



An Empirical Study of the Casual Relationship Between IT Investment and Firm Performance

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The promise of increased competitive advantage has been the driving force behind the large-scale investment in information technology (IT) over the last three decades. There is a continuing debate among executives and academics as to the measurable benefits of this investment. The return on investment (ROI) and other performance measures reported in the academic literature indicate conflicting empirical findings. Many previous studies have based their conclusions on the statistical correlation between IT capital investment and firm performance data of the same time period. In this study we argue that the causal relationship between IT investment and firm performance could not be reliably established through concurrent IT and performance data. We further submit that it would be more convincing to infer causality if the IT investments in the preceding years are significantly correlated with the performance of a firm in the subsequent year. Using the Granger causality models and three samples of firm level financial data, we found no statistical evidence that IT investments have caused the improvement of financial performance of the firms in the samples. On the contrary, the causal models suggest that improved financial performance over consecutive years may have contributed to the increase of IT investment in the subsequent year. Implications of these findings, as well as directions for future studies, are discussed.

INTRODUCTION

The so-called "Productivity Paradox" has created an increasing awareness of the issues that surround the question: What value does information technology add to an organization? The paradox is described as that "[the] delivered computing power in the U. S. economy has increased by more than two orders of magnitude since 1970, yet productivity, especially in the service sector, seem to have stagnated" (Brynjolfsson, 1993, p. 67). Here management is faced with the dilemma: Does it pay to invest in information technology (IT) provided that there are other investment opportunities?

The case literature of the 1980s and 90s attempted to show that IT provided competitive advantages to firms by adding value across all aspects of the value chain, improving operational performance, reducing costs, increasing decision quality, and enhancing service innovation and differentiation (Applegate et al., 1996; Porter and Millar, 1985). More recent literature suggests that sustained competitive advantages can be achieved through building and leveraging key IT assets

such as human resources, reusable technology and partnership between IT and business management (Ross, Beath, and Goodhue, 1996). The underlying theory is that these operational and strategic improvements as a result of effective use of IT should lead to corresponding improvements in productivity, revenue, and profits for those firms which consistently make higher investment in IT than their competitors. In the case of high-tech companies, IT often is the product or service that directly contributes to revenue and profit.

There are several empirical studies that support such arguments. Brynjolfsson and Hitt (1996) estimated that the net marginal product of IT staff is about \$1.62, and that of IT capital is about 48% or better, which are at least as large as these of other types of capital investment. Mitra and Chaya (1996) showed that the firms that spent more on IT achieved lower cost of production and lower total operating cost when compared with their peers in the same industry, indicating that IT investment indeed improves operational efficiency.

However, not all studies of industry and firm level

financial data have shown positive causal relationship between IT investment and improved firm performance. Morrison and Berndt (1990) found that in the manufacturing sector, every dollar spent on IT only delivered on average about \$0.80 of value on margin, an indication of overspending in IT. Loveman's study (1994) of 60 business units found that IT investment has a negative output elasticity, indicating that the marginal dollar would have been better spent on other categories of capital investment. Even though such a negative impact of IT on a firm's output seems unlikely and counter-intuitive, it is consistent with the findings of Hitt and Brynjolfsson (1996). Their study of 370 firms showed that IT stock has negative impacts on firm performance measures, such as return on assets, return on equity, and total return, though the magnitude of such impact is quite small.

Closer examinations of these studies, however, revealed a flaw in the methodologies: the impact of IT on firm performance was tested using the IT capital data and the performance data of the same time period. Under such circumstances, the positive and significant correlation between IT capital variables and the firm performance variables has no inherent implication of a causal relationship, no matter how this correlation is established: whether it is through Canonical correlation, economic production functions, or t-tests. This is because one can equally reasonably argue, given the same test results, that it is the higher revenue or profit that caused the firm to spend more on IT capital, or that firms allocate more capital spending when they anticipate better financial performance in the coming years.

In this study, we investigate the impact of IT investment on firm productivity and performance using well accepted causal models based on firm level financial data. We argue that no matter what theoretical or empirical models are used, with the currently available testing techniques, it is unlikely that using concurrent IT and firm performance data would yield conclusive causal relationship between the two. We further submit that it would be more convincing to conclude that IT investment does impact firm performance if it can be shown that the IT investments in the preceding years are significantly correlated with the output level of a firm in the subsequent year, but not vice versa.

RESEARCH BACKGROUND

There is no doubt in the management and MIS literature regarding the value of information and IT in the organizational context. A major problem for senior corporate management, however, is that the "added value" that IT is supposed to deliver to a firm is difficult to discern from business financial data. This could be attributed to several causes, primarily the inability of organizations to track the return of investment in IT when the impact of such investment may cross many business processes and value chain activities. Thus, it is often difficult for IS managers to convince senior management to invest in IT projects when other capital

spending opportunities exist.

What is needed is the empirical evidence at the firm level that investment in IT does provide added value to organizations. In light of this position, measuring the effectiveness of information technology has been consistently ranked as one of the most significant issues facing corporate information systems management in the 1980s and 1990s (Brancheau et al., 1996; Sethi and King, 1994). This pressure is only likely to increase with the increasingly fierce competition and the general trend of downsizing, which have forced top management to closely scrutinize any IT investment. As one top executive put it (Violino, 1998, p. 62): "We understand that enhancing systems is critical in today's world. But we look at every system we get to make sure there's a payback." It is likely that the decision to invest in IT will be increasingly based on the comparative financial returns of IT projects, rather than reported successful IT investment experienced by other organizations.

The necessity to understand IT investment from a value-added perspective has resulted in a new research area: information technology economics. An early study in this area was by Alpar and Kim (1990) who utilized a cost function to examine the impact of IT investment on the financial performance of commercial banks. The results were mostly mixed: IT investment was found to be negatively correlated with cost, while the relationship between the IT expense ratio and the return on equity (ROE) was insignificant in six out of the eight years studied.

In the study of Mahmood and Mann (1993), the Pearson correlation and Canonical correlations were obtained between a set of six organization performance variables and a set of six IT investment variables using the *Computerworld* "Premier 100" companies¹ of 1989. Based mostly on the correlation, it was found that organizational performance measures, such as sales by total assets, market value to book value, and return on investment (ROI), were significantly positively correlated with IT investment measures, such as IT budget as percentage of revenue and percentage of IT budget for training employees. However, it was also found that IT budget as a percentage of total revenue was significantly negatively correlated to performance measures such as sales by total assets, market value to book value and ROI.

Mitra and Chaya (1996) also used the *Computerworld* "Premier 100" companies but with five-year data from 1988 to 1992. The relationship between IT investment and firm performance measures were tested using average values of at least three out of the five data points for each firm. Firms in the sample were grouped into different categories based on normalized z-scores of different operational and performance measures. Then t-tests and one-tailed Mann-Whitney tests were used to determine whether one group is different from another. It was found that high IT spenders had a lower average cost of operation than low IT spenders. It was thus concluded that high spenders on information technology

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