INNOVATION STRATEGY: IT, R&D AND PROFITABILITY

Vijay K. Vemuri, Ph.D., C.W. Post Campus, Long Island University, vvemuri@liu.edu
Gregory M. Kellar, Ph.D., SUNY – Old Westbury, kellarg@oldwestbury.edu
Anthony M. Akel, Ph.D., C.W. Post Campus, Long Island University, aakel@liu.edu

ABSTRACT

Studies have been performed concerning the individual success of R&D intensity, Information Technology (IT) usage or the effects of innovation over time. Each separate analysis has shown to varying degrees why each of these strategic areas is important. This paper investigates the association between IT, R&D, innovation and profitability. A sample of 36 firms in the consumer goods industry was chosen to test inter-relationships among the above variables. Paired t-tests and non-parametric equivalents were the statistical analyses used to test the hypotheses. It was found that R&D intensity was greater for smaller firms while IT innovation was stronger in larger companies. Further, statistical results reveal that the two separate strategies of deploying high R&D intensity or investing heavily in IT innovation both yield similar profitability results. An interesting observation was that even though no firm pursued both strategies at high levels, profitability was not harmed, i.e. intensive pursuit of one of these strategies was sufficient for profitability.

Keywords: Information technology, innovation, corporate strategy, profitability, research and development, firm size

INTRODUCTION

During the past two decades, information technology (IT) has enabled businesses to go through major transformations. Many new IT initiatives, including Y2K compliance, e-commerce, IT-enabled mega mergers, supply chain integration, euro conversion, and distributed databases, requiring extensive outlays were implemented. To support these initiatives, IT budgets of most companies increased substantially (15). Past empirical studies exploring the association between profitability and IT resulted in inconclusive, and often contradictory findings. To shed additional light on this subject, the importance of innovation strategy as an explanatory factor in understanding the relationship between IT and profitability is examined.

An important question to ask is, how effective are IT investments in improving business performance and value? The linkage between IT and performance can be better understood by examining the impact of IT on productivity, and profitability separately. Productivity analysis is always difficult. Early evidence from macro-level productivity measures suggested that computerization of businesses did not lead to improved productivity (5). This apparent lack of association between IT and aggregate productivity has been studied and the term "productivity paradox" was coined. Possible explanations such as measurement errors in inputs and outputs, aggregation of data, lags in learning and adjustment, redistribution of profits and mismanagement of IT (2) have been suggested. However, recent firm-level analyses utilizing bigger sample sizes found that information technology had a positive effect on the output of a firm (6, 5, 16). These studies have led to questioning the validity of the productivity paradox.

Many empirical research studies suggest that association between profitability and IT is either weak, or nonexistent because of the measures used for profitability. Other studies support increased profitability and financial performance (19, 21, 13) due to IT. However, other financial measures such as the connection between return on investment and IT are either not significant (19, 21) or negative (12, 3). These findings support some observations and anecdotal evidence. Still some firms are more successful than others in realizing the value of their IT investments. In some cases, inept IT deployment has led, in part, to poor financial performance, e.g. implementation problems of supply chain management software mainly contributed to third quarter losses of Hershey Foods and bankruptcy of FoxMeyer Health to flawed implementation of SAP software.

Alignment of Information Technology and Corporate Strategy

IT investments do not always cause higher profitability (19, 21). Often, deployment of IT necessitates redesigning business processes and shifting strategic focus. The strategic choices made by a firm are intervening factors, which in conjunction with investment in IT contribute to higher profitability. In fourteen annual surveys of top management conducted by CSC (7), alignment of information systems and corporate goals ranked very high among the twenty critical information system issues ─ in most years ranking as the most critical.

A number of information systems researchers have advocated linking information system plans with corporate strategy. The importance of functional integration of business strategy and IT strategy and a framework for conceptualizing the integration has been documented (10). The necessity of building the linkage between corporate strategy (internal strategy including organizational design, competitive strategies, and business portfolio strategy) and information technology based on economic theories has also been studied (1). Agency and transaction cost theories form a foundation for the amalgamation of IT and corporate strategy. They also aid in reaching testable conclusions about decentralization of decision making and firm size (9). The intricate link between IT and corporate strategy lead to many important predictions and empirical results. One such prediction is that firms will be less vertically integrated due to enhanced coordination (14) afforded by IT. Other significant results relating IT and corporate strategy show that negative correlations exist between firm size and IT investment (4). Still other studies show that IT investment in conjunction with decentralized decision making results in improved productivity (3). Also productivity may be diminished if the level of decentralization is not appropriately chosen.

Despite the emerging conclusions connecting profitability, IT and certain corporate strategies, very little research is focused on corporate strategy as a mitigating variable linking IT and profitability. A recent study (21) confirms that IT alone does not enhance profits, return on assets, and return on equity, but in combination with vertical disintegration and diversification strategies it does.

INNOVATION AS A STRATEGY

Innovation is the process by which businesses improve their competitiveness and profitability by creating and/or adopting relevant new products and ideas. Innovation strategy is recognized as an effective response strategy to competitive forces (18). Innovations result in the development of new products and services, new features in existing products and services, and new ways to produce or sell them. The scope of innovation can be quite varied. Activities ranging form automation of order taking to developing hydrogen-powered automobiles are broadly considered innovations.

Different Perspectives of Innovation

To understand the relationship between innovation, corporate strategic scope and organizational capabilities, four different perspectives of innovations ranging from incremental innovation to innovations leading to drastic change are offered (11). These four perspectives can be grouped into 1) innovations that improve core businesses and exploit strategic advantages, and 2) innovations that develop new capabilities and lead to revolutionary change. Many, if not most, IT initiatives can be considered as innovations belonging to the first group that improve core businesses. Enterprise resource planning, supply chain management, customer relationship management, data warehouses and data mining, and upgrades to communications infrastructure are popular IT initiatives implemented by medium to large enterprises. A distinguishing feature of these initiatives is that they provide opportunities to improve organizational processes, better coordinate value chains, provide up-to-date information to improve decision making, and increase customer satisfaction.

IT innovations and R&D

IT innovations and R&D can be viewed as different response strategies to competitive forces. IT innovations lead to improvements in internal processes, coordination, and decision making, while R&D leads to significant changes in products, services, and markets served by a firm. Little is known about how these two strategies relate to each other. Do firms expend effort to pursue both IT innovations and R&D simultaneously, or, do they choose one innovation strategy over the other? Is there a preferred sequence to pursue these strategies? This paper addresses these issues.

RESEARCH QUESTIONS

It can be argued that innovators are innovators and they seek opportunities to improve efficiencies in existing operations with IT innovations, as well as, prepare for the future with R&D effort simultaneously. However, resources available for innovations can be limited. Resource constraints may force a company to choose between improving existing operations (IT focused innovations), and actively seeking new products, services and markets (R&D focused innovations). This paper helps to clarify how companies in the consumer goods industry have been allocating their resources as they innovate. It also measures the financial consequences of their chosen strategies.

H1: Companies that invest in IT innovation intensively also invest in R&D intensively. In addition it is hypothesized that companies that do not invest in IT innovation intensely do not invest in R&D.

The past research on R&D suggests that there is a marked relationship between firm size and R&D. Scherer (20) reports strong relationship between inventive output of a firm (as measured by number of patents) and size of the firm (as measured by sales or R&D employees). This study will test if these expectations hold true for IT innovation.

H2: A positive relationship exists between firm size and the level of IT innovations.

It would be reasonable to expect that those companies that pursue an IT innovation strategy would be more efficient and hence more profitable. This leads to:

H3: Those companies that pursue an IT innovation strategy are more profitable than those that do not.

RESEARCH METHODOLOGY

To test the above hypotheses the Consumer Goods Industry was chosen. Past studies have found that there are substantial differences among different industries in the level of IT investments (22) and the results obtained due to IT (16 and 22). Similarly, literature shows that different industries invest in R&D at very different levels and even use R&D intensity as the definition of industry technology level. To observe variation in R&D intensity levels and IT innovation, high-tech and low-tech industries are avoided. The Consumer Goods Industry avoids the extremes of levels of R&D intensity and IT investments (17) and allows for appropriate measurements.

Information Week's Annual Survey of IT Innovators in the consumer goods industry served as the initial dataset in the study. There were 59 different companies listed from 1996 to 2001. A company was considered to be an IT innovator if it showed up on the six annual lists included in the data.

Structural and financial data for similar companies were obtained from Standard and Poor's Compustat. The resulting dataset included only publicly traded companies of which only 36 of the original 59 companies coming from 26 distinct primary SIC codes were included (the other four companies were not publicly traded). The total dataset included 651 companies of which 615 companies were not classified as IT innovators. Data concerning each company in the sample included: primary SIC code, annual revenues, assets, R&D expenses, R&D intensity (R&D expenses divided by annual revenues), ROA, ROE, and ROI. These data were collected for the years 1994 to 2001 (from two years preceding the IT innovation listing to the ending date). The dates allowed for testing the companies for differences before their listing and throughout the tested period. This approach allowed for identification of significant changes that may have occurred due to the companies' involvement or lack of involvement in IT initiatives.

The data were grouped by primary SIC code and the above listed fields were averaged for each group. The averages were calculated separately for IT innovators and non-IT innovators.

A paired t-test, and non-parametric equivalents were used to determine if significant differences existed between IT innovators and non-IT Innovators with respect to company size (assets and annual revenues). Also, R&D intensity was compared for the two groups. Finally, financial performances (ROA, ROE, and ROI) were compared across the two groups. All comparisons were performed using t-tests and non-parametric equivalents.

RESULTS

The results of the statistical tests are listed below in table 1. Note that IT innovators are larger companies than their non-IT innovator counterparts. This was statistically significant with an α-value of less than 1%. The R&D intensities of the two groups were then compared and found to be statistically different with the smaller, non-IT innovators investing much more intensely in R&D. These results show that H3 is rejected while H2 is not rejected. Absolute R&D expenses of the groups were tested and the larger, IT innovators were found to spend slightly more than their smaller counterparts. Finally, profitability of the two groups was compared and no statistical differences were found, thus H1 was rejected.

Table 1

Dataset	Comparison of means*	Conclusion**	p-value***
Assets	$\overline{Assets}_{ITIC} = \overline{Assets}_{NITIC}$	**ITIC have more assets than NITIC**	**.009**
Revenues	$\overline{\mathrm{Re}venues}_{ITIC} = \overline{\mathrm{Re}venues}_{NITIC}$	**ITIC have more revenues than NITIC.**	**.0129**
R&D	$\overline{R\&D}_{ITIC} = \overline{R\&D}_{NITIC}$	**No statistical difference**	**.466**
R&D intensity	$\overline{R\&D\mathrm{intensity}}_{ITIC} = \overline{R\&D\mathrm{intensity}}_{NITIC}$	**NITIC are more R&D intensive than ITIC.**	**.015**
ROA	$\overline{ROA}_{ITIC} = \overline{ROA}_{NITIC}$	**No statistical difference**	**.420**
ROE	$\overline{ROE}_{ITIC} = \overline{ROE}_{NITIC}$	**No statistical difference**	**.424**
ROI	$\overline{ROI}_{ITIC} = \overline{ROI}_{NITIC}$	**No statistical difference**	**.333**

*** Comparison of Means of the items listed across all SIC codes on a year by year basis**
**** ITIC refers to Information Technology Innovative Companies**
NITIC refers to Companies that are not Innovators of Information Technology
***** the reported p-value is the largest value observed for the compared means across all years and across all tests whenever statistical significance is shown (sign test, Wilcoxon matched pairs test, and paired t-test). Others are representative.**

DISCUSSION

Companies in the consumer goods industry appear to be choosing proven strategies over time with respect to their foci on IT innovation. Dial corporation, Dimon, Inc., Maytag corporation, Colgate Palmolive and Proctor and Gamble are among thirty five firms consistently ranked as IT innovators (Information Week). There a number of reasons for the financial success of these firms, however all relate well over time between the financial success ratios and strategy of high IT innovation. Implementing the currently aligned strategy seems to fit the financial rewards

sought by those firms. Smaller companies in the study have benefited by greater R&D intensity (a strategy focus usually associated with longer-term returns) and smaller IT innovations (a shorter-term horizon).

Larger organizations in the study show that they have benefited by having lesser R&D intensity and greater IT innovation for the six year period. As companies create competitive strategies they must be consistent with market requirements if they are to be successful. It is reasonable to expect that larger firms will avail themselves of IT usage greater than smaller firms because of the costs and the need for using this technology, i.e., the increased complexity of size. One of the interesting results of this study is that greater use of IT by larger firms brings financial success; however, the smaller companies with less IT usage also show good financial returns. This result will question "what is good for GM is good for the country". Granted additional studies are needed to validate the argument.

LIMITATIONS

This study has investigated the consumer goods segment and the results can be extrapolated from those firms chosen for the study. Other predictions will be limited. The time frame chosen is six years. IT studies as well as R&D effectiveness studies are difficult to validate over long periods of time because of the nature of technological change. Many new developments, as well as, new players may create better mouse traps and skew the results. In addition, other strategic changes, such as merger and acquisitions may have hidden influences. Causes and effects are often taken as "other things being equal" thus additional validations must be made. This is why many results are often applicable to sample only. In this study IT innovation may be biased by specialized IT providers focusing sales efforts on large companies. Large companies in the study are more profitable with IT innovation strategy although the data did not support statistical significance.

CONCLUSIONS

This study limited itself to R&D and IT innovations of consumer goods firms. It revealed that greater R&D and greater IT innovation were not commonly pursued strategies by the sampled firms. Factors such as previous investments, previous returns, new technologies, and other developments from specific technology investments could be influential factors. The study however adds to the understanding that IT innovations alone do not increase success even for firms in the same industry. This study also supports the literature and shows why findings in these studies often differ.

FUTURE RESEARCH

Although IT innovation is not a high priority for smaller firms in this study they should benefit from its deployment. Studies involving investment versus return over time will help determine the resources needed to realize benefits. These studies could show investments needed for successful returns and possibly encourage smaller firms to be more IT innovative. Studies involving other business segments are needed. Issues such as these serve to further explain and validate investments in IT innovations.

REFERENCES

1. Bakos, J.Y., and Treacy, M. (1986). Information Technology and Corporate Strategy: A Research Perspective, MIS Quartely, (10), 107-119.
2. Brynjolfsson, E. (1993). The Productivity Paradox of Information Technology, Communications of the ACM, (36), 67-77.
3. Brynjolfsson, E. (1998). Beyond the Productivity Paradox, Communications of the ACM, (41), 49-55.
4. Brynjolfsson, E., Malone, T., Gurubaxani, V., and Kambil A. (1994). Does Information Technology Lead to Smaller Firms, Management Science, (40), 1628-1644.
5. Brynjolfsson, E. and Hitt, L. (1996). Paradox Lost? Firm-Level Evidence on the Returns to Information Systems Spending, Management Science, (41), 49-55.
6. Brynjolfsson, E. and Hitt, L. (1998). Beyond the Productivity Paradox, Communications of the ACM, (41), 49-55.
7. CSC. (2001). Critical Issues of Information Systems Management, 14th Annual Survey of I/S Management Issues.
8. Dewan, S. and Min, C. (1975). The Substitution of IT for other factors of Production: A Firm-level Analysis, Management Science, (43), 1660-1675.
9. Gurubaxani, V., and Whang, S. (1991). The Impact of Information Systems on Organizations and Markets, Communications of the ACM, (34), 59-75.
10. Henderson, J., and Venkataraman, N. (1993). Strategic Alignment: Leveraging Information Technology for Transforming Organizations, IBM Systems Journal, (32), 4-16.
11. Hickman, C., and Raia C. (2002). Incubating Innovation, Journal of Business Strategy, 23, 14-18.
12. Hitt, L., and Brynjolfsson, E. (1996). Prodctivity, Business Profitability, and Consumer Surplus: Three Different Measures of Information Technology Value, MIS Quarterly, (20), 121-142.
13. Hitt, L., Wu, D., and Zhou, X. (2002). ERP Investment and Productivity Measures, Journal of Management Information Systems, (19), 71-98.
14. Malone, T., Yates, J., and Benjamin, R. (1987). Electronic Markets and Electronic Heirarchies, Communications of the ACM, (30), 484-497.
15. Mears, J. and Dubie, D. (2002). IT Budgets Down, But Not Demand For Technology, Network World, 24.
16. McKinsley and Company (2002). US Productivity Report. 1995-2000.
17. National Science Foundation, Division of Science Resources Studies (NSF/SRS), Research and Development in Industry: 1999, Early Release Tables (Arlington, VA 2001).
18. Porter, M. (1990) Competitive Strategy, Free Press, New York.
19. Rai, A., Patnayakuni, R., and Patnayakuni, N. (1997). Technology Investment and Business Performance, Communications of the ACM, (40), 89-97.
20. Scherer, F. (1984). Innovation and Growth. Cambridge, MA: MIT Press.
21. Shin, N. (2001). The Impact of Information Technology on Financial Performance: The Importance of Strategic Choice, European Journal of Information Systems, (10), 227-236.
22. Stiroh, K. (2001). Investing in Information Technology: Productivity Payoffs for U.S. Industries, Current Issues in Economics and Finance, (7), 1-6.