IS Support for Top Managers' Dynamic Capabilities, Environmental Dynamism, and Firm Performance: An Empirical Investigation

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Despite a continual interest in developing information systems (IS) to support the work of top managers, assessing the impact of IS support for top managers and their capabilities on the bottom-line performance of firms has received little attention in existing literature. Drawing upon the resource-based view of competitive advantage, this paper argues that firms that provide IS support for their top managers' dynamic capabilities may enjoy competitive advantage and superior firm performance. The performance impact of IS support for two key dynamic capabilities of top managers (fast response and mental model building) under different (dynamic vs. stable) external environments was then examined and assessed with both survey and archival data. The results show that IS support for the fast response capability of top managers improved both profitability and labor productivity in a dynamic external environment. On the other hand, the study did not find either direct or indirect effects of IS support for the mental-model building capability of top managers.

During the past decade, researchers concerned with the strategic management of information systems (IS) have increasingly utilized the resource-based view of

competitive advantage to reexamine the strategic contributions of IS (Mata, Fuerst & Barney, 1995; Powell & Dent-Micallef, 1997; Lado & Zhang, 1998; Bharadwaj, 2000; Byrd, 2001; Wheeler, 2002; Wade & Hulland, 2004; Bhatt & Grover, 2005; Ravichandran & Lertwongsatien, 2005). One key insight from this line of inquiry is that IS may contribute to competitive advantage and superior firm performance by supporting or enabling the development of a firm's dynamic capabilities (Wheeler, 2002; Sambamurthy, Bharadwaj & Grover, 2003; Zhang, 2005). Accordingly, a growing number of studies have been conducted to explore IS support for different types of dynamic capabilities and assess the performance impact of such IS support (Bharadwaj, 2000; Christiaanse & Venkatraman, 2002; Tippins & Sohi, 2003; Zhang, 2005). While this body of research has linked IS support for several dynamic capabilities (e.g., strategic flexibility, organizational learning, and knowledge assets) to a firm's competitive position and performance, little conceptual and empirical work has been devoted to the issues of how IS can be deployed to support the dynamic capabilities of top managers and how such IS support may affect the bottom-line performance of firms. Given the critical roles of top managers and their managerial capabilities in determining the acquisition and development of other valuable organizational resources and capabilities for competitive advantage (Lado & Wilson, 1994; Adner & Helfat, 2003), it is worthwhile and necessary to explore the kind of support IS may provide for top managers' dynamic capabilities. It may also help to ascertain whether firms can derive competitive benefits from IS support for these dynamic capabilities. Moreover, addressing these issues would help increase top managers' knowledge about how information technology (IT) may enhance their effectiveness. The lack of such knowledge may be one main reason why many top managers are not actively involved in using IS in their work and decision making (Orlikowski, 2000; Pijpers et al., 2001).

The purposes of this study are, therefore, to investigate IS support for top managers' dynamic capabilities and the competitive impact of such IS support. Specifically, the study examined IS support for two key dynamic capabilities of top managers (fast response and mental model-building) as well as the performance impact of the IS support. Both capabilities are viewed as crucial to the long-term competitive success of a firm in the strategic management research (Brumagim, 1994; Lado & Wilson, 1994; Hitt, Keats & DeMarie, 1998; Eisenhardt & Martin, 2000; Adner & Helfat, 2003). Furthermore, in view of the growing recognition that the strategic value of an organizational capability and its IS support depend upon different external environments (Miller & Shamsie, 1996; Li & Ye, 1999; Eisenhardt & Martin, 2000), the study explored an important environmental context (environmental dynamism) in which the strengths of the association between IS support for the two dynamic capabilities of top managers and firm performance were likely to vary across firms. Discerning the moderating effects of external dynamism on the performance impact of such IS support is important for our understanding of the conditions under which firms are more likely to reap the benefits from providing IS support for top managers' dynamic capabilities.

The rest of the paper proceeds as follows. The next section presents the emerging resource-based view of the strategic roles of IS to provide the conceptual foundation

for linking IS, top managers' dynamic capabilities, and competitive advantage. This is to be followed by a discussion of the concept of top managers' dynamic capabilities, their strategic importance, and more specifically, two of top managements' dynamic capabilities (fast response and mental model building). IS support for the two dynamic capabilities of top managers, its performance impact, and the moderating effects of environmental dynamism are then examined. The methodology section describes the research method and the findings of the study. The last section presents the implications of the research findings, the limitations of the study, and some suggestions for future research and practice.

Theoretical Background and Hypotheses

Resource-based View of the Strategic Impact of IS

As a popular theoretical perspective in the strategic management literature, the resource-based view of the firm holds that firm's resources and capabilities which are unique and difficult to imitate or substitute can gain and maintain competitive advantage and superior performance (Barney, 1991). While early resource-based analysis of the strategic roles of IS views IS as commodity-like resources that are unlikely to have any direct impact on firm performance (Clemons, 1986; Mata et al., 1995), more recent research indicates that despite lacking characteristics that are unique or difficult to imitate, IS may play an indirect (supporting) role in influencing firm performance (Powell & Dent-Micallef, 1997; Lado & Zhang, 1998; Bharadwaj, 2000; Byrd, 2001; Wade & Hulland, 2004; Ravichandran & Lertwongsatien, 2005). Drawing from the concept of complementary assets – resources whose presence enhances the values of other resources (Teece, 1986) – researchers who examine the supporting role of IS argue that IS may contribute to competitive advantage to the extent that they support the creation or leveraging of rent-yielding, distinctive organizational capabilities that are hard to imitate or substitute (Lado & Zhang, 1998; Bharadwaj, 2000; Byrd, 2001; Ravichandran & Lertwongsatien, 2005). Bharadwaj (2000) further argues that firms providing such IS support may create a complex set of complementary resources that are not easily matched by competitors, hence generating sustainable competitive advantage. There is growing evidence of the supporting role of IS (Powell & Dent-Micallef, 1997; Bharadwaj, 2000; Tippins & Sohi, 2003; Ravichandran & Lertwongsatien, 2005; Zhang, 2005). In one of the earliest resource-based studies of the indirect effect of IS, Powell and Dent-Micallef (1997) found that some U.S. retailers gained performance advantages from deploying IT to leverage preexisting, complementary human and business resources. In another investigation, Bharadwaj (2000) compared a group of IT-leading firms (firms that used IT to develop certain intangible resources, customer orientation, knowledge assets, and synergy) to a matched control sample of firms with regards to several key profit and cost ratios, and found that the IT leaders outperformed the control firms.

Top Managers' Dynamic Capabilities

Among the distinctive organizational capabilities that resource-based scholars view as potential sources of sustainable competitive advantage are a firm's dynamic

capabilities, which refer to "the firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments" (Teece, Pisano & Shuen, 1997, p. 516). As more and more industries and markets are facing rapid and unpredictable changes these days, there is growing recognition in the resource-based literature that the mere possession of an appreciate bundle of specific resources and capabilities is insufficient for the firm to sustain competitive advantage in such an environment. Rather, the firm must constantly develop new resources and capabilities to deal with the new market demands in order to survive and prosper (Teece, et al., 1997; Eisenhardt & Martin, 2000; Rindova & Kotha, 2001). Over the years, a number of value-creating dynamic capabilities such as product development, top managers' capabilities, knowledge creation, alliance and acquisition, and strategic flexibility have been identified and studied (Hitt et al., 1998; Eisenhardt & Martin, 2000; Adner & Helfat, 2003). Among these different dynamic capabilities, top managers' capabilities are deemed as one of the most critical determinants of a firm's long-term competitive success in the resource-based literature (Brumagim, 1994; Lado & Wilson, 1994; Eisenhardt & Martin, 2000; Adner & Helfat, 2003). As a direct analogy of the general dynamic capabilities (Adner & Helfat, 2003), top managers' dynamic capabilities not only enable the strategic leaders of a firm to cope with changing circumstances in its external environments (Eisenhardt & Martin, 2000; Rosenbloom, 2000; Tripsas & Gavetti, 2000), but also determine how well the firm acquires and builds other valuable organizational resources and capabilities and converts them into products and services valued by customers (Brumagim, 1994; Lado & Wilson, 1994; Adner & Helfat, 2003). Despite the influence of top managers' dynamic capabilities on the firm's competitive position or performance, how IS can be deployed to support these capabilities and how much competitive gain the firm may enjoy from such IS support have received scant attention in the literature. It is argued in this paper that providing IS support for certain critical dynamic capabilities of top managers may yield competitive advantage and superior firm performance.

While top managers may rely on a number of managerial capabilities to acquire and develop new organizational resources and capabilities to deal with environmental changes, two key capabilities stand out in the literature (Isenberg, 1984; Hitt et al., 1998; Adner & Helfat, 2003; Baum & Wally, 2003). First is the fast response capability, which represents top managers' ability to react or respond quickly to changes in the external environment (Eisenhardt, 1990; El Sawy, 1991; Hitt et al., 1998; Baum & Wally, 2003). Addressing the criticality of the fast response capability in strategic decision making, Eisenhardt (1990, p. 39) made the following observation:

> "Strategy making has changed. The carefully conducted industry analysis or the broad-ranging strategic plan is no longer a guarantee of success. The premium now is on moving fast and keeping pace. More than ever before, the best strategies are irrelevant if they take too long to formulate."

Firms operating in different industry and market environments may benefit from their top managers' ability to make speedy strategic decisions because fast strategic decisions facilitate early adoption of successful new products, new technologies, or

improved business models that yield competitive advantage (Baum, 2000; Jones, Lanctot, Teegen, 2000). Fast strategic decisions may also help a firm create preemptive resource combinations that lead to economies of scale and knowledge synergies (Baum & Wally, 2003). Recent empirical research shows that top managers' fast decision-making capability has a positive effect on firm growth and profitability (Baum & Wally, 2003).

Besides being valuable to a firm, the fast response capability of top mangers tends to be firm-specific and difficult to imitate. Behavioral and cognitive research on top managers and their behaviors indicates that top management capabilities are developed through cognitive and behavioral characteristics that are unique to the top management team of a particular firm (Hambrick, 1989). Moreover, top managers facing high complexity, uncertainty and intra-firm conflict differ in their capabilities to make sound strategic choices that create rents for their companies (Amit & Schoemaker, 1993; Molloy & Schwenk, 1995). In their recent analysis of dynamic capabilities which include the fast response capability of top managers, Eisenhardt and Martin (2000) observe that effective response to a fast changing environment relies on the ability to create real-time knowledge specific to the situation facing a firm. These authors also argue that the fast response capability is causally ambiguous because it is developed based on extensive experiential (learning-by-doing) actions that obscure its causality. Therefore, the fast response capability of top managers holds the potential of sustainable competitive advantage.

Another critical dynamic capability of top managers is mental model building, which reflects top managers' ability to change their existing beliefs and assumptions to fit with new environments or handle disconfirming information (Isenberg, 1984; Vandenbosch & Higgins, 1995; Hitt et al., 1998). In the literature of strategy formulation and decision making, researchers have long held the view that top managers often consciously or unconsciously use their mental models to guide their search, selection, interpretation and use of information about their environments in making strategic decisions (Weick, 1979; Isenberg, 1984). It is well documented that top managers who fail to constantly test, correct and revise their mental models often inadequately perceive and act on their external environments and, consequently, make suboptimal strategic decisions (Isenberg, 1984; Porac, Thomas & Baden-Fuller, 1989; Walsh, 1995; Rosenbloom, 2000; Tripsas & Gavetti, 2000). Moreover, recent empirical studies on how mental models affect strategic decision making in different industry settings have shown that top managers from different firms facing similar external conditions differed in their abilities to develop new mental models (Tripsas & Gavetti, 2000; Holbrook et al., 2000; Adner & Helfat, 2003). Since the process of mental model development involves the use of such idiosyncratic and costly-to-imitate resources as top managers' firm-specific experience and knowledge, organizational culture, and organizational structure (Hambrick & Mason, 1984; Walsh & Ungson, 1991; Lado & Wilson, 1994), top managers with superior capabilities to develop valid mental models are likely to generate sustained competitive advantage for their companies.

IS Support for Fast Response

In order for top managers to rapidly respond to changes in their external

environments, they must be capable of collecting internal and external information, identifying critical strategic problems and making strategic decisions in a timely manner (Wang & Chan, 1995; Eisenhardt & Martin, 2000). It is evident in the executive information systems (EIS) literature that, by providing on-line access to various external databases, EIS enable top executives to search and retrieve a large amount of external information about suppliers, customers, competitors, financial organizations, stockholders, regulatory bodies and interest groups, etc. in a timely manner (Rasheed & Datta, 1991; Boone, 1993; Young & Watson, 1995). EIS can also transform traditional management report systems to offer top executives more non-financial information in critical areas of their firms (Rockart & DeLong, 1988). Moreover, by facilitating easy and efficient collection of quantitative data, EIS free up more time for gathering soft, qualitative data and reduces top executives' reliance on their staff for information gathering, hence lowering the extent of information filtering and uncertain absorption by their staff (Huber, 1984; Rockart & DeLong, 1988; Volonino, Watson & Robinson, 1995). Empirical work on the organizational impact of EIS has generated evidence showing that EIS support for executive search and gathering of external and internal information has led to improved productivity, more successful new product introduction, and improved decision making in terms of quicker identification of potential problems and opportunities (Leidner & Elam, 1993; Sayeed & Brightman, 1994; Ahituv, Zif & Machlin, 1998).

Group decision support systems (GDSS) may also facilitate top executives' searches for information about the potential sources of competitive advantage (Dennis, Nunamaker & Paranka, 1991). By allowing people from different geographic locations to meet each other at the same time in different time periods, GDSS enable a larger number of employees and managers at different organizational levels to participate in a meeting system, thus increasing the top managers' accessibility to information and knowledge of their subordinates (Dennis et al., 1990; Huber, Valacich & Jessup, 1993). The anonymity feature of GDSS can be used to promote relatively uninhibited group discussions, leading to more open and candid generation and evaluation of ideas (Dennis et al., 1991; Huber et al., 1993). Another useful GDSS support for executive information gathering at meetings is the effective creation, organization and distribution of all the electronic data exchanges (minutes, documents and conclusions) and displays (graphics, tables and texts) during a meeting (Huber et al., 1993).

Besides facilitating quick search and gathering of information, IS can be used to assist top managers in conducting fast, yet comprehensive decision analyses. There is some evidence suggesting that IS may significantly increase the extent of a senior executive's decision analysis without slowing down the whole decision process. In their survey of forty-six executive users of EIS, Leidner and Elam (1993) found that comprehensive analysis could coexist with speed when EIS provided both real-time information and analytic tools such as drill-down and trend analysis. Molloy and Schwenk (1995) also reported that the use of EIS, decision support systems, and expert systems helped strategic decision makers generate and analyze a greater number of alternatives, thus increasing the comprehensiveness of the decision making process.

IS Support for Mental Model Building

Research on IS support for human cognitive processes reveals that firms may develop IS to assist their senior managers in developing and evaluating their mental models (Boland, Tenkasi & Te'Eni, 1994; Vandenbosch & Higgins, 1995; Baets, 1998). Boland et al. (1994) described an actual system (Spider) designed to help users construct their own cognitive maps and evaluate their assumptions and preferences. Baets (1998) documented another system capable of fostering the development of shared mental models from individual mental models. By utilizing the artificial neural networks technology, the system enabled a chemical company to construct an overall picture (mental map) of a particular business process based on the mental models of different stakeholder groups (e.g., the company, the government and the local community). The EIS literature also suggests that the analytical and modeling capabilities (e.g., what-if analysis and simulation) built into many EIS may assist top managers in surfacing and testing assumptions in their mental models or making their implicit mental models more explicit so that they are more testable and easier to communicate (Rockart & DeLong, 1988).

Some evidence from field research suggests that organizational performance improvements may accrue from IS support for critical evaluation of the mental models and assumptions of decision makers. Vandenbosch and Higgins (1995) investigated the performance impacts of two types of support provided by executive support systems (ESS): one for mental model maintenance (fitting new information in extant mental models) and one for mental model building (changing mental models to accommodate new information). They found that perceived competitive performance was strongly related to ESS support for mental model building, while ESS support for mental model maintenance had no effect on perceived competitive performance.

The Moderating Role of Environmental Dynamism

Environmental dynamism describes the rate and unpredictability of changes in a firm's external environment (Dess & Beard, 1984). Research in the resource-based view of competitive advantage has increasingly recognized that the strategic value of a firm's resource or capability depends on specific market contexts (Miller & Shamsie, 1996; Eisenhardt & Martin, 2000; Priem & Butler, 2001). For example, Miller and Shamsie (1996) found that property-based resources (e.g., exclusive long-term contracts with star actors and theaters) improved financial performance in a predictable environment, while knowledge-based resources such as production and coordinative talent boosted financial performance in a changing and unpredictable environment. Through influencing the strategic values of fast response and mental model building, environmental dynamism may affect the performance impact of IS support for these two capabilities. Empirical studies on IS impact on organizational performance also suggest that a firm's ability to reap the benefits from its IS investments may be conditioned by environmental dynamism (Jones, Rockmore & Smith, 1996; Li & Ye, 1999). Li and Ye (1999), for instance, found that IT investments exerted a stronger positive effect on financial performance in a dynamic environment than in a stable environment.

Facing rapid changes in technologies, markets, and competition, top managers rely

more on the fast response capability to cope with the changing external conditions and thereby survive and/or prosper in the new environment (Wang & Chan, 1995; Hitt et al, 1998). The empirical studies conducted by Eisenhardt and her associate showed that top managers' ability to obtain real-time information about their businesses and environments affected the speed of strategic decision making and thus firm performance in a high-velocity environment (Bourgeois & Eisenhardt, 1988; Eisenhardt, 1989). Correspondingly, EIS researchers have found that one of the main reasons for top managers' interest in developing and adopting EIS is to better respond to the changing business climate (Watson, Rainer & Koh, 1991; Bajwa, Rai & Ramaprasad, 1998). Hence, the greater demands that the dynamic external environment places on top managers' fast response capability and its IS support suggest that firms would benefit more from IS support for fast response in a dynamic environment than in a stable environment.

Hypothesis$_1$: The interaction between IS support for fast response and environmental dynamism is positively related to firm performance.

Like the fast response capability, the ability to test, correct and revise mental models is more crucial for top managers in firms facing a greater degree of change and uncertainty in their external environments. Case studies in the strategic management literature have documented how the obsolete views held by top managers led to poor decision making and action in new business environments (Porac et al., 1989; Rosenbloom, 2000; Tripsas & Gavetti, 2000). Tripsas and Gavetti (2000), for example, illustrated the difficulty Polaroid faced in managing its new digital imaging business due to the influence of an inapt mental model held by its top management. In view of the criticality of evaluating and adjusting top managers' mental models in a turbulent environment, it is logical to expect IS support for mental model building to provide greater economic value to firms operating in a dynamic environment than in a stable environment.

Hypothesis$_2$: The interaction between IS support for mental model building and environmental dynamism is positively related to firm performance.

Methodology

Sample and Data Collection

The data for this study came from two sources. The data tapping the independent and moderating variables was gathered from a mail survey of 778 large companies in the U.S. in 1998. The performance and control variables data was collected from the Research Insight (formerly known as Compustat) database. The target respondents of the mail survey were senior IS executives, most of whom held the positions of either vice president of IS or chief information officer (CIO). Before being mailed out, the survey instrument (see Appendix A) was pre-tested and refined for content validity and item clarity with senior IS executives from five Fortune 500 companies

headquartered in a mid-western state. 153 usable responses were received, representing a response rate of 20 percent. This response rate is comparable to those reported in similar studies using senior IS executives in large firms (Powell & Dent-Micallef, 1997; Byrd & Turner, 2001; Kearns & Lederer, 2003; Bhatt & Grover, 2005). Of the responding firms, 75 (49 percent) were manufacturers; 40 (26.1 percent) were service companies; 25 (16.4 percent) were in wholesale or retail trade; and 13 (8.5 percent) were in the transportation or public utilities segment.

To test for potential non-response bias in the sample, the respondent firms were compared to their non-respondent counterparts with respect to sales and number of employees. T-test results showed no significant differences in both characteristics between the two groups. In keeping with Armstrong and Overton (1977), another non-response bias check was conducted by comparing early with late respondents. T-tests of the mean differences for the three explanatory variables failed to reveal any significant differences. Together, these checks provided some evidence for the absence of non-response bias in the data set.

Measures

Independent variables. IS support for fast response is defined as the extent to which IS provide support for top managers' ability to proact or respond quickly to changes in the external environment. Since no relevant scales existed, this construct was measured with a four-item scale developed based on the ideas of Leidner and Elam (1993), Sayeed and Brightman (1994) and Ahituv et al. (1998). IS support for mental model building refers to the extent to which IS provide support for top managers' ability to change their existing beliefs and assumptions in the new external environment (Vandenbosch & Higgins, 1995). This construct was measured with a five-item scale adopted from Vandenbosch and Higgins (1996). For each of the nine items, the respondents were asked to indicate the extent to which their IS had provided a particular type of support during the previous three years on a five-point, Likert-type scale with anchors ranging from "Very great extent" (= 5) to "No extent" (= 1). To assess the construct validity and discriminant validity of the two scales, a principal components factor analysis with varimax rotation was performed on the nine items. The factor analysis (see Table 1) revealed two distinct factors explaining approximately 78 percent of the total variance and corresponding with IS support for fast response and IS support for mental model building, respectively.

Moderating variable. Four items were adopted from Leuthesser and Kohli (1995), and Judge and Miller (1991) to measure environmental dynamism. For each item, the respondents were asked to indicate the frequency of changes in a particular area on a five-point, Likert scale with anchors ranging from "Very Frequent Change" (= 5) to "No Change" (= 1). A separate factor analysis (see Table 2) of these four items revealed a single factor explaining about 63 percent of the total variance, confirming the unidimensionality of the scale.

Dependent variables. The bottom-line performance of the sample firms was measured in terms of profitability and labor productivity. A popular profitability ratio, return on sales (ROS), was used to measure profitability. While other profitability ratios such as return on assets (ROA) and return on equity (ROE) have also been used

in other studies (Brown, Gatian & Hicks, 1995; Li & Ye, 1999), ROS was chosen over ROA and ROE mainly because ROS is not only closely related to ROA and ROE, but also less susceptible to variation in accounting procedures (Price & Mueller, 1986; Li & Ye, 1999). Labor productivity represents an intermediate measure of firm performance. In view of the potential time lag in gauging IS impact on firm performance (Brynjolfsson, 1993), IS researchers have recommended the use of labor productivity to capture potential IS effects (Barua, Kriebel & Mukhopadhyay, 1995). Labor productivity was measured as income per employee (Brown et al., 1995). To smooth annual fluctuations and average out short-term effects, a three-year average (covering the years of 1997, 1998 and 1999) was calculated and used for ROS and income per employee, respectively.

Table 1: *Factor Anaylsis of IS Support*

Item Description	IS Support for Fast Response	IS Support for Mental Model Building
Provide top managers with quick access to external database	.658	
Provide top managers with quick access to internal information	.887	
Help top managers identify problems faster	.786	
Help top managers make decisions more quickly	.670	
Challenge top managers' perspectives		.904
Question top managers' preconceptions		.916
Foster top managers' creativity		.871
Expand top managers' scopes of thinking		.876
Re-orient top managers' thinking		.875
Eigen Value	2.67	4.32
% of common variance explained	29.70	47.98
Cronbach Alpha	.81	.96

Table 2: *Factor Anaylsis of Environtmental Dynamism*

Item Description	Loadings
The product/service features desired by your customers	.903
The product/service features offered by your competitors	.886
The product/process technologies in your industry	.780
The price sensitivity of customers	.540
Eigen Value	2.50
% of common variance explained	62.49
Cronbach Alpha	.78

Control variables. Since the firms participating in the survey came from a variety of industries, it was necessary to control, to some degree, the different industry conditions under which the firms operated. To control for the industry effects, SIC codes were first used to classify the firms into four groups: 1) manufacturing, 2) transportation and public utilities, 3) wholesale and retail trade, and 4) service. Where a firm operated in more than one industry, the firm's SIC code was determined by identifying the industry from which the firm received the largest percentage of sales and the corresponding SIC code. Three dummy variables (each with values of 0 or 1) were then created for the second (transportation and public utilities), the third (wholesale and retail trade) and the fourth (service) groups of firms. For each dummy variable, a firm was assigned a value of 1 if it belonged to a group.

The fourth control variable was firm size, which has frequently been used in other studies involving firm performance as a dependent variable (Tam, 1998; Li & Ye, 1999). In keeping with convention, firm size was measured as the number of full-time employees. The fifth control variable was organizational slack which is indicative of a firm's ability to generate cash flow for reinvestment (Chakravarthy, 1986). Organizational slack needs to be controlled due to its potential influence on a firm's financial performance, as well as, the firm's ability to invest in and develop IS (Kettinger, et al., 1994; Li & Ye, 1999). A traditional ratio, Current Ratio (current assets to current liabilities), was used to measure organizational slack (Bourgeois, 1981).

Analyses

To test the hypotheses, two sets of hierarchical regression analyses were performed, using ROS and income per employee as the dependent variables. In the first stage of each set of the analyses, the five control variables were entered as a set into a regression model to separate their effects. In the second stage, the two independent variables (IS support for fast response and IS support for mental model building) and the moderating variable (environmental dynamism) were added to the model to separate their main effects. In the third stage, two interaction terms (one between IS support for fast response and environmental dynamism, and one between IS support for mental model building and environmental dynamism) were added to the equation to test the interactive effects. To avoid potential multicollinearity among the independent and moderator variables, the factor scores for IS support for fast response and IS support for mental model building (calculated from the factor analysis of the nine IS support items) were used in the regression analyses (Malhotra, 1993), and environmental dynamism was mean-centered before being entered into the model (Cronbach, 1987; Aiken & West, 1991). The regression equations used in each stage of the regression analyses are presented in Table 3.

Table 3: *Hierachical Regression Analyses*

Stage	Purpose	Regression Equation
1	Test the main effects of the control variables	$DV = \alpha + TP + WR + S + EMP + CACL + \varepsilon$
2	Test the main effects of the independent and moderating variables	$DV = \alpha + TP + WR + S + EMP + CACL + ISFR + ISMMB + ED + \varepsilon$
3	Test the interactive effects between the independent variables and the moderating variable	$DV = \alpha + TP + WR + S + EMP + CACL + ISFR + + ISMMB + ED + ISFR*ED + ISMMB*ED + \varepsilon$

DV = dependent variable
α = the constant
TP = industry dummy 1 (transportation and pubic utilities)
WR = industry dummy 2 (wholesale and retain trade)
S = industry dummy 3 (service)
EMP = number of employees
CACL = current assets to current liabilities
ISFR = IS support for fast response
ISMMB = IS support for mental model building
ED = environmental dynamism
ISFR*ED = product term between ISFR and ED
ISMMB*ED = product term between ISMMB and ED
ε = the residual term

Results

Table 4 reports the means, standard deviations and zero-order correlations for all the variables. The correlations reveal only a positive relationship between IS support for fast response and income to employees ($r = .18$, $p < .05$). Environmental dynamism had a strong positive association with IS support for fast response ($r = .28$, $p < .001$) and a moderate positive relationship with IS support for mental model building ($r = .16$, $p < .05$). These relationships suggest that firms facing a higher degree of environmental change tended to provide more support for the two dynamic capabilities of their top managers. It is worth noting that the correlation between the two IS support variables was very high ($r = .60$, $p < .001$). The inter-correlations among these three variables indicate potential problems with multicollinearity.

Table 5 displays the results of the hierarchical regression analyses. Models 1 and 4 involve the five control variables only. Models 2 and 5 include all the control variables, the two independent variables and the moderating variable. Models 3 and 6 comprise all of the control, independent and moderating variables, plus the two interactive terms. As depicted in Models 2 and 5, IS support for fast response only had a direct effect on income per employee ($b = .17$, $p < .05$), while IS support for mental model building had no direct effect on either income per employee or ROS. Hypothesis 1 predicts that the interaction between IS support for fast response and environmental dynamism is positively related to firm performance. Models 3 and 6 show that the interaction term between IS support for fast response and environmental dynamism

was significant in predicting ROS (b = .18, p < .05) and income per employee (b = .16, p < .10) in the expected direction. These results provided support for Hypothesis 1. Hypothesis 2 states that the interaction between IS support for mental model building and environmental dynamism is positively related to firm performance. The moderation results provided no support for this hypothesis because the interaction term between IS support for mental model building and environmental dynamism was not significant in predicting either ROS or income per employee.

Table 4: *Means, Standard Deviations and Correlation Coefficients*[a]

Variable	Mean	s. d.	1	2	3	4	5	6	7	8	9
1. Return on sales	.05	.06									
2. Income per employee (in thousands)	17.22	29.80	.63***								
3. Transportation & public utilities	.08	.28	.01	-.06							
4. Wholesale & retail trade	.16	.37	-.27***	-.21**	-.14+						
5. Service	.26	.44	.43***	.35***	-.18*	-.26***					
6. Number of employees (in thousands)	34.70	63.00	.02	-.08	.04	.26***	-.18*				
7. Current assets to current liabilities	1.89	3.02	.01	.16*	-.09	-.04	.22**	-.08			
8. IS support for fast response	3.31	.78	.05	.18*	.08	.06	.01	.10	.03		
9. IS support for mental model building	2.79	.99	.01	.13	-.04	-.05	.01	.04	.01	.60***	
10. Environmental dynamism	3.59	.78	.07	.10	.02	.01	.23**	-.02	.05	.28***	.16*

[a] N = 153. Correlations greater than or equal to .14 are significant at the .10 level; $r \geq .16$ are significant at the .05 level; $r \geq .21$ are significant at the .01 level; $r \geq .26$ are significant at the .001 level; all two-tailed tests.

Table 5: *Regression Results*[a]

Variables	ROS			Income/Employee		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Control						
Transportation and public utilities	.05	.05	.03	-.02	-.03	-.05
Wholesale and retail trade	-.19*	-.20*	-.20*	-.14	-.15+	-.15+
Service	.38***	.39***	.40***	.28**	.28**	27**
Number of employees	.13+	.12	.14+	.02	.01	.01
Current assets to current liabilities	-.08	-.08	-.07	.08	.07	.08
Main effects						
IS support for fast response		.05	.06		.17*	.16+
IS support for mental model building		-.02	-.04		.10	.08
Environmental dynamism		-.04	.01		-.02	.05
Moderating effects						
IS support for fast response × environmental dynamism			.18*			.16+
IS support for mental model building × environmental dynamism			-.05			.08
R^2	.20	.20	.23	.13	.17	.20
ΔR^2			.03		.04	.03
F	6.87***	4.30***	3.99***	4.35***	3.49***	3.42***
ΔF		.21	2.41+		1.91**	2.78+

[a] N = 153. Standardized regression coefficients are shown.
+p < .10, *p < .05, **p < .01, ***p < .001

Additional Analyses

Since IS support for mental model building did not have either a direct or an interactive effect on either measure of firm performance, two additional sets of regression analyses were performed with this variable and its interactive term dropped from the equations. The results show that the interactive effect between IS support for fast response and environmental dynamism on ROS remained significant at .05 level, while the significance level for the interactive effect on income per employee increased to .05 (b = .17). The latter result hence strengthened the support for Hypothesis 1.

Discussion

In view of the growing recognition that IS support for rent-yielding, distinctive organizational capabilities may yield competitive advantage and superior firm performance, this research was undertaken to investigate the relationships between IS support for two critical dynamic capabilities (fast response and mental model building) of top managers and firm performance under different environmental conditions. The results indicate that some firms improved labor productivity from IS support for fast response. Furthermore, the study found that IS support for fast response was positively related to both labor productivity and profitability in a dynamic environment. On the other hand, the study did not find any direct or indirect effect of IS support for mental model building.

The study contributes to the research and practice concerning the strategic value of IS support for top managers in two regards. First, despite a growing interest in developing and using IS to support the work of senior executives among academics and practitioners, we currently know relatively little about the organizational impact of IS support for top executives. Even though previous research suggests that benefits such as improved productivity, decision making and response time may accrue from such IS support (Belcher & Watson, 1993; Leidner & Elam, 1993; Young & Watson, 1995), it remains unclear whether these operational benefits would eventually increase a firm's bottom-line performance, given the small amount of empirical attention to this issue. Without empirical evidence, firms interested in investing in IS to support their top managers have little basis for their investment decisions. The lack of empirical evidence for the bottom-line impact of IS support for senior executives may also be another reason why top managers in many firms do not utilize IS in their decision making (Nord & Nord, 1995; Orlikowski, 2000; Pijpers et al., 2001). By finding a positive link between IS support for one dynamic capability (fast response) of top managers and the bottom-line performance of firms in a dynamic external environment, this research generates some initial evidence for the competitive benefits from deploying IS to support top executives and their managerial capabilities. With this information, firms can be more informed about what kind of IS support should be provided for top management. They can also better educate their top managers in the value of using IS and thereby increase top managers' use of IS.

Second, the findings from this study increase our understanding of the role of environmental dynamism in influencing the economic benefits of IS support for top

managers. While prior research has found a higher level of adoption of IS support among top executives when their firms face a high degree of turbulence in their external environments (Bajwa et al., 1998), there has been little evidence as to how effective the IS support is in helping top executives and their firms respond to environmental change and uncertainty. The empirical support found for the moderating effect of environmental dynamism on the performance impact of IS support for the fast response capability of top managers suggests that IS can be an effective tool for top managers to make quick and effective decisions for competitive success in turbulent times. The importance of environmental dynamism highlighted in the study also underscores the need for firms and their managers to pay close attention to their external conditions if they expect to reap economic returns from providing IS support to their top managers.

The unexpected finding that IS support for the mental model building capability of top mangers had no direct or indirect effect on firm performance contradicts the previous research by Vandenbosch and Higgins (1995) who found a positive relationship between ESS support for mental model building and perceived competitive performance. The null effect of IS support for mental model building can be explained by the possibility that IS designed to support top managers' mental model building were relatively novel when the study was undertaken. This is evidenced by the lower average level (2.79) of IS support for mental model building than that (3.31) of IS support for fast response. It might then take a longer period of time for senior executives to appreciate and learn how to use IS that question and re-orient their thinking. The longer learning curve for trying and using IS support for mental model building might in turn prolong the time-lag effect of the IS support. It is also possible that senior executives were less involved in using IS support for mental model building even though such IS support was available to them (Pijpers et al., 2001). In other words, simply developing and deploying IS to provide the right type of IS support, as suggested by the prior resource-based analyses of the strategic use of IS, might not necessarily lead to competitive advantage unless the available IS support is actually utilized. Hence, future inquiry of IS support for top executives' mental model building needs to measure and control top managers' actual use of the IS support in question.

The findings from this study need to be interpreted within its limitations. First, derived from cross-sectional data, the significant results proved only association, not causality. Second, the study relied on perceptual data collected from single informants in measuring the IS support and environmental dynamism. Data collected in such a manner may be subject to the respondents' cognitive biases and distortions. On the other hand, by employing objective measures of the performance and control variables, the study reduced similar biases and inaccuracies in collecting the data for those variables and avoided the problem of 'common method variance.' Third, since the study was based on data collected seven or eight years ago when the general business environment (e.g., the use of internet and outsourcing were less prevalent at that time) was different from that of today, whether the research results can be generalized to the current settings may be questionable. Further research based on more recent information reflecting current corporate performance and IS support for top managers' work is needed before one draws any further conclusions about the

performance impact of IS support for top managers' dynamic capabilities. Finally, the response rate (20 percent) for the survey used in the research, while comparable to those of similar studies, was relatively low and thus limited the generalizability of the study results. Obtaining high response rates for sensitive information concerning the strategic use of IS continues to be a challenge for researchers.

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Appendix
Survey Instrument

I. Please indicate the extent to which your information systems have provided each of the following support during the past three years on a scale ranging from 1 (no extent) to (5 very great extent):

1) provide top managers with quick access to external database
2) provide top managers with quick access to internal information
3) help top managers identify problems faster
4) help top managers make decisions more quickly
5) challenge top managers' perspectives
6) question top managers' preconceptions
7) foster top managers' creativity
8) expand top managers' scopes of thinking
9) re-orient top managers' thinking

II. Please indicate the frequency of changes in each of the following areas during the past year on a scale ranging from 1 (no change) to 5 (very frequent change):

1) the product/service features desired by your customers
2) the product/service features offered by your competitors
3) the product/process technologies in your industry
4) the price sensitivity of customers