

Information Technology Investment

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ABSTRACT

Much evidence regarding the relationship between IT investment and firm performance is contradictory. Numerous issues have been summarized and discussed as factors that contribute to the contradictory findings. While many researchers have found IT investments to have a positive performance impact, others have failed to support those findings. These contradictory findings concerning IT investment appear at the firm, industry, and national economy levels of analysis. There are four broad issues related to the role of IT within an organization that are factors contributing to the contradictory findings: structural business characteristics, management ability, definition of IT, and measurement approach. While there are many studies that use broad secondary indices and economic models to look for mathematical relationships between IT investment and firm performance, few studies take an in-depth look at the role of IT within an organization and expose the dynamics of this relationship.

Keywords: IT Investment, Firm Performance, Structural Business Factors, intangibility

INTRODUCTION

While many researchers have found IT investments to have a positive performance impact, others have failed to support those findings. These contradictory findings concerning IT investment appear at the firm, industry, and national economy levels of analysis. There are four broad issues related to the role of IT within an organization that are factors contributing to the contradictory findings: structural business characteristics, management ability, definition of IT, and measurement approach.

A typical example concerns examining economic data at the national level. Roach (1996) concluded that investments in IT have not improved productivity in the services sector, while Quinn and Bailey (1994) found “strong evidence” to the contrary.

Why findings among the literature are contradictory is the subject of this paper. The contradictions are discussed by examining the four major issues mentioned in the literature as important determinants of the study results. By discussing these issues, the considerable complexity involved in investigating the relationship between IT investment and firm performance is exposed.

CONTRADICTIONARY FINDINGS

While there are many studies that use broad secondary indices and economic models to look for mathematical relationships between IT investment and firm performance, few studies take an in-depth look at the role of IT within an organization and expose the dynamics of this relationship. After examining cross-sectional, firm-level performance data, Brynjolfsson and Hitt (1996) concluded that the productivity paradox is over, yet Roach (1996), also using firm level performance data, disagreed. Using data from the banking industry, Alpar and Kim (1990) were unable to replicate either the findings of Bender’s (1986) insurance industry study or those of Cron and Sobol’s (1983) medical industry study, and they concluded that there may not be an optimal level of IT investment for a firm within a particular industry.

STRUCTURAL BUSINESS FACTORS

Table 1 lists significant studies in IT investment. Some researchers highlight the importance of structural factors on a firm's ability to derive positive results from IT investments (Loveman, 1994). Structural business factors include industry composition, the level of technological sophistication, the business strategy of the firm, strategy implementation, the historical behavior of the firm and industry, and the information intensity of the firm and industry (Markus and Soh, 1993).

Table 1: IT Investment Literature

| STUDY | RELATIONSHIP BETWEEN IT INVESTMENT AND PERFORMANCE | | | |
|--------------------------|---|------|----------|-------|
| | Positive | None | Negative | Mixed |
| Cron & Sobol 1983 | | | | ✓ |
| Bender 1986 | ✓ | | | |
| Alpar & Kim 1990 | | | | ✓ |
| Floyd & Wooldridge 1990 | ✓ | | | |
| Harris & Katz 1991 | ✓ | | | |
| Weill 1992 | | | | ✓ |
| Markus & Soh 1993 | | | | ✓ |
| Quinn & Bailey 1994 | ✓ | | | |
| Loveman 1994 | | ✓ | | |
| Brynjolfsson & Hitt 1996 | ✓ | | | |
| Roach 1996 | | ✓ | | ✓ |

Structural factors are an important determinant of IT investment impact because as factors, such as firm size and information intensity, vary, so, too, does the role of IT within the firm. For instance, large banks, which typically spend approximately 45% of their capital stock on IT, receive higher returns from IT spending than smaller banks due to economies of scale. Harris and Katz (1991) found organizational performance in an insurance company's home office to be positively related to its level of IT investment because the operation is information intensive. They concluded that firms whose information processes were more integrated and coordinated through IT outperformed other firms. Because differences across studies may be attributable to industry and firm level structural factors, scholars have concluded that cross-sectional assessments of IT investments may be misleading (Floyd and Woolridge, 1990). Findings reported in studies that use cross-sectional data may not be supported in industry specific studies, and findings from within industry studies may be contradictory when there are size differences between firms. This is because the role of IT is different between firms with different structural characteristics and the potential of IT investments to have a positive organizational impact varies accordingly.

MANAGEMENT ABILITY

Mismanagement of IT investment is also a reason prior literature may present contradictory findings. To realize the potential benefits of IT investments, management must be able to effectively choose information initiatives, direct the use of IT resources, properly implement new and modified systems, and make the necessary adjustments to organizational processes. Weill (1992) uses the term "conversion effectiveness" to describe management's ability to effectively convert IT inputs into effective information outputs.

To effectively influence IT returns managers must understand the role of IT within their firm and be able to incorporate IT effectively into organizational routines. This is because IT tends to have a reinforcing effect. It helps well managed firms succeed but further confuses improperly structured processes. Without considerable managerial attention to the effective use of IT within organizational processes, the benefits from IT are likely to go unrealized. Management's ability to effectively direct IT related resources is an important determinant of IT investment returns.

Few studies have explored managerial action at the firm or industry level to better understand how management decisions impact investment returns. One exception is Weill's (1992) valve manufacturing study that confirms managers purposely invest in IT for different reasons. He showed that managers consciously choose different types of IT investments based on the role they will play within the organization and that the types should not be expected to have equal levels of return.

HOW INVESTMENT IS DEFINED

Differing definitions of information technology investment also contribute to the contradictory findings. Researchers have tended to employ narrow definitions of IT investment, although that is changing. Roach (1996) defined IT investment to include only computers, office equipment, communications equipment, photocopiers and related equipment. King and Grover (1991) expanded this definition to include investment in all non-human resources dedicated to the processing, storage and communication of information and the organization of those resources. Brynjolfsson and Hitt (1996) went even further when they included investment in software, training, and organizational transformation.

There are many examples of authors who have conceptualized IT investment as a factor input and who have investigated its relationship to performance results using a production function (Cron and Sobol, 1983; Bender, 1986; Alpar and Kim, 1990). Inherent in this approach is the belief that some level of IT investment input yields a given level of performance output. For instance, Alpar and Kim (1990) concluded that a 10% increase in IT investment was associated with a decrease in total costs of 1.9% in the banking industry. Bender's (1986) study had as its objective the determination of the proportion of total expense that should be allocated to IT so that a firm would experience the greatest economic gain. Conceptually, the issue with this approach is that traditional economic models treat production function inputs and outputs as tangible, measurable factors of production.

The debate centers on the issue of intangibility and concerns both the input and output side of the production function equation. On the input side, IT investment dollars are often spent on intangibles such as managerial effectiveness, user training, organizational routines, organizational culture, complementary software, and human capital. On the output side of the equation, intangibles such as improved customer service, product and service quality, and timeliness are often sought benefits of IT investments.

There are two responses to the issue of intangibility among leading researchers. One response is to try to measure the intangible aspects of IT investment. Brynjolfsson and Hitt (1996) suggest that this can be done, but that intangible factors must be included in the economic equation. The alternative approach is to investigate the behavioral aspects of IT investments. This was the approach taken in Weill's (1992) value manufacturing study. The advantage to this approach is that more is learned about the role of IT within the firm. The disadvantage of this approach is that measurement is very difficult.

The issue of intangibility may be at the conceptual root of many of the contradictory findings in IT investment research. This is because intangible costs and benefits are not well captured in economic terms (Loveman, 1994) and cross-sectional analysis ignores the fact that the level of intangible components contained within a firm's portfolio of products and services is unique. This conceptual issue presents numerous measurement challenges for researchers.

MEASUREMENT APPROACH

While scholars may disagree as to whether IT investments may be appropriately considered as factor inputs and performance results as factor outputs in economic functions, they do agree that measuring the impact of IT investments is a difficult undertaking (Remenyi et al., 1997). Brynjolfsson and Hitt (1996) states "after reviewing the literature to date, it appears that the shortfall of IT productivity is as much due to deficiencies in our measurement and methodological toolkit as to mismanagement by users and developers" .

The issue is that the determination of benefits from IT investments depends on the ability of researchers to measure the impacts accurately. Accurately determining IT impacts is difficult for at least three reasons: the

relationship between IT investment and firm performance is complex, appropriate measures are difficult to determine, and the nature of the relationship includes a temporal component. These measurement issues are the topic of this section.

The relationship between IT investment and firm performance is unclear. Scholars have characterized it as complex and circular in nature (Weill, 1993), mutually reinforcing (Harris and Katz, 1991), and indirect (Banker et al., 1993). As a result, evaluating IT investments poses many problems not encountered with traditional assets. The focus shifts from measuring dollar benefits to measuring indirect, diffuse, qualitative and contingent impacts that are difficult to accurately quantify. Benefits may be distributed in such a way as to accrue to a party other than the party bearing the costs. The IT benefits may be in the form of improved coordination efficiency among organizations and dependent upon the inter-organizational relationship for realized gains; and, mismanagement may cause any potential IT investment gains to be negated either through a failure to prudently employ the IT resources or through failure to properly implement the technology. Given the complexity of the relationship between IT investments and realized gains, contradictory findings are hardly surprising. The complexity of the relationship makes finding appropriate measures very difficult. The most commonly used measures are accounting measures. Accounting measures include firm level indicators such as total expenses, operating income, return on assets, and other measures traditionally found on a firm's income statement or balance sheet. The problems with using these measures include: traditional accounting measures do not adequately reflect white-collar productivity improvements; firm level measurements may be only indirectly influenced by IT investment accounting measures fail to fully capture IT's intangible value; accounting measures assess only a firm's past performance without consideration for a firm's future profit potential; and, accounting measures do not adequately reflect intermediate performance gains, such as capacity utilization and inventory turnover, and this is where IT benefits are likely to be found. But if accounting measures are so bad, why do so many researchers use them (e.g. Cron and Sobol, 1983; Bender, 1986; Wiseman, 1988; Alpar and Kim, 1990;)?

The theoretical justification for the use of accounting data is that if, in fact, IT investment leads to improved firm performance, then it should show up on the income statement and balance sheet. The fallacy of that argument is that a firm's financial statements are affected by many factors other than IT investment and, therefore, positive effects of IT investment may not be apparent. Brynjolfsson and Hitt (1993) notes, "the more one looks at the studies of IT performance, the more it looks like mismeasurement is at the core of the productivity paradox" '.

Whereas accounting measures are short term in nature, IT investments are long term and return must be examined over an extended period of time. The temporal nature of IT investment occurs because there is a learning curve associated with the use of IT and because the restructuring necessary to fully exploit new technology takes time to fully implement.

SUMMARY

In summary, these measurement issues contribute to the contradictory findings in the literature because the measures employed do not accurately reflect the true costs and benefits of IT investments. Unfortunately, data that captures the costs and benefits accurately does not readily exist. Harris and Katz (1991) believe that the lack of data has been the most limiting factor relative to research developments in this area. Future studies need to develop new, accurate measures that properly capture the level of IT investment and the related changes in organizational performance.

Much evidence regarding the relationship between IT investment and firm performance is contradictory. Numerous issues have been summarized and discussed as factors that contribute to the contradictory findings. Future studies should be designed to address the structural, managerial, definitional, and measurement issues discussed. Only then will the organizational role of IT investments be empirically documented and a clear understanding of the relationship between IT investments and firm performance emerge.

AUTHOR INFORMATION

Melinda Cline is an Associate Professor of Information Systems at Texas Wesleyan University. She received her Ph.D. from Florida State University. Her research interests include information technology investment, organizational change, knowledge-based systems, impacts of new technologies, and international business. She has published articles in the *Journal of Information Systems Management*, *Information Strategy*, *Decision Support Systems*, *Computers and Society*, *Managerial Auditing Journal*, *Journal of Computer Information Systems* and *Computer Science Education*.

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REFERENCES

1. Alpar, Paul and Moshe Kim (1990), "A Microeconomic Approach to the Measurement of Information Technology Value," *Journal of Management Information Systems*, Fall, 7(2) 55-69.
2. Bender, Donald H. (1986) "Financial Impact of Information Processing," *Journal of Management Information Systems*, Fall, III(2), 22-32.
3. Brynjolfsson, Erik and Lorin Hitt (1996), "Paradox Lost? Firm-Level Evidence on the Returns to Information Systems Spending," *Management Science*, April, 42(4), 541-558.
4. Cron, W. and M. Sobol (1983), "The Relationship Between Computerization and Performance: A Strategy for Maximizing Economic Benefits of Computerization," *Information and Management* (6), 171-181.
5. Floyd, Stephen W. and Bill Wooldridge (1990), "Path Analysis of the Relationship Between Competitive Strategy, Information Technology, and Financial Performance," *Journal of Management of Information Systems*, Summer, 7(1), 47-64.
6. Harris, Sidney E. and Joseph L. Katz (1991), "Organizational Performance and Information Technology Investment Intensity in the Insurance Industry," *Organizational Science*, August, 2(3), 263-295.
7. King, William R. and Varun Grover (1991), "The Strategic Use of Information Resources: An Exploratory Study," *IEEE Transactions on Engineering Management*, November, 38(4), 293-305.
8. Loveman, Gary W. (1994), "Information Technology and the Corporation of the 1990's," in Thomas J. Allen and Michael S. Scott Morton (Eds.) *Research Studies*, New York, NY: Oxford University Press.
9. Quinn, James Brian and Martin Neil Bailey (1994), "Information Technology: Increasing Productivity in Services," *Academy of Management Executive*, 8(3), 28-51.
10. Remenyi, Dan, Michael Sherwood-Smith, and Terry White (1997), *Achieving Maximum Value From Information Systems: A Process Approach*. West Sussex, England: John Wiley and Sons Ltd.
11. Roach, Stephen S. (1996), "The Hollow Ring of the Productivity Revival," *Harvard Business Review*, November-December, 81 - 89.
12. Weill, Peter (1993), "The Role and Value of IT Infrastructure: Some Empirical Observations," in Rajiv D. Banker, Robert J. Kauffman and Mo Adam Mahmood (Eds.), *Strategic Information Technology Management: Perspectives on Organizational Growth and Competitive Advantage*, Harrisburg, PA: Idea Group Publishing.

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