 2004; Malhotra et al., 2005; Rosenzweig and Roth, 2007).

We also note that Procter & Gamble plays a lead role or even “owns” many of these stocking and allocation-related decisions, which historically have been viewed as retailer decisions (Konsynski and Tiwana, 2004). In this way, e-collaboration expands the cognitive capacity of managers because decision responsibilities can now be more readily apportioned to the most knowledgeable supply chain partner(s) for that particular decision-making situation/ activity.

In summary, e-collaboration, when properly executed, enhances a manufacturer’s ability to maintain, advance, and broaden its relationships with key customers, which leads to improved performance. Because transaction-specific know-how and interfirm knowledge-sharing routines are socially
complex advantages subject to considerable causal ambiguity and time-compression diseconomies, they are difficult to replicate (Barney, 1991; Dyer and Hatch, 2006; Jap, 1999, 2001). Thus, we offer the following hypothesis:

**Hypothesis 1.** E-collaboration is positively related to performance.

### 2.2. E-collaboration and Performance in Context

But are there conditions under which the costs associated with e-collaboration outweigh the expected benefits? To explore such a proposition, we go beyond the defining theoretical reasons as to why we would expect a positive relationship between e-collaboration and performance (i.e., on account of interfirm relation-specific assets and knowledge-sharing routines) to examine key product and market characteristics outlined in several seminal information systems studies that are likely to affect the proposed relationship.

Along with asset specificity, Malone et al.’s (1987) conceptual study highlights the importance of product complexity, and specifically complexity of product description, in determining the appropriateness of various technology-enabled coordination structures across the supply chain. Clemons et al. (1993) likewise identify asset specificity and product complexity as important factors in this regard, but augment their theoretical discussion with explicit consideration of the number of potential suppliers for a product, or the degree of market fragmentation. Accordingly, in addition to product complexity, environmental considerations like market fragmentation should be taken into account when studying the relationship between e-collaboration and performance.

Choudhury (1997) empirically examines such environmental factors underlying a firm’s choice of IOS in the context of the aircraft parts industry. Specifically, the author finds that the appropriate choice of IOS is in part a function of market variability, which is conceptualized as a combination of market fragmentation and market volatility as described below in Section 2.2.2.

While market variability roughly corresponds to aspects of two of the three key environmental dimensions outlined in Dess and Beard’s (1984) study of task environments—complexity and dynamism—it does not adequately capture the third dimension, environmental munificence, which we define as the extent to which an industry is characterized by a high growth rate of demand. Thus, below we examine the ways in which product complexity, market variability, and environmental munificence influence the proposed relationship between e-collaboration and performance.

#### 2.2.1. Linking e-collaboration, Product Complexity, and Performance

The design, manufacture, and supply of complex, customized products typically calls for the exchange of rich product-related information (e.g., customer specifications, engineering drawings, and technical details) across multiple functional areas of supply chain partners (Bensaou, 1999a; Evans and Wurster, 2000; Novak and Eppinger, 2001; Rosenzweig et al., 2009). Without such an exchange, customers may experience difficulties in evaluating purchase choices prior to the product purchase or in assessing product performance afterwards (Cannon and Perreault, 1999; Clemons et al., 1993; Malone et al., 1987). At the same time, complex, customized products are often associated with high levels of demand uncertainty (Fisher, 1997; Saed et al., 2005). In situations such as these, close collaborative relationships are needed in order to address the bounded rationality of supply chain partners and to ultimately reduce coordination costs (Bensaou and Anderson, 1999; Clemons et al., 1993; Closs et al., 2008; Malone et al., 1987).

Alternatively, when products do not require specialized know-how to exchange, customers typically desire transactional-type relationships with a multitude of manufacturers (Cannon and Perreault, 1999; Gosain and Palmer, 2004). For example, standard products that can be accurately, easily, and quickly described, and that are synchronized across trading partners, tend to be good candidates for “spot purchasing” by means of electronic markets that connect buyers and sellers via a central database (Choudhury et al., 1998; Malone et al., 1987). Further, standard, well-defined products such as these typically do not change much over time and therefore have relatively stable and predictable demand (Fisher, 1997). In this context, manufacturers gain very little by developing Internet-enabled, collaborative relationships with customers because minimal information exchange is required. Instead, interorganizational coordination can be accomplished by way of simple procedures and preplanning (Bensaou, 1999a; Bensaou and Anderson, 1999; Rosenzweig et al., 2009).

Lambert and Knemeyer (2004, 116) maintain that “partnerships [and supporting information system capacity] are costly to implement—they require extra communication, coordination, and risk sharing. They are justified only if they stand to yield substantially better results than the firms could achieve without partnering.” As a result, we offer the following hypothesis:

**Hypothesis 2.** The relationship between e-collaboration and performance is diminished when products are low in complexity.

#### 2.2.2. Linking e-collaboration, Market Variability, and Performance

Like environmental munificence, market variability represents an external force beyond the short-run control of management, and therefore it presents both threats and opportunities to the organization (Cannon and Perreault, 1999; Flynn and Flynn, 1999; Ward et al., 1995). Following Choudhury (1997), we define market variability to include market fragmentation, conceptualized as the number of manufacturers competing in the marketplace, and market volatility, the rate at which prices change over time (see also Cannon and Perreault, 1999; Choudhury et al., 1998).

When markets are low in fragmentation and prices are relatively stable, customers generally desire a close, collaborative relationship because the opportunity costs of tying themselves to a few key manufacturers and thereby forgoing comparison-shopping are low (Bensaou
and Anderson, 1999; Cannon and Perreault, 1999; Carr and Pearson, 1999; Castrogiovanni, 2002; Choudhury, 1997; Choudhury et al., 1998; Clemons et al., 1993; Malone et al., 1987). As the market becomes increasingly fragmented and volatile, however, there are likely to be instances in which it does not “pay” as much for manufacturers and customers to develop such mutually dependent, tightly integrated processes (Clemons et al., 1993; Kumar and van Dissel, 1996). Indeed, supply chain partners should consider development of less-constrained, loosely coupled processes that enable flexibility in highly variable markets (Dyer and Singh, 1998; Konsynski and Tiwana, 2004).

To elaborate, as the number of competing manufacturers increases, we expect customers to become increasingly concerned with remaining highly attuned to market nuances (Goodhue et al., 1992). In such an environment, customers may, at times, be forced to alter business activities and processes with a dynamic pool of partners. Along these lines, we expect customers to pursue arm’s-length relationships with numerous manufacturers in order to identify as many as possible with the product in stock and to compare prices and service levels (Bensaou and Anderson, 1999; Choudhury, 1997; Choudhury et al., 1998; Malone et al., 1987). In keeping with Dwyer and Oh (1987), who assert that greater variability in the environment requires channel members to adopt decentralized, informal decision structures, we offer the following hypothesis:

**Hypothesis 3.** Market variability weakens the relationship between e-collaboration and performance.

### 2.2.3. Linking e-collaboration, environmental munificence, and performance

In the management literature, *environmental munificence* refers to the amount of resources within an environmental context (environmental capacity) and the extent to which that environment can support sustained growth (Castrogiovanni, 1991; Dess and Beard, 1984; Koka et al., 2006; Kotha and Nair, 1995). According to Wiersema and Bantel (1993, 489), “[A]n environment lacking in munificence offers limited growth opportunity, which leads, in turn, to intensive competitive dynamics.” That is, with limited growth opportunities, manufacturers typically attempt to increase demand for their products at the expense of competitors; competition becomes a zero-sum game (Castrogiovanni, 1991). In response to these competitive dynamics, manufacturers often emphasize deep penetration of existing markets, reliable deliveries, and the development and maintenance of customer loyalty (Koka et al., 2006). Clearly, e-collaboration is one way in which manufacturers can achieve the level of channel coordination called for in this type of environment.

Manufacturers competing in munificent environments, however, are typically not subject to the same competitive dynamics, and in some instances, demand for products may actually exceed supply. In such a scenario, we would expect manufacturers to focus on those activities that increase capacity, rather than explicit development of e-collaboration, in order to take full advantage of current and future opportunities offered by the munificence of the environment (Yasai-Ardekani, 1989). At the same time, e-collaboration is likely to commit manufacturers to satisfying demand of current customers at the expense of multiple new customers, the latter of which may ultimately be of greater value to the business (Danneels, 2003). Therefore, we posit that

**Hypothesis 4.** Environmental munificence weakens the relationship between e-collaboration and performance.

### 3. Research design

#### 3.1. Data collection

As part of a larger research project (see Rosenzweig and Roth, 2007), we collected the data for our study in the summer of 2002 by means of a Web survey targeting manufacturers that were using a B2B marketspace to supply customer organizations with direct goods (i.e., not indirect goods/maintenance, repair, or operating supplies) and/or services (e.g., logistics planning). To determine the final set of constructs and associated items underlying this study for inclusion in the Web survey, we undertook several key steps.

First, as a check of content validity for the various constructs and items derived from the literature, we conducted interviews with seven practitioners from companies such as KPMG Consulting (now BearingPoint, Inc.), IBM, and Longistics. The interviewees, with titles including Director-Integrated Supply Chain Program, Director of e-Commerce, and President, had extensive knowledge of and experience with managing Internet-enabled commerce practices across the supply chain. During the interviews, we covered a series of open-ended questions over the course of several hours, on average, and such discussions led to refinement of the construct definitions and items and ultimately to preparation of the questionnaire items and scales for the Web survey.

Second, we conducted a small pre-test (n = 11) of the resulting Web survey to assess factors such as clarity of wording, the ease of completing the survey, and estimated completion time. For this pre-test, we targeted respondents from the field study sample frame described below. Based on the pre-test data and follow-up phone calls to participating respondents, we changed the wording in a few questions, revised the range of response categories in several cases, and removed questions, when feasible, that either generated a high item nonresponse rate or were highly redundant. Because several pre-test respondents reported that the survey was too long, eliminating such questions was critical to improving the overall survey design and subsequently the field study response rate. After these revisions were made to the Web survey, we deployed the field study in summer of 2002, the discussion of which we now turn.

As no single formal list of B2B marketspace users exists, the target audience for the field study was developed from several key sources that are representative of the research population (i.e., all manufacturers using a B2B marketspace to interact with customer organizations by supplying direct goods and/or services). Given large manufacturers are more
likely to have engaged in Internet-enabled commerce than small manufacturers (cf. Harland et al., 2007), it is important that the sample frame tap sources composed of a fair amount of large manufacturers. To do so, our sample frame included all U.S.-affiliated, manufacturing members of the Supply Chain Council (SCC) (http://www.supply-chain.org) as well as a random sample of U.S. companies featured on the InternetWeek 2001 “100 E-Business Leaders” and Forbes’ 2001 “B2B: Best of the Web” lists. Specifically, we cross-referenced and supplemented the SCC list with companies identified in the InternetWeek list and with the clients of the promising B2B companies identified in the Forbes list to ensure that we adequately specified U.S. manufacturers engaged in Internet-enabled, collaborative activities with customers. The resulting sample frame consisted of a total of 170 U.S. manufacturers.

From this sample frame, we identified U.S. senior supply chain or e-business managers that interact directly with customers of their organization’s primary B2B marketspace, that is, the single B2B marketspace with the most significant impact on the organization’s downstream supply chain operations. Higher level managers, such as our targeted respondents, are typically more reliable sources of information pertaining to strategic operations management issues than their less-senior colleagues (Miller and Roth, 1994).

We reached target respondents from 115 of these 170 companies comprising the sample frame by means of an initial, introductory telephone call. Interested respondents were then sent an email invitation to participate in the study, which included a brief description of the research and a link to the Web survey. We followed up with an email reminder if we did not receive a completed survey from a particular respondent within 1 week, and, when necessary, with a phone call reminder after an additional week (Dillman, 2000). We received a total of 50 completed surveys, for a response rate of 29.4% (50/170).

In terms of assessing nonresponse bias, 86 of the 170 U.S. manufacturers comprising the sample frame are publicly traded organizations for which Compustat data is available. Using this set of publicly traded organizations (n = 86), tests for nonresponse bias revealed no significant difference between respondents and nonrespondents along 2002 Compustat number of employees and sales volume data. We also compared early and late survey respondents on a variety of descriptive statistics, including market position, sales volume, and number of employees (Armstrong and Overton, 1977), and the results likewise showed no statistically significant differences.

As expected, survey respondents had substantial work experience, averaging 10.9 years with their firm and 2 years in their current position (e.g., V.P. of Supply Chain, Director of E-business). In terms of the unit of analysis, the majority of respondents identified the enterprise (42%) as the highest level in their organization at which the primary B2B marketspace is used, followed by the division/group level (30%), and the business-unit level (22%). These organizations had been, on average, participating within the specified primary B2B marketspace for a little over 2 years, with responses ranging from 1 month to about 7.5 years.

The organizations comprising the sample represent a variety of industrial sectors, including the chemical (22%), consumer products (20%), and high-tech (16%) sectors. Consistent with literature that suggests large organizations are more likely to engage in Internet-enabled commerce than small organizations, as well as our sample frame, almost half of the survey respondents reported that their organization holds the number one or two position in the primary markets served via the B2B marketspace. Likewise, the median sales volume for the enterprise is $4.8 billion, while the median number of enterprise employees exceeds 16,000.

3.2. Measurement development

3.2.1. E-collaboration

In creating the e-collaboration scale, we asked respondents to specify how routinely they use the primary B2B marketspace to facilitate collaborative activities with the primary customer, including product design, forecasting/production planning, and logistics planning (Ahmad and Schroeder, 2001; Rosenzweig et al., 2009; Zhu and Kraemer, 2002); see Appendix for details regarding the measures used in the analysis. Importantly, our e-collaboration scale captures the extent to which the manufacturer’s systems, routines, and procedures are linked to its primary customer, which is the B2B marketspace customer representing the highest percentage of the manufacturer’s sales or the manufacturer’s most significant relationship for competing in the future. Strength on e-collaboration denotes considerable interfirm relation-specific assets and interfirm knowledge-sharing routines.

3.2.2. Product and market characteristics

We use the type of product manufactured, or degree of product customization, as a proxy measure for product complexity. Consistent with Safizadeh et al. (2000) and Saeed et al. (2005), this single-item scale ranges from the manufacture of standardized products to customized products.

Since the market characteristics studied in this research represent managerial perceptions regarding these attributes, we operationalize the market variability and environmental munificence constructs using perceptual measures (Ward et al., 1995). Our market variability scale is based on two survey questions measuring the extent to which customers have numerous, alternative sources of supply to meet demand and the extent to which the business environment is characterized by rapidly changing prices (Cannon and Perreault, 1999; Choudhury, 1997). Kotha and Nair (1995) assert that growth in demand represents one of the most common ways to conceptualize environmental munificence. Consistent with these studies and with Wiersema and Bantel (1993), we operationalize environmental munificence using a single-item measure that captures the seller’s perception of whether the industry is characterized by a high growth rate of demand.

3.2.3. Performance

Radjou et al. (2003) conclude that U.S. manufacturers must take a new approach to technology-enabled supply
chain management, which includes a focus on performance metrics tied to customer satisfaction and revenue generation instead of the sole traditional focus on metrics aimed at cycle time and cost reduction. At the same time, a meta-analysis by Kohli and Deveraj (2003) found that studies employing productivity-based dependent variables (e.g., cycle time) are more likely to uncover positive payoffs associated with IT investments than those employing profitability-based dependent variables. Thus, we operationalize the dependent variable, performance, using two multi-item scales: operational performance and business performance.

Operational performance is captured by means of three survey questions that assess the extent to which B2B marketspace participation improved the seller’s forecast accuracy, order fill rate/line item fill rate, and order fulfillment cycle time. This three-item scale enables us to tease out the impact of e-collaboration and various product and market characteristics on process-related performance (Mukhopadhyay and Kekre, 2002). For business performance, we asked respondents to indicate the extent to which B2B marketspace participation improved their organization’s customer retention rate, sales volume growth, and profitability (Barua et al., 2004; Jap and Mohr, 2002; Mukhopadhyay and Kekre, 2002).

3.2.4. Control variables
Manufacturers that participate in Internet-enabled, collaboratively oriented activities with customers are likely to first automate more routine transactions such as order entry, order tracking, billing, and payment (Jap and Mohr, 2002; Johnson et al., 2007; Mukhopadhyay and Kekre, 2002; Saeed et al., 2005). According to Jap (2001, 29), “As the [manufacturer-customer] dyad grows in its understanding of each other, they are able to engage in more sophisticated planning activities and processes that may lead to greater positions of rent-earning potential.”

Consistent with the literature, we refer to the more basic transactional processes facilitated through the manufacturer’s use of the Internet as e-transactions (Boyer and Olson, 2002; Frohlich and Westbrook, 2002; Johnson and Whang, 2007; Johnson et al., 2007; Rosenzweig and Roth, 2007; Tsikriktsis et al., 2004; Zhu and Kraemer, 2002). E-transactions enable more efficient execution of routine processes by eliminating unnecessary data entry tasks, reducing order entry errors, and increasing information visibility (e.g., price, product availability, and location) across the supply chain. At the same time, e-transactions may offer customers an attractive alternative (and perhaps more sophisticated) means by which to transact business with manufacturers. As a result, we control for the effects of e-transactions on performance in our analysis. To create the two-item e-transactions measure, we asked respondents to specify how routinely they use the primary B2B marketspace to facilitate customer order entry and order tracking.

Note that we also assessed the need to control for the effect of length of B2B marketspace participation on performance, as more established relationships may simply yield better results (Bharadwaj et al., 1999; Clemons et al., 1993; Mukhopadhyay and Kekre, 2002). Since this variable had no statistically significant effect on performance, we removed it from the analysis.

Finally, because scale effects may account for differences in performance, we include a measure of organization size (number of employees) as a control in our analysis (Gaimon, 1997; Roth and Miller, 1992).

4. Data analysis and results

To simultaneously assess the measurement model and determine the effects of e-collaboration on performance as a function of product complexity, market variability, and environmental munificence, we employ the PLS approach to structural equation modeling using VisualPLS 1.04a (Chin, 1998; Chin et al., 2003). This components-based approach to estimation readily accommodates the presence of moderated relationships in the structural model (Fig. 1), and does so effectively with a relatively small sample size.

Our PLS analysis contains multiplicative interaction terms, which we develop following the procedure outlined in Chin et al. (2003). Because interaction terms increase the potential for multicollinearity, we standardize (μ = 0; σ2 = 1) all items reflecting the predictor and moderator constructs (Aiken and West, 1991; Chin et al., 2003; Cronbach, 1987; Drazin and Van de Ven, 1985; Venkatesan, 1989). In doing so, we minimize the degree of multicollinearity among the variables and improve the interpretability of the results.

To estimate the statistical significance of the parameter estimates, we employ a bootstrapping procedure with replacement using 500 samples (generated from the original dataset). We likewise utilize bootstrap samples of 250 and 1000 to assess the stability of the parameter estimates. The results are consistent across the 250, 500, and 1000 bootstrap samples.

Finally, all items in the analysis described below are univariate normal, but some data is missing for the items. Because the extent of missing data is small (<10%, a rule-of-thumb threshold value) and the data are missing completely at random (MCAR) according to Little’s MCAR test (p > .10), we simply replace the missing data using the mean substitution imputation approach (Hair et al., 1995; Little, 1988; Tsikriktsis, 2005).

4.1. Measurement validation

4.1.1. Reliability
The standardized path loadings of the items with their respective constructs easily exceed the commonly applied threshold of 0.70 (Chin, 1998; Table 1). This provides evidence for the reliability of the individual items. Likewise, the constructs exhibit adequate interitem reliability (Fornell and Larcker, 1981; see composite reliability values in Table 2).

4.1.2. Validity
We offer evidence of convergent validity in three key ways. First, all items load positively and significantly on their respective constructs (p ≤ .001; Table 1). Second, all constructs exhibit composite reliabilities of 0.88 or higher.
Third, as a rule-of-thumb, the average variance extracted (AVE) should be greater than 0.50 (Chin, 1998; Fornell and Larcker, 1981). The AVE for all constructs easily exceeds this threshold value (Table 2).

The AVE is also used to evaluate discriminant validity (Chin, 1998; Fornell and Larcker, 1981). The square root of the AVE for each construct is greater than all other cross-correlations (Table 2), which provides evidence for the distinctiveness of the constructs. The principal components factor analysis loadings (omitted for brevity) further establish discriminant validity; all items have high loadings on their respective constructs with low cross-loadings on the others.

In terms of criterion validity, true to form, manufacturers with strength on e-collaboration tend to co-own various physical assets with primary customers (Clemons et al., 1993; Dyer and Singh, 1998; Williamson, 1985), including process equipment \( (p \leq .001) \) and information and software systems \( (p \leq .001) \), as evidenced by ANOVA tests. E-collaboration also correlates positively \( (r = .24; p \leq .10) \)

### Table 1

<table>
<thead>
<tr>
<th>Construct</th>
<th>Item</th>
<th>Mean</th>
<th>S.D.</th>
<th>Standardized path loadings</th>
<th>T-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-collaboration</td>
<td>Collaborative product design</td>
<td>1.46</td>
<td>1.11</td>
<td>.88</td>
<td>13.84</td>
</tr>
<tr>
<td></td>
<td>Collaborative forecasting/prod'n planning</td>
<td>1.90</td>
<td>1.43</td>
<td>.89</td>
<td>17.00</td>
</tr>
<tr>
<td></td>
<td>Logistics planning</td>
<td>1.94</td>
<td>1.38</td>
<td>.92</td>
<td>29.92</td>
</tr>
<tr>
<td>Product complexity</td>
<td>Degree of product customization</td>
<td>2.44</td>
<td>1.12</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Market variability</td>
<td>Availability of alternative sources of supply</td>
<td>3.08</td>
<td>1.34</td>
<td>.94</td>
<td>5.58</td>
</tr>
<tr>
<td></td>
<td>Rapidly changing prices</td>
<td>3.12</td>
<td>1.35</td>
<td>.83</td>
<td>4.50</td>
</tr>
<tr>
<td>Environmental munificence</td>
<td>Growth rate of demand</td>
<td>2.63</td>
<td>1.21</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Operational performance</td>
<td>Order fulfillment cycle time</td>
<td>3.10</td>
<td>1.01</td>
<td>.87</td>
<td>20.22</td>
</tr>
<tr>
<td></td>
<td>Order fill rate/line item fill rate</td>
<td>2.98</td>
<td>.96</td>
<td>.94</td>
<td>36.03</td>
</tr>
<tr>
<td></td>
<td>Forecast accuracy</td>
<td>2.76</td>
<td>1.01</td>
<td>.76</td>
<td>7.65</td>
</tr>
<tr>
<td>Business performance</td>
<td>Customer retention rate</td>
<td>3.18</td>
<td>1.05</td>
<td>.84</td>
<td>10.82</td>
</tr>
<tr>
<td></td>
<td>Sales volume growth</td>
<td>3.07</td>
<td>1.00</td>
<td>.93</td>
<td>42.72</td>
</tr>
<tr>
<td></td>
<td>Profitability</td>
<td>3.14</td>
<td>1.04</td>
<td>.93</td>
<td>35.27</td>
</tr>
<tr>
<td>E-transactions</td>
<td>Order entry</td>
<td>3.25</td>
<td>1.71</td>
<td>.95</td>
<td>19.89</td>
</tr>
<tr>
<td></td>
<td>Order tracking</td>
<td>2.88</td>
<td>1.67</td>
<td>.95</td>
<td>26.60</td>
</tr>
<tr>
<td>Size</td>
<td>Number of employees</td>
<td>2.71</td>
<td>2.04</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>
Industry Groups and Industries

the Census, Annual Survey of Manufactures: Statistics for data segmented by SIC/NAICS code from the U.S. Bureau of (1993–2002), derived using the total value of shipments rate of growth in industry sales over a 10-year period significantly (our perceptual measure correlates positively and significantly \( r = .28; p < .001 \)) with a measure that captures the extent to which the primary products sold to the primary customer are complex, thereby establishing criterion validity. In establishing criterion validity for market variability, we find that our measure is positively correlated with an objective measure from the U.S. Bureau of the Census, 2002 Economic Census: Manufacturing Sector Concentration Ratios dataset that captures the total number of companies in the industry, segmented by NAICS code \( r = .28; p < .10 \). Turning to environmental munificence, our perceptual measure correlates positively and significantly \( r = .34; p < .01 \) with an objective measure of the rate of growth in industry sales over a 10-year period (1993–2002), derived using the total value of shipments data segmented by SIC/NAICS code from the U.S. Bureau of the Census, Annual Survey of Manufactures: Statistics for Industry Groups and Industries Reports as outlined in Dess and Beard (1984).

A perceptual measure capturing the influence of B2B marketplace participation on the organization’s order-to-cash cycle time performance helps establish criterion validity for operational performance, as the two are positively and significantly correlated \( r = .73; p < .001 \). Finally, our business performance scale correlates positively and significantly with a perceptual measure of the impact of B2B marketplace participation on the organization’s sales-per-employee performance \( r = .73; p < .001 \), thereby demonstrating criterion validity: high employee productivity enables the organization to offer customers superior value, which in turn drives customer loyalty and retention, revenue growth, and ultimately profitability (Barua et al., 2004; Heskett et al., 1994).

### 4.1.3. Common methods variance

Self-report survey studies with a common rater are susceptible to common methods variance (CMV). To reduce the likelihood that respondents “edit their responses to be more socially desirable, lenient, acquiescent, and consistent with how they think the researcher wants them to respond,” we guaranteed respondent anonymity (Podsakoff et al., 2003, 888).

We also segmented the questions pertaining to the predictor and criterion variables into different sections of the survey. Note that these variables were derived from different scale anchors/formats (see Appendix). Such “procedural remedies” for controlling method bias make it difficult for the respondents to link together the various measures, particularly since the survey is fairly long (Podsakoff et al., 2003).

To evaluate the extent to which CMV influences our empirical findings, we conducted several post hoc tests of the data. Results from Harman’s single-factor test suggest minimal evidence of method bias (Harman, 1967). Analysis using a single-method-factor approach advocated by Podsakoff et al. (2003) and implemented in PLS by Liang et al. (2007) likewise shows that CMV is not problematic. That is, after controlling for the effects of an unmeasured latent method factor in our PLS model, all path loadings of the hypothesized indicators with their respective constructs remain statistically significant. Furthermore, the average indicator variance explained by the latent method factor is a mere .004 (compared to .843 for the average indicator variance explained by the substantive constructs).

Finally, if CMV was present to a significant degree in our data, it would be unlikely that we would have observed the expected relationships between measures derived using publicly available, objective data and our perceptual measures of market variability and environmental munificence as described in Section 4.1.2.

### 4.2. Testing the structural model

The standardized path coefficients associated with the structural model are provided in Fig. 1. Our model exhibits adequate predictive validity, as it explains 45.6% of the variance in operational performance and 44.3% of the variance in business performance (Fig. 1). Of the variance in operational performance, 3.8% is explained by the control variables, 28.7% by the main effects, and 13.1% by the moderation effects. For business performance, 3.0% of the variance is explained by the control variables, 28.7% by the main effects, and 4.1% by the moderation effects.

Recall that Hypothesis 1 posits that e-collaboration positively influences performance. The PLS results in Fig. 1 indicate that e-collaboration has a positive and significant effect on operational \( \beta = .73; p < .01 \) and business
We found no empirical support for Hypothesis 2: the relationship between e-collaboration and performance does not differ based upon the level of product complexity. That is, the interaction effect of e-collaboration and product complexity on operational \((\beta = -0.13; p > .10)\) and business \((\beta = -0.18; p > .10)\) performance is not statistically significant.

Turning to the market characteristics, the results do not support Hypothesis 3: the level of perceived market variability does not influence the relationship between e-collaboration and operational performance \((\beta = 0.19; p > .10)\) or between e-collaboration and business performance \((\beta = 0.15; p > .10)\). In terms of Hypothesis 4, the results indicate that the slope of the relationship between e-collaboration and operational performance varies, as expected, as a function of the level of perceived environmental munificence \((\beta = -0.37; p < .05)\). Essentially, the positive relationship between e-collaboration and operational performance becomes less pronounced as the level of environmental munificence increases. In contrast to the operational performance results, we found no evidence that e-collaboration and environmental munificence act as joint predictors of business performance \((\beta = -0.09; p > .10)\). Hence, Hypothesis 4 is only partially supported.

Of the control variables, organization size had a negative and significant relationship with both operational \((\beta = -0.24; p < .05)\) and business \((\beta = -0.16; p < .10)\) performance. E-transactions was a significant control variable \((\beta = 0.19; p < .10)\) for business performance. In the next section, we discuss the structural model results, beginning with the effects of the two control variables and the direct effects of e-collaboration on performance.

5. Discussion

Our data indicates that, on average, smaller organizations experience greater improvements in performance on account of their Internet-enabled commerce than larger organizations. Although large organizations typically have greater resources and bargaining power than small organizations, the sheer size of a large organization may, in part, inhibit its ability to use Internet-based tools to better serve key business customers (Evans and Wurster, 2000; Harland et al., 2007).

We also found a positive and significant relationship between e-transactions and business performance. By streamlining and automating customer-related transactional activities such as order entry and tracking, manufacturers reduce administrative costs and ultimately improve profitability (Choudhury et al., 1998; Johnson et al., 2007). Likewise, the results suggest that existing customers (and perhaps new customers) appreciate the availability and ease of use of such electronic channels for transacting business (Jap and Mohr, 2002; Tsikriktsis et al., 2004).

In terms of operational performance, the Hypothesis 1 test results suggest that e-collaboration facilitates the exchange of insights regarding future customer demand, which in turn leads to a more responsive supply chain (Clemons et al., 1993; Deveraj et al., 2007; Frohlich and Westbrook, 2002; Jap and Mohr, 2002; Zhu and Kraemer, 2002). This is supported by the example of Whirlpool and Sears, which utilize a Web-based tool to share forecasts and collaborate on any exception items (Slone, 2004). By doing so, Whirlpool has been able to minimize its forecast errors, which has resulted in higher service levels and lower costs associated with finished goods inventory. We also found a positive, significant relationship between e-collaboration and business performance, which provides an initial step in allaying Zhu and Kraemer’s (2002, 289) assertion that “overall aggregate measures of firm performance such as total sales and profit margins appear to be too ‘remote’ to be significantly associated with e-commerce capability.”

5.1. Relationship between e-collaboration, product complexity, and performance

The Hypothesis 2 test results indicate that, on average, the relationship between e-collaboration and performance is not significantly influenced by the level of product complexity. In a post hoc examination of all direct effects, we find that product complexity shares negative relationships leaning towards statistical significance with operational \((\beta = -0.17; p = 0.12)\) and business performance \((\beta = -0.14; p = 0.14)\), consistent with empirical findings in Bozarth et al. (2009). Bozarth et al. (2009) conclude that factors like product customization and demand variability tend to increase the size and scope of the manufacturing task, which, in turn, increases planning costs and negatively impacts schedule attainment.

Although not statistically significant, the observed direct effects of product complexity on performance are suggestive and help shed light on our Hypothesis 2 results. To begin, when product complexity is high, the Hypothesis 1 test results indicate that e-collaboration leads to improved operational and business performance as expected from our theoretical arguments. Namely, e-collaboration helps overcome the negative performance implications of designing, manufacturing, and supplying complex, customized products. Stated differently, manufacturers are able to glean the desired performance benefits associated with the exchange of such products (e.g., sales growth through product differentiation; see Closs et al., 2008) by means of e-collaboration.

Interestingly though, based on our Hypothesis 2 test results, e-collaboration provides similar performance benefits when manufacturers exchange less complex products. That is, despite the fairly standard, well-defined nature of less complex products, we still observe a positive and significant effect between e-collaboration and performance.

We suspect manufacturers able to eke out such benefits do so by closely collaborating with key customers to “optimize” the flow of their less complex, standard products characterized by routine, high-volume requirements (Choudhury, 1997; Harland et al., 2007). Demand under this scenario tends to be stable and predictable over time, which facilitates the use of model-based algorithms to automatically generate plans, forecasts, and schedules.
(Kumar, 2001). Optimization techniques of this kind have the potential to reduce slack across the supply chain (Saeed et al., 2005), which likely accounts for our findings with respect to Hypothesis 2.

In this way, e-collaboration, when properly executed, can be beneficial across varying degrees of product complexity. For complex, customized products, e-collaboration offers a much-needed forum for knowledge exchange consistent with our theoretical arguments. Alternatively, when products are fairly standard, well-defined, and subject to high-volume requirements, e-collaboration allows for closeness with key customers concerned with optimizing product flows across the supply chain. Investments in e-collaboration in this latter case, while still costly, appear to be worthwhile despite the earlier logic suggesting otherwise (see Section 2.2.1). Future research should analyze this expanded view of the ways in which e-collaboration leads to performance, given a level of product complexity, in more detail.

5.2. Relationship between e-collaboration, market variability, and performance

We found no empirical support for Hypothesis 3: market variability does not appear to diminish the influence of e-collaboration on performance. Our post hoc examination of the direct effects indicates a weak relationship between market variability and business performance leaning towards statistical significance ($\beta = .13; p = .14$), which, in part, informs the Hypothesis 3 test results.

There are two differing views in the literature regarding the relationship between market variability and performance. On the one hand, based on the industrial economics literature, when customers have few, alternative sources of supply, a manufacturer may simply exploit a customer’s dependence on it which would tend to improve the manufacturer’s performance (Clemons et al., 1993). Accordingly, this view supports a negative relationship between market variability and performance.

Specific to our research, the alternative view suggests a positive relationship such that a manufacturer’s performance may actually be improved by means of B2B market space participation when markets are highly variable. Because customers have numerous alternative sources of supply under these circumstances, effective B2B market space participation essentially helps differentiate a manufacturer from competitors, thereby contributing to the possibility of making a customer’s “short list” of preferred manufacturers (Choudhury, 1997). Such a scenario increases a manufacturer’s odds of earning the customer’s business in highly variable markets, which would likely lead to improved manufacturing performance.

The direction of the observed relationship between market variability and business performance, while not statistically significant, is consistent with this latter view. Understanding the positive direction of this relationship provides guidance in terms of explaining the Hypothesis 3 test results, to which we now turn.

The extant literature that relates constructs like e-collaboration, market variability, and performance tends to do so more in terms of a customer’s incentives than a manufacturer’s incentives (see, for example, Choudhury, 1997). To be consistent with the dominant logic of this literature, Section 2.2.2 develops Hypothesis 3 primarily in terms of the type of Internet-enabled, supply chain relationship that customers desire, on average, with manufacturers, given a level of market variability. Recall such a focus leads us to posit that market variability weakens the relationship between e-collaboration and performance.

The lack of statistical significance associated with the Hypothesis 3 test results suggests the presence of a “counteracting” force that essentially neutralizes this hypothesized effect. Given the observed relationship between market variability and business performance ($\beta = .13; p = .14$), we believe such a counteracting force may be explained by also explicitly considering a manufacturer’s incentives—in lieu of the current dominant focus on a customer’s incentives in the literature—for investing in e-collaboration in highly variable markets. In this regard, we suggest that it is the customer, on average, who finds it less desirable to engage in e-collaboration when markets are highly variable, and not necessarily the manufacturer.

In highly fragmented markets, manufacturers presumably benefit from some level of demonstrable customer commitment as discussed above in our examination of the direct effect of market variability on performance. E-collaboration certainly provides one vehicle by which a manufacturer can readily attract and ensure business, thereby improving its performance, and some customers are apparently willing to offer manufacturers this level of commitment despite the variable nature of the market. Further conceptual development and empirical testing of this more balanced, integrated understanding of the dual incentives for engaging in e-collaboration in highly variable markets offers an interesting opportunity for future research.

We note that while the foregoing discussion regarding the manufacturer’s incentives provides an explanation for our Hypothesis 3 test results, it motivates the question as to why some customers appear to be willing to engage in e-collaboration in highly variable markets. In light of our Hypothesis 2 findings, perhaps it is beneficial for customers to engage in e-collaboration in such markets with respect to the exchange of products that are fairly standard, well-defined, and subject to high-volume requirements (Choudhury, 1997). Given our relatively small sample size, we leave to future research to examine the effects of such combinations of contextual factors (three-way interaction terms) on the relationship between e-collaboration and performance.

5.3. Relationship between e-collaboration, environmental munificence, and performance

The Hypothesis 4 test results provide evidence that the relationship between e-collaboration and operational performance is particularly strong in low-demand-growth environments, which are characterized by intense competitive pressures. Within such a relatively “fixed pie” of
demand scenario, e-collaboration enables a manufacturer to forge closer bonds with and better anticipate the needs of key business customers.

Alternatively, given the rate at which demand grows in munificent environments, an unwavering focus on the development of collaborative processes with a select subset of existing customers—at the expense of multiple, new customers—may exacerbate the overall risk of shortages and/or excess supplies. This, in turn, may lead to the loss of emerging, yet critical, market opportunities (Danneels, 2003; Yasai-Ardekani, 1989).

To elaborate, it is reasonable to assume that, on average, the value of existing business customers is not as high in munificent environments (relative to those environments lacking in munificence). At the same time, it may be difficult for manufacturers competing in highly munificent environments to discern which customers are the “right” ones (i.e., most valuable to the business) to target for collaborative, Internet-enabled relationships. And even if the “right” business customers are targeted for e-collaboration, the growth rate in demand for that subset of customers (piece of the pie) is unlikely to match the growth rate in demand of the overall market (pie). Such a scenario supports our Hypothesis 4 tests results with respect to the diminished relationship between e-collaboration and operational performance in highly munificent environments.

The Hypothesis 4 test results also indicate that, on average, the relationship between e-collaboration and business performance does not vary on account of the level of environmental munificence. Interestingly, while not hypothesized but consistent with the management literature (see, e.g., Koka et al., 2006; Wiersema and Bantel, 1993; Yasai-Ardekani, 1989), we observe a strong positive and significant relationship between environmental munificence and business performance ($\beta = .30$; $p < .01$).

According to the management literature, environmental munificence represents one of the most fundamental predictors of business performance. Such favorable environments are fairly forgiving in the sense that the rate of market growth enables a manufacturer to generate slack resources and to subsequently strengthen its competitive position. For this reason, environmental munificence also tends to be a key factor in the viability of a given business strategy over time (Dess and Beard, 1984).

With regards to the business strategy, e-collaboration is essentially a strategic operations choice (Hayes and Wheelwright, 1984; Skinner, 1969), and in particular, what Giffi et al. (1990) refer to as an “integration” choice. Manufacturing strategy literature suggests that the greater the extent to which an organization aligns its pattern of strategic operations choices with the business strategy, the better its odds of economic success (Roth and Miller, 1992). On account of the forgiving nature of munificent environments and its role in the long-term viability of a given business strategy, it may be that manufacturers in our sample, on average, attain business performance benefits by means of e-collaboration because this operations strategic choice is highly aligned with the chosen business strategy.

In summary, what the above suggests is that despite the apparent downsides associated with engaging in e-collaboration in highly munificent environments, manufacturers, on average, do not experience the expected declines in business performance as posited in Hypothesis 4. In this regard, the direct effects of e-collaboration and environmental munificence on business performance dominate the interaction effect posited in Hypothesis 4.

Finally, we note that consistent with the perspective taken in the environmental munificence literature (see, for example, Dess and Beard, 1984), our summary of these results focuses for the most part on a manufacturer’s incentives for engaging in e-collaboration, given a level of environmental munificence. In line with our discussion of the Hypothesis 3 test results, future research should consider an expanded view that, conceptually and empirically, more explicitly takes into account the customer’s incentives.

6. Conclusions

Much of the extant literature touts the increasing importance of investing in integrated processes and technologies with supply chain partners. We know from the supply chain management literature that a failure to collaborate with partners often leads to distorted information flows, which in turn result in ineffective production, capacity, and transportation scheduling/planning; excess inventory and/or stockouts; and loss of revenues and customers (Corbett et al., 1999; Lee et al., 1997). Along these lines, Rayport and Jaworski (2004, 58) assert that “as the focus of competition shifts from what companies do to how they do it, the new frontier of competitive advantage lies in the quality of interactions and relationships companies can establish with their customers and markets.”

Building on the relational view, we establish e-collaboration as a mechanism by which manufacturers can develop and maintain strong ties with primary customers (Dyer and Hatch, 2006; Dyer and Singh, 1998; Johnson et al., 2007; Tsikriktsis et al., 2004). In doing so, we bridge insights from the operations strategy, information systems, and strategic management literatures—as well as from practice—to develop and test a model that predicts the operational and business benefits of e-collaboration.

Our empirical results indicate that the greater the extent of Internet-enabled, collaborative activities conducted with key customers, the better a manufacturer’s performance. Consistent with the literature, the results suggest that e-collaboration improves the manufacturer’s ability to accurately predict and fulfill customer orders in a timely fashion (see, e.g., Mukhopadhyay and Kekre, 2002). In contrast to prior research, however, we find that e-collaboration improves the manufacturer’s ability to reap business-related performance benefits as well (see, e.g., Zhu and Kraemer, 2002).

These observed relationships are strong, despite our relatively small sample size and the early stage of B2B marketplace adoption at the time of data collection. According to Bharadwaj et al. (1999, 1011), “...due to the substantial learning curve associated with the use of information systems, investments in IT systems may take
years to add value to a firm and are therefore more likely to be reflected in future profit streams.”

One might ask whether these conclusions apply regardless of the nature of the product exchanged, and whether the observed effects would still obtain in other types of competitive environments. In keeping with contingency theory (Drazin and Van de Ven, 1985; Prescott, 1986; Venkatraman, 1989), this study suggests that the move toward more collaborative, Internet-enabled supply chain relationships is not always desirable, even when properly executed (Cannon and Perreault, 1999; Gosain and Palmer, 2004; Goffin et al., 2006; Harland et al., 2007). Our results offer some evidence that the effect of e-collaboration on performance is more complex than previously suggested, and raises some additional interesting questions as discussed in Section 5.

We find that high levels of perceived environmental munificence, but not market variability and product complexity level, diminish the positive effect of e-collaboration on operational performance. Our results suggest that developing strength on e-collaboration may not be in the manufacturer’s best interests when competing in highly munificent markets. However, it is important to note that any lengthy delay in the development of e-collaboration with key business customers—even in highly munificent environments—may be risky, since transaction-specific know-how and interfirm knowledge-sharing routines are subject to considerable time-compression diseconomies (Barney, 1991; Goffin et al., 2006; Jap, 1999).

For the practicing manufacturing manager, our study illustrates the type of performance benefits that can be attained when engaging in Internet-enabled, collaborative activities with primary customers. In addition, we show that the operational benefits associated with e-collaboration are particularly pronounced when manufacturers compete in less munificent environments. Thus, we offer managers a framework describing the conditions under which investments in e-collaboration may be more appropriate, and subsequently, more beneficial. This initial framework should be of great practical utility to manufacturers, as it provides guidance regarding the areas in which limited resources should be allocated to generate the most value. As noted by Jap and Mohr (2002, 37):

Too often, we observe firms who throw technology at their distribution channel or supply chain, only to be disappointed with the returns from these investments. Although leveraging technology in B2B relationships is a complex task that needs to be thoughtfully planned and carefully executed, clearly the payoffs in B2B e-commerce are there and yet to be realized.

Our work also informs research, because it offers a foundation upon which scholars can build in incorporating the relational view—a less commonly applied theoretical lens in the B2B arena—in their work. In addition, the study lends credence to the notion that effective deployment of boundary-spanning resources is in part contingent upon external environmental factors.

Over the next few years, most firms will engage in some form of Internet-enabled activities with supply chain partners (Rosenzweig and Roth, 2007; Sanders, 2007; Woods et al., 2003). Given this anticipated growth, our research takes an important step toward uncovering the differential impact of e-collaboration on performance and identifying several contextual factors that may be underlying those differences.

In accomplishing these objectives, however, we made several research design choices that resulted in some limitations to our study. First, since manufacturers were at a relatively early stage of B2B marketplace adoption at the time of the data collection, and given the resulting sample size concerns, our study focuses solely on the downstream link between manufacturers and customers. Ahmad and Schroeder (2001, 21) conclude, “Streamlining information sharing in only one direction of the supply chain may create a bottleneck in the other direction, making the whole system inefficient.” Future research that incorporates into the analysis both downstream and upstream linkages between manufacturers and suppliers would provide a valuable contribution to this literature. Going further, it would be interesting to examine our research questions through the lens of complex adaptive systems, which broadens the perspective to connected supply chain systems (see Holweg and Pil, 2008).

Second, our measures capture the manufacturer’s perceptions of the supply chain relationship and performance. It is possible that the customer’s point of view differs. Such self-report survey studies using a single informant, while common in the operations management literature, are nonetheless susceptible to the effects of CMV. Although our survey design mitigates the potential for CMV, and results from Harman’s single-factor test and the single-method-factor approach suggest that CMV is not present to a significant degree in the data, we encourage future researchers to utilize data from multiple sources and informants across the supply chain similar to the dyadic approach outlined in Liu et al. (2009). For instance, use of multiple informants across the supply chain would be particularly valuable in understanding a manufacturer’s and customer’s incentives for engaging in e-collaboration in highly variable markets as suggested in Section 5.2.

Third, because our sample is dominated by fairly large manufacturers, the results may not be generalizable to small manufacturers. Nonetheless, the organization size-related results suggest that small organizations can in fact generate benefits on account of their Internet-enabled commerce. Future research should examine this issue in greater detail.

Fourth, while the observed statistical power of our model is adequate (.93 versus the .80 threshold recommended by Cohen, 1988), we suggest future research employ a larger dataset than the one utilized here. On a related note, as discussed above, the combined impact of e-collaboration and product and market characteristics on performance may be more complex than the simple interactions examined in this research (Drazin and Van de Ven, 1985; Koka et al., 2006). Further, the nature of the interactions may be curvilinear. Nonetheless, the independent variables do account for a fair amount of variance in operational and business performance ($R^2 = .46$ operational performance;
While the empirical findings presented in this study are of a somewhat tentative nature due to the relatively small sample size, they do highlight the need for future research in this important, emerging area of operations strategy. Clearly, much work remains to be done to improve our understanding of how Internet-enabled, B2B collaborative relationships interact with the contextual factors investigated in this research as well as with additional factors such as product importance (Cannon and Perreault, 1999; Carr and Pearson, 1999) and supplier/customer power (Benton and Maloni, 2005; Holweg and Pil, 2008; Konsynski and Tiwana, 2004; Malhotra et al., 2005) to drive supply chain performance.

Acknowledgements

We would like to acknowledge the valuable suggestions of the Associate Editor and four anonymous reviewers, which have greatly improved the paper. Benn Konsynski, Jeff Stratman, and University of Notre Dame seminar participants also provided helpful comments.

Appendix. Measurement items for key constructs

**Organization size:**

Approximately how many employees, in full time equivalents (FTE), does your organization currently employ?

1. Under 250
2. 250 to 500
3. Over 500 to 1000
4. Over 1000 to 2000
5. Over 2000 to 4000
6. Over 4000 to 8000
7. Over 8000

**E-transactions:**

How routinely do you use the primary B2B marketspace to facilitate the following activities with your primary customer today?

<table>
<thead>
<tr>
<th>Activity</th>
<th>Don't Use</th>
<th>Use Monthly</th>
<th>Use Daily</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order entry</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Order tracking</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

**E-collaboration:**

How routinely do you use the primary B2B marketspace to facilitate the following activities with your primary customer today?

<table>
<thead>
<tr>
<th>Activity</th>
<th>Don't Use</th>
<th>Use Monthly</th>
<th>Use Daily</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaborative product design</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Collaborative forecasting/production planning</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Logistics planning</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

**Product complexity:**

Please select the one category below that best describes the degree of customization in the primary products that you sell to your primary customer within the primary B2B marketspace.

1. Mostly standard products with no options
2. Mostly standard products with standard options
3. Mostly standard products modified to customer specifications
4. Mostly standard products with options modified to customer specifications
5. Mostly customized products manufactured to customer specifications

**Market variability:**

Please indicate the extent to which you agree with the following statements about the business environment where the primary B2B marketspace is currently being used.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Our customers have numerous, alternative sources of supply to meet demand.</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>
In your opinion, how did participation within the primary B2B marketspace impact your performance on the following business outcomes?

### Business performance:

**Environmental munificence:**

Please indicate the extent to which you agree with the following statements about the business environment where the primary B2B marketspace is currently being used.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Some Improvement</th>
<th>Substantial Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>A high growth rate of demand characterizes this industry.</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Our business environment is characterized by rapidly changing prices.</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

**Operational performance:**

In your opinion, how did participation within the primary B2B marketspace impact your performance on the following business outcomes?

<table>
<thead>
<tr>
<th>Worse</th>
<th>Some Improvement</th>
<th>Substantial Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Order fulfillment cycle time</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>b. Order fill rate/line item fill rate</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>c. Forecast accuracy</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

**Business performance:**

In your opinion, how did participation within the primary B2B marketspace impact your performance on the following business outcomes?

<table>
<thead>
<tr>
<th>Worse</th>
<th>Some Improvement</th>
<th>Substantial Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Customer retention rate</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>b. Sales volume growth</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>c. Profitability</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

### References


Danneels, E., 2003. Tight-loose coupling with customers: the enact-
Robey, D., 2006. Consensus and diversity in IS research: theoretical foundations of empirical studies of I&S. Working paper, Robinson College of Business, Georgia State University, Atlanta, GA.


