A Study of Information Technology Operating and Capital Expenditures and Their Effect on Positive Firm Outcomes

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Abstract

For many years, business has invested significant resources in information technology, hardware, software, and manpower. The Productivity Paradox is the seeming lack of productivity gains despite the increased investment in IT (information technology). For many decades the existence of a Productivity Paradox has been the subject of research interest. Conflicting results have been obtained from a variety of data sets. Until this study however there has been no study that has specifically reviewed operating and capital information technology expenditures and their impact on positive firm outcomes. The objective of this study was to investigate information technology productivity with a new data set and measure both information technology capital and operating expenditures to determine whether increased expenditures had a significant impact on how a firm viewed their IT quality as measured by improved decision making, data integrity, and data consistency. Results of the study indicated that changes in levels of information technology expenditures as a percent of revenues did not have a consistent positive impact on firm level productivity in this large sample of firms. The Productivity Paradox does seem to continue and sheer increase of expenditures does not directly result in improved firm outcomes. The major contribution of the study is that it provides an analysis of the impact of information technology expenditures on perceived firm IT quality.

Keywords: productivity paradox, capital expenditures, operating expenses, information technology

1. INTRODUCTION

Since 1987, many researchers such as Erik Brynjolfsson, Paul Strassman, and Loren Hitt have studied the problem of whether the huge investment in information technology (IT) has had a positive impact on overall productivity in the economy and specifically on the firm. A variety of data sources has been analyzed across different perspectives and researchers have come to different conclusions on this central question.

The Productivity Paradox concept started in 1987 with Robert Solow, the Nobel prize-winning economist, who said that computers can be seen everywhere but in the productivity statistics (Solow, 1987). The Paradox as presented by Strassmann is that, despite large investments in information technology, productivity as measured by cost of goods sold has not increased (McCune, 1998). Loveman, in 1988, studied information technology capital versus output over a five-year period, and found no correlation between information technology spending and output increase (Brynjolfsson, 1993). The Productivity Paradox simply stated that empirical investigations in the late 1980s and early 1990s seemed to show that information technology investments, by a variety of measures, were not contributing to overall productivity gains. Since the late 1980s, however, a series of studies have provided different, more positive results for information

technology investments. The studies have included Brynjolfsson and Hitt (1996), Bharadwaj, Bharadwaj, and Knosynski (1999).

More recent studies in the 2000's continue the debate on the effect of information technology on firm performance. Lapointe, L., Mignerat, M., & Vedel, I. (2011) studied the increased expenditures in the health industry and found that despite these large expenditures health services productivity may not be keeping pace, suggesting a possible Health IT Productivity Paradox. Liu, T. K., Chen, J. R., Huang, C. J., & Yang, C. H. (2013) found a significant positive impact on information technology expenditures and labor productivity in a study they performed in Taiwan. Tambe and Hitt (2012) suggest conflicting results in how and whether information technology expenditures increase productivity. They saw differences in results based on company size, type of industry, and in time of improvement realization. The end result of recent studies is that they generally have the same results as classic past studies; no clear conclusion can be drawn as to whether IT expenditures increase productivity or to what extent they may affect productivity,

2. RELEVANCE OF THE STUDY

The general question addressed in this research is similar to many previous studies, i.e., does investment in information technology have a significant positive effect on overall firm productivity and performance. This work, however, adds to the literature in several ways:
1. This empirical study analyzes both operating and capital information technology expenditures.
2. This research examines current information.
3. It includes a large sample of organizations with varying sizes and industries.
4. It examines performance via three quality variables.
The work is an extension of the authors' past works on this critical issue (self-references to be added).

3. BARRIERS AND ISSUES

As with any empirical research, the biggest challenge was to find an appropriate data source to empirically investigate the proposed research problem. The first step in obtaining a data set was to review the data sets used by other researchers in the field. The data sources for the studies presented in the literature search vary from government sources to major publications' survey data, to private empirical surveys. A data set heretofore unanalyzed was the Financial Executives' Institute Annual Survey of Technology Issues for Financial Executives. The survey is a major analysis of company views on IT and includes relevant questions to address our study.

4. AREA TO BE INVESTIGATED

Many of the major studies that have been performed are at this point decades old. But the issue of whether or not there is a productivity paradox has never been resolved. This work is an attempt to revisit this area of study using current broad based data analysis. This study empirically investigates the following research proposal: Positive firm outcomes are recognized for firms that have a higher investment in information technology. In other words IT adds to productivity and there is no Productivity Paradox.

5. SIGNIFICANCE OF THE STUDY

This study represents a significant research issue due to the sheer size of information technology spending in the economy as a whole, and its expected positive impact on firms. The significance of the study is that 32.5% of all business capital investment is IT related, not including software and systems development. (Dos Santos, Peffers, and Mauer, 1993) This is a very significant expenditure for business. It should be determined whether IT increases firm outcomes. The study of the productivity impact of information technology on organizations started slowly. Though commercial applications for computer technology started in the late 1950s and accelerated through the 1960s and 1970s, there was little research on measuring the benefits gained from information technology spending. The implementation of management information systems and related technology were accepted in organizations through the perceived savings in manpower gained from automating clerical tasks such as payroll, accounts payable, and other financial applications. But beginning in the early 1980s, researchers tried to measure the impact that IT was having on the individual firm, in specific applications, and on the economy as a whole. No significant studies focusing on IT productivity were developed until the early 1980s. Then the pace of studies significantly accelerated and reached its peak in the period 1987-1995. Results from two decades of studies have

resulted in little consensus on whether IT spending is having a significant favorable impact on individual firms or the economy as a whole.

6. SURVEY SOURCE AND METHODOLOGY

In order to test these hypotheses, specific corporate data were required. We found a data set that was available from Financial Executives International. Financial Executives International is "the preeminent association for CFOs and other senior finance executives." It has … CFOs, VPs of Finance, Treasurers, Controllers, Tax Executives, Academics, Audit Committee members [in] companies large and small, public and private, cross-industry (FEI, 2010). The FEI, each year, commissions a large scale study of "technology issues for Financial Executives." Thel survey instructions follow.

"FEI's Committee on Finance & Information Technology (CFIT) and Financial Executives Research Foundation (FERF), in partnership with Gartner, are conducting the twelfth annual survey of Technology Issues for Financial Executives. This research examines and reports on information technology from the perspective of the financial executive." (FEI, 2010).

According to FEI (2010) "The 2010 Gartner-CFIT-FERF Technology Survey captured 482 senior financial executives' views of technology—double the responses compared to 2009. The study provides a consistent picture of the CFO's view of technology and offers an important opportunity for you to benchmark your internal initiatives and perspectives with those of other finance organizations."

As a part of this study, specific information was obtained from top financial executives on systems quality and expenditures. These questions and responses were sufficiently detailed and pertinent to our hypotheses to serve as the bases for testing this study's hypotheses. The main advantage is the large data set and the independent collection from a private membership trade group. All data has been collected and furnished by the Financial Executives International and remains their property. Use for academic and research purposes was obtained by the author. The author wishes to sincerely thank the organizations for their cooperation.

The overall questionnaire included 44 questions in the noted categories but sub-questions and ranked responses raised the overall individual data points to more than 220. From this overall report a small subsection was used to analyze the relevant hypotheses. Selected responses from the Demographics section were included as well.

The specific questions used to test the hypotheses are listed.

(FEI, 2010)

The use of rich secondary sources for scholarly research is well established across social sciences. Some studies that primarily or exclusively use secondary data are found in management (Sanhu & Kapoor, 2010), government (Siau & Long, 2009) supply chain (Thakkar, Kanda, & Deshmukh, 2009), accounting (Talha, Raja, & Seetharaman, 2010), marketing (Panigyrakis, Kapareliotis, & Ventoura, 2009), medical (Broyles, Chou, Mattachione, & Al-Assaf, 2010), economics (Gouvea & Kassicieh, 2009), and education (Martelli & Abels, 2010).

General Linear Model (GLM) Univariate analysis was used for test the hypotheses. SPSS 20.0 was used for all statistical analyses. The dependent variable was the positive outcome variable and the independent variables were IT expenditures and Demographic data.

7. DEMOGRAPHICS OF PARTICIPANTS

Overall, in the survey there were approximately 483 usable responses from corporations (depending on the question). The demographics of the group follow.

Nearly 83% of the respondents were from the Corporate. The sample reflects the strong executive position that most of the respondents held. This study thus reflects top executive views on the related technology. The remaining participants were at the Group or Division/Unit level. Table 1 reflects the size distribution of the organizations. In general, the organizations are large with 56% over $100 million in sales. The largest respondents were in the less than $100 million sales category but there were still 126 respondents with sales greater than $1 billion.

8. QUESTIONS

As noted, a small subset of the questions in the survey was used to explore our research question. The specific questions used were:

6a. What is your company's IT operating expenses (not including depreciation) as a percentage of revenue?

Example: 3 percent entered as 3.0

6b. What is your company's IT capital expenditure as a percentage of revenue?
Example: 3 percent entered as 3.0

2a. How would you grade the relative maturity of your management information environment in terms of its ability to readily provide relevant analyses, decision making and management reporting information?
(please specify)
Exceptional, Superior, Average, Poor, Failing

2b. Please indicate how consistent is the management and financial reporting delivered by the finance team with other operational reporting performed by line of business managers:
Highly consistent – there is never any disagreement over numbers on management meetings
Quite consistent – there are minor differences between operational reports and finance data
Somewhat consistent – the high level numbers agree (often due to manual reconciliation) but we find it hard to explain variances in finance data with data form operational systems
Inconsistent – we spend a lot of time in management meetings arguing over whose numbers are right.

9a. What is your overall level of satisfaction with your organization's "information integrity", defined as accuracy, consistency and reliability of information?
Highly satisfied, Somewhat satisfied, Neutral, Somewhat dissatisfied, Highly dissatisfied

9. HYPOTHESES

With the secondary dataset and the available questions, we were able to develop two hypotheses to explore if increases in information technology expenditures provide positive firm outcomes.

Hypothesis 1 Investment in IT operating expenses as a percent of revenues will improve firm information maturity, information integrity, and/or information consistency

Hypothesis 2 Investment in IT capital expenditures as a percent of revenues will improve firm information maturity, information integrity, and/or information consistency

10. RESULTS

The first hypothesis was that investment in IT operating expense as a percent of revenues would result in positive firm outcomes. The second asked the same question based on IT capital expenses. Specifically, GLM Univariate analyses were performed with three separate positive outcomes for a firm, Maturity (ability to readily provide relevant analyses, decision making and management reporting information), Consistency (how consistent is the management and financial reporting delivered by the finance team with other operational reporting performed by line of business managers), and Integrity (accuracy, consistency and reliability of information). These GLM analyses were repeated twice, once including company size as a separate independent variable and second using industry as a separate independent variable. Tables 2 thru 7 show the significance of these variables as well as interaction effects of size or industry and IT Op expense and IT Cap expense. Table 2 shows that neither changes in IT Operating expense nor changes in IT Capital expenditures had a significant influence on Maturity as the dependent variable. There was also no interaction effect between size and IT Operating or Capital Expenses. From this first analysis we can conclude that there does appear to be a productivity paradox across all sizes of organizations regardless of size. Companies that spent more on IT either in capital or operating expenses did not enjoy higher ability to provide relevant analysis, decision making or management reporting. Table 3 presents a similar analysis for information consistency. Though significance levels are generally improved, there was found no significant direct or interaction impact from IT Operating expense or IT capital expenses. This again found to be the case across all sizes of organizations. Table 4 finally examines integrity of information and finds no significant direct or interaction impact from changes in IT Operating Expense or IT Capital expense.

In tables 4 to 7 we perform the same GLM analyses using Maturity, Consistency, and Integrity and finds no significant direct or interaction impact.

For all variables, there was no significant influence on any of the positive dependent variables. Hypotheses 1 and 2 cannot be supported. Firms that had a higher percentage of IT operating or capital expenditures did not experience improved Information Maturity,

Information Consistency, or Information Integrity. And this did not vary based on either industry size nor industry type. There were also no significant interaction effects as well. This is illustrated in the tables 2-7 by examining the significance of the variables or the interactions. None were $p < .05$.

11. CONCLUSIONS AND IMPLICATIONS

The overall objective of the study was to determine whether a Productivity Paradox still existed and currently exists at the firm level for major organizations. In other words, the question was whether information technology had a positive impact on positive firm effects. The results of the study generally found no positive relationship between IT spending as a percent of revenue and firm level positive outcomes, Information Maturity, Information Consistency, and Information Integrity. Based on these measures a Productivity Paradox at the firm level was observed in this study.

12. ANTICIPATED BENEFITS

The implications of the findings may influence corporate spending on information technology in both operating and capital areas, since information technology expenditures generally did not add positive outcomes of the firm. Other variables also come into play to create positive outcomes for a firm. This suggests that not all IT expenditures are successful or add value to a firm. Care must be taken with IT expenditures. This study advances knowledge of the impact of information technology spending.

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Tables

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than $100 Million	211	43.7	43.8	43.8
	$100 Million – $499 Million	111	23.0	23.0	66.8
	$500 Million – $999 Million	34	7.0	7.1	73.9
	$1 Billion – $5 Billion	64	13.3	13.3	87.1
	Greater than $5 Billion	62	12.8	12.9	100.0
	Total	482	99.8	100.0	
Missing	System	1	.2		
Total		483	100.0		

Table 1 Company Sizes

Dependent Variable: Maturity

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	44.413[a]	105	.423	.706	.978
Intercept	447.575	1	447.575	747.095	.000
Size	1.133	4	.283	.473	.756
ITOpExp	4.811	14	.344	.574	.884
ITCapEx	7.043	10	.704	1.176	.308
Size * ITOpExp	7.362	19	.387	.647	.867
Size * ITCapEx	5.498	13	.423	.706	.757
ITOpExp * ITCapEx	9.181	23	.399	.666	.876
Size * ITOpExp * ITCapEx	3.799	9	.422	.705	.704
Error	135.394	226	.599		
Total	3120.000	332			
Corrected Total	179.807	331			

a. R Squared = .247 (Adjusted R Squared = -.103)

Table 2 Maturity and Size Analysis

Dependent Variable: Consistency

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	65.181[a]	105	.621	1.157	.184
Intercept	216.542	1	216.542	403.656	.000
Size	1.811	4	.453	.844	.499
ITOpExp	10.630	14	.759	1.415	.147
ITCapEx	8.620	10	.862	1.607	.106
Size * ITOpExp	10.351	19	.545	1.016	.444
Size * ITCapEx	9.325	13	.717	1.337	.193
ITOpExp * ITCapEx	6.583	23	.286	.534	.962
Size * ITOpExp * ITCapEx	6.404	9	.712	1.326	.224
Error	121.238	226	.536		
Total	1675.000	332			
Corrected Total	186.419	331			

a. R Squared = .350 (Adjusted R Squared = .047)

Table 3 Consistency and Size Analysis

Dependent Variable: Integrity

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	134.366[a]	105	1.280	1.057	.362
Intercept	253.717	1	253.717	209.599	.000
Size	3.455	4	.864	.714	.583
ITOpExp	16.680	14	1.191	.984	.470
ITCapEx	10.442	10	1.044	.863	.569
Size * ITOpExp	20.417	19	1.075	.888	.599
Size * ITCapEx	21.213	13	1.632	1.348	.187
ITOpExp * ITCapEx	22.489	23	.978	.808	.720
Size * ITOpExp * ITCapEx	13.828	9	1.536	1.269	.255
Error	273.571	226	1.210		
Total	2283.000	332			
Corrected Total	407.937	331			

a. R Squared = .329 (Adjusted R Squared = .018)

Table 4 Integrity and Size Analysis

Dependent Variable: Maturity

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	100.573[a]	199	.505	.842	.864
Intercept	485.800	1	485.800	809.318	.000
ITOpExp	4.656	11	.423	.705	.732
ITCapEx	3.940	10	.394	.656	.763
Industry	15.050	30	.502	.836	.710
ITOpExp * ITCapEx	5.824	9	.647	1.078	.383
ITOpExp * Industry	29.330	44	.667	1.111	.319
ITCapEx * Industry	16.968	32	.530	.883	.648
ITOpExp * ITCapEx * Industry	1.828	7	.261	.435	.879
Error	79.234	132	.600		
Total	3120.000	332			
Corrected Total	179.807	331			

a. R Squared = .559 (Adjusted R Squared = -.105)

Table 5 Maturity and Industry Analysis

Tests of Between-Subjects Effects

Dependent Variable: Consistency

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	112.696[a]	199	.566	1.014	.469
Intercept	221.341	1	221.341	396.312	.000
ITOpExp	7.506	11	.682	1.222	.279
ITCapEx	7.794	10	.779	1.396	.189
Industry	14.976	30	.499	.894	.628
ITOpExp * ITCapEx	4.481	9	.498	.891	.535
ITOpExp * Industry	23.465	44	.533	.955	.558
ITCapEx * Industry	22.728	32	.710	1.272	.174
ITOpExp * ITCapEx * Industry	2.185	7	.312	.559	.788
Error	73.722	132	.559		
Total	1675.000	332			
Corrected Total	186.419	331			

a. R Squared = .605 (Adjusted R Squared = .008)

Table 6 Consistency and Industry Analysis

Tests of Between-Subjects Effects

Dependent Variable: Integrity

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	239.668[a]	199	1.204	.945	.644
Intercept	293.040	1	293.040	229.877	.000
ITOpExp	12.638	11	1.149	.901	.541
ITCapEx	16.195	10	1.619	1.270	.254
Industry	38.289	30	1.276	1.001	.474
ITOpExp * ITCapEx	6.377	9	.709	.556	.831
ITOpExp * Industry	39.707	44	.902	.708	.906
ITCapEx * Industry	35.050	32	1.095	.859	.683
ITOpExp * ITCapEx * Industry	6.663	7	.952	.747	.633
Error	168.269	132	1.275		
Total	2283.000	332			
Corrected Total	407.937	331			

a. R Squared = .588 (Adjusted R Squared = -.034)

Table 7 Integrity and Industry Analysis