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Information Technology and Diversification:
How Their Relationship Affects Firm Performance

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ABSTRACT

While the importance of IT coupled with organizational changes for business performance has been widely discussed in the information systems (IS) literature, there has been little empirical research on the issue. This research examines empirically the relationship between IT and diversification by employing multiple diversification measures. It also examines empirically the relative impact on performance of IT and diversification. Results show that diversification coupled with increased IT spending improves firm performance when its strategic emphasis is on related diversification. The results also show that firms place strategic focus on related diversification when they increase IT spending, and that they require more IT when their strategic emphasis is tilted toward related diversification. The findings imply that by providing a better means of coordination, IT enables scope economies, efficient utilization of business resources and collaboration across individual business units, eventually leveraging the benefits of diversification.

Keywords: *collaboration; coordination; diversification; firm performance; information technology; strategic direction*

INTRODUCTION

Emerging technologies can often allow firms to reexamine how they do business, stimulate creative thinking, and ultimately create new opportunities. In the e-business environment, where process automation and digitization are critical for business success, efforts to redesign processes and effectively coordinate value chain-activities with customers and suppliers are ever more important. Information technology (IT), including the Internet and related technologies, can make its fullest impact on organizations when it is deployed in conjunction with changes in business processes, structures, and strategies.

While the importance of coupling IT with organizational changes for business performance has been widely discussed in the information systems (IS) literature (Brynjolfsson & Hitt,

1996; Brynjolfsson & Yang, 1998; Clemons & Row, 1991; Dewan, Michael, & Min, 1998; Rai, Patnayakuni, & Patnayakuni, 1997; Shin, 2001, 2006), there has been little empirical research on the issue. Brynjolfsson and Yang (1998) found that an increase of one dollar in IT capital was valued by the stock market at about ten dollars, and this extra nine dollars represented the value obtained from organizational changes to complement IT investments. Brynjolfsson and Hitt (1996) also found that IT had its greatest contribution to output in firms that adopted a more decentralized and human capital-intensive work system.

This research examines empirically the relationship between IT and diversification by employing multiple diversification measures. It also examines empirically the relative impact on performance of IT and diversification. Several empirical analyses in two stages attempt to answer the following questions:

1. Do firms increase their strategic emphasis on related diversification when they increase IT spending?
2. Is business performance improved by increased IT spending when firms place their strategic emphasis on related diversification?

By answering these questions, this study attempts to shed light on why the impact of IT on firm performance may not be constant across firms. It concludes that IT spending complements the strategic choices of firms, such as a strategic decision to focus on related diversification. The empirical aspects of this complementarity have received little attention from previous IS and economics research.

THEORETICAL BACKGROUND: PRIOR RESEARCH ON DIVERSIFICATION AND IT

Economics research posits that a firm is a collection of physical, human and intangible resources capable of undertaking a number of separate economic activities. Some resources may be relatively product specific, and thus utilized to produce a particular good or service through one business line. Other resources, however, may have the potential to increase production of goods or services in multiple business lines. When a firm has excess capacities that are insufficiently utilized in its current operations and cannot be sold in external markets, it will expand their use by diversifying its operations into multiple markets (Caves, Porter, Spence, & Scott, 1980; Clarke, 1985; Penrose, 1959; Rumelt, 1974).

A firm can diversify its operations into either related or unrelated markets. Related diversification means that a firm diversifies into business areas close to the one in which it originated (for example, computer and communications product manufacturing), while unrelated diversification refers to a firm diversifying into more distant areas unrelated to its current business (for example, computer product manufacturing and banking). When a firm pursues related diversification, its ability to achieve tangible economic benefits depends on increased coordination, communication, and collaboration among its different business lines (Hill, 1994; Hill & Hoskisson, 1987). Individual divisions share market information, managerial expertise, technical knowledge, and physical resources such as supply chains and distribution channels. Thus, when a firm pursues related diversification, it should consider the costs of coordinating resources, including the costs of information sharing, across related markets (Williamson, 1975). On the other hand, unrelated diversification is pursued with the goal of realizing economic benefits from the exploitation of an internal capital market in which capital can be more efficiently allocated than in external markets (Hill, 1988). Because there are no interrelationships among divisions, that is, no sharing of business resources, unrelated diversification does not require as much coordination and collaboration as related diversification (Hill, 1994; Hill & Hoskisson, 1987).

IT is widely used to share information and coordinate business resources across multiple markets (Clemons, Reddi, & Row, 1993; Gurbaxani & Whang, 1991; Malone, Yates, & Benjamin, 1987). Because IT provides a better means of coordination and collaboration across multiple markets, firms pursuing related diversification may require increased IT investment. Similarly, increased IT investment may facilitate diversification, particularly related diversification. A firm's IT investment, therefore, can be the cause or the effect of its diversification. In other words, IT can complement a firm's diversification strategy or vice versa.

The relationship between IT and diversification has been examined by previous IS research (Dewan et al., 1998; Hitt, 1999). Dewan et al. (1998) found that diversification, especially related diversification, was likely to increase a firm's demand for IT. They argue that their findings might reflect a greater need for coordination of assets and information processing within diversified firms. Working from similar findings, Hitt (1999) argues not only that diversified firms have a higher demand for IT capital, but that increased use of IT is associated with a slight increase in diversification. While Dewan et al. (1998) and Hitt (1999) have provided the implications of the complementarity of IT and diversification for firm performance, they did not empirically analyze the issue in their studies. The issue of how the complementarity of IT and diversification affects firm performance has been examined by several recent papers. Shin (2006) finds a positive interaction effect between IT and strategic direction, defined as the difference between related and unrelated diversification. Liu, Ravichandran, Han, and Hasan (2006) also find that the interaction effect between IT and diversification is positive only for related diversification.

This study is similar to the prior work done by Shin (2006) and Liu et al. (2006), but while the prior work focused on the interaction effect of IT and diversification, this study shows the directional effect of IT and diversification by performing empirical analyses in two stages. This study also examines lagged effects of IT, which was not done in Shin's study (2006).

DIVERSIFICATION AND PERFORMANCE IMPACTS OF IT

Diversification can increase the demand for IT because of the need for coordination and collaboration across multiple markets. In today's global economy in which firms can diversify across national borders, the use of IT for diversification has become ever more important since IT lowers the additional costs of coordination and collaboration, thereby augmenting the benefits of diversification. Thus, increased use of IT can improve the performance of highly diversified firms. However, the contribution of IT to firm performance may depend on the direction of the firm's diversification strategy (Shin, 2006). If a firm's strategic direction is oriented more toward related diversification, in which coordination and collaboration are critical for success, increased use of IT may improve the firm's performance by providing a better means of coordination and collaboration. However, if a firm's strategic direction is oriented more toward unrelated diversification, which does not require as much coordination and collaboration as related diversification, increased use of IT may have less impact on the firm's performance.

The strategic direction of diversification (strategic direction, in short) is defined here as the relative emphasis a firm places on related diversification relative to unrelated diversification. A measure of strategic direction is constructed as follows:

Strategic Direction (SD) = Related Diversification – Unrelated Diversification

Positive scores indicate a firm's relative emphasis on related diversification; negative scores indicate its relative emphasis on unrelated diversification. It is expected that IT will

improve the performance of firms when they place emphasis on related rather than unrelated diversification. On the other hand, IT is not likely to leverage the performance of firms when they place emphasis on unrelated rather than related diversification. This result does not negate the importance of unrelated diversification for firm performance, but rather highlights the importance of IT for leveraging the benefits of related diversification.

METHODOLOGY AND ANALYSIS: DATA SOURCES AND VARIABLE CONSTRUCTIONS

The study employs two data sources: *Information Week*'s annual data set of IS budgets for the three years from 1995 to 1997 and the Compustat database for the five years from 1995 to 1999.

IT intensity is calculated by dividing the IS budgets by the number of employees. As measures of diversification, we employ the Entropy indexes of total diversification, related diversification and unrelated diversification (Jacquemin & Berry, 1979). A measure of strategic direction is constructed by taking the difference between the Entropy index of related and unrelated diversification (i.e., related diversification – unrelated diversification). Two other diversification indexes—the Concentric index (Caves, et al., 1980; Montgomery & Wernerfelt, 1988; Wernerfelt & Montgomery, 1988) and the Herfindahl index—are also employed as measures of diversification.[1]

Data items such as sales, total assets, capital investment, the number of employees, and return on assets (ROA) are obtained from the Compustat database for the same firms included in the Information Week 500 data set. Tobin's q, ROA, gross margin, and revenue per employee are employed as measures of firm performance. To construct the measure of Tobin's q, we employ the same method used by Bharadwaj, Bharadwaj, and Konsynski (1999):

Tobin's q = (MVE + PS + DEBT)/TA
Where
MVE = (Closing price per share at the end of the fiscal year) * (Number of common shares outstanding)
PS = Liquidation value of the firm's outstanding preferred stock
DEBT = (Current liabilities – Current assets) + (Book value of inventories) + (Long-term debt)
TA = Book value of total assets

Tobin's q is defined as the ratio of the capital market value of a firm to the replacement value of its physical assets. This incorporates a market measure of firm value (Bharadwaj et al., 1999; Montgomery & Wernerfelt, 1988). According to Bharadwaj et al. (1999), Tobin's q is forward-looking, risk-adjusted, and less susceptible to changes in accounting practices, compared to accounting-based performance measures such as ROA. In other words, it reflects the ex-ante financial market valuation of the level and risk of future profitability. Tobin's q has been widely used in economics research to measure the intangible values of factors such as R&D and brand equity (Cockburn & Griliches, 1988; Simon & Sullivan, 1993). Some recent IS studies have also used Tobin's q to examine the intangible value created by IT (Anderson, Banker, & Nan, 2002; Bharadwaj, et al., 1999; Brynjolfsson & Yang, 1998; Tam, 1998; Tanriverdi, 2006). The use of Tobin's q for measuring intangible value is based on the assumption that the long-run equilibrium market value of a firm must be equal to the replacement value of its physical assets, giving a q value close to unity (Bharadwaj et al., 1999). Any upward deviation from this unity, where q is significantly greater than one, indicates that there is an unmeasured source of value, which is generally attributed to the intangible value created by the firm. Since IT creates significant intangible benefits such as improved market orientation, better coordination and collaboration, higher product quality, and more effective business strategies and processes, the use of Tobin's q as a measure

of firm performance can provide a means of capturing IT's true value to a firm.

The sample includes 535 observations (267 different firms) for the three years from 1995 to 1997. The sample statistics are shown in Table 1.

METHODOLOGY

The basic methodology is to analyze the combined data set for five years (1995-1999) using an ordinary least squares (OLS) regression with lag variables: one-year and two-year lags. To analyze the relationship between IT and diversification, an analysis with IT and multiple diversification indexes is conducted. Then we analyze the performance impacts of IT and diversification. For the analysis with the one-year lag, IT intensity from 1995 to 1997 and diversification and firm performance from 1996 to 1998 are employed. For the analysis with the two-year lag, IT intensity from 1995 to 1997 and diversification and firm performance from 1997 to 1999 are employed.[2]

ANALYSIS OF IT AND DIVERSIFICATION

The Model

The model measures the relationship between IT and diversification, while controlling for industry- and year-specific effects.

$$DIV_{i,t} = \beta_0 + \beta_1 IT_{i,t-1} + \beta_2 DIV_{i,t-1} + \beta_3 CAP_{i,t} + \beta_4 Industry_{i,t} + \beta_5 Year_{i,t} + \varepsilon \quad (1)$$

DIV stands for the Entropy index of total diversification. It is replaced in turn by two other diversification variables: the Concentric and Herfindahl indexes. The model includes a one-year lagged variable of total diversification ($DIV_{i,t-1}$) because the analysis conducted without controlling for this variable may overestimate the significance of IT (Santhanam & Hartono, 2003; Tanriverdi, 2006; Zhu, 2004). It also helps reduce the adverse impact of serial correlation in the regression (Zhu, 2004). For the analysis of the two-year lags, the one-year lagged IT ($IT_{i,t-1}$) is replaced by the two-year lagged IT ($IT_{i,t-2}$). Capital intensity (capital investment/

Table 1. Sample statistics (1995 to 1999)

Variables and other data	Mean	St. Deviation	No. of Obs.
IT intensity (IS budgets/employee)	5,091.8	6,033.3	535
Related diversification (Entropy)	.1794	.2843	535
Unrelated diversification (Entropy)	.3713	.4146	535
Strategic direction	-.1919	.4993	535
Total diversification. (Entropy)	.5507	.5060	535
Concentric	.5214	.4932	542
Herfindahl	.3140	.2753	542
Capital intensity	.5579	.1570	535
Tobin's q	1.790	1.401	321
Return on assets (ROA)	.0911	.0951	366
Gross margin	.3409	.1722	394
Revenue per employee	268,713.4	218,208.5	393
Total sales (in million)	11,855.8	20,890.3	535
Total assets (in million)	15,852.5	35,926.9	535

total assets) is included as a control variable for firm-specific effects. Because the model employs ratio variables for both dependent and independent variables, we do not include firm size as a control variable. Dummy variables for each industry categorized by the SIC code and for each year are also included in order to account for industry differences and macroeconomic (or market) trends. ε is the residual term with zero mean, which captures the net effect of all unspecified factors.

The differing impact of IT on related and unrelated diversification is estimated separately using the following two models:

$$RD_{i,t} = \beta_0 + \beta_1 IT_{i,t-1} + \beta_2 RD_{i,t-1} + \beta_3 CAP_{i,t} + \beta_4 DIV_{i,t} + \beta_5 Industry_{i,t} + \beta_6 Year_{i,t} + \varepsilon \quad (2)$$

$$URD_{i,t} = \beta_0 + \beta_1 IT_{i,t-1} + \beta_2 URD_{i,t-1} + \beta_3 CAP_{i,t} + \beta_4 DIV_{i,t} + \beta_5 Industry_{i,t} + \beta_6 Year_{i,t} + \varepsilon \quad (3)$$

RD and URD stand for the entropy indexes of related and unrelated diversification respectively. As in the model of diversification, each model includes one-year lagged variables of related ($RD_{i,t-1}$) and unrelated diversification ($URD_{i,t-1}$) respectively. Capital intensity and total diversification (entropy index) are included as control variables for firm specific effects. Industry and year dummies are also included as control variables.

We also estimate a model with strategic direction (the entropy index of related diversification—the entropy index of unrelated diversification) in order to directly examine if a firm places emphasis on related rather than unrelated diversification when it increases IT spending. A firm can direct its operations into both related and unrelated diversification. However, the important strategic decision is not whether to choose one or the other, but how much emphasis to place on one relative to the other. A firm can pursue both related and unrelated diversification for different reasons, but what really matters is the firm's strategic focus (Shin, 2006). Unlike models (2) and (3) shown earlier, which examine the impact of IT on related and unrelated diversification separately, the model of strategic direction captures both components at the same time. The model includes related diversification (one-year lagged), capital intensity, total diversification (entropy index), industry and year dummies as control variables.

$$SD_{i,t} = \beta_0 + \beta_1 IT_{i,t-1} + \beta_2 RD_{i,t-1} + \beta_3 CAP_{i,t} + \beta_4 DIV_{i,t} + \beta_5 Industry_{i,t} + \beta_6 Year_{i,t} + \varepsilon \quad (4)$$

As discussed earlier, a firm's increased IT spending can be the result of its diversification: Namely, a firm that places emphasis on related diversification relative to unrelated diversification may require increased IT spending. In order to examine this reverse causality, we use a simultaneous regression model by taking IT as a dependent variable and strategic direction as an independent variable.

$$IT_{i,t} = \beta_0 + \beta_1 SD_{i,t} + \beta_2 IT_{i,t-1} + \beta_3 CAP_{i,t} + \beta_4 RDIV_{i,t} + \beta_5 Industry_{i,t} + \beta_6 Year_{i,t} + \varepsilon \quad (5)$$

Unlike the other models, this one does not include a lagged variable of strategic direction, since a firm can adjust the level of IT spending relatively easily compared to strategic direction. A one-year lagged IT variable, capital intensity, related diversification (Entropy index), industry and year dummies are included as control variables.

Models 1 to 5 test the following hypotheses respectively:

H1: There is a positive relationship between IT and total diversification.
H2: There is a positive relationship between IT and related diversification.
H3: There is a positive relationship between IT and unrelated diversification.
H4: IT has a positive relationship with strategic direction.
H5: Strategic direction has a positive relationship with IT.

ANALYSIS FOR FIRM PERFORMANCE

The Model

The model measures the relationship between IT and firm performance as measured by Tobin's q, gross margin, revenue per employee, and ROA while controlling for diversification and capital intensity, as well as industry- and year-specific effects. The model also includes a one-year lagged variable of ROA to control for past performance since the performance impact of IT can be overestimated if there is no control for past performance (Santhanam and Hartono, 2003; Tanriverdi, 2006; Zhu, 2004).

$$\text{Performance}_{i,t} = \beta_0 + \beta_1 \text{IT}_{i,t-1} + \beta_2 \text{RD}_{i,t} + \beta_3 \text{DIV}_{i,t} + \beta_4 \text{CAP}_{i,t} + \beta_5 \text{ROA}_{i,t-1} + \beta_6 \text{Industry}_{i,t} + \beta_7 \text{Year}_{i,t} + \varepsilon \quad (6)$$

For the analysis of the two-year lags, the one-year lagged IT is replaced by the two-year lagged IT. When ROA is employed as a dependent variable, the one-year lagged variable of Tobin's q is employed as a past performance variable. The model is also estimated separately using the strategic direction variable instead of the diversification variables (RD and DIV).

$$\text{Performance}_{i,t} = \beta_0 + \beta_1 \text{IT}_{i,t-1} + \beta_2 \text{SD}_{i,t} + \beta_3 \text{CAP}_{i,t} + \beta_4 \text{ROA}_{i,t-1} + \beta_5 \text{Industry}_{i,t} + \beta_6 \text{Year}_{i,t} + \varepsilon \quad (7)$$

Models 6 and 7 test the following hypothesis:

H6: There is a positive relationship between IT and firm performance.

RESULTS: IT AND DIVERSIFICATION

As shown in Table 2, the current level of IT spending is strongly associated with an increase in diversification after two years. The coefficient of IT (two-year lagged) indicates that the null hypothesis of zero effect of IT can be rejected at a confidence level of .01 when the entropy index is employed as a measure of diversification. The F values suggest that the overall model is statistically significant at a level of .01. The results are the same for the Concentric and Herfindahl measures of diversification (Table 3). IT is also associated with an increase in related diversification, and the impact is stronger for IT spending that has been lagged for two years, with a coefficient of .065 ($p < .01$). As expected, IT is associated with a slight increase in unrelated diversification after two years. The coefficient of IT is .035 and significant at a .10 confidence level.

The model also explores the impact of IT on diversification by using the variable of strategic direction (Table 4). As expected, IT is strongly correlated with an increase in strategic direction, and its impact is stronger after two years, with a coefficient of .075 ($p <.01$). The results indicate that firms place their strategic emphasis (or focus) on related diversification when they increase IT spending.

Table 5 shows the results of a direct test of reverse causality with the simultaneous regression model. The results show that strategic direction is strongly associated with an increase in IT spending, with a coefficient of .139 ($p <.05$). The results in Tables 4 and 5 suggest that there is some causality in both directions between IT and strategic direction, which reflects a mutual reinforcement of IT and strategic direction.

Our results are consistent with the findings of previous studies done by Dewan et al. (1998) and Hitt (1999). However, this study is different from them since it examines lagged effects of IT and employs a measure of strategic direction, in addition to other diversification measures, which captures and quantifies the components of both related and unrelated diversification at the same time. It also employs a more recent data set (1995-1999), compared to the previous studies.[3] This study is also distinct from the two studies in that Dewan et al. (1998) analyzed the IT demand side only, and Hitt (1999) did not

Table 2. Results for IT and total/related/unrelated diversification (entropy index)

Independent Variables	Dependent Variables					
	DIV_t		$RDIV_t$		$URDIV_t$	
	Model with One-YR Lag	Model with Two-YR Lag	Model with One-YR Lag	Model with Two-YR Lag	Model with One-YR Lag	Model with Two-YR Lag
$(IT/EMP)_{t-1}$	-.002[1] (-.090)[2]		.038* (1.848)		-.002 (-.145)	
$(IT/EMP)_{t-2}$		.076*** (3.045)		.065*** (2.713)		.035* (1.700)
$(CAP/ASSET)_t$	.028 (1.391)	.017 (.650)	.007 (.315)	-.001 (-.052)	.031 (1.720)	.023 (1.032)
DIV_{t-1}	.908*** (50.38)	.879*** (36.07)				
$RDIV_{t-1}$			.803*** (34.59)	.761*** (27.98)		
$URDIV_{t-1}$					.654*** (26.38)	.594*** (21.18)
DIV_t			.157*** (6.68)	.193*** (7.09)	.332*** (13.19)	.386*** (13.81)
Other Controls	Industry & Year	Industry & Year	Industry & Year	Industry & Year	Industry & Year	Industry & Year
Adjusted R^2	84.6 %	77.0 %	80.5 %	77.7 %	87.1 %	83.7 %
F Statistic	291.13***	145.66***	201.41***	140.51***	327.77***	207.45***
N	529	436	535	442	535	442

*** (p<.01), * (p<.10)

[1] *Standardized coefficients are reported.*

[2] *The values in parentheses are t-statistics.*

Table 3. Results for IT and diversification (concentric and Herfindahl indexes)

Independent Variables	Dependent Variable			
	$CONC_t$		$HERF_t$	
	Model with One- Year Lag	Model with Two-Year Lag	Model with One-Year Lag	Model with Two-Year Lag
$(IT/EMP)_{t-1}$	-.015[1] (-.826)[2]		-.006 (-.345)	
$(IT/EMP)_{t-2}$		.058** (2.325)		.077*** (3.066)
$(CAP/ASSET)_t$	.027 (1.356)	.016 (.601)	.024 (1.201)	.018 (.676)
$CONC_{t-1}$	.904*** (49.75)	.876*** (36.24)		
$HERF_{t-1}$			.903*** (49.44)	.877*** (35.54)
Other Controls	Industry & Year	Industry & Year	Industry & Year	Industry & Year
Adjusted R^2	84.0 %	76.8 %	84.1 %	76.1 %
F Statistic	285.91***	149.28***	287.90***	143.76***
N	542	449	542	449

*** (p<.01), ** (p<.05)

[1] *Standardized coefficients are reported.*

[2] *The values in parentheses are t-statistics.*

Table 4. Results for IT and strategic direction

Independent Variables	Dependent Variable: SD_t	
	Model with One-Year Lag	Model with Two-Year Lag
$(IT/EMP)_{t-1}$	.043*[1] (1.848)[2]	
$(IT/EMP)_{t-2}$		.075*** (2.713)
$RDIV_{t-1}$	.914*** (34.59)	.882*** (27.98)
$(CAP/ASSET)_t$	.008 (.315)	-.002 (-.052)
DIV_t	-.835*** (-31.27)	-.749*** (-23.72)
Other Controls	Industry & Year	Industry & Year
Adjusted R^2	74.7 %	70.0 %
F Statistic	144.47***	94.52***
N	535	442

*** (p<.01), * (p<.10)
[1] Standardized coefficients are reported.
[2] The values in parentheses are t-statistics.

Table 5. Results for strategic direction and IT

Independent Variables	Dependent Variable: $(IT/EMP)_t$
SD_t	.139**[1] (2.189)[2]
$(IT/EMP)_{t-1}$	.480*** (8.977)
$(CAP/ASSET)_t$	-.090 (-1.532)
$RDIV_t$	-.068 (-1.053)
Other Controls	Industry & Year
Adjusted R^2	28.0 %
F Statistic	12.12***
N	287

*** (p<.01), ** (p<.05)
[1] Standardized coefficients are reported.
[2] The values in parentheses are t-statistics.

distinguish related and unrelated diversification in his analysis.

FIRM PERFORMANCE

As shown in Table 6, IT is positively associated with firm performance as measured by Tobin's q. The positive relationship is significant for both one and two-year lagged IT. The results are the same for models (6) and (7). Diversification is negatively associated with firm performance, while strategic direction is positively associated with firm performance. However, the relationship is significant only for total diversification.

The explained variance (R^2) of the results is relatively low (in the ranges of 30 and 40 percent), compared to the one in the analysis of IT and diversification. This indicates that there might be some missing variables in the model. Previous research suggests that organizational resources and capabilities (e.g., R&D intensity, advertising intensity, and intangibles such as flexible culture, customer and supplier relationships, and human IT skills) can influence returns from IT investments (Bharadwaj, 2000; Wade & Hulland, 2004). On the other hand, there has been limited attention on strategic factors, such as diversification, and their importance for IT returns. Because of the focus of this research is on diversification and how it is related to IT

Table 6. Results for Tobin's q

Independent Variables	Dependent Variable			
	Tobin's q_t			
	Model with One-Year Lag	Model with One-Year Lag	Model with Two-Year Lag	Model with Two-Year Lag
$(IT/EMP)_{t-1}$	.111**[1] (2.427)[2]	.132*** (2.869)		
$(IT/EMP)_{t-2}$			.120** (2.521)	.124** (2.556)
$RDIV_t$	-.040 (-.728)		-.038 (-.646)	
DIV_t	-.120** (2.120)		-.111* (-1.934)	
SD_t		.019 (.435)		.014 (.296)
$(CAP/ASSET)_t$	-.073* (-1.648)	-.064 (-1.430)	-.070 (-1.496)	-.071 (-1.503)
ROA_{t-1}	.580*** (13.09)	.571*** (12.72)	.544*** (11.58)	.540*** (11.37)
Other Controls	Industry & Year	Industry & Year	Industry & Year	Industry & Year
Adjusted R^2	43.4 %	41.7 %	37.4 %	35.9 %
F Statistic	21.44***	21.79***	16.67***	16.99***
N	321	321	315	315

*** (p<.01), ** (p<.05), * (p<.10)

[1] *Standardized coefficients are reported.*

[2] *The values in parentheses are t-statistics.*

payoffs, we do not include variables identified by previous research in our model. This might result in specification error and cause biased estimates of standard errors. However, specification error is not likely to be a problem if the included and excluded variables are independent; in that case, the estimates of included variables are not affected by variables excluded (Berry & Feldman, 1985).[4] Since the present research does not consider variables of organizational resources and capabilities, it would be valuable for future research to examine IT returns holistically by considering all the factors that affect firm performance, for example, both strategic factors and organizational resources and capabilities.

As shown in Tables 7 and 8, IT is positively associated with firm performance as measured by gross margin and revenue per employee, and its impact is significant. The results are the same for models (6) and (7). The impact of diversification, including strategic direction, is not significant, except for total diversification in Table 7. Its impact is negative as in the regression with Tobin's q.

IT is negatively associated with firm performance as measured by ROA (not reported here). However, the negative relationship is not significant, and the results are the same for models (6) and (7).

Table 9 summarizes our hypothesis test results.

The results indicate that increased IT spending improves firm performance as measured by Tobin's q, gross margin, and revenue per employee, but not by ROA. In the previous section, we found that firms place their strategic emphasis on related diversification with increased IT spending (Table 4), and that firms require more IT when they are oriented more toward related diversification (Table 5). Overall, this implies that the economic benefits of diversification are leveraged by IT when its direction is oriented toward related diversification. By providing a better means of coordination, IT facilitates the coordination of diverse production activities and the collaboration of individual business units, eventually enhancing the benefits from this diversification. The summary of the overall findings is presented in Figure 1.

Table 7. Results for gross margin

Independent Variables	Dependent Variables			
	GM_t			
	Model with One-Year Lag	Model with One-Year Lag	Model with Two-Year Lag	Model with Two-Year Lag
$(IT/EMP)_{t-1}$	.172***[1] (3.778)[2]	.188*** (4.140)		
$(IT/EMP)_{t-2}$			.221*** (4.765)	.224*** (4.804)
$RDIV_t$	.009 (.171)		.011 (.199)	
DIV_t	-.141*** (-2.613)		-.120** (-2.219)	
SD_t		.056 (1.302)		.044 (.994)
$(CAP/ASSET)_t$	.066 (1.307)	.084* (1.658)	.070 (1.390)	.076 (1.501)
ROA_{t-1}	.387*** (8.825)	.376*** (8.526)	.389*** (8.614)	.383*** (8.446)
Other Controls	Industry & Year	Industry & Year	Industry & Year	Industry & Year
Adjusted R^2	33.2 %	32.0 %	32.4 %	31.5 %
F Statistic	17.28***	17.84***	16.14***	16.88***
N	394	394	381	381

*** (p<.01), ** (p<.05)*

[1] Standardized coefficients are reported.

[2] The values in parentheses are t-statistics.

Table 8. Results for revenue per employee

Independent Variables	Dependent Variables			
	RPE_t			
	Model with One-Year Lag	Model with One-Year Lag	Model with Two-Year Lag	Model with Two-Year Lag
$(IT/EMP)_{t-1}$	.547***[1] (12.066)[2]	.539*** (11.972)		
$(IT/EMP)_{t-2}$			.461*** (9.444)	.459*** (9.430)
$RDIV_t$	-.015 (-.292)		-.026 (-.452)	
DIV_t	.081 (1.505)		.056 (.997)	
SD_t		-.038 (-.884)		-.033 (-.713)
$(CAP/ASSET)_t$	-.034 (-.675)	-.043 (-.854)	-.037 (-.703)	-.039 (-.734)
ROA_{t-1}	-.002 (-.057)	.003 (.069)	-.034 (-.707)	-.032 (-.671)
Other Controls	Industry & Year	Industry & Year	Industry & Year	Industry & Year
Adjusted R^2	33.6 %	33.4 %	25.9 %	26.0 %
F Statistic	17.50***	18.87***	11.99***	13.05***
N	393	393	378	378

*** (p<.01)*

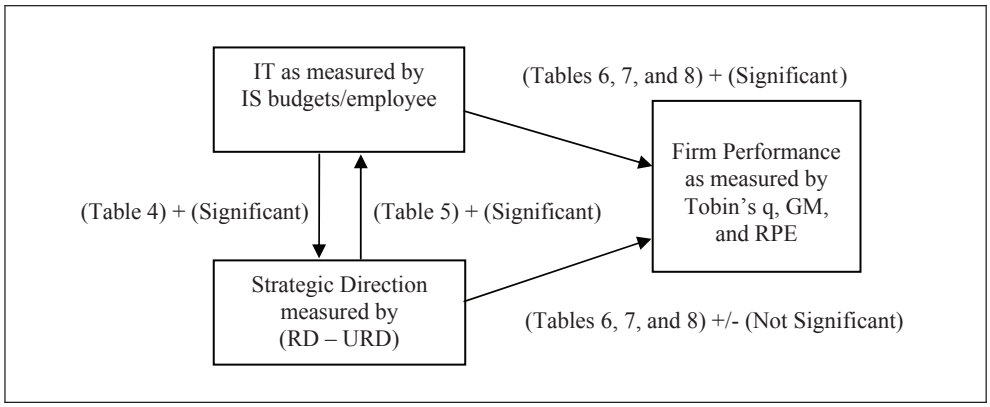
[1] Standardized coefficients are reported.

[2] The values in parentheses are t-statistics.

Table 9. Summary of hypothesis test results

Hypothesis	Sign	Result	Tables
1	+	Supported	2,3
2	+	Supported	2
3	+	Supported (weak)	2
4	+	Supported	4
5	+	Supported	5
6	+	Supported (but not for ROA)	6, 7, 8

Figure 1. Findings on IT, strategic direction, and firm performance



Note: RD (Entropy Related Diversification); URD (Entropy Unrelated Diversification); GM (Gross Margin); RPE (Revenue per Employee)

DISCUSSION AND CONCLUSION

By conducting empirical analyses in two stages,this research demonstrates that IT leverages the benefits of diversification (Figure 1). Based on the findings obtained from several two-staged empirical analyses, this research shows that IT improves firm performance when firms place emphasis on related, rather than unrelated, diversification. In other words, IT complements the strategic decision to focus on related diversification.

Replications and extensions can contribute to the accumulation of knowledge, and it is critical for the development of a discipline (Benbasat & Zmud, 1999; Berthon, Pitt, Ewing, & Carr, 2002; Santhanam & Hartono, 2003). This research contributes to the stream of IT business value research by extending previous IS studies by conducting several empirical analyses to explore: (1) the relationship between IT and diversification by employing multiple measures of diversification and (2) the impact of IT and diversification on firm performance as measured by Tobin's q, gross margin, revenue per employee, and ROA. Another contribution of this research is that it shows the mechanism of how firm performance is improved by IT and diversification by illustrating the directional effect of the two. The insignificant estimates of strategic direction in the performance analysis (Figure 1) indicate that on average technology-driven business strategy (diversification led by IT investments) has little performance impact,

while business-driven technology investment has a significant performance impact. The results imply that our business strategy must guide our decisions on technology investment, not the other way around. However, the high standard errors of the estimates also indicate that some firms are obtaining a significant value from technology-driven business strategy, while others are not. This variation could be of significant interest for future research, for example, how to make technology-driven business strategy more successful.

Companies invest in IT to execute their strategies successfully, thereby creating value. In today's turbulent and fast changing global business environments, companies can create new market opportunities across national borders by developing new products or by finding new customer segments. IT is a critical strategic resource to help companies pursue these new market opportunities with low additional coordination and collaboration costs. By providing a better means of sharing information and coordinating business resources, such as supply chains, distribution channels, marketing expertise, managerial and technical expertise, market information, and other tangible and intangible resources, IT can enable scope economies and efficient utilization of business resources across multiple markets. However, when companies pursue diversification, they should be cautious not to lose their strategic focus and ensure that the new market opportunities do not impair their core strategic position.

This research is not free from limitations: One limitation is that it does not consider all the factors that influence firm performance. Thus, as discussed earlier, there is considerable variance in the dependent variable (firm performance) left to be explained. However, since the focus of this research is on diversification and how it is related to IT performance, we would leave the elucidation of the unexplained variance of firm performance to future research.

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ENDNOTES

1 The Entropy index of total diversification is a weighted average of the sales shares of the different four-digit SIC code industries, where the weight for each industry is the logarithm of the inverse of its share. The Entropy index of related diversification (RD) measures the extent of diversification arising from operations in several industries of the same two-digit SIC code industry group. The Entropy index of unrelated diversification (URD) measures the extent of diversification arising from extending operations into different two-digit SIC code industries. It follows that total diversification is equal to the sum of RD and URD. Unlike the Entropy index, the Concentric and Herfindahl indexes do not distinguish between related and unrelated diversification. The concentric index measures the degree of distance or relatedness between industries. Weights are given based on industry sales shares. This value depends on the relations between the industries. On the other hand, the Herfindahl index measures industry concentration. This index is defined as one minus the sum of squared shares of a firm's activities in different industries (Dewan et al., 1998; Shin, 2006).

2 We take a one-year and a two-year lag structure based on previous IS research (Brynjolfsson, Malone, Gurbaxani, & Kambil, 1994), which shows that the impact of IT is not fully realized immediately and is greatest after a lag of one to two years. We analyze with a one-year and two-year lag separately because they are highly correlated.

3 Dewan et al. (1998) used a data set from 1988 through 1992, and Hitt (1999) used a data set from 1987 through 1994.

4 The interaction between an independent variable in the model and a variable that has been left out often causes the problem of heteroscedasticity—the error term in a regression model does not have constant variance (Berry & Feldman, 1985). Heteroscedasticity does not influence the bias of regression coefficients, but it can bias the estimation of standard errors.

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