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Namchul Shin  
*Pace University*

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# The Relationship between Information Technology and Diversification: Its Implications for Firm Performance

Namchul Shin  
Pace University  
nshin@pace.edu

## ABSTRACT

This research examines empirically the relationship between IT and diversification by employing a measure of strategic direction, and the relationship between IT and firm performance as measured by Tobin's q and ROA by considering intangible benefits of diversification, such as improved coordination and better market orientation that can be leveraged by IT. The results indicate that increased IT spending improves firm performance as measured by Tobin's q, but not by ROA. It also finds that firms tend to place their strategic emphasis on related diversification with increased IT spending. Overall, this implies that the intangible benefits of diversification are leveraged by IT. By providing a better means of coordination, IT facilitates the coordination of diverse production activities and leads firms to place their strategic emphasis on related diversification, eventually achieving intangible benefits from this diversification.

## Keywords

Information technology, diversification, strategic direction, firm performance, Tobin's q, ROA

## INTRODUCTION

Previous information systems (IS) research (Dewan, Michael, and Min 1998; Hitt 1999) has examined the relationship between IT and diversification based on the speculation that information technology (IT) can affect firm structure by reducing the costs of sharing information and coordinating economic activities. After examining what types of firms make the largest investments in IT, Dewan et al. (1998) argue that diversification, particularly related diversification, is likely to increase a firm's demand for IT because the scope of the firm increases the need for coordination and information processing. According to Hitt (1999), firms diversify into new product markets because IT makes it possible to coordinate diverse production activities. He also argues that increased diversification requires a higher demand for IT capital. Based on the previous research, Shin (2003) examined empirically the impact of IT on the financial performance resulting from diversification by focusing on the strategic direction of different firms as measured by the difference of related and unrelated diversification indexes. His research attempted to tackle the question of whether IT improves the performance of diversified firms when their strategic direction is oriented more toward related diversification. In his study, Shin (2003) demonstrated that IT improves the financial performance of diversified firms as measured by gross margin when their strategic direction is oriented more toward related diversification. However, the performance impact of IT associated with strategic direction was not detected for other performance measures such as return on assets (ROA) and return on equity (ROE).

This research examines empirically the relationship between IT and diversification by employing a measure of strategic direction, and the relationship between IT and firm performance as measured by Tobin's q by considering intangible benefits of diversification, such as improved coordination and better market orientation that can be leveraged by IT. ROA is also employed as a measure of firm performance to examine if the intangible benefits leveraged by IT are reflected in such a performance measure.

Strategic direction is defined as the relative emphasis a firm places on related diversification relative to unrelated diversification (Shin 2003). The construct is measured by the difference of related and unrelated diversification indexes (related diversification index minus unrelated diversification index). A firm can diversify its operations into both related and unrelated markets. 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 direction. By employing the construct of strategic direction, this research attempts to capture and quantify both components at the same time, unlike the studies done by Dewan et al. (1998) and Hitt (1999), which examined related and unrelated diversification separately.

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, Bharadwaj, and Konsynski 1999; Montgomery and Wernerfelt 1988). According to Bharadwaj et al. (1999), Tobin's q, a market-based performance measure, is capable of capturing IT's true contribution to firm value because it is forward-looking, risk-adjusted, and less susceptible to changes in accounting practices, compared to accounting-based performance measures such as ROA and ROE. 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 and Griliches 1988; Simon and Sullivan 1993). Some recent IS studies have also used Tobin's q to examine the intangible value created by IT (Anderson, Banker, and Hu 2002; Bharadwaj et al. 1999; Brynjolfsson and Yang 1997; Tam 1998). Examining the intangible benefits and costs of IT investments, Brynjolfsson and Yang (1997) found that an increase of one dollar in IT capital is associated with an increase of up to ten dollars in the market value of the firm. They argue that installing computers not only requires adjustment costs, but can also create a valuable intangible asset in the process. In light of the fact that IT creates significant intangible benefits such as improved market orientation, better coordination, higher product quality, support for strategies and business process, the use of Tobin's q as a firm performance measure may provide a means of examining IT's true value to a firm.

## DATA SOURCES

This study employs two data sources: Information Week's annual survey data set of IS budgets from 1995 to 1997 and the Compustat database.

IT intensity is calculated by dividing the IS budgets by total sales. A measure of strategic direction is constructed using the Entropy indexes of related and unrelated diversification (Jacquemin and Berry 1979). Two other diversification indexes – the Concentric index (Caves, Porter, Spence, and Scott 1980; Montgomery and Wernerfelt 1988; Wernerfelt and Montgomery 1988) and the Herfindahl index – are also employed in order to construct multiple measures of strategic direction. A Pearson Correlation analysis for all four diversification indexes finds that the Concentric and Herfindahl indexes are closer to the Entropy unrelated diversification index than the Entropy related diversification index. Thus, the Concentric and Herfindahl indexes are treated as other measures of unrelated diversification in addition to the Entropy index of unrelated diversification.

In summary, the following three measures of strategic direction are employed for the study:

- 1)STD1: Entropy index of related diversification – Entropy index of unrelated diversification
- 2)STD2: Entropy index of related diversification – Concentric index
- 3)STD3: Entropy index of related diversification – Herfindahl index

Tobin's q and ROA are employed as measures of firm performance. To construct the q ratio, we employ the same method used by Bharadwaj et al. (1999):

$$\text{Tobin's } q = (\text{MBV} + \text{PS} + \text{DEBT})/\text{TA}$$

where

MBV = (Closing price of share at the end of the fiscal year)\*(Number of common shares outstanding)

PS = Liquidating 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

## METHODOLOGY AND ANALYSIS

### Methodology

The basic methodology is to analyze the combined data set for three years (1995-1997) using an ordinary least squares (OLS) regression. To analyze the relationship between IT and diversification, an analysis with IT and strategic direction is conducted. Then we analyze the relationship between IT and firm performance as measured by Tobin's q and ROA, including strategic direction as a control variable.

### Analysis with IT and Strategic Direction

#### The Model

The model measures the relationship between IT and strategic direction as measured by STD1, STD2, and STD3, while controlling for industry- and year-specific effects.

$$STD_{it} = \beta_0 + \beta_1 IT_{it} + \beta_2 INDUSTRY_{it} + \beta_3 YEAR_{it} + \epsilon$$

where

$STD_{it}$  = Strategic direction of the *i*th firm in year *t*

$IT_{it}$  = IS budgets/sales of the *i*th firm in year *t*

$INDUSTRY_{it}$  = a dummy for industry

$YEAR_{it}$  = a dummy for year

$\epsilon$  = an error term with zero mean

STD stands for strategic direction. It will be replaced in turn by each of the three strategic direction variables: STD1, STD2, and STD3. Because the model employs ratio variables for both dependent and explanatory variables, we do not employ firm size as a control variable. In order to control for industry- and year-specific effects, dummy variables for each industry categorized by the SIC code and for each year are included.

**Results**

As shown in Table 1, IT is strongly associated with an increase in strategic direction. The results indicate that firms place their strategic emphasis on related diversification with increased IT spending. The results are the same for all three measures of strategic direction (STD1, STD2, and STD3). The null hypothesis of zero effect of IT can be rejected at the .05, .01, and .01 confidence levels when STD1, STD2, and STD3 are employed as measures of strategic direction.

**Table 1: OLS Regression Results**

Independent Variables	Dependent Variables		
	STD1	STD2	STD3
IT	.139** (2.303) <sup>1</sup>	.181*** (2.956)	.163*** (2.704)
Dummy	Industry & Year	Industry & Year	Industry & Year
Adjusted R <sup>2</sup>	10.4 %	7.3 %	10.1 %
N	299	299	299

Key: \*\*\* (p<.01), \*\* (p<.05), \* (p<.1)

<sup>1</sup> The values in parentheses are t-statistics.

**Analysis with IT and Firm Performance**

**The Model**

The model measures the relationship between IT and firm performance as measured by Tobin’s q and ROA, while controlling for strategic direction as well as industry- and year-specific effects.

$$PERF_{it} = \beta_0 + \beta_1 IT_{it} + \beta_2 STD_{it} + \beta_3 INDUSTRY_{it} + \beta_4 YEAR_{it} + \epsilon$$

where

$PERF_{it}$  = Tobin’s q and ROA of the *i*th firm in year *t*

$IT_{it}$  = IS budgets/sales of the *i*th firm in year *t*

$STD_{it}$  = Strategic direction of the *i*th firm in year *t*

$INDUSTRY_{it}$  = a dummy for industry

$YEAR_{it}$  = a dummy for year

$\varepsilon$  = an error term with zero mean

### Results

As shown in Table 2, IT is positively associated with firm performance as measured by Tobin's q. The positive relationship is significant, and the results are the same when STD1, STD2, and STD3 are employed as control variables. The sign of the estimate of strategic direction is positive when STD 2 is employed.

As shown in Table 3, however, IT is not strongly associated with firm performance as measured by ROA. The sign of the estimate of strategic direction is positive for all three STD variables.

**Table 2: OLS Regression Results for Tobin's q**

Variable	STD1 <sup>1</sup>	STD2	STD3
IT	.127** (2.118) <sup>2</sup>	.119** (1.971)	.122** (2.028)
STD	-.043 (.743)	.011 (.200)	-.007 (.113)
Dummy	Industry & Year	Industry & Year	Industry & Year
Adjusted R <sup>2</sup>	12.7 %	12.5 %	12.5 %
N	299	299	299

Key: \*\*\* (p<.01), \*\* (p<.05), \* (p<.1)

<sup>1</sup> STD1 is employed for STD.

<sup>2</sup> The values in parentheses are t-statistics.

**Table 3: OLS Regression Results for ROA**

Variable	STD1 <sup>1</sup>	STD2	STD3
IT	-.095 (1.339) <sup>2</sup>	-.100 (1.387)	-.099 (1.383)
STD	.040 (.649)	.047 (.772)	.051 (.832)
Dummy	Industry & Year	Industry & Year	Industry & Year
Adjusted R <sup>2</sup>	6.6 %	6.6 %	6.7 %
N	269	269	269

Key: \*\*\* (p<.01), \*\* (p<.05), \* (p<.1)

<sup>1</sup> STD1 is employed for STD.

<sup>2</sup> The values in parentheses are t-statistics.

The results indicate that increased IT spending improves firm performance measured by Tobin's q, but not by ROA. In the previous section, it is found that firms place their strategic emphasis on related diversification with increased IT spending. Overall, this implies that intangible benefits of diversification, such as better coordination and improved market orientation, are leveraged by IT. By providing a better means of coordination, IT facilitates the coordination of diverse production activities and leads firms to place their strategic emphasis on related diversification, eventually achieving intangible benefits from this diversification. Such intangible benefits are reflected in firm performance measured by Tobin's q, but not by ROA since Tobin's q captures the intangible benefits, while as we saw earlier ROA does not.

### CONCLUSION

This research extends the previous studies done by Dewan, et al. (1998), Hitt (1999), and Shin (2003) by conducting several empirical analyses: 1) the relationship between IT and diversification, by employing a measure of strategic direction, and 2) the relationship between IT and firm performance as measured by Tobin's q and ROA.

Replications and extensions can contribute to the accumulation of knowledge, which is critical for the development of a discipline (Benbasat and Zmud 1999; Berthon, Pitt, Ewing, and Carr 2002; Santhanam and Hartono 2003). By using Tobin's q as a performance measure, this research also attempts to show the intangible benefits leveraged by IT, which have not been detected in accounting-based performance measures such as ROA.

## FUTURE RESEARCH DIRECTIONS AND AMCIS PRESENTATION

This research is still in progress and will pursue several different methodologies. The model will be run separately for the manufacturing and service industry sectors in order to examine if the impact of IT on diversification, as measured by strategic direction, and the impact of IT on firm performance, as measured by Tobin's  $q$ , differ across sectors. A different methodology such as a two-stage least-squares (TSLS) regression will be also employed in order to correct the potential problem of simultaneity (or reverse causality: for example, instead of an increase in IT spending leading to diversification, diversification leads firms to increase the level of IT spending). As an instrumental variable, a once-lagged variable of IT intensity will be employed, which by definition, cannot be affected by the dependent variable in the following year.

The presentation of this research (in progress) will include the results obtained from OLS regression. It may include the industry analysis and TSLS regression results if they are completed before AMCIS.

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