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THE IMPACT OF INFORMATION TECHNOLOGY ON FIRM PERFORMANCE:

AN EMPIRICAL STUDY ON THE ROLE OF THE ALIGNMENT OF INFORMATION TECHNOLOGY WITH BUSINESS STRATEGY

Namchul Shin
School of Computer Science and Information Systems, Pace University, One Pace Plaza, New York, NY 10038
Phone: 212-346-1492; Fax: 212-346-1863; Email: nshin@pace.edu

ABSTRACT

Information technology (IT) does not automatically improve firm performance. It is one essential tool that should be coupled with organizational factors such as business strategies. A firm can maximize the value from its IT investments by aligning them with business strategies because IT improves scope economies and coordination. In this paper, we examine empirically the contribution of IT to firm performance measured by net profit, focusing on the alignment of IT with business strategies such as vertical disintegration and product diversification. Empirical analysis shows that IT does not directly improve firm performance, but that IT improves firm performance in conjunction with vertical disintegration and product diversification. This research provides empirical evidence that alignment of IT with business strategies such as vertical disintegration and product diversification can improve firm performance.

1. INTRODUCTION

Firms invest in computers and telecommunications technologies in order to improve their business performance. However, these investments fail to improve business performance for some firms while others show marked improvement. One explanation for this variation is that investment in computers and other types of information technology (IT) does not automatically improve firm performance; instead, it is one essential tool that should be coupled with organizational factors such as business strategies.

Previous research has found that, on average, IT increases productivity (Loveman 1994; Lichtenberg 1995; Brynjolfsson and Hitt 1996; Dewan and Min 1997). However, the overall value of IT varies enormously from firm to firm. Some firms are highly productive with high IT investments, but other firms are less productive with similar investments (Brynjolfsson and Hitt 1998). To explain the difference, Brynjolfsson and Hitt (1995) examined the sources of this variation using the statistical technique of a firm-effects model. According to them, about half of benefits of IT investments drive from unique characteristics of individual firms. However, they have failed to identify the firm-specific characteristics that contribute to IT value. The question of whether IT contributes to firm profitability has also not been clearly answered yet. Most of previous research has shown this contribution to be minimal, negative, or mixed (Cron and Sobol 1983; Turner 1985; Bender 1986; Markus and Soh 1993).

IT does not automatically improve firm profitability. Previous research has not considered organizational factors such as strategic choices, which can affect firm profitability in conjunction with IT. Strategic choices, such as vertical integration and product diversification are closely related to firm performance (Bakos and Tracy 1986). A firm can maximize the value derived from its IT investments by aligning them with business strategies because IT improves scope economies and coordination (Henderson and Venkatraman 1993). This paper examines empirically the contribution of IT to firm performance measured by net profit by focusing on the alignment of IT with business strategies such as vertical disintegration and product diversification.

2. THEORY AND RESEARCH QUESTIONS

IT can be an effective means of both internal (intra-organizational) and external (inter-organizational or market) coordination. According to previous research (Brynjolfsson, Malone, Gurbaxani, and Kambil 1994), IT is correlated with a decrease in firm size. This implies that IT leads to vertical disintegration by reducing external coordination costs relatively more than internal coordination costs. Several other researchers also argue that IT facilitates value-adding partnerships (Johnston and Lawrence 1988; Malone, Yates, and Benjamin 1989; Bakos Brynjolfsson 1993, 1997).

Firms pursue vertical integration to avoid high market (external) coordination costs (Williamson 1975). Because IT also reduces these costs, combining IT investments with vertical integration may not be the best strategic choice. Smaller firms building up a value-adding partnership can exploit benefits such as economies of scale, scope and specialization by using IT. However, because IT also reduces internal coordination costs, firms may pursue vertical integration, which facilitates better control. Even though previous researchers provide empirical evidence for the association of IT with vertical disintegration (Brynjolfsson, Malone, Gurbaxani, and Kambil 1994; Dewan, Michael, and Min 1998), we have little evidence that the association of IT with vertical disintegration improves firm performance, e.g., profitability. Thus, further research is required to determine whether the alignment of IT with vertical disintegration (or market coordination) improves firm performance.

Firms diversify their operations into multiple business lines for efficient utilization of surplus resources, e.g., physical assets, managerial and technical expertise, and market information, which

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are insufficiently utilized in the firms' current operations (Clarke 1985). However, potential economic benefits from sharing business resources are often not realized because of the costs of coordinating resources across multiple business lines (Hill and Hoskisson 1987; Hill 1994; Montgomery 1994). Because IT is effective for coordinating business resources across multiple business units, IT can improve the economic performance of highly diversified firms. In other words, economic benefits of diversification can be leveraged by the capabilities of IT, which facilitates better coordination and communication. Recent research by Dewan, Michael, and Min (1998), partially supports this argument. According to them, firms that are more diversified, especially in related lines of business, make greater investments in information technology.

According to Hitt and Brynjolfsson (1996), although IT investments produce a significant increase in firm output, they do not improve business profitability at all. The reason is that IT reduces buyers' costs of searching for low-cost products and services and selecting alternative suppliers, while the reduction of costs in input utilization by automation and flexible manufacturing may contribute to productivity increases. Thus, firms will attempt to protect their profitability, relying on business strategies such as product diversification and differentiation (Bakos 1998). In other words, the economic benefits of IT can be leveraged by appropriate business strategies. From this perspective, we argue that firm performance can be improved by IT investments in conjunction with product diversification.

These theoretical considerations lead to the following research questions:

1. Does IT directly improve firm performance?
2. Does IT improve firm performance in conjunction with vertical disintegration?
3. Does IT improve firm performance in conjunction with product diversification?

3. ECONOMETRIC APPROACH

3.1 The Model and Methodology

The model measures the relationship between IT and net profit, while controlling for vertical integration, product diversification, the interaction effects of IT with vertical disintegration and product diversification, and other firm-specific characteristics such as R&D and capital intensities, and industry- and year-specific effects.

$$Profit_{it} = b_0 + b_1 IT_{it} + b_2 VI_{it} + b_3 DIV_{it} + b_4 ITS*VDI_{it} + b_5 ITS*DIV_{it} + b_6 R\&D_{it} + b_7 CAPITAL_{it} + b_8 INDUSTRY_{it} + b_9 YEAR_{it} + e$$

where

$Profit_{it}$ = Net profit of the ith firm in year t
IT_{it} = IT intensity (IT spending/selling, general, and administrative expenses) of the ith firm in year t
VI_{it} = Vertical integration of the ith firm in year t
DIV_{it} = Product diversification of the ith firm in year t
$ITS*VDI_{it}$ = The interaction term of IT spending and vertical disintegration (the inverse of vertical integration) of the ith firm in year t
$ITS*DIV_{it}$ = The interaction term of IT spending and product diversification of the ith firm in year t
$R\&D_{it}$ = R&D intensity (R&D expenses/selling, general, and administrativeexpenses) of the ith firm in year t
$CAPITAL_{it}$ = Capital intensity (Capital expenses/selling, general, and administrative expenses) of the ith firm in year t
$INDUSTRY_{it}$ = A dummy for industry
$YEAR_{it}$ = A dummy for year
e = An error term with zero mean

We remove firm size effects using intensity measures such as IT spending, R&D and capital expenses divided by selling, general, and administrative expenses. We use IT spending for the interaction variables; product diversification is a ratio variable, and the variable for vertical disintegration is derived from vertical integration (also a ratio variable). In order to control for firm-specific characteristics, industry- and year-specific effects, we include R&D and capital intensity variables, and dummy variables for each industry that is categorized by the SIC code. We estimate the model for the full sample and also estimate for the manufacturing and service industry sectors separately in order to examine if the interaction effects of IT differs across industry sectors. The model basically tests three hypotheses: 1) IT directly improves firm performance, 2) IT improves firm performance in conjunction with vertical disintegration, and 3) IT improves firm performance in conjunction with product diversification. Based on theories discussed in the previous section, it is expected that the coefficients of both interaction terms (b4 and b5) be positive, but the coefficient of IT (b1) be negative.

To analyze the relationship between IT and net profit, we perform an analysis of the combined data set for all five sample years by using an ordinary least squares (OLS) regression. The description of data sources and construction of variables is presented in the next section.

3.2 Data Sources and Variable Measures

This research employs two data sources: the data set of IT spending by large U.S. firms included in the Computerworld annual survey over the period 1988 to 1992 and the Compustat database.

The total central IS budget figure reported in the survey is used as a measure of IT spending. This figure includes labor expenses, materials, purchased services and software, and capital spending for the central IS department.

We use the Compustat database to obtain the data items for net profit, vertical integration, product diversification, R&D and capital expenses. We employ net profit as a measure of firm performance. Vertical integration refers to the degree to which multiple stages of production are combined under common ownership. Because a vertically integrated firm produces greater value-added internally, vertical integration is measured as the ratio of value-added to total sales (Gort, 1962). Value-added is derived from subtracting the costs of raw materials from the value of production (the sum of total sales and remaining inventory). We employ the inverse of vertical integration as a measure of vertical disintegration because less vertical integration implies more vertical disintegration. Product diversification refers to the extent to which a firm operates in multiple business (or product) lines. For the measure of product diversification, we employ the sales-weighted entropy measure introduced by Jacquemin and Berry (1979). The entropy measure for product diversification can be obtained from the 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 measure refers to the extent of diversification arising from operations in several industries of

the different four-digit SIC code industry group.

4. EMPIRICAL RESULTS AND DISCUSSION

From the analysis of the relationship between IT and net profit, we found that IT spending is strongly associated with a decline in net profit for the full sample ($p < .01$). However, the interaction term of IT spending and product diversification is strongly associated with an increase in net profit ($p < .05$). The estimates are consistent with our hypothesis that IT alone does not improve firm performance. They also support the hypothesis that IT improves firm performance when a firm increases the extent of product diversification. The null hypothesis of zero effect of the interaction term can be rejected for the full sample at the .05 (two-tailed) confidence level. These results imply that a firm uses IT in conjunction with product diversification to improve its performance. In other words, a firm should increase IT spending to improve its performance when it also pursues product diversification. The interaction term of IT spending and vertical disintegration has also a strong positive relationship with net profit ($p < .01$). This result supports the hypothesis that IT improves business performance when a firm decreases the degree of vertical integration. It indicates that firm performance is improved when a firm increases IT spending associated with vertical disintegration. The results are also consistent with previous research that shows increased IT investment to be associated with increased product diversification and decreased vertical integration (Brynjolfsson, Malone, Gurbaxani, and Kambil 1994; Dewan, Michael, and Min 1998).

From the separate industry sector analysis, it is also found that the interaction term of IT spending with vertical disintegration is positively associated with net profit for both the manufacturing ($p < .01$) and service industries ($p < .05$). The interaction term of IT and product diversification is positively associated with net profit for the manufacturing industry ($p < .10$), but not for the service industry ($p < .10$). The results indicate that the alignments of IT with vertical disintegration and product diversification are more effective in the manufacturing industry in terms of increased net profit. The results are shown in Table 1.

Table 1. OLS Regression Results

Variable	Manufacturing	Service	Full Sample
IT	-.172***	.133	-.149***
	(96.6)	(778.3)	(89.6)
VI	.124**	.483	.180***
	(187.0)	(338.8)	(140.2)
DIV	-.056	1.364***	-.048
	(76.3)	(232.1)	(67.6)
ITS*VDI	.642***	1.045**	.635***
	(.085)	(1.244)	(.077)
ITS*DIV	.078*	-.654*	.089**
	(.161)	(2.569)	(.151)
R&D	.119**	-1.635	.093**
	(181.3)	(8871.1)	(161.9)
CAPITAL	.243***	-.321	.252***
	(29.5)	(325.0)	(26.3)
Dummy	Industry and Year	Industry and Year	Industry and Year
Adjusted R^2	62.4%	75.2%	60.0%
N	337	33	370

Key: ***(p<.01), **(p<.05), *(p<.1)
The values in the parentheses are standard errors

5. CONCLUSION

In this paper, we examined empirically the contribution of IT to firm performance measured by net profit by focusing on the interaction (or alignment) effects of IT with vertical disintegration and product diversification. Data was analyzed for the full sample and for both the manufacturing and service industry sectors for the five years from 1988 to 1992.

This research provides empirical evidence for the importance of the alignment of IT with business strategies such as vertical disintegration and product diversification for improving firm performance. The results also shed light on how firms can effectively utilize IT, a question which has not been clearly answered by previous research. Another contribution is that compared to previous studies, this research controlled for firm-specific characteristics such as R&D and capital intensities in addition to the strategic variables such as vertical integration and product diversification.

Our results show that IT alone does not improve firm performance, but that IT improves firm performance in conjunction with vertical disintegration and product diversification. Our results are also consistent with the recent findings that increased IT investment was associated with increased product diversification and decreased vertical integration. Furthermore, our findings support the argument that by reducing buyers' search cost, IT lowers the price paid for products or services and thereby reduces firm profitability. Our findings also support the argument that by improving scope economies and coordination, IT can shape appropriate business strategies, and at the same time, the economic benefits of IT can be leveraged by such business strategies.

REFERENCES

Bakos, Y. "The Emerging Role of Electronic Marketplaces on the Internet,"*Communications of the ACM*, 41, 8, 35-42, August 1998.

Bakos, Y. and Brynjolfsson, E. "From Vendors to Partners: The Role of Information Technology and Incomplete Contracts in Buyer-Supplier Relationships." *Journal of Organizational Computing*, 3, 3, 301-328, 1993.

Bakos, Y. and Brynjolfsson, E. "Organizational Partnerships and the Virtual Corporation," in *Information Technology and Industrial Competitiveness: How Information Technology Shapes Competition*, Kluwer Academic Publishers, 1997

Bakos, Y and Tracy, M.E. "Information Technology and Corporate Strategy: A Research Perspective," *MIS Quarterly*, 107-119, June 1986.

Bender, D.H. "Financial Impact of Information Processing," *Journal of Management Information Systems*, 3, 2, 22-32, 1986.

Brynjolfsson, E. and Hitt, L. "Information Technology as a Factor of Production: The Role of Differences Among Firms," *Economics of Innovation and New Technology*, 3, 4, 183-200, May 1995.

Brynjolfsson, E. and Hitt, L. "Paradox Lost? Firm Level Evidence on the Returns to Information Systems Spending," *Management Science*, 541-558, April 1996.

Brynjolfsson, E. and Hitt, L. "Beyond the Productivity Paradox," *Communications of the ACM*, 41, 8, 49-55, August 1998.

Brynjolfsson, E., Malone, T.W., Gurbaxani, V., and Kambil, A. "Does Information

Technology Lead to Smaller Firms?" *Management Science*, 40, 12, 1628-1644, December 1994.

Clarke, R. *Industrial Economics*, Basil Blackwell Ltd., 1985.

Cron, W.L. and Sobol, M.G. "The Relationship Between Computerization and Performance: A Strategy for Maximizing the Economic Benefits of Computerization," *Information and Management*, 6, 171-181, 1983.

Dewan, S., S.C. Michael, and C. Min, "Firm Characteristics and Investments in Information Technology: Scale and Scope Effects," *Information Systems Research*, 9, 3, 219-232, September 1998.

Dewan, S. and Min, C. "Substitution of Information Technology

for Other Factors of Production: A Firm-Level Analysis," *Management Science*, 43, 12, 1660-1675, December 1997.

Gort, M. *Diversification and Integration in American Industry*, Princeton: Princeton University Press, 1962.

Henderson, J.C. and Venkatraman, N. "Strategic Alignment: Leveraging Information technology for Transforming Organizations," *IBM Systems Journal*, 32, 1, 4-16, 1993.

Hill, C.W.L. "Diversification and Economic Performance," in *Fundamental Issues in Strategy,* R.P. Rumelt, D.E. Schendel, and D.J. Teece, Eds. HBS Press, Boston, MA, 297-321, 1994.

Hill, C.W.L. and R.E. Hoskisson, "Strategy and Structure in the Multiproduct Firm," *Academic Management Review*, 12, 2, 331-341, 1987.

Hitt, L. and Brynjolfsson, E. "Productivity, Business Profitability, and Consumer Surplus: Three Different Measures of Information Technology Value," *MIS Quarterly,* 121-142, June 1996.

Jacquemin, A.P. and Berry, C.P. "Entropy Measure of Diversification and Corporate Growth," *Journal of Industrial Economics*, 27, 4, 359-369, 1979.

Johnston, R. and Lawrence, P.R. "Beyond Vertical Integration: The Rise of the Value-Adding Partnership," *Harvard Business Review*, 94-101, July-August 1988.

Lichtenberg, F.R., "The Output Contributions of Computer Equipment and Personnel: A Firm-Level Analysis," *Economics of Innovation and New Technology*, 3, 4, 201-217, May 1995

Loveman, G. W. "Assessing the Productivity Impact of Information Technologies," in

Allen, T.J. and Scott-Morton, M. *Information Technology and the Corporation of the 1990s*, Oxford University Press, New York, New York, 1994.

Malone, T.W., J. Yates, and R.I. Benjamin, "The Logic of Electronic Markets," *Harvard Business Review*, 166-170, May-June 1989.

Markus, M.L. and Soh, C. "Banking on Information Technology: Converting IT Spending into Firm Performance," in Banker, R.D., Kauffman, R.J., and Mahmood, M.A. *Strategic Information Technology Management: Perspectives on Organizational Growth and Competitive Advantage*, Idea Group, 1993.

Montgomery, C.A. "Corporate Diversification," *Journal of Economic Perspectives*, 8, 3, 163-178, 1994.

Turner, J. "Organizational Performance, Size and the Use of Data Processing Resources," Working Paper, Center for Research in Information Systems, New York University, 1985.

Williamson, O.E., *Markets and Hierarchies: Analysis and Antitrust Implications*, New York: Free Press, 1975.