ANTECEDENTS AND CONSEQUENCES OF THE ADOPTION OF INTERNET-BASED INTERORGANIZATIONAL SYSTEMS: AN EMPIRICAL STUDY

This study creates a model of the relationships among organizational, interorganizational and technological factors, Internet-based interorganizational systems (IBIS) and various measures of firm performance. First, the study uses structural equation modeling (SEM) to empirically test these relationships. The study also utilizes multiple group analysis to test the model relationships across firms using several environmental and organizational factors as moderators.

Introduction

The Internet-enabled supply chain (SC) is a byproduct of the developments in the Internet-based interorganizational information systems (IOIS). The term interorganizational systems (IOS) has been used to describe IT systems that cross organizational boundaries (Bakos, 1991) such as extranets and EDI. To compete effectively in the dynamic global markets, firms increasingly need to integrate their operations with those of their partners using IOS as discrete functions within the SC such as MRPII and JIT become insufficient (Stonebraker & Liao, 2004). Some of the organizational performance benefits that can be reaped from such IOS include search cost reduction, inventory reduction, and closer relationships with customers (Johnston & Vitale, 1988). According to surveys conducted by the US Census Bureau, approximately 93% of online sales in the US were accounted by B2B activity ($2,716 billion) in 2006. Most of this activity was conducted through proprietary EDI systems via value-added networks (VAN) and over the Internet. According to Statistics Canada, approximately 45% of Canadian firms in the private sector purchased goods and services online in 2006, whereas only 8% sold online. B2B sales totaled $31.4 billion, which constituted about 68% of total e-commerce sales conducted by private firms.

Thus, B2B e-commerce plays an increasingly important role in the North American economy and has become a significant factor in the evolution of SCs. The main difference between the electronic supply chain (e-SC) and the traditional SC is that the e-SC is founded upon technology-based relationships and the decisions made within the SC are heavily affected by efficiency gains (Williams, Esper, & Ozment, 2002). There are a number of information channels that could be used in supply chain management (SCM) to link SC partners such as auctions, purchasing groups, electronic agents and trading exchanges. Using these online SCs, firms can obtain real-time synchronized information by using extensible markup language (XML) on prices, delivery information and so on. Both large and small firms are now using the Internet as one of the main platforms in their upstream, downstream, and internal SCs (Williamson, Harrison, & Jordan, 2004).

There is limited empirical research on factors that affect the adoption of IBIS and how the adoption of these technologies affects various measures of firm performance when contextual factors might act as moderators. Thus, the main objective of this paper is to improve our understanding of the
effects of various organizational and environmental factors on IBIS-firm performance relationships. The potential role of moderators is emphasized by Melville, Kraemer, and Gurbaxani (2004) and Wade and Hulland (2004). A survey of North American firms is conducted to test a model of the relationships among factors that determine IBIS adoption, the adoption of IBIS, business process performance, operational performance and financial performance. Thus, unlike many of the previous empirical studies in this area, this study uses business process performance as a mediator between IBIS and other performance measures in line with suggestions from the relevant literature (e.g., Melville et al., 2004; Wade & Hulland, 2004).

The proposed model is tested using several organizational (the length of IBIS implementation, firm type, firm age, and type of firm ownership) and environmental (dynamism, complexity, and hostility) factors as moderators to determine whether the model relationships hold in different contexts or not. The ultimate goal of this research is to develop an empirically-grounded conceptual framework that managers can use to better understand how the adoption of IBIS affect various measures of firm performance in relation to organizational characteristics and the competitive environment. This will help them prioritize the allocation of their firms’ resources to IBIS-related investments based on their firms’ performance goals, organizational characteristics and competitive environment. In addition, this research will benefit researchers by creating a strong foundation for future empirical research in this area.

Prior Research

A number of previous studies have been conducted in the general IT literature that analyzed the effects of IT on firm performance. However, these studies yielded conflicting results in that some reported positive gains and some found no gains or reported losses from making investments in IT. These inconsistent results may be attributed to the fact that many of these studies did not take into account differences in industry or organizational characteristics (Lee & Kim, 2006; Ragowsky, Stern, & Adams, 2000). Mukhopadhyay, Kekre, and Kalathur (1995) found that Chrysler saved $220 million due to improved information exchanges with its suppliers as a result of using EDI. Barua, Kriebel, and Mukhopadhyay (1995) analyzed the economic impacts of IT using 60 survey responses from the manufacturing sector. The study concluded that many of the positive effects of IT were on intermediate variables (i.e., operational variables such as capacity utilization and inventory turnover), which, in turn, drove higher level variables such as market share and profitability. Auramo, Kauremaa, and Tanskanen (2005) conducted case studies and surveys of progressive firms that used IT solutions in their SCs such as EDI and extranets. They found that these solutions helped firms improve customer service, operational efficiency, information quality and agility of their supply networks.

Some of the other studies in the field also explored certain organizational characteristics that may be complementary to IT. For instance, Zhu (2004) used the resource-based view (RBV) to investigate the complementarity of back-end IT infrastructure and front-end e-commerce capability. The study found that this complementarity had a strong positive effect on firm performance measured by sales per employee, inventory turnover and cost reduction. The overall business value that resulted from this complementarity was greater than the individual effects of IT infrastructure and e-commerce capability. The author argued that the so-called “productivity paradox” found across different studies could be attributed to the absence of measurement of complementarities in addition variations in methods and measures across these studies. Another group of IT related empirical studies (e.g., Barua, Konana, & Whinston, 2004; da Silveira & Cagliano; Iyer, Germain, & Frankwick, 2004; Ranganathan, Dhaliwal, & Teo, 2004) focused on the adoption and performance effects of Internet technologies in SCM. For example, Barua et al. (2004) tested a model positing that the abilities of firms to coordinate and utilize their resources created online informational capabilities, which resulted in customer and supplier-side digitization. The model also
suggested that this digitization improved financial performance. Ranganathan et al. (2004) tested a model, where organizational environment and external environment were posited to lead to the internal assimilation and external diffusion of Web technologies in firms’ SCs, respectively, which then resulted in improved performance. These model relationships were supported using data from North American firms. However, most of these previous studies did not analyze the effects of moderators on IBIS-performance relationships. Thus, in this exploratory study, we attempt to shed some light on the potential moderating role of organizational and environmental factors in these relationships.

Research Model

The model shown in Figure 1 has been developed through literature review to test a number of hypotheses. Several studies have been conducted before to determine the factors that affect the adoption of IT (e.g., Chwelos, Benbasat, & Dexter, 2001; Premkumar, Ramamurthy, & Nilakanta, 1994; Teo, Wei, & Benbasat, 2003). Among competing theories of IT adoption, including information richness theory, theory of communicative action, and structuration theory, innovation diffusion theory has received the most attention from researchers (Lewis, Bajwa, & Pervan, 2004). In fact, it has been widely used as a foundation in EDI research (Chwelos et al., 2001). Innovation diffusion theory [92] provides several perceived innovation characteristics, including relative advantage, complexity, compatibility, observability, and triability, that may either encourage or inhibit innovation adoption. These characteristics have been used in EDI adoption research by researchers such as Premkumar et al. (1994) and Teo, Tan, and Wei (1995).

Chwelos et al. (2001) stated that since research based on innovation diffusion theory only dealt with technological factors (i.e., perceived characteristics of the technology) that affected adoption, most research on EDI adoption took an organizational approach, focusing on organizational and interorganizational factors, as well as technological factors. According to Teo et al. (2003), the identification of organizational factors that influenced EDI and IOS adoption drew mainly from the organizational innovativeness perspective based on the works of researchers such as Damanpour (1991) and Premkumar and Ramamurthy (1995). For example, the set of factors used by Premkumar and Ramamurthy (1995) included internal need (technological factor), top management support (organizational factor) and competitive pressure and exercised power (interorganizational factors). Hart and Saunders (1997) hypothesized that relative power and trust between two firms played a role in their adoption and usage of EDI.

In addition, Wade and Hulland (2004) argue that the RBV is very valuable for information systems (IS) research and Melville et al. (2004) focus on RBV’s usefulness to the study of IT business value. Both studies use the RBV to formulate propositions for future IT research. The RBV argues that firms have heterogeneous resources, which enable them to achieve competitive advantage and superior long-term performance (e.g., Wernerfelt, 1984; Barney, 1991). Thus, the RBV can be used to discuss how IBIS, as technological resources, can help make firms more competitive by enabling them to improve firm performance in different areas. A number of previous studies used the RBV to analyze the relationship between IT and business value (e.g., Mata, Fuerst, & Barney, 1995; Bharadwaj, 2000). Wade and Hulland (2004) also argue that potential moderators might affect the relationship between IS resources and performance and therefore researchers applying the RBV in IS context must make it a top priority to identify moderating constructs. In addition, Jean, Sinkovics, and Kim (2008) state that the analysis of the effects of moderators is an emerging stream of research in the IT business value area and that these moderators have not been fully investigated. In fact, this is the main goal of the current study. Thus, the model shown in Figure 1 will be used to test the moderating effects of a number of contextual factors. This study will test differences in model relationships across firms based on the following organizational factors: length of IBIS implementation (0-1 year vs. 1-3 years vs. more than 3 years), firm
type (service firms vs. manufacturing firms vs. merchandising firms, where merchandising firms included retailers, wholesalers, and distributors), firm age (0-5 years vs. 6-15 years vs. more than 15 years), and type of firm ownership (publicly-traded vs. closely-held vs. sole proprietorship). This study will also test if the model relationships are moderated by environmental factors, including dynamism (stable vs. turbulent), complexity (low complexity vs. high complexity), and hostility (low hostility vs. high hostility).

**Hypotheses**

Various organizational, interorganizational, institutional, and technological factors may determine the adoption of IOIS such as EDI and IBIS. Pressure from business partners and competitors are two such factors. Firms that face intense competition are more likely to adopt new technologies. This is especially true if their competitors have largely adopted these technologies and these firms do not want to be viewed as less innovatively capable (Goodstein, 1994).

This is in line with institutional theory (DiMaggio & Powell, 1983), which suggests that mimetic pressures may force organizations to adopt the practices or innovations of other organizations in their environments, whether they carry any technical value or not, to gain social legitimacy. In addition, firms face coercive pressures, which entail formal or informal pressures from other organizations such as governmental regulatory bodies, parent corporations, or other organizations they are dependent on, which are more dominant in terms of the resources they own. These pressures force firms to adopt structures or practices that serve the interests of the organizations exerting the pressure. Finally, normative pressures are those that may be exerted by suppliers, customers, and business, trade, and professional organizations to adopt a certain innovation (DiMaggio & Powell, 1983; Teo et al., 2003).

Costs associated with implementing new IOIS can also act as either incentives or impediments to the adoption of these technologies. The innovation diffusion perspective (Rogers, 1995) suggests that less costly innovations are more likely to be adopted. This perspective has also been used in EDI adoption literature (e.g., see Premkumar et al., 1994). Since the Internet is interactive and gives firms access to global markets, they can reduce inventory, procurement and coordination costs (Zhu, Dong, Xu, & Kraemer, 2006). Thus, the adoption of IBIS along the supply chain can result in large cost savings (Tan & Teo, 1998), providing incentives for firms to conduct electronic business. On the other hand, the large costs associated with the implementation of Internet technologies can also be impediments to the adoption of these technologies. These include the initial investment costs in these technologies, the costs of supporting hardware and software, employee training costs, as well as costs that may be incurred to restructure the organization or reengineer business processes in line with the requirements of electronic business (Zhu et al., 2006).

The importance of top management support in the successful implementation of innovations is also well known. Top management has the responsibility to project the vision for change to all organizational stakeholders, allocate scarce resources for the introduction of innovations and the establishment of needed infrastructure (Zmud, 1984). Previous empirical evidence also suggests that top management support is an important factor for the successful adoption of IOS (Grover, 1993). In addition, research on EDI adoption (e.g., Finnegan, Golden, & Murphy, 1998; Premkumar et al., 1995) is in agreement with the significant role played by this factor.

In addition, when IOIS are used, trust issues may arise when the supply chain partners fear that the greater information shared through these linkages can be used at their expense and thus lead to loss of control. Therefore, the development of mutual trust between supply chain partners is of great importance when IOIS are implemented (Son, Narasimhan, & Riggins, 2005). Hart and Saunders (1997) argued that
mutual trust was important for EDI adoption, because it encouraged firms to make the needed investments for adoption and discouraged them from engaging in opportunistic behavior. The presence of trust also ensured the long term success of EDI adoption (Hart & Saunders, 1997). Various dimensions of trust and their significance for the adoption of IBIS have also been discussed by other studies (e.g., McKnight, Choudhury, & Kaemar, 2002; Schoder & Haenlein, 2004; Bunduchi, 2008).

**Figure 1**

**A Model of IBIS and Performance**

Technological factors related to the characteristics of the Internet such as network reliability, data security, scalability, and complexity can also be found in the literature as factors affecting the adoption of IBIS. Network reliability is the degree to which a firm is able to successfully transfer critical business application to and from its supply chain partners over the Internet (Soliman, Chen, & Frolick, 2003). The increasing use of the Internet and the corresponding requirement to have flawless delivery of critical applications over the Internet are pushing internet service providers to improve network reliability,
efficiency, and service quality (Awduche & Jabbari, 2002). Improvements in these areas are likely to increase IBIS adoption. Data security is also a concern when using IBIS. It deals with the extent to which data exchanged and transactions conducted on the Internet are secure. IBIS are based on open standards and are more vulnerable to security breaches compared to legacy systems such as EDI that are based on VAN (Zhu et al., 2006). Therefore, some firms may feel that the risks associated with using these systems (e.g., risk of exposure of important data related to customer accounts, payments, product design etc.) are too great (Stewart & Segars, 2002). In fact, previous research suggests that many small and medium-sized firms are not implementing Internet technologies due to potential data security problems (Lawson-Body & O'Keefe, 2006).

Another characteristic of the Internet that encourages the adoption of IBIS is its scalability, which refers to the economies of scale and scope provided by the Internet. The adoption of IBIS can enable firms to expand their market reach and create new markets for their products (Petersen, Welch, & Liesch, 2002; Lee, 2003). It also helps firms create electronic linkages with numerous entities such as customers, suppliers, retailers, brokers, co-producers, employees, and shareholders (Kandampully, 2003). Finally, complexity, which is “the degree to which an innovation is perceived as relatively difficult to understand and use” (Rogers, 1995, p. 242), is another factor that may affect IBIS adoption. Rogers (1995) suggested that less complex innovations were more likely to be adopted. Lin (2008) argued that electronic business was a complex innovation since it required both technological adjustments such as combining the Internet platform with the existing IT infrastructure, as well as administrative adjustments such as changes in organizational processes of supply chain partners. However, other authors (Soliman & Janz, 2004; Gallear, Ghobadian, & O'Regan, 2008) argued that IBIS were less complex to implement compared to EDI since the Internet had one common communication standard (TCP/IP) that made it easier to communicate with multiple trading partners. Thus:

Hypothesis 1 (H1): Organizational, interorganizational, institutional, and technological factors (i.e., adoption factors) have a direct, positive effect on the adoption of IBIS.

Since the RBV does not specify the mechanisms needed for firm resources to achieve competitive advantage, Melville et al. (2004) analyze previous IT business value models to posit relationships between IT resources and firm performance. They contend that improvements in organizational performance occur after IT resources are applied within the appropriate business processes and improvements in these processes are realized. A similar viewpoint is expressed by Premkumar et al. (1994), who argue that information obtained from EDI has to be aligned well with the internal IS applications in order for EDI to enhance the efficiency and effectiveness of firm’s operations. For example, the purchase order received from customers through EDI can be valuable only if it is integrated with the production planning system (Premkumar et al., 1994).

Based on strategic IT research, Wade and Hulland (2004) also suggest that the effect of IT on firm performance is indirect and that intermediate-level dependent variables at the business process level must be used to measure the performance effects of IT resources. In fact, the findings of a study by Dehning, Richardson, and Zmud (2007) indicate that manufacturing firms’ IT-based SCM systems help them improve financial performance through improvements in their business processes. In addition, Barua et al. (2004) state that, according to the EDI and marketing literature, IBIS lead to improvements in various business processes such as cycle time reduction, quality improvement, customer satisfaction, buying experience, and loyalty, which, in turn, lead to improved financial performance. Similar findings were reported by Shah and Shin (2007), who concluded that the effect of IT investment on financial performance was significant only through the mediating effect of operational performance.
Thus, the current study posits that the adoption of IBIS have a direct effect on business process performance, which measures the efficiency of specific business processes. Improvements in these specific business processes, in turn, boost operational performance (which measures overall firm operational performance), which eventually lead to improvements in financial performance. The effect of business process performance on financial performance is expected to be both direct and indirect through the mediating effect of operational performance. Although there is scant empirical evidence showing a direct positive link between IT investment and financial performance, some studies (e.g., Stratopoulos & Dehning, 2000) found that those firms that utilized their IT resources more efficiently obtained better financial results. However, Stratopoulos and Dehning’s (2000) findings suggested that effective IT users outperformed their less effective counterparts for only 3-4 years and lost their financial advantage as other competitors adopted the same IT resources. Devaraj and Kohli (2003) also discovered that greater actual IT usage led to better financial and quality performance. Given that some of these studies found a direct positive link between IT resources and financial performance, we also posit that the adoption of IBIS have a direct effect on financial performance, in addition to its indirect effects through business process performance and operational performance.

Hypothesis 2 (H2): The adoption of IBIS has a direct and positive effect on business process performance.

Hypothesis 3 (H3): The adoption of IBIS has a direct and positive effect on financial performance.

Hypothesis 4 (H4): Business process performance has a direct and positive effect on operational performance.

Hypothesis 5 (H5): Business process performance has a direct and positive effect on financial performance.

Hypothesis 6 (H6): Operational performance has a direct and positive effect on financial performance.

As mentioned before, although some of the previous studies such as Barua et al. (2004) and Ranganathan et al. (2004) analyzed the effects of IBIS on limited measures of performance, these studies did not account for the effects of moderators. As indicated below, we posit hypotheses regarding the moderating effects of four organizational factors— the length of IBIS implementation, firm type, firm age, and firm ownership type— as well as the effects of three environmental factors— dynamism, complexity, and hostility— on the model relationships. Due to lack of space, the detailed discussion on these hypotheses has been omitted.

Hypothesis 7 (H7): The relationships among adoption factors, the adoption of IBIS, business process performance, operational performance and financial performance are different across firms with different lengths of IBIS adoption.

Hypothesis 8 (H8): The relationships among adoption factors, the adoption of IBIS, business process performance, operational performance and financial performance are different across manufacturing firms, service firms and merchandising firms.

Hypothesis 9 (H9): The relationships among adoption factors, the adoption of IBIS, business process performance, operational performance and financial performance are different across younger firms and older firms.
Hypothesis 10 (H10): The relationships among adoption factors, the adoption of IBIS, business process performance, operational performance and financial performance are different across publicly-traded firms, closely-held firms, and sole proprietorships.

Hypothesis 11 (H11): The relationships among adoption factors, the adoption of IBIS, business process performance, operational performance and financial performance are different across firms in turbulent and stable business environments.

Hypothesis 12 (H12): The relationships among adoption factors, the adoption of IBIS, business process performance, operational performance and financial performance are different across firms in high complexity environments and firms in low complexity environments.

Hypothesis 13 (H13): The relationships among adoption factors, the adoption of IBIS, business process performance, operational performance and financial performance are different across firms in highly hostile environments and firms in less hostile environments.

**Methodology**

**Variable Measures and Research Instrument**

The survey instrument contained a set of demographic questions, which were followed by 23 items that measured the factors affecting the adoption of IBIS (nine factors). These factors were operationalized by Soliman and Janz (2004) through a survey study. Seven items were utilized to measure the adoption of IBIS based on the categories of IBIS used by Lancioni, Smith, and Schau (2003). The respondents were asked to rate the extent to which they used IBIS in these SCM activities.

Firm performance measures were based on the IT business value literature and the works of authors such as Barua et al. (1995), Melville et al. (2004), and Wade and Hulland (2004). Eleven items in the survey measured the level of firms’ performance in different areas since their implementation of IBIS compared to that of their major competitors. These included five items for business process performance (which measured the efficiency of specific business processes), three items for operational performance (which measured overall firm operational performance), and three items for financial performance. Seven items measured environmental factors, including environmental dynamism (three items), environmental complexity (one item), and environmental hostility (three items) (Miller & Friesen, 1983). Using Jaworski and Kohli's (1993) approach, a split group analysis was performed for each environmental factor. For example, for the complexity factor, the sample was sorted in ascending order and was then split at the median to form two subgroups, one with relatively low complexity and the other with relatively high complexity. A 1-7 Likert scale was used for all of the items. The organizational factors were each measured by a single question.

**Data Collection and Sample**

A sample of 3000 firms was randomly selected from the Council of Supply Chain Management Professionals mailing list and the Industry Canada website (http://strategis.gc.ca). Two reminders were e-mailed following the first survey to increase the response rate. As a result, 420 responses were obtained, but 99 of the responses were not deemed usable either due to missing data or because these firms did not use IBIS to conduct transactions with their customers and suppliers. In addition, two of the cases were outliers and were therefore deleted. Thus, the usable number of responses was 319. Table 1 shows a profile of these respondents. Nonresponse bias was tested by dividing the responses into two groups as early and late respondents and conducting t-tests on the two groups’ mean responses to ten randomly
selected survey questions (Armstrong & Overton, 1977). The results showed that the two groups were similar and that nonresponse bias was likely minimal.

Table 1

Profile of the Respondents

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Job titles</td>
<td>CEO: 37, President: 96, Vice president: 23, Director: 31, Corporate manager: 12, Other manager: 53, Coordinator: 5, Supervisor: 6, Others: 56</td>
</tr>
<tr>
<td>Number of employees at the site</td>
<td>0-20: 170, 21-100: 71, 101-500: 33, 501-1000: 14, 1001-2500: 9, 2501-5000: 14, Unspecified: 8</td>
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</table>

Analyses

Preliminary Analyses

Using EQS 6.1 for Windows, the model variables were screened by conducting confirmatory factor analysis (CFA) to see whether they were indeed measured by their associated items. All of the items had statistically significant factor loadings on their assigned variables. However, two of the nine factors (trust and complexity) did not load significantly on adoption factors. Note that Lin (2008) did not find complexity to be a significant predictor of e-business implementation as well.

In addition, the unidimensionality and reliability of the scales, as well as their convergent validity, discriminant validity, and criterion-related validity were assessed (Anderson & Gerbing, 1982). Based on these analyses, the reliability and validity of all the scales were established. The details of these preliminary analyses were not reported here to save space. In addition, all of the variables were tested for the assumptions of multivariate analysis, including normality, linearity, multicollinearity, and singularity. The results showed that there were no statistically significant violations of these assumptions. Although there was no univariate nonnormality, there was some multivariate nonnormality, which was detected by
higher than acceptable Mardia’s coefficient values (greater than 3). Therefore, we used robust statistics, including the Satorra-Bentler chi-square ($\chi^2$) statistic and robust Comparative Fit Index (CFI) (Satorra & Bentler, 1994) both of which adjust standard errors to calculate parameter estimates. Finally, the corresponding items of the model variables were parcelled to reduce them to a manageable level, as well as to meet sample size requirements for multiple group analysis (Hall, Snell, & Foust, 1999).

**Structural Path Model Analyses**

The model was first run using the full data (n=319). Then it was run using each subgroup data as indicated in Table 2. An adequate model fit for each subgroup is a precursor to conducting multiple group analysis, which is discussed in the next section. We used the $\chi^2$ significance test, CFI and standardized root mean square residual (SRMR) to assess model fit. CFI and SRMR are relatively unaffected by sample size and minimize the effect of sample size in assessing model adequacy (1998). Citing Hu and Bentler’s (1999) study, Kline (2005) states that CFI “values greater than roughly 0.90 may indicate reasonably good fit of the researcher’s model”. He also argues that “values of the SRMR less than 0.10 are generally considered favorable” (Kline, 2005). Therefore, an acceptable goodness-of-fit in this study was defined as $\text{CFI} \geq 0.90$ and $\text{SRMR} < 0.10$.

Table 2 shows that the robust CFI values for subgroups ranged from 0.76 to 0.94, and the SRMR values ranged from 0.064 to 0.165, indicating that approximately half of the subgroups including the “0-1 year”, “service firms”, “>3 years”, “0-5 years”, “6-15 years”, “publicly-traded”, “sole proprietorship”, “turbulent environment”, “high complexity”, and “high hostility” subgroups did not have adequate model fits (i.e., either robust CFI<0.90 or SRMR>0.10, or both). Therefore, most of these subgroups were not used in multiple group analyses discussed in the next section. Since four of these subgroups (“>3 years” with robust CFI=0.90 and SRMR=0.10, “6-15 years” with robust CFI=0.93 and SRMR=0.106, “high complexity” with robust CFI=0.89 and SRMR=0.100, and “high hostility” with robust CFI=0.93 and SRMR=0.102) had fit indices that were close to the acceptable cutoff points, they were retained for further analysis. Dropping two subgroups from the firm ownership type and one subgroup from the dynamism contextual factors meant that multiple group analysis could not be conducted for these factors.
### Table 2
**Goodness-of-Fit Indices for Structural Path Model Analyses Using the Full Sample and Subgroup Samples**

<table>
<thead>
<tr>
<th>Contextual factor</th>
<th>Subgroup</th>
<th>n</th>
<th>S-By2</th>
<th>df</th>
<th>S-By2/df</th>
<th>p-value</th>
<th>Robust CFI</th>
<th>SRMR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of IBIS implementation</td>
<td>All data</td>
<td>319</td>
<td>128.47</td>
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<td>3.06</td>
<td>0.00000</td>
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<td></td>
<td>0-1 year</td>
<td>40</td>
<td>62.88</td>
<td>42</td>
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<td>0.0205</td>
<td>0.78</td>
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<td></td>
<td>1-3 years</td>
<td>70</td>
<td>57.36</td>
<td>42</td>
<td>1.37</td>
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<td>0.088</td>
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<tr>
<td></td>
<td>&gt;3 years</td>
<td>122</td>
<td>89.08</td>
<td>42</td>
<td>2.12</td>
<td>0.00003</td>
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<td>0.100</td>
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<td>Firm type Service firms</td>
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<td>0.146</td>
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<td>96.75</td>
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<td>2.30</td>
<td>0.00000</td>
<td>0.90</td>
<td>0.088</td>
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<td>Merchandising firms</td>
<td>62</td>
<td>57.10</td>
<td>42</td>
<td>1.36</td>
<td>0.0601</td>
<td>0.93</td>
<td>0.084</td>
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<td>58</td>
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<td>77</td>
<td>72.93</td>
<td>42</td>
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<td>184</td>
<td>92.68</td>
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<td>2.21</td>
<td>0.00001</td>
<td>0.91</td>
<td>0.087</td>
</tr>
<tr>
<td>Firm age 0-5 years</td>
<td></td>
<td>69</td>
<td>77.80</td>
<td>42</td>
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<td>0.00065</td>
<td>0.94</td>
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<tr>
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<td>6-15 years</td>
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<td>&gt;15 years</td>
<td>60</td>
<td>64.26</td>
<td>42</td>
<td>1.53</td>
<td>0.01512</td>
<td>0.89</td>
<td>0.105</td>
</tr>
<tr>
<td></td>
<td></td>
<td>65</td>
<td>76.57</td>
<td>42</td>
<td>1.82</td>
<td>0.00088</td>
<td>0.88</td>
<td>0.102</td>
</tr>
<tr>
<td>Firm ownership type</td>
<td>Closely-held</td>
<td>170</td>
<td>77.80</td>
<td>42</td>
<td>1.85</td>
<td>0.00065</td>
<td>0.94</td>
<td>0.064</td>
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<td></td>
<td>Publicly-traded</td>
<td>147</td>
<td>111.73</td>
<td>42</td>
<td>2.66</td>
<td>0.00000</td>
<td>0.86</td>
<td>0.133</td>
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<tr>
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<td>Sole proprietorship</td>
<td>204</td>
<td>117.60</td>
<td>42</td>
<td>2.80</td>
<td>0.00000</td>
<td>0.90</td>
<td>0.090</td>
</tr>
<tr>
<td></td>
<td>High complexity</td>
<td>108</td>
<td>82.62</td>
<td>42</td>
<td>1.97</td>
<td>0.00018</td>
<td>0.89</td>
<td>0.100</td>
</tr>
<tr>
<td>Dynamism</td>
<td>Stable environment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Turbulent environment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complexity</td>
<td>Low complexity</td>
<td>190</td>
<td>93.23</td>
<td>42</td>
<td>2.22</td>
<td>0.00001</td>
<td>0.92</td>
<td>0.086</td>
</tr>
<tr>
<td></td>
<td>High complexity</td>
<td>127</td>
<td>71.82</td>
<td>42</td>
<td>1.71</td>
<td>0.00281</td>
<td>0.93</td>
<td>0.102</td>
</tr>
</tbody>
</table>

Figure 2 shows the parameter estimates for the full sample, including factor loadings, path coefficients for the structural paths, and the amount of explained variance ($R^2$) for the dependent variables. All of the first six hypotheses except H3 (the effect of the adoption of IBIS on financial performance) were statistically significant for the full data. The results showed that the adoption of IBIS affected operational performance indirectly through business process performance. The adoption of IBIS also affected financial performance indirectly through the mediating effects of both business process performance and operational performance. However, the structural path model results for the six hypotheses slightly varied across different subgroups. For example, one interesting finding was that H3 was nonsignificant for all of the subgroups except for manufacturing firms and for firms greater than 15 years old. H3 was not only significant but negative as well for both of these two subgroups.

**Multiple Group Analyses**

Moderated regression analysis and multiple group analysis are two empirical methods that are used to test the effects of moderators. Although moderated regression analysis is a widely accepted technique in various fields of research, multiple group analysis was chosen as the more appropriate
method in this study, since the relationships among one latent construct and several measures are being analyzed (Homburg & Giering, 2001). In the previous section, the proposed model was tested using single samples. Multiple group analysis is a useful method for testing the invariance of the components of the measurement model and the structural model across multiple samples (Byrne, 1994). Multiple group analysis compares model parameters across subgroups. Depending on the goals of the researcher, the parameters that can be tested to determine their invariance across subgroups include factor loadings, structural paths, factor variances or covariances, factor residuals, and error variances or covariances (Byrne, 1994). Based on this study’s objectives, equality constraints were imposed only on factor loadings and structural paths. EQS estimates these parameters simultaneously to get “efficient estimates” (Byrne, 1994). Thus, the subgroups of each contextual factor were tested simultaneously to determine the invariance of factor loadings and structural paths across them. The significance of the equality constraints can be determined by analyzing the LM $\chi^2$ associated with each constraint, which is obtained from the EQS output. A probability value greater than 0.05 (significance level) for a LM $\chi^2$ means that the factor loading or the structural path hypothesized to be equal across subgroups is indeed equal (Byrne, 1994). Goodness of fit indices used to assess the adequacy of model fit in multiple group analysis are the same as those used in a regular structural model path analysis.

**Figure 2**

*Structural Path Analysis Results for the Full Sample*

*All of the other model parameters were significant at p<0.001.*
The results are shown in Table 3. The table shows that all of the multiple group analysis results except those for hostility (robust CFI=0.93 and SRMR=0.097) indicate poor model fits due to SRMR values of greater than 0.10. Thus, overall, the results suggest that the subgroups within each contextual factor except hostility are noninvariant with each other. They also affirm that three of the four subgroups that were deemed to have inadequate model fits but were retained for further analysis for having fit indices close to the cutoff points (i.e., “>3 years”, “6-15 years”, and “high complexity”) are indeed different from the subgroup they are compared with, whereas the “high hostility” subgroup is in fact similar to the “low hostility” subgroup.

Summary of the Results of Analyses

Within the length of implementation factor, only the “1-3 years” subgroup had an adequate model fit. The “>3 years” subgroup had an inadequate model fit, and the “0-1 year” group, which was excluded from multiple group analysis, had a very poor model fit. A closer look at the standardized parameter estimates of the “1-3 years” and the “>3 years” subgroups indicated that the key differences between the two models were the size of the effect of the adoption of IBIS on business process performance (H2) and the size of the effect of business process performance on financial performance (H5). That is, even though the effect size for H2 was larger for the “1-3 years” subgroup (0.484 vs. 0.312) with an R² value of 23.4% versus 9.7%, the effect size for H5 was smaller (0.524 vs. 0.605) with an R² value of 60.4% vs. 71.7%, as compared to the “>3 years” subgroup. The size of the effect of operational performance on financial performance (H6) was comparable across the two models (0.307 for the “1-3 years” subgroup vs. 0.297 for the “>3 years” subgroup), and the size of the effect (0.701) of business process performance on operational performance (H4) and the R² (49.1%) were exactly the same for both subgroups.

Within firm type, service firms had a very poor model fit and were not included in multiple group analysis. The multiple group analysis results showed that even though both manufacturing and merchandising firms had well-fitting models, the model relationships for merchandising firms were different from those for manufacturing firms (robust CFI =0.90 and SRMR=0.125). In fact, a closer look at the standardized parameter estimates of each model indicated that the factor loadings and path coefficients, as well as the explained variance for the dependent variables, were greater for merchandising firms. Within firm age (robust CFI =0.90 and SRMR=0.116) and firm ownership type (for which multiple group analysis could not be conducted), only firms greater than 15 years old and closely-held firms had adequate model fits, respectively. All of the hypotheses for the four organizational factors (i.e., H7, H8, H9, and H10) were thus supported.

As for the environmental factors, the subgroups within dynamism and complexity were different from each other, where only the “stable environment” and “low complexity” subgroups had well-fitting models. This is an unexpected finding in that even though H11 and H12 were supported, the expectation that the “turbulent environment” subgroup would have a better model fit than the “stable environment” subgroup and that the “high complexity” subgroup would have a better model fit than the “low complexity” subgroup was not. Finally, H13 was not supported since the model fit was similar for both the “low hostility” and “high hostility” subgroups.

Discussion and Study Implications

Findings from Structural Path Analyses

One general finding is that the adoption of IBIS does not directly affect financial performance, but they generally indirectly affect it through business process performance and operational performance.
However, this direct relationship is significant and negative in manufacturing firms and in firms older than 15 years. The reason why this is the case in older firms might be due to the structural inertia that are often found in these firms (e.g., see Chatterjee, Grewal, & Sambamurthy, 2002), which may make IBIS use less effective. However, the underlying reason for this finding in manufacturing firms is less straightforward. Future studies should explore this finding in more detail. These findings have implications for managers in terms of assessing the impact of their IBIS implementation decisions. That is, although IBIS initiatives will not directly improve financial performance, they will likely contribute to it in the long term through improvements in business process performance and operational performance.

Table 3

Goodness-of-Fit Indices for Multiple Group Analysis

<table>
<thead>
<tr>
<th>Contextual factor*</th>
<th>S-Bχ²</th>
<th>df</th>
<th>S-Bχ²/df</th>
<th>χ²/df</th>
<th>p-value</th>
<th>Robust CFI</th>
<th>Robust SRMR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of IBIS implementation**</td>
<td>160.9579</td>
<td>96</td>
<td>1.68</td>
<td>0.00004</td>
<td>0.91</td>
<td>0.105</td>
<td></td>
</tr>
<tr>
<td>Firm type***</td>
<td>175.715</td>
<td>96</td>
<td>1.83</td>
<td>0.00000</td>
<td>0.90</td>
<td>0.125</td>
<td></td>
</tr>
<tr>
<td>Firm age****</td>
<td>196.607</td>
<td>96</td>
<td>2.05</td>
<td>0.00000</td>
<td>0.90</td>
<td>0.116</td>
<td></td>
</tr>
<tr>
<td>Complexity</td>
<td>211.078</td>
<td>96</td>
<td>2.20</td>
<td>0.00000</td>
<td>0.90</td>
<td>0.114</td>
<td></td>
</tr>
<tr>
<td>Hostility</td>
<td>173.691</td>
<td>96</td>
<td>1.81</td>
<td>0.00000</td>
<td>0.93</td>
<td>0.097</td>
<td></td>
</tr>
</tbody>
</table>

* Firm ownership type was excluded from the analysis due to inadequate model fits for the "publicly-owned" and "sole proprietorship" subgroups.

** The "0-1 year" subgroup was dropped from the analysis since it had an inadequate model fit. Even though the ">3 years" subgroup did not have a good model fit, it was still included in the analysis together with the "1-3 years" group since its fit indices were close to the cutoff points.

*** The "service firms" subgroup was dropped from the analysis due to a poor model fit.

**** The "0-5 years" subgroup was dropped from the analysis for having a poor model fit. Even though the "6-15 years" subgroup did not have a good model fit, it was still included in the analysis together with the ">15 years" group since its fit indices were close to the cutoff points.

Findings from Multiple Group Analyses

Length of IBIS implementation. The findings support the hypothesis that the length of IBIS implementation is a moderating factor. The fact that firms that implemented IBIS for less than a year (the “last adopted” group) had a very poor model fit suggests that managers should not probably expect any significant gains from the implementation of IBIS within the first year. This is because the effective diffusion of IBIS within different organizational processes is not likely to be complete yet. Firms that were “in the middle” (those that adopted IBIS 1-3 years before the survey) were the only group that had an adequate model fit, while firms that implemented IBIS for more than 3 years also had a close-to-adequate model fit. The main difference between the two groups was how the adoption of IBIS affected
business process performance and how business process performance affected financial performance. The former effect was larger for “in the middle” firms, which may suggest that the positive effect of IBIS on business process performance peak within the first 1-3 years of implementation after which it drops. The latter effect was greater for the “first adopted” group, which may suggest that the financial performance benefits of IBIS increase after 3 years of implementation, while they are steadier during the first 1-3 years after implementation. This makes sense given that it takes time for improvements in business process performance measures such as customer service, supplier relationships, and quality of design processes to translate into improved financial results.

**Firm type.** There was full support for the hypothesis that manufacturing firms, service firms and merchandising firms were different from each other in terms of model fit. The findings showed that service firms had a very poor model fit. This is in line with the findings of some of the previous studies such as Bhatt (2000), who reported that integrated communication networks were more effective in manufacturing firms than in service firms in improving processes and customer focus. Frohlich and Westbrook (2002) also found that Internet-enabled SC integration strategies produced better performance results in manufacturing firms than in service firms. Some of the possible reasons given for weaker performance effects of these technologies in service firms include: less reliance by service firms on these technologies since demand for their products and services is less certain and cannot be determined through these technologies (Bhatt, 2000). Future studies should use a larger and a more diverse sample of service firms. It would be even more informative to compare different industries if enough data could be collected from distinct industries since the adoption of IBIS and the benefits obtained may be different across industries. Finally, the model fit was adequate for both manufacturing and merchandising firms. However, the results showed that the effects of the adoption of IBIS on various performance measures was stronger in merchandising firms, which suggested that merchandising firms probably placed more emphasis on the adoption of IBIS.

**Firm age.** As hypothesized, the model fit was different for younger and older firms. That is, the model fit was very poor for the youngest group of firms (i.e., 0-5 year subgroup) and inadequate for firms between 6 and 15 years old. This finding provided support for those previous studies (e.g., Sorensen & Stuart, 2000) that argued that younger firms were at a disadvantage when it came to the implementation of new IT. As mentioned before, some of the previous studies argued that older firms had more experience with integrating new processes into their operations and possessed more financial resources than younger firms, which likely made it easier for them to implement IBIS and achieve performance gains. Younger firms can learn from older firms by benchmarking their IT functions against those of older firms that have already had success with the implementation of IBIS. Future studies could test whether firm age would also moderate the model relationships for different IBIS technologies.

**Firm ownership type.** To the best of our knowledge, the moderating effect of firm ownership type on IT-performance relationship has not been empirically studied before. The hypothesis that the model fit would be different across closely-held firms, publicly-traded firms, and sole proprietorships was supported. From an agency point of view, the finding that the model had a good fit for closely-held firms and not for publicly-traded firms may be explained by the presence of greater agency costs in publicly-traded firms. However, these potential costs were not directly measured in the current study. Future studies should design instruments to control for the moderating effects of agency costs in assessing model fit. The finding that sole proprietorships did not have a good model fit could be due to potential agency costs that may act as a deterrent in their IT investment decisions. These firms could create systems to improve planning and monitoring of their investments. As a result, as they expand their operations by making new IT investments, they would be in a better position to control agency costs that may arise from this expansion.
**Dynamism, complexity, and hostility.** The model fit was different for subgroups within two of the three environmental factors —dynamism and complexity. However, contrary to expectations, firms operating in more stable and less complex environments had better model fits than those in turbulent and more complex environments, respectively. It is possible that firms in more stable and less complex environments realize that in order to counter the challenges posed by the global markets, they need to make IBIS an important part of their business planning, and they perceive increased performance benefits from the use of these systems. On the other hand, firms in turbulent and more complex environments may view the use of IBIS as a normal part of doing business and do not particularly perceive them as technologies that give them a competitive edge. As well, there were no differences between firms operating in low and high hostility environments. This suggests that more intense competition does not necessarily affect how rigorously firms implement IBIS and the performance benefits received from these technologies. Thus, the effects of these three environmental factors as moderators are mixed. Dembla, Palvia, and Krishnan (2007) also reported that environmental uncertainty (which combined hostility, complexity, and dynamism into one independent variable) had no effect on perceived usefulness of web-enabled transaction processing systems. The authors deduced that these systems were possibly a requirement to be competitive in turbulent markets rather than an advantage.

**Study Limitations**

One of the limitations of the study is that the survey instrument relies on the perceptions of the respondents, a limitation common to all survey research. The three performance measures were also based on the respondents’ perceptions; objective measures based on hard data would be more reliable. In addition, the measurement of the independent and dependent constructs using the same survey instrument may have led to potential common method bias. Using multiple methods may help overcome this problem. The use of single informants as opposed to multiple informants may have also introduced bias into the data. Finally, since this study uses cross-sectional data rather than longitudinal data, it does not establish causality between the variables in the tested model.

**Conclusion**

This study creates a model of the relationships among organizational, interorganizational and technological factors, the adoption of IBIS and several firm performance measures. These hypotheses are then tested using data from a sample of North American firms. One of the main contributions of this study is its rigorous analysis of whether various organizational and environmental factors play a role in moderating the hypothesized model relationships. The results indicate that all of the four organizational factors (length of IBIS implementation, firm type, firm age, and firm ownership type) are significant moderators, whereas the effects of the three environmental factors (dynamism, complexity, hostility) as moderators are less clear. More research is still needed to better understand the role played by various moderators in the adoption of IBIS, as well as other IOIS, and their eventual effects on firm performance.
References


