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DOES INFORMATION TECHNOLOGY ALWAYS LEAD TO BETTER FIRM PERFORMANCE? THE ROLE OF ENVIRONMENTAL DYNAMISM

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Abstract

In recent years, there has been considerable interest in whether and the extent to which information technology contributes to firm performance and business value. Using the resource-based view of the firm, recent research highlights the notion of IT capability of the organization and finds that higher IT capability leads to superior firm performance. This study, however, argues that one has to reckon the influence of environmental uncertainty (in this study, specifically dynamism*) when evaluating the link between IT capability and business value. This study makes use of Galbraith's* information processing theory *of the firm, which posits that information processing needs and capabilities must match for superior performance. Extending this argument, one would expect that organizations need much greater amounts of information in more dynamic environments and that greater information processing capabilities (accrued via superior IT capabilities) must exist in such environments and vice versa. Using cross-sectional archival data, this study finds, somewhat contrary to previous assertions, that high IT capability does not add business value to firms operating in more dynamic environments, but that it does add business value in relatively more stable environments. In addition, under low environmental dynamism condition, the performance advantages of high IT capability are found to sustain over time. These findings raise interesting implications and directions for future research. Further, environmental dynamism emerges as a quasi-moderator of the relationship between IT capability and firm performance.*

Keywords: Business value, firm performance, information technology (IT), capability, resource-based view, information processing theory, fit, environmental dynamism, quasi-moderator

Introduction

In today's hypercompetitive business environments, hardly anyone questions the important role that information technology plays. The conventional wisdom is that IT is necessary for business survival and that prudent deployment and management of IT resources and capabilities leads to enhanced value for the firm. While much of research has been conducted to test such conventional wisdom, the debate on IT business value continues. The inconsistency or paradox that exists in the link between IT and business value (Brynjofsson and Hitt 1996) has been attributed partly to inappropriate conceptualization, need for additional contingency variables, or flawed research methodology (Hitt and Brynjolfsson 1996; Lucas 1993). Meanwhile, the resource-based view (RBV) of the firm (Barney 1991) has been increasingly drawn upon in recent years to provide a robust theoretical explanation of IT business value (e.g., Mata et al. 1995; Wade and Hulland 2004). In particular, recent empirical examination, using a perceptual ranking of an organization as being an "IT leader" as a proxy for IT capability, shows a link between IT capability and superior firm performance (Bharadwaj 2000; Santhanam and Hartono 2003). However, as posited by Wade and Hulland (2004), there is a need for additional investigation by considering contingent variables such as environmental turbulence or dynamism, because the nature of IT resources and their deployment for building capabilities would differ between firms in a relatively stable versus a very dynamic external environment.

In light of the above call, a stream of research that is particularly relevant is the information processing theory (IPT) of organizations. This theory identifies three key concepts: information processing needs, information processing capabilities, and the fit between the two to obtain optimal performance (Galbraith 1973). Environmental uncertainty is a critical factor confronting practically all organizations and firms are constantly engaged in reducing uncertainty with various coping strategies including collecting more information for decision making (Thompson 1967). Uncertainty in the environment stems from the complexity of the environment and the dynamism (a.k.a. turbulence, volatility) or the frequent changes to various environmental variables (Duncan 1972). Uncertainty also stems from the capacity or lack thereof for growth within the industry, the notion of munificence (Dess and Beard 1984). Lack of relevant and timely information on these environmental variables and a lack of understanding of their interactions cause uncertainty in the decision processes. Typically, organizations engage in strategies to cope with uncertainty such as (1) developing buffers or boundary spanners that reduce the impact of uncertainty, and (2) implementing structural mechanisms and information processing capabilities that enhance information flow and thereby reduce uncertainty. One example of the first strategy is having inventory buffers to reduce the impact of uncertainty in demand or supply. An example of the second strategy is the redesign of business processes and implementation of integrated information systems that improve the flow of information and reduce uncertainty within organizational subunits, and between the firm and its external stakeholders. Arguments have been advanced that firms should aspire toward building *dynamic capability* through their IT resources for information processing and an agile organizational design to cope with environmental dynamism (Eisenhardt and Martin 2000).

Drawing from RBV and IPT, the primary research question that we seek to explore in this study is that if IT capability leads to superior firm performance as noted in two major recent studies (Bharadwaj 2000; Santhanam and Hartono 2003), under what environmental conditions (focusing specifically on dynamism) does this happen? The paper is structured as follows: The background literature in RBV and IPT is briefly examined to build the rationale for our research model. The research method including data collection and data analysis approaches is discussed in the following section. This is followed by the study's results and discussion in the subsequent section. These are followed by a brief set of conclusions and directions for future research.

Literature Review and Hypotheses

IT Capability and Firm Performance: Resource-Based View of the Firm

The resource-based view (RBV) of the firm (Barney 1991) has been used in recent research to examine the link between IT capability and business value (Bharadwaj 2000; Santhanam and Hartono 2003). According to RBV, organizations that work toward and are able to develop resources that are rare or unique, difficult for others to imitate, transfer, or substitute with other resources would be able to obtain and maintain a competitive advantage in their operating environments.

Among an organization's many tangible resources (e.g., physical assets such as plant and machinery, distribution centers) and intangible resources (brand image, reputation, goodwill), IT resources are emerging increasingly as sources of comparative advantage. A number of views about what constitutes IT resources (and, in turn, capabilities) have emerged in the past decade (a good review of this exists in Wade and Hulland 2004). For example, Ross et al. (1996) propose three types of IT assets (technology, human, relationship) that would need to interact with three types of IT processes (planning, cost effective operations and support, fast delivery) to confer to superior IT capability. Similarly, Feeny and Willcocks (1998) identify nine core IS capabilities within four major areas: business and IT vision, IT architecture, delivery of IS services, and IS leadership including informed decision on sourcing. Marchand, et al. (2000) propose the concept of information orientation comprised of three key elements: information technology practices, information management practices, and information values and behaviors. There are also semantic distinctions that have been raised; Santhanam and Hartono (2003) caution on the need to distinguish between IT and IS resources and their influence on performance. Bharadwaj et al. (1999) propose and empirically validate IT capability as a multidimensional construct consisting of six dimensions: IT–business partnership, external IT linkages, business IT strategic thinking, IT-business process integration, IT management, and IT infrastructure.

Regardless of which of the above-noted orientations is taken, a compelling argument has been made using the perspective of a resource-based view that firms can and do differentiate themselves on the basis of suitable blending of their various IT resources (infrastructure, human skills, IT application development and sourcing, service delivery) in developing superior IT capability. It is not merely the expenditure on IT assets or resources but the unique combination in which they are packaged and interwoven into their business practices that should confer a superior IT capability. Using this rationale, two recent research studies have proposed that superior IT capability would be associated with "higher profit" ratios and "lower cost" ratios and found empirical support using the same archival data set for the time period 1991 to 1994 (Bharadwaj 2000; Santhanam and Hartono 2003). In this study, we extend these previous studies by examining how this IT capability-firm performance relationship varies under different external environmental conditions as called for recently (Wade and Hulland 2004).

Environmental Dynamism and the Notion of Fit: Information Processing Theory

Researchers in organizational theory have identified three major dimensions for uncertainty: complexity and dynamism (Duncan 1972; Miller and Friesen 1982), and munificence (Dess and Beard 1984). While complexity captures the number of factors and their interactions relevant to decision making, dynamism (volatility or turbulence) captures the relative rate of change to those factors and ability to predict those changes. Munificence reflects the capacity or opportunity for firms within the industry to grow. In this study, the specific focus is on examining the (contingent) influence of one environment dimension: dynamism on the link between IT capability and firm performance. This contingency relationship has been suggested by information processing theory and the notion of fit.

The concept of fit is a core construct in the information processing theory of the firm. Achieving a fit between the information processing needs and the information processing capabilities to achieve optimal organizational performance has been a primary mission of organizational designers (Daft and Lengel 1986; Galbraith 1973; Tushman and Nadler 1978). For instance, Daft and Lengel (1986) expounded the contingency design theory positing that the fit between information needs and information processing capabilities results in better unit performance. In the strategic IS literature, Chan et al. (1994) found that the alignment between business strategic orientation and IS strategic orientation had significant effect on both IS effectiveness and business performance. In the interorganizational context, the notion of fit was conceptualized and empirically tested first by Bensaou and Venkatraman (1995).

Fit, although intuitive from a theoretical perspective, is an elusive concept for empirical research. While it is easy to theorize the concept, its operationalization and empirical testing with an appropriate statistical procedure is still a major issue. Venkatraman (1989) provides an excellent overview of various forms of fit, i.e., (1) moderation, (2) mediation, (3) matching, (4) gestalts, (5) profile deviation, and (6) covariation. His study focused primarily on strategy research where the concept of fit is extensively used to develop taxonomies of strategies (Hambrick 1984; Miles and Snow 1978), assess internal congruence (Miller and Friesen 1982), and evaluate fit between strategy and structure (Chandler 1962). Similarly, Umanath (2003) provides an excellent description of these concepts in the context of IS research, and identifies three broad categories of fit: congruence, contingency, and holistic. While congruence is a criterion-free (i.e., no dependent variable) specification based on bi-variate examination of correlation, contingency is an interaction specification modeled as moderation or mediation effect. Holistic is a systems specification that corresponds to the "gestalt" or "profile deviation" approach of Venkatraman and is tested using pattern analysis.

Drawing from the information processing theory and the notion of fit, the role of environmental dynamism on the relationship between IT capability and firm performance is elaborated next. Organizations operating in more dynamic or rapidly changing environments are expected to have greater need for information (on the changes that are occurring in their operating context) and information processing mechanisms (Dess and Beard 1984; Duncan 1972; Flynn and Flynn 1999; McArthur and Nystrom 1991; Weinzimmer et al. 1998). Thus, different types of IT assets and resources may be needed in more dynamic (volatile or turbulent) vis-à-vis relatively more stable environments. For instance, in relatively stable environments, much of the organization's efforts may be directed toward creating competitive edge in its operating marketplace; given the relatively slow pace of environmental changes, the likelihood of the competitive edge being sustained over an extended time frame is high (Wade and Hulland 2004). Under such circumstances, organizations may tend to emphasize exploitation of their existing stocks of knowledge and the IT capabilities that they have built up.

On the other hand, in a more dynamic or turbulent environment, first, it may be difficult to create any competitive advantage because of the many changes occurring simultaneously. Furthermore, it may be very difficult to sustain whatever competitive edge may have been created because the rapidly occurring environmental changes can neutralize and render any benefits generated obsolete. The organizations need to be more agile in being able to anticipate and respond, or at least rapidly react, to the changes taking place. Firms in such volatile and dynamic environments may be required to constantly reconfigure their various IT resources, generate or acquire new knowledge, and look out for new opportunities as they unfold. Thus, one would expect that in very dynamic environments not only would the firms have to acquire and process greater amounts of information but also they will need to proactively seek out varied types of competitive intelligence and knowledge via higher IT capability.

Stated simplistically, higher environmental dynamism can be expected to impose greater and more varied information processing needs, thus demanding a comprehensive and yet agile and higher IT capability to be able to successfully operate in their markets. On the contrary, when the environment is relatively stable, higher IT capability may not necessarily be essential.

Based on the foregoing (brief) discussions of the two key theory bases (information processing theory and resource-based view) of the firm and the notion of "fit" as the basic foundation, the research model is shown in Figure 1.

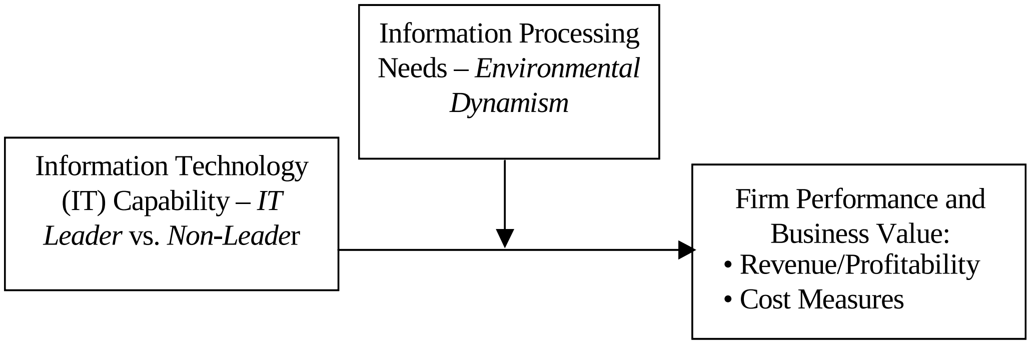

Figure 1. Research Model

The research model illustrates the two main constructs of this study, *environmental dynamism* (triggering the extent of information processing needs) and *IT capability* (*leader* versus *non-leader*—reflecting the organization's information processing capabilities), as well as their impacts on firm performance. Consistent with IPT and the definition of fit, this study investigates the impact of the fit between information processing needs and capabilities on firm performance, following the concept of "fit as moderating" (Venkatraman 1989) or "fit as contingency" (Umanath 2003). Specifically, this research posits that the interaction effects of the two variables will have a significant impact on organizational outcome. Hence, the following two hypotheses are empirically evaluated.

> *Hypothesis 1: When the external environment dynamism is relatively high, higher IT capability will be associated with superior firm performance.*

> *Hypothesis 2: When the external environment dynamism is relatively low, higher IT capability will not be associated with superior firm performance.*

In addition, it is reasonable to expect that developing superior IT capabilities require considerable amounts of time. In view of the fact that IT capability is not merely the deployment of technology but triggers significant organizational changes and needs social engineering, it is even more logical to expect that benefits in terms of organizational performance from IT capability will require considerable time to take hold. In other words, the benefits from IT capabilities will require some time to materialize, i.e., time lag effects, which have been demonstrated by some recent studies (e.g., Brynjolfsson and Hitt 2003; Santhanam and Hartono 2003). This leads to the third hypothesis:

> *Hypothesis 3: The relationship between higher IT capability and superior firm performance under conditions of higher environmental dynamism will be even more evident over time—the time lag effect.*

Research Method

Sample and Data Collection

Consistent with this study's objective of delineating the relationships between IT capability, environmental dynamism, and firm performance, it is necessary to retain the same conceptualization as those of recent studies published on this topic. Therefore, in line with the previous two studies (Bharadwaj 2000; Santhanam and Hartono 2003), firms identified as *IT leaders* are supposed to be representative of superior information processing capabilities. Note that environmental dynamism is treated as a moderating variable (**z**) of the relationship between IT capability and firm performance following the research model. In addition, we also wanted to explore any lagged time effect of the moderating role of dynamism with the cross-sectional data. Hence, the same set of IT leaders and matched controls (i.e., non-leaders) as that in Bharadwaj was used in this study. In view of the fact that some of the firms, especially the control or non-leader firms, in the original data set have either been acquired or merged with another corporation over the past 8 to 10 years, it was not possible to collect data on all 56 firms noted in the previous study. When the control firms from the original list were not found, the same procedure as adopted in previous studies was used to locate a control matched to the leader sample by size, industry, and type. The performance data of all firms were retrieved from Standard and Poor's COMPUSTAT databases. However, due to the unavailability of the performance data in the current version of

COMPUSTAT of some firms for reasons noted above, the final sample in this study contained 48 pairs of matched leader firms and non-leader firms.

Research Design

A 2 × 2 IT capability (high: leader vs. low; control or non-leader) and environmental dynamism (high vs. low), full factorial design was employed to test the hypotheses. The matched pairs of leader and control firms could be considered, respectively, as treatment group and control group in a typical experimental design, In particular, the matching procedure controlled many potentially confounding organizational factors to ensure a clean examination of the two factors of interest: IT capability and external environmental dynamism.

Operationalization of Variables

Independent Variables

IT capability was operationalized as a categorical variable with two levels (high and low) using the rankings of firms as IT leaders (for 1991, 1992, 1993, and 1994) by industry and academic experts announced by *InformationWeek* in their four special issues: September 21, 1992; September 27, 1993; October 10, 1994; and September 18, 1995 (Bharadwaj 2000; Santhanam and Hartono 2003). As clarified by Bharadwaj, only 6 of the 56 firms had been designated as an IT leader in each of 4 years (1991 to 1994) while 34 of the firms had been on this elite list only for 2 of the 4 years, and 16 of them for 3 of 4 years. In view of this, the rankings were considered as an indicator of the average IT capability for the years from 1991 to 1994 rather for any specific year, since the total list of 56 leader firms was compiled from that period but not specifically for any one individual year. Specifically, IT capabilities of IT leader firms were coded as high while those of the control firms were coded as low.

Environmental dynamism was operationalized as the standard error of the regression coefficient of industry-level sales reported by all firms for each specific four-digit SIC code regressed over time. This standard error was then standardized for size by dividing it by the mean value of the industry-level sales as per the practice in management literature (Dess and Beard 1984; Keats and Hitt 1988; Weinzimmer et al. 1998). Similar to IT capability, a concurrent environmental dynamism for the period of 1991 to 1994 for each industry on the four-digit SIC was computed. First, the environmental dynamism for each industry was computed from the five-year regression following the above procedure for the individual year from 1991 to 1994. For example, the 1991 dynamism was obtained by regressing the industry-level sales over a five-year period from 1987 to 1991—the standard error of this regression coefficient was divided by the mean of industry-level sales. The same procedure was followed to compute the dynamism for years 1992, 1993, and 1994. Second, the average of the values for dynamism for the four years from 1991 to 1994 was calculated and split into two levels (high and low). This categorical variable was then used as an indicator of the environmental dynamism of each industry, which was concurrent to the IT capability indicator used in the study.

Dependent Variables

The same set of eight performance measures was used: five profit ratios and three cost ratios. The profit ratios were ROS (return on sales), ROA (return on assets), OI/A (operating income to assets), OI/S (operating income to sales), and OI/E (operating income to employees). The cost ratios were COG/S (cost of goods sold to sales), SGA/S (selling and general administration costs to sales), and OpExp/S (total operating expenses to sales). The performance data for the 48 pairs of leader and control firms from not only 1991 to 1994, but also for the period 1995 to 1997 were obtained from COMPUSTAT. In light of the fact that not all of the 48 firms (or 56 firms in Bharadwaj study) were listed as leaders for each of the four years, it would be inaccurate to compare leaders and control group (non-leader) firms for each of the four years. Therefore, similar to the operationalization of IT capability and environmental dynamism as described above, the average of 1991 to 1994 was calculated to represent the concurrent performance of the leader and control firms in our subsequent data analyses.

In summary, the data set had two independent variables, each represented as a two-level categorical variable of IT capability and environmental dynamism during the period of 1991 to 1994. The eight dependent variables were organized as cross-sectional data by years, i.e., average for 1991 to 1994, 1995, 1996, and 1997.

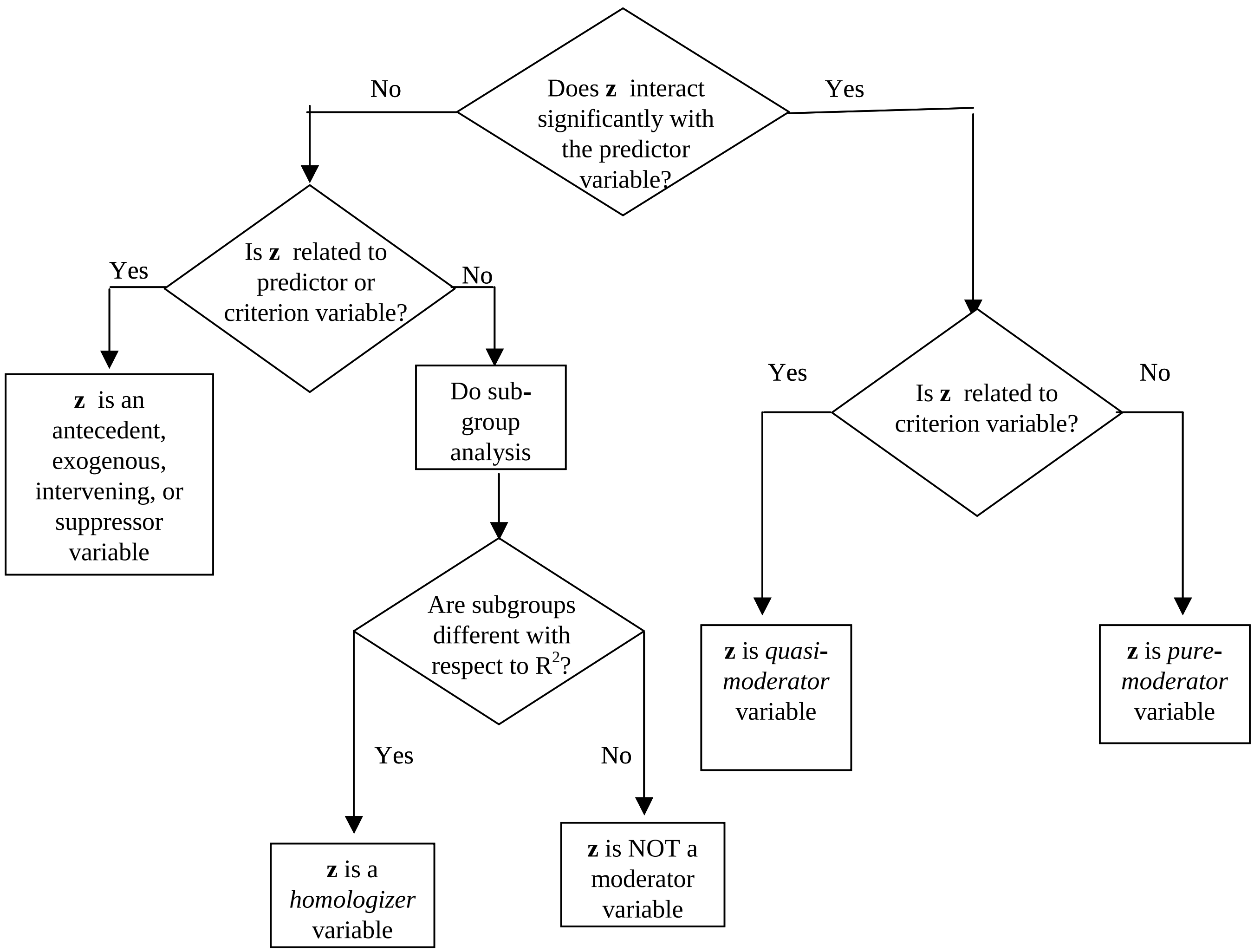

Figure 2. Framework for Identifying Moderator Variables, z
(Reprinted with permission from *Journal of Marketing Research,* published by the American Marketing Association, Sharma, S., Durand. R. M., and Gur-Arie, O., "Identification and Analysis of Moderator Variables," (18:3), 1981, page 297.)

Data Analysis

Since the two factors (treatment variables) were categorical variables and there were eight dependent performance measures, the moderating effects were tested using multivariate analysis of variances (MANOVA). However, the 2 × 2 research design had an unbalanced design, as the cells (the combinations of IT capability and environmental dynamism) were unequal in size. Thus, SAS GLM MANOVA was used to test the main and interaction effects of IT capability and environmental dynamism on the set of eight performance measures.

Theoretically, there are three types of moderators: *homologizer*, *pure moderator*, and *quasi moderator* (Arnold 1982; Sharma et al. 1981). A schema to identify the different types of effect is shown in Figure 2.

In general, a homologizer affects the *strength* of the relationship of interest, in this case, the link between IT capability and firm performance. Under the homologizer contingency, the magnitude of the IT capability and firm performance relationship differs significantly for firms operating in either high or low environmental dynamism. Following the procedure shown in Figure 2, a necessary condition for the homologizer to be true is that environmental dynamism has no significant direct relationship with either IT capability or firm performance. On the other hand, environmental dynamism is either a pure or a quasi-moderator, when it exhibits an effect on the *form* of the relationship between IT capability and firm performance. As a pure moderator, environmental dynamism significantly interacts with IT capability but has no direct correlation with IT capability or firm performance. If environmental dynamism not only interacts with IT capability but also directly relates to performance, then it is a quasi-moderator.

Therefore, following the procedure in Figure 2, a step-by-step statistical analysis was conducted to systematically examine the moderating role of environmental dynamism on the IT capability–firm performance relationship. Basically, the interaction effects of IT capability and dynamism on firm performance were tested with MANOVA. Then, when the interactions tested were significant, the correlations between dynamism and firm performance were further examined to delineate quasi-moderator from pure-moderator. On the other hand, when the interactions were not significant, the procedure was also followed to test for homologizer. Due to the space limitations, we have analyzed and reported the first part of analysis of the moderator role of dynamism. The correlation matrix among the study variables is presented in Table 1 (Kendall Tau b correlation coefficients were used as IT capability and dynamism were categorical variables).

Results

As noted above, four sets of MANOVA models were developed, each using average values for 1991 to 1994, 1995, 1996, and= 1997 with the entire set of eight firm performance measures as dependent variables. The results of the overall model and each individual dependent variable from these four models are presented in Tables 2 through 5. (Due to the space limit, the tables of mean performance values for the various time periods are not included.)

The last column in the upper panel of each of these tables shows the three effects—IT capability, environmental dynamism, or the interactions of IT capability-dynamism—in the overall MANOVA model using Wilks Lambda as the test statistic. Only the main effect of dynamism appears to be significant at an overall level across 1991 to 1994 and the three subsequent time periods; IT capability only shows a significant effect for 1995.

A careful examination of the results by the individual dependent variables in these four tables indicates some interesting patterns. Dynamism appears to (more consistently) directly influence the various performance measures: four of these in 1991 to 1994, and at least six to seven of the eight performance measures from 1995 onward. IT capability seems to start having some weak effects on OI/S and OpExp/S in 1995 and 1996 followed by some direct effects on a few more performance measures (ROS, ROA, and OI/A) in 1997.

Table 1. Summary Statistics and Correlations for 1991-1994 Average Values

Variable	N	Mean	S.D.	3	4	5	6	7	8	9	10
IT Capability	96	N/A[a]	N/A	0.1179	0.1049	0.1204	0.0560	-0.0092	-0.0093	-0.0499	-0.1560
Env. Dynamism[c]	96	N/A[b]	N/A	0.0399	-0.1924**	-0.3673***	0.0083	0.1036	0.0333	-0.2134**	-0.1093
ROS 91-94[d]	96	0.03978	0.0529	1.0000							
ROA 91-94	96	0.03007	0.0444	0.7302***	1.0000						
OI/A 91-94	94	0.12587	0.0681	0.3166**	0.7306***	1.0000					
OI/S 91-94	94	0.17765	0.1198	0.5195***	0.1479	0.1325	1.0000				
OI/E 91-94	93	52.63951	83.843	0.1791*	0.0114	-0.0653	0.6865***	1.0000			
COG/S 91-94	96	0.66488	0.1850	- 0.5270***	-0.3241**	-0.2958**	-0.6479***	-0.2776**	1.0000		
SGA/S 91-94	68	0.23458	0.1093	0.3595**	0.25869*	0.2894*	0.3150**	-0.0251	-0.8481***	1.0000	
OPEX/S 91-94	68	0.83432	0.0968	-0.6069***	-0.1913	-0.1690	-0.9999***	-0.5865***	0.7333***	-0.3035**	1.0000

[a]Not applicable since this is classified as a binary variable in the data set for the period1991-94 (1 = IT leader, 0 =Non-leader). **Source:** *InformationWeek* September 21, 1992; September 27, 1993; October 10, 1994; and September 18, 1995.
[b]Not applicable since this is classified as a binary variable in the data set (1 = High dynamism, 0 = Low dynamism) cutoff by mean value.
[c]The correlation among IT capability (V1) and Dynamism (V2) in the above table at –0.0450 was not significant.
[d]All other measures are obtained from COMPUSTAT database.
***$p \leq .01$; **$p \leq .05$; *$p \leq .10$; all other unmarked (with asterisks) correlation values are not significant.

Table 2. MANOVA Results on *Firm Performance Average—1991-1994* Time Period

	Firm Performance Dimensions (Mean & Standard Deviation)								**Wilks Lambda: Overall Model**
	ROS	***ROA***	***OI/S***	***OI/A***	***OI/E***	***COG/S***	***SGA/S***	***OpExp/S***	**(Sig. Level)**
F Value & Significance Level: *IT capability (Leader-Control)*	$1.14^{n.s.}$	$0.45^{n.s.}$	$2.35^{n.s.}$	$1.22^{n.s.}$	$0.57^{n.s.}$	$0.15^{n.s.}$	$1.07^{n.s.}$	$2.38^{n.s.}$	$0.8125^{n.s.}$
Dynamism (High-Low)	$0.24^{n.s.}$	6.16^{**}	$1.22^{n.s.}$	28.1^{****}	10.60^{***}	$0.57^{n.s.}$	5.86^{**}	$1.25^{n.s.}$	0.4989^{****}
IT Capability X *Dynamism* – FIT	$0.37^{n.s.}$	2.77^{*}	$0.85^{n.s.}$	$1.80^{n.s.}$	$0.01^{n.s.}$	$0.26^{n.s.}$	$0.01^{n.s.}$	$0.85^{n.s.}$	$0.9121^{n.s.}$
Support for Hypothesis on Fit	NO	YES	NO	NO	NO	NO	NO	NO	NO

$^{****}p \leq 0.001$; $^{***}p \leq 0.01$; $^{**}p \leq 0.05$; $^{*}p \leq 0.10$; $^{n.s.}$not significant

Table 3. MANOVA Results on *Firm Performance During Year 1995*

	Firm Performance Dimensions (Mean & Standard Deviation)								**Wilks Lambda: Overall Model**
	ROS	***ROA***	***OI/S***	***OI/A***	***OI/E***	***COG/S***	***SGA/S***	***OpExp/S***	**(Sig. Level)**
F Value & Significance Level: *IT capability (Leader-Control)*	$0.37^{n.s.}$	$0.01^{n.s.}$	3.81^{*}	3.79^{*}	$1.43^{n.s.}$	$0.04^{n.s.}$	$1.73^{n.s.}$	3.81^{*}	0.7609^{**}
Dynamism (High-Low)	$0.05^{n.s.}$	8.86^{***}	4.46^{**}	20.8^{****}	10.52^{***}	$0.08^{n.s.}$	4.65^{**}	4.46^{**}	$0.05^{n.s.}$
IT Capability X *Dynamism* – FIT	$0.01^{n.s.}$	$0.93^{n.s.}$	$0.06^{n.s.}$	3.24^{*}	$0.45^{n.s.}$	$0.02^{n.s.}$	$0.01^{n.s.}$	$0.06^{n.s.}$	$0.9316^{n.s.}$
Support for Hypothesis on Fit	NO	NO	NO	YES	NO	NO	NO	NO	NO

$^{****}p \leq 0.001$; $^{***}p \leq 0.01$; $^{**}p \leq 0.05$; $^{*}p \leq 0.10$; $^{n.s.}$not significant

Table 4. MANOVA Results on *Firm Performance During Year 1996*

	Firm Performance Dimensions (Mean & Standard Deviation)								**Wilks Lambda: Overall Model**
	ROS	***ROA***	***OI/S***	***OI/A***	***OI/E***	***COG/S***	***SGA/S***	***OpExp/S***	**(Sig. Level)**
F Value & Significance Level: *IT capability (Leader-Control)*	$2.15^{n.s.}$	$1.73^{n.s.}$	2.88^{*}	$1.92^{n.s.}$	$0.19^{n.s.}$	$0.06^{n.s.}$	$1.03^{n.s.}$	2.88^{*}	$0.8685^{n.s.}$
Dynamism (High-Low)	$0.94^{n.s.}$	5.61^{**}	9.14^{***}	8.74^{***}	21.2^{****}	$0.09^{n.s.}$	4.02^{**}	9.14^{***}	0.5335^{****}
IT Capability X *Dynamism* – FIT	$0.33^{n.s.}$	4.47^{**}	$0.02^{n.s.}$	4.93^{**}	$2.07^{n.s.}$	$0.01^{n.s.}$	$0.01^{n.s.}$	$0.02^{n.s.}$	$0.9011^{n.s.}$
Support for Hypothesis on Fit	NO	YES	NO	YES	NO	NO	NO	NO	NO

$^{****}p \leq 0.001$; $^{***}p \leq 0.01$; $^{**}p \leq 0.05$; $^{*}p \leq 0.10$; $^{n.s.}$not significant

Table 5. MANOVA Results on *Firm Performance During Year 1997*

	Firm Performance Dimensions (Mean & Standard Deviation)								**Wilks Lambda: Overall Model**
	ROS	***ROA***	***OI/S***	***OI/A***	***OI/E***	***COG/S***	***SGA/S***	***OpExp/S***	**(Sig. Level)**
F Value & Significance Level: *IT capability (Leader-Control)*	5.97**	3.87*	6.42**	4.03**	2.67$^{n.s.}$	0.78$^{n.s.}$	0.81$^{n.s.}$	6.42**	0.8505$^{n.s.}$
Dynamism (High-Low)	6.28**	0.84$^{n.s.}$	9.66***	8.14***	25.6****	0.44$^{n.s.}$	2.97*	9.66***	0.5266****
IT Capability X *Dynamism* – FIT	0.63$^{n.s.}$	3.32*	0.01$^{n.s.}$	4.67**	0.54$^{n.s.}$	0.03$^{n.s.}$	0.09$^{n.s.}$	0.09$^{n.s.}$	0.9177$^{n.s.}$
Support for Hypothesis on Fit	NO	YES	NO	YES	NO	NO	NO	NO	NO

$^{****}p \leq 0.001$; $^{***}p \leq 0.01$; $^{**}p \leq 0.05$; $^{*}p \leq 0.10$; $^{n.s.}$not significant

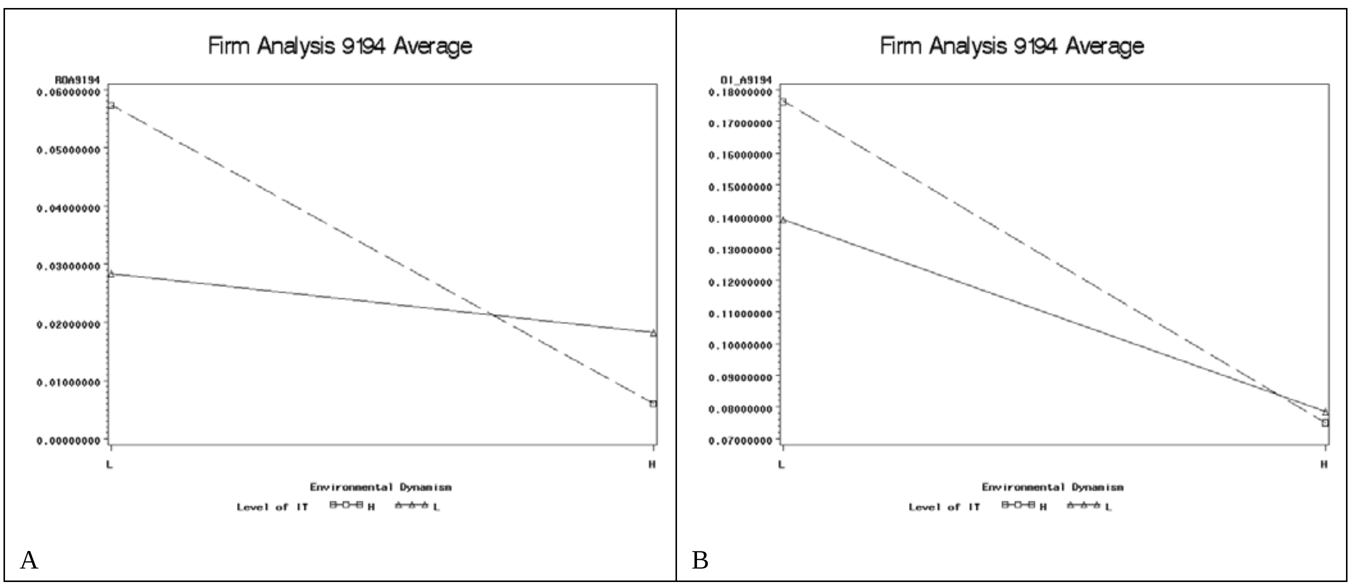

Figure 3. Effects of IT Capability and Dynamism on *ROA* and *OI/A* for 1991-1994

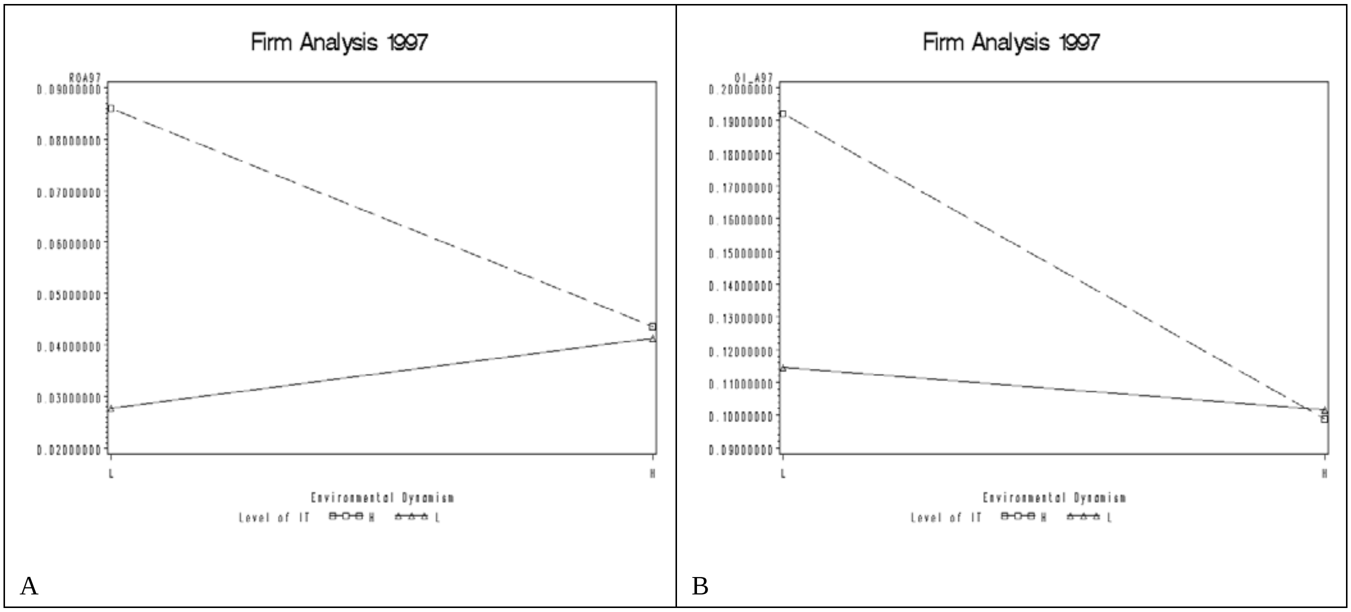

Figure 4. Effects of IT Capability and Dynamism on *ROA* and *OI/A* for 1997

The interaction between these two factors has a fairly consistent but narrow domain of influences on ROA and OI/A. However, as we will discuss a little later and quite interestingly, the observations seem to be contrary to our expectations which have been developed based on the information processing theory of organizations. As seen from the results in these tables (and the two figures of the IT capability × dynamism interaction plots—Figure 3A and Figure 3B presented for illustration), when dynamism is low, higher IT capability (alluded to by leader firms) results in significantly superior performance than in their control counterparts. Conversely, higher IT capability does not exhibit significant advantage or only has negligible effect over the control group when the firms are operating in a high dynamism environment. Over time (years 1995 and further along, from results of plots not presented here in the interest of space), the patterns appear to be more significant, especially for firms in low dynamism environments (as illustrated in Figure 4A and Figure 4B for year 1997).

Given that the interaction effect is significant in only two of the eight performance measures (i.e., ROA and OI/A), further analysis of the nature of moderating effect was conducted using the procedure outlined in Figure 2 (Sharma et al. 1981) as noted earlier. From the correlation results in Table 1, it may be noted that the **z** variable (dynamism) is not correlated with the predictor variable (IT capability). Since **z** is significantly correlated with the two criterion measures, ROA ($r = -0.1924$, $p \leq .05$) and OI/A ($r = -0.3673$, $p \leq .01$), dynamism seems to behave as a quasi-moderator of IT capability–firm performance relationship on ROA and OI/A. In other words, environmental dynamism affects firm performance through not only direct effects but also moderates the *form* of the IT capability–firm performance relationship.

Discussions and Limitations

The results from the study present contradictory findings about the link between IT capability and firm performance. For the overall MANOVA model, the interactions of IT capability × dynamism were not found significant. Further, IT capability does not exhibit significant main effect on the performance variables except weak effect in 1995. On the other hand, dynamism exhibits significant main effect through all of the time periods. The results of the main effects seem not to be in line with previous studies. One possible explanation is that a reduced sample size (48 versus 56, and furthermore quite a few missing observations, as many as15 matched pairs of firms on the cost measure, SGA/S and, thus, OpExp/S) may have created problems of lower statistical power. This observed missing pattern appears to be consistent with the reports of the recent study using the same archival data (Santhanam and Hartono 2003). Furthermore, note that this study employed a different research design and made use of MANOVA unlike the earlier studies, which measured differences in means for each of the eight measures separately using non-parametric tests of mean differences. However, given that the eight measures of performance are strongly correlated with one another (21 out of the 28 pairs of correlations are significant), a multivariate technique as used in this study would appear more appropriate and necessary.

When examining the three effects on each individual dependent variable, dynamism emerged to be a quasi-moderator of the IT capability–firm performance relationship on two profit ratios (i.e., ROA and OI/A). Further, the performance advantages of IT capability seem to be significant when the firms are operating in low environmental dynamism. When firms operate in high environmental dynamism, such performance advantages of IT capability vanish.

Notwithstanding the above, the results appear to contradict the argument derived from Galbraith's (1973, 1977) information processing theory that there should be an alignment between information needs and processing capabilities. That higher IT capability of firms facing more dynamic environments would be expected to lead to better performance is logically sound. Yet, this study finds a pattern in the opposite direction with higher IT capability enabling firms to derive better performance in less dynamicor volatile environments.

There may be a few plausible explanations for this finding. First, it takes significant amount of time for firms to introduce, build, and institutionalize major changes to IT capability with multi-year project efforts to make changes to IT infrastructure. In the meanwhile, the operating environments change continuously and at a furious pace with the result any changes to IT capability to be aligned to the previous environmental conditions have been rendered obsolete. It is, thus, more than feasible that organizations are mired in the notion of *static* rather than *dynamic alignment* as alluded to in recent research (Eisenhardt and Martin 2000; Wade and Hulland 2004). Given that considerable investments have already been made to build IT capability and the apprehension to make any further investments of resources in the face of rapid changes, it appears rational that firms may seek to exploit their IT potential in at least more stable environments—a focus on static rather than dynamic efficiency (Ghemawat and Costa 1993).

Second, it is possible that companies look toward other coping mechanisms such as boundary spanners and various types of buffers in the presence of greater environmental uncertainty besides IT capability. For instance, Flynn and Flynn (1999) found IT systems to be not at all important in moderating the relationship between manufacturing environment uncertainty and manufacturing performance; they found simplicity of product design, multifunctional and flexible employees, supervisory interactions, and customer relationships to be important contingent variables.

Finally, there is an underlying premise that the firms ranked by various experts to be IT leaders (and presumed, as a consequence, more capable on IT aspects) were indeed the most appropriate corporations. Notwithstanding anecdotal stories of certain IT-related actions chronicled in the trade press of these presumed IT leader firms, they may simply be incorrect choices. It would be very difficult for the experts to disentangle themselves and separate out the halo effect of past organizational performance when engaged in subjective evaluations. For instance, K-Mart Corporation was listed as an IT leader along with Wal-Mart; it is now known beyond much doubt that it was the ineffective and inflexible IT of K-Mart that was one of the key reasons for its bankruptcy.

As noted before, the direct effects of IT capability appear to be more apparent as also the fact that the degree of interaction effect (on the same two performance measures, ROA and OI/A) becomes stronger in later years. This confirms the arguments just made that major changes to IT capability not only take considerable time to institute but deriving business benefits can be even more time consuming as well as evasive. The results suggest that there may be some sort of an optimal period for the results to take root. It may also be that the benefits may start eroding after being sustained for a reasonable period. Obviously, such a dynamic phenomenon cannot be examined and generalized with cross-sectional archival data.

This study has implications for both researchers and managers by delineating the contingency effects of environmental dynamism on the IT capability–firm performance relationship. However, it could also be extended in the following areas. First, this study considered only one dimension of environmental uncertainty, dynamism. Future research needs to examine the other dimensions such as munificence and complexity, and take a more holistic approach to operationalzing and using environmental uncertainty. Furthermore, it is necessary to consider the various sources of uncertainty from within the organization that also need to be addressed by and aligned with IT capability.

Conclusions

The study set out to pose a central question: Does IT capability always leads to superior firm performance? External environmental uncertainty emerging from dynamism was examined as one aspect of differing contextual conditions. Firms with high IT capability were found to exhibit significant performance advantages over their counterparts only when operating in relatively low environment dynamism. The findings add contradictory evidence to the debate on IT business value. However, financial measures of performance are only one of the many aspects where IT capability can be expected to and is capable of providing value. There have been increasing calls in recent years for a more holistic evaluation of IT effectiveness with balanced score card, service quality measures, activity based cost measurement and management, total cost of ownership and total benefits of ownership, total value measurement and management, and real options approach claiming to some of the competing as well as complementary approaches (Kaplan and Norton 1992; Luehrman 1998; Luftman et al. 2004; Parasuraman et al. 1985). In order to better understand the relationship between IT capability, environmental conditions, and firm performance, several lines of future research could be conducted. The practice of using perceptual ranking of IT leaders as a proxy may not be adequate in accurately representing the IT capability of a firm. Beyond the need to develop a more comprehensive measure for IT capability (a good start is the scales developed by Bharadwaj et al. 1999), it would be necessary to capture the dynamic nature of decisions about IT capability and measure these synchronously with aspects of environmental uncertainty (external as well as internal as noted in the limitations section) to examine and address the paradoxical findings of this study that went contradictory to the conceptual arguments rooted in the information processing theory of the firm. It may be desirable to simultaneously use both self-reported data from companies (using measurement scales such as the one developed by Bharadwaj et al.) and objective data from archival data sources to tease out and address inconsistencies. The findings of this study have once again raised the awareness and adequate interest in addressing the resilient issue of business value of IT.

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