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8-2010

A method to measure the accounting abnormal returns of largescale information technology investments: the case of enterprise systems

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ABSTRACT

There is a considerable body of literature about the business value of information technology. Although there is empirical evidence about the positive impact of large-scale information technology on firm performance, the number and variety of quantitative methods used to measure this impact is considerable. Besides this diversity in the methods, almost none of them have both strong theoretical basis and strong econometric robustness. A method to measure accounting-based abnormal returns of large-scale information technology is proposed. Unlike existing accounting and market measures, this measure considers industry tendencies over time and the magnitude of the measure can be used as a proxy of the business value of the IT initiative. The method is implemented using a sample of enterprise systems implementations in public companies. This is a unique methodology based on recent accounting research, which propose an econometric model to capture annual abnormal returns of large-scale information technology initiatives. The method is validated with theoretical arguments and empirical results. Empirical results suggest that the measurement of the IT payoff is reliable, valid and robust.

Keywords (Required)

Large-scale IT systems, enterprise systems, financial impact, accounting abnormal returns.

INTRODUCTION

Since Brynjolfsson (1993) popularized the concept of "IT productivity paradox", researchers have had difficulties to provide evidence about the impact of IT on business value. Recent studies have provided important empirical evidence of the supposed positive impact of IT investments on business value (Chatterjee, Pacini and Sambamurthy 2002; Hitt, Wu and Zhou 2002). These empirical papers use different methods to capture the contribution of IT systems to business value. There are differences in the type of proxies used to measure this contribution –market vs. accounting/financial metrics- and also important differences in the robustness of the methods. In addition, different authors conceptualize business value differently. These method differences can have important implications in empirical results and also in the possibility to capture the magnitude of the actual impact of the IT investment on business value. It has been argued that an important reason for equivocal results in the IT business value literature is due to inadequate measurement and analysis methodologies (Brynjolfsson 1993; Kohli and Devaraj 2003) and also differences in time lag measuring the IT payoff. Based on recent accounting research, a specific method is proposed to capture the contribution of IT large-scale systems to business value.

Leading researchers in IS have pointed out the difficulty in measuring performance effects of IT innovations in organizations and have called for more sophisticated and creative methods beyond the self-reported perceptual measures and pure accounting measures of revenue or profits (Sambamurthy 2001). By having a robust method to measure the contribution of enterprise systems to firm performance, researchers will be able to examine relevant environmental, organizational and technological factors that might be systematically associated with such contribution.

The literature about the business value of IT and enterprise systems is presented first, and then the methodology is proposed along with its implementation using data from 272 public firms that announce an enterprise system implementation. Finally, a discussion about the validity of the methodology is presented along with the conclusion.

THE BUSINESS VALUE OF INFORMATION TECHNOLOGY

The IS literature has provided three streams of research to measure the impact of IT investments on business value (Kumar 2004). One stream of research uses accounting measures to examine the overall impact of IT investments on business value in the form of productivity, profitability and consumer value (Chatterjee et al., 2002; Hitt and Brynjolfsson 1996). Kohli and Devaraj (2003) provides a meta-analysis of this stream of research. Hitt and Brynjolfsson (1996) found that IT investments

may increase consumer surplus while not improving firm profitability. In another example, Hitt et al. (2002) found positive impact of IT investment on business value in the form of several accounting metrics such as used labor productivity, return on assets, inventory turnover, return on equity, profit margin, asset turnover, account receivable turn over, debt to equity ratio, and finally, Tobin's q. The second stream of research proposes methods based on real options theory (Benaroch and Kauffman 1999). These studies use option valuation models from the finance literature such as the Black-Scholes model. The third stream of research examines the market reaction to IT investment announcements. Event study methodology is used to measure this market reaction. Assuming that the market is efficient, it is possible to evaluate future business value influenced by significant events such as investment announcements. For example, this approach evaluates the effects of IT strategic investments on stock prices when these investments are significant and announced to the market (see Chatterjee et al., 2002; Dos Santos, Peffers and Mauer 1993).

Like IT infrastructures, enterprise systems can be considered to be large-scale IT systems due to its organizational impacts and the great amount of resources involved. To illustrate the methodology, the financial payoff of ES is examined. In the next section we discuss the ES business value research along with the specific methodologies used to measure the ES payoff.

THE BUSINESS VALUE OF ENTERPRISE SYSTEMS

ERP advocates argue that ERP systems improve business efficiency and provide competitive advantage (Hayes, Hunton and Reck 2001). However, several case studies and few cross-sectional studies have produced opposite results (Nicolaou 2004). Table 1 shows a summary of methods and findings of previous cross-sectional studies about the impact of ES on business value.

Author/ year	Sample	Time period	Method	Finding
(Hayes et al., 2001)	91 ERP adopters	1990-1998	Event study : market reaction to ERP investment announcements	The market reacted positively; small/healthy firms experienced the highest abnormal return
(Poston and Grabski 2001)	50 ERP adopters	1993-1997	Pairwise t-test to compare financial metrics (cost ratios, residual income ratio, and #employees ratio) before vs. 1, 2, and 3 years after implementation	Mixed results: no significant cost reduction and residual income for the first 3 years after the implementation; and the ratio of number of employees to sales significantly decreased
(Hitt et al., 2002)	350 SAP adopters, and more than 1000 non-adopters	1986-1998	Multiple regression based on production functions. Dependent variables: Financial Ratios (Labor productivity, ROA, ROE, inventory turnover, profit margin, asset turnover, account receivable turnover, debt to equity, Tobin's q. (post-implementation time is not clearly specified)	ERP adopters showed greater performance in most of the financial ratios; Reduction in performance and productivity shortly after the implementation; Better market valuation during and after implementation (measured by Tobin's q)
(Hunton, Lippincott and Reck 2003)	63 ERP adopters (from Hayes et al. 2001), and 63 non-adopters	1990-1996	Multiple regression and t-test mean comparison of financial ratios between adopters vs. non-adopters, and 1 year before vs. 3 years after. Financial metrics used: ROA, ROS, ROI, ATO	No significant improvement for ERP adopters, but non-adopters experienced a decline in performance;
(Nicolaou 2004)	242 ERP adopters; 204 non-adopters	1990-1998	Multiple regression and t-test mean comparison of financial ratios between adopters vs. non-adopters, and 3 years before vs. 3 years after the implementation. Financial metrics used: ROA, ROI, IOA, OIS, CGSS, SGAS	The annual improvement of ROA was significantly higher for ERP adopters 4 years after the implementation; there was a performance decline in the short term; ERP adopters had better performance only after 2 years of implementation
(Ranganathan and Brown 2006)	116 ERP adopters	1997-2001	Event study and regression model to examine the relation between the market reaction and ERP project variables.	The market reacted positively in general. The higher the number of modules and number of locations, the higher the market value. Size was not significant, industry was significant

Table 1. ES cross-sectional studies about ES impact on business value

There are some methodological issues that raise concerns about the actual impact of ERP on business value. Hayes et al. (2001) and Ranganathan and Brown (2006) use the event study methodology. Although the event study methodology is well established in the finance and economic literature, recent research suggests that this methodology has to be used with caution since the information of the event is so complex that the investors do not have the cognitive ability to process it (Harrison, Oler and Allen 2004).

The rest of the studies use accounting metrics such as profitability ratios, sales growth and cost ratios. These studies use either simple statistic techniques such as t-test mean comparison or multiple regression analysis to analyze whether business performance significantly changed after the ERP implementation. Some of the studies compare differential performance with a matched sample of non-adopter firms.

Nicolaou (2004) examined the financial long-term impact of ERP systems on firm performance. He used a large sample, controlled for past performance, used a wide window before and after the implementation, used a matching sample of non-adopters, and he used several indicators of business performance. However, he did not control for industry effects (Reck 2004).

The review of this literature can be summarized in the identification of two important gaps. First there is a lack of studies that have examined the long-term financial impacts of ES investments. Second, the methodologies do not control for important effects such as hallo effects and industry tendency. Due to the great difficulty in singling out the contribution of IT on firm performance, it is important to consider more robust methodologies that control for performance tendencies within the industry, as well as past performance. The present study proposes a methodology to measure the contribution of the large-scale IT systems on business performance – the IT payoff.

THE PROPOSED LARGE-SCALE IT PAYOFF METHOD

The payoff of the large scale IT system is measured as the difference between the actual financial performance and an expected financial performance. The expected financial performance is estimated based on accounting fundamentals and past industry financial performance based on sub-samples of matching firms. Accounting fundamental analysis is used to make estimations about future firm performance in terms of stock price and/or earnings. Accounting fundamentals is a set of financial variables that financial analysts usually look at before making recommendations to investors (Lev and Thiagarajan 1993). The version of accounting fundamentals used in this study is the Pietroski (2000)'s F-score. F-score is an aggregate score based on annual changes in profitability, financial leverage and inventory turnover. The F-score conveys information about the potential of the firm to experience abnormal positive returns in the future. Appendix A provides a brief review of accounting fundamentals and a justification of the prediction model, and Appendix B explains how the F-score is computed.

For each IT implementer, a matching sample has to be created. This matching sample is composed of similar firms in terms of industry and size. The criterion to consider a firm to be similar is based on matching criteria proposed by Barber and Lyon (1996). These matching criteria are used to detect abnormal performance after certain events (see more details in Appendix A). In order to maximize accuracy of the measure for the IT payoff, a systematic procedure is followed to create adequate matching sub-samples as benchmarks for each IT implementer. Then, F-scores and financial ratios of the control firms are used to estimate an expected future financial performance of the treatment firm. The difference between the actual and expected financial performance, the abnormal return, is the measure for the IT payoff. The following paragraphs will explain in more detail the prediction model used to estimate the expected future financial performance.

One regression model for each matching sample was created. F-scores and ROA[1] of the matching sample firms at t and t-1 are the independent variables, while the ratio of cash flow from operations to total assets (CFRr) at t+1, t+2, t+3, and t+4 is the dependent variables. The regression coefficient estimates of this model are used to compute the estimated future performance at t+1, t+2, t+3, and t+4 of the treatment firm using its own F-scores and ROA at t and t-1. The difference between actual and predicted future financial performance is the measure for the IT payoff.

[1] ROA has been the most common accounting metric that has been used to measure operational firm performance in accounting (Barber and Lyon, 1996) and IS literature (Davis et al., 2003) since it conveys information about the productivity of operating assets and it is robust to . ROA is defined as:

ROA = (Operating Income) / (average of beginning-and ending-period book value of total assets)

Operating Income = Revenues – cost of goods sold – selling, general and administrative expenses

The following regression model is used to estimate future financial performance[2]:

$$CFRr_{(i)(j,t+\tau)} = \beta_{0(i)} + \beta_{1(i)} * FScore_{(i)(j,t)} + \beta_{2(i)} * FScore_{(i)(j,t-1)} + \beta_{3(i)} * ROA_{(i)(j,t)} + \beta_{4(i)} * ROA_{(i)(j,t-1)} + \varepsilon_{(i)(j)} \quad \text{(Eq.1)}$$

Where:
t = year when the firm went live with the ES
τ = [1..4] years
i = [1..N], N = ES implementation cases
j = [1 .. M_i], M_i = Number of control firms in the subsample i
$CFRr_{(i)(j,t+\tau)}$ = cash flow to total assets ratio of control firm j, subsample i at $t+\tau$
$ROA_{(i)(j,t)}$ = ROA at t for firm j from the subsample i
$ROA_{(i)(j,t-1)}$ = ROA at $t-1$ for firm j from the subsample i
$FScore_{(j)(j,t)}$ = FScore at t for firm j from the sub-sample i
$FScore_{(i)(j,t-1)}$ = FScore at $t-1$ for firm j from the sub-sample i

For N cases in the sample, 4*N regression functions were created. For each treatment firm *i*, a sub-sample of *Mi* firms (from the same industry and similar in size) was used to compute the regression coefficient estimates.

The ES payoff for each treatment firm *i* was computed as the error term of Eq(1) when plugging the treatment firm's F-score and ROA values at times *t* and *t-1*. In other words, this was the difference between the expected or predicted future financial performance using each regression function *i* for each implementation firm, and the actual financial performance of that firm *i* at $t+\tau$:

$$ESpayoff_{(i,t+\tau)} = CFRr_{(i,t+\tau)} - Expected\_CFRr_{(i,t+\tau)}$$

Where:
$ESpayoff_{(i,t+\tau)}$ = ES contribution of firm i to financial performance at t+τ
$CFRr_{(i,t+\tau)}$ = CFRr of firm i at t+τ
$Expected\_CFRr_{(i,t+\tau)}$ = Expected CFRr of firm i from the sub-sample i at t+τ

$$Expected\_CFRr_{(i,t+\tau)} = \beta_{0(i)} + \beta_{1(i)} * FScore_{(i,t)} + \beta_{2(i)} * FScore_{(i,t-1)} + \beta_{3(i)} * ROA_{(i,t)} + \beta_{4(i)} * ROA_{(i,t-1)}$$

IMPLEMENTING THE IT PAYOFF METHOD

Data collection

ES "went-live" media announcements between 1994 and 2001 were identified using the Lexis-Nexis database. Although firms started adopting ES in the early 1990s, very few firms completed implementation before 1994. The time period of interest ends in 2001 because four years of financial data after the ES implementation are used to examine the ES contribution to long-term financial performance[3]. Financial data of these firms and a set of matching firms were pulled from the Standard and Poor Compustat database.

[2] It is also possible to use ROA as the dependent variable and the results will be consistent

[3] At the time of data collection and analysis, financial data from Compustat was available until 2005. Therefore, the post-implementation time period for all firms was four years (from t+1 to t+4, t being the implementation year).

Sample description

A systematic process was followed to search for ES "went-live" announcements within the LexisNexis database. The search was based upon a combination of keywords including "implemented", "deployed", and "went-live" along with the names of popular enterprise vendors[4]. Then, every announcement was analyzed in detail to identify actual "went live" announcements and their characteristic, such as type of ES, implementation year, firm that implemented the ES, and vendor. From this list, public firms were identified. 4,462 announcements were reviewed and only 659 announcements were related to public firms implementing an ES. However, this only included 525 public firms since several firms had more than one announcement. For these firms, only the first announcement was kept in the sample. Out of these 525 firms, only 359 firms had financial data in Compustat to compute the f-scores and financial ratios for at least one year after implementation of the ES. Out of these 359 firms, 26 firms were dropped due to the lack of control firms needed to estimate the IT payoff.

Out of these remaining 333 firms, 61 firms had incomplete financial data for the four years after ES implementation. An exhaustive investigation of these 61 firms was conducted to determine their status during those four years. SEC filings and media announcements were used as the source of this investigation. Most of these firms were merged with other firms, were acquired by other firms, or went bankrupt. Due to this situation, these firms were dropped from the sample. As a result, the sample for analysis consists of 272 firms. Figure 1 shows the number of ES implementation cases over time.

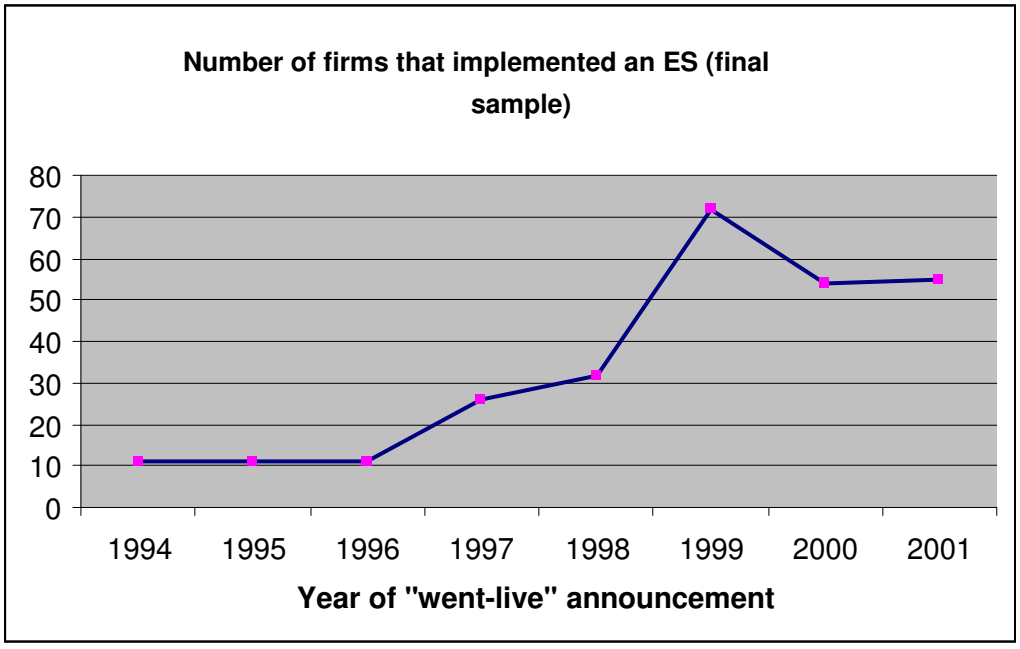

Figure 1. Number of firms in the final sample that implemented an ES

59 firms (58.5%) are manufacturing firms, and 133 are service firms (41.5%). The median total of assets for manufacturing firms was $3.1 billion, while the median total of assets for service firms was $1.88 billion.

Measuring the ES payoff

To ensure a systematic procedure, a computer algorithm was coded and implemented. This algorithm constructs one sub-sample for each ES implementer –or treatment firm. In addition, the algorithm computes all f-scores and financial ratios of both treatment and control firms. For each ES implementer one prediction model was constructed. For each ES implementer

[4] Common ERP/ES vendors were identified. An initial list of common vendors documented by Hayes et al (2001) was used. to search announcements of ES implementation. I used this list of vendor names.

the algorithm created one sub-sample of control firms. Then, using financial data from the ES implementer and its respective sub-sample, the parameters for these models were estimated using OLS regression.

In order to have another proxy for measuring the ES payoff, an alternative model equivalent to Equation 1 was also implemented using ROA as the dependent variable. Considering these two models, 2,679 OLS regressions were run for the 359 firms with valid financial data from t-2 to t+1 (=359 firms * 3.7 average years with financial data * 2 models). This was automated using a Visual Basic script in SPSS.

To increase the accuracy of the method, 26 treatment firms were dropped since they had sub-samples of less than 9 control firms[5]. From the remaining 333 firms, 61 were dropped due to the lack of financial data after the first year of implementation. Thus, the final sample consisted of 272 firms. The average sample size for all the sub-samples was 21.

Plugging the F-scores and ROA at t and t-1 in the 2679 regression models of the form of Eq(1), the predicted future performance for return on assets (ROA) and cash flow ratio (CFR) was computed for each year at t, t+1, t+2, t+3, t+4. Then, for each year, the predicted ROA and predicted CFR was subtracted from the actual ROA and the actual CFR respectively to get the two final measures of the ES payoff at t+1, t+2, t+3 and t+4. These proxy measures are named abnormal ROA (abROA) and abnormal cash flow ratio (abCFR).

Validation tests

Since ITPAY is significantly different from existing methods to measure performance effects of events, further validation tests were performed. To test for reliability of the measure, the two proxies of the measure were compared: abnormal cash flows (abCFR) and abnormal ROA (abROA). To check for construct validity, two tests were performed. Table 2 presents the means, standard deviations and bivariate correlations of the different types of abnormal returns for four years after the implementation:

Variable	Mean	SD	1	2	3	4	5	6	7	8	9
1. abCFR(t+1)	0.0051	0.1227	1								
2. abCFR(t+2)	0.0257	0.1548	.264(***)	1							
3. abCFR(t+3)	0.0077	0.1273	.478(***)	.536(***)	1						
4. abCFR(t+4)	0.0155	0.1302	.263(***)	.256(***)	.493(***)	1					
5. AvgAbCFR	0.0150	0.1014	.581(***)	.759(***)	.835(***)	.653(***)	1				
6. abROA(t+1)	0.0046	0.1415	**.580(***)**	.455(***)	.551(***)	.260(***)	.664(***)	1			
7. abROA(t+2)	0.0069	0.1259	.294(***)	**.726(***)**	.555(***)	.313(***)	.690(***)	.581(***)	1		
8. abROA(t+3)	0.0096	0.1571	.475(***)	.493(***)	**.823(***)**	.540(***)	.771(***)	.605(***)	.591(***)	1	
9. abROA(t+4)	0.0138	0.1399	.284(***)	.242(***)	.451(***)	**.822(***)**	.583(***)	.300(***)	.355(***)	.594(***)	1
10. AvgAbROA	0.0114	0.1265	.380(***)	.596(***)	.692(***)	.546(***)	**.850(***)**	.780(***)	.766(***)	.803(***)	.634(***)

*** Correlation is significant at the 0.001 level (2-tailed)

Notations:

abCFR(t+j): abnormal cash flow at t+j ; abROA(t+j): abnormal return on assets at t+j

AvgAbCFR: average abnormal cash flow over time from t+1 to t+4;

AvgAbROA: average abnormal return on assets over time from t+1 to t+4

Table 2. Means, standard deviations and correlations of abnormal ROA and abnormal CFR (N=272)

For reliability of the measures, it is expected that each year-matched pair of abnormal ROA and abnormal CFR to be positively and strongly correlated. For the four years and the average of the four years, the correlation of the measures is positive and very significant (p-values <0.001). The two measures are strongly correlated, with correlations above 0.76 for t+2, t+3, and t+4, and 0.58 at t+1. Considering that the correlation of the measures is very significant over the four years, and it is very high after the first year of implementation, it is possible to argue that at least, both measures are tapping the same unobserved variable.

To test for construct validity, the following tests were performed. One is related to the difference in ES payoff between early and late ES implementers, and another test is related to the difference in ES contribution between different types of ES.

[5] At least 5 control firms are needed to estimate the regression parameters of Equation 1. Then, we took the conservative criteria of a minimum number of control firms to be 9. In the popular "matched sample comparison group" methodology used in accounting, finance and IS literature (see Bharadwaj, A. S. (2000) A resource-based perspective on information technology capability and firm performance: An empirical investigation, *MIS Quarterly,* 24, 1, 169-196), each treatment case is directly compared with only one control case. The method developed here requires more than 9 control firms for each treatment firm.

According to organizational innovation literature (Damanpour 1991), and specifically IS literature related to adoption of enterprise systems (Hendricks, Singhal and Stratman 2007), early adopters of technological innovations enjoy higher abnormal returns than late adopters. Then, it was expected that the measures for abnormal returns would be higher for early ES implementers than that of late ES implementers. Considering the Y2k as the point of reference, the sample was divided in two: early implementers were those firms that implemented an ES between 1994 and 1999, while late implementers were those firms that implemented an ES between 2000 and 2001. Figures 2 and 3 show the difference in abnormal returns between early and late implementers.

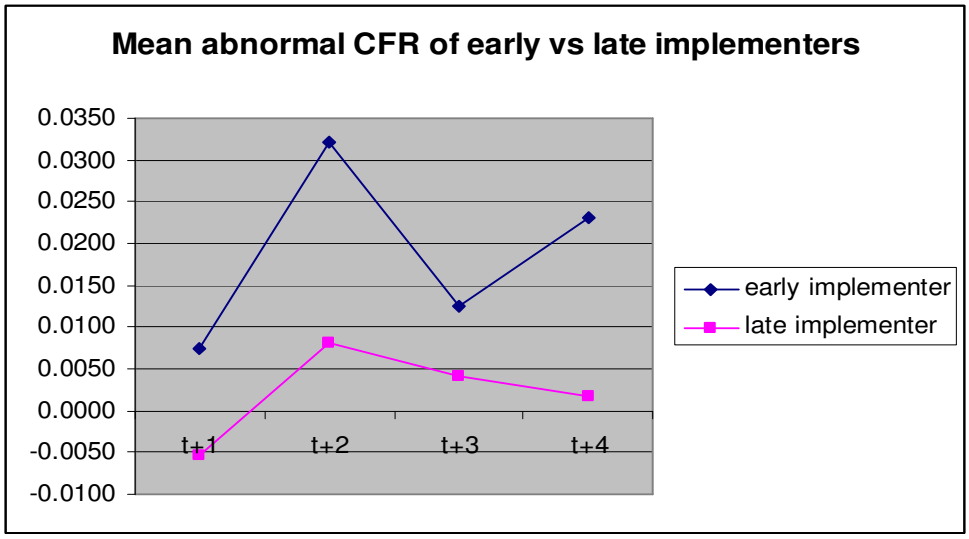

Figure 2. Differences in mean abnormal cash flow ratio between types of implementers

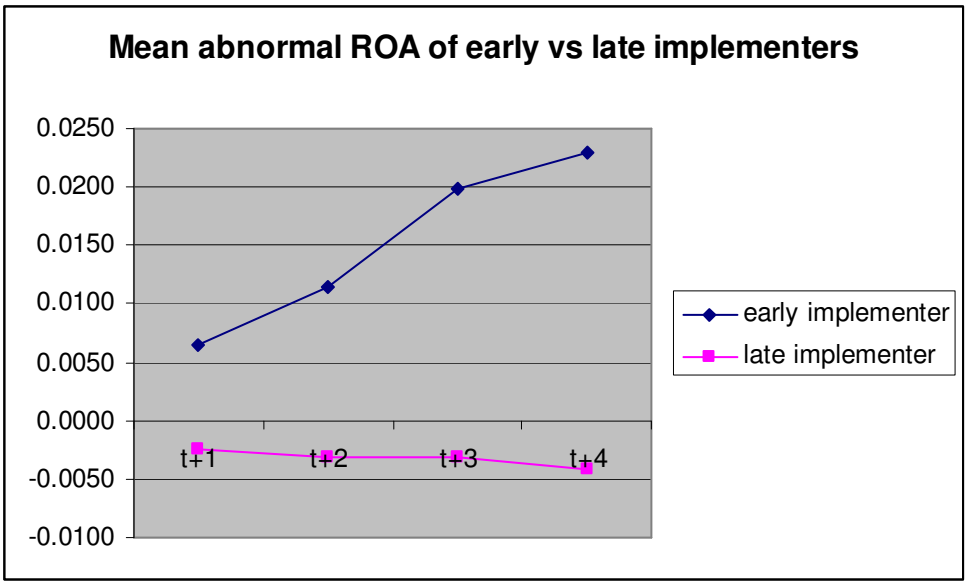

Figure 3. Differences in mean abnormal ROA between types of implementers

These results show systematic abnormal returns for early implementers compared to late implementers. For all four years, both abnormal CFR and abnormal ROA were higher for early implementers compared with late implementers. Looking at the statistical significance of the differences between these two groups, for year t+4, abnormal CFR and abnormal ROA of early implementers are statistically greater than the abnormal CFR and abnormal ROA of late implementers (p-values=0.06 for abCFR, and 0.04 for abROA). For year t+2, abnormal CFR of early implementers is significantly greater than the abnormal CFR of late implementers (p-value=0.07). Considering the average of the four years, both the abnormal CFR and the abnormal ROA of early implementers were significantly higher than those of late implementers (p-value=0.05 for abCFR and 0.06 for abroad).

Theoretical arguments and empirical findings suggest that investments in IT infrastructures have higher payoff than IT applications in the long run (Chatterjee et al., 2002). ERP systems are considered first generation ES type. First generation ES type can be considered an infrastructure for second generation ES (SCM, CRM, ecommerce applications and business intelligence systems). The firms were classified in two groups: firms that implemented a first-generation ES and firms that implemented either a second generation type of ES or a decision-making ES –named extended ES. Figures 4 and 5 illustrate the difference in abnormal returns between these two groups:

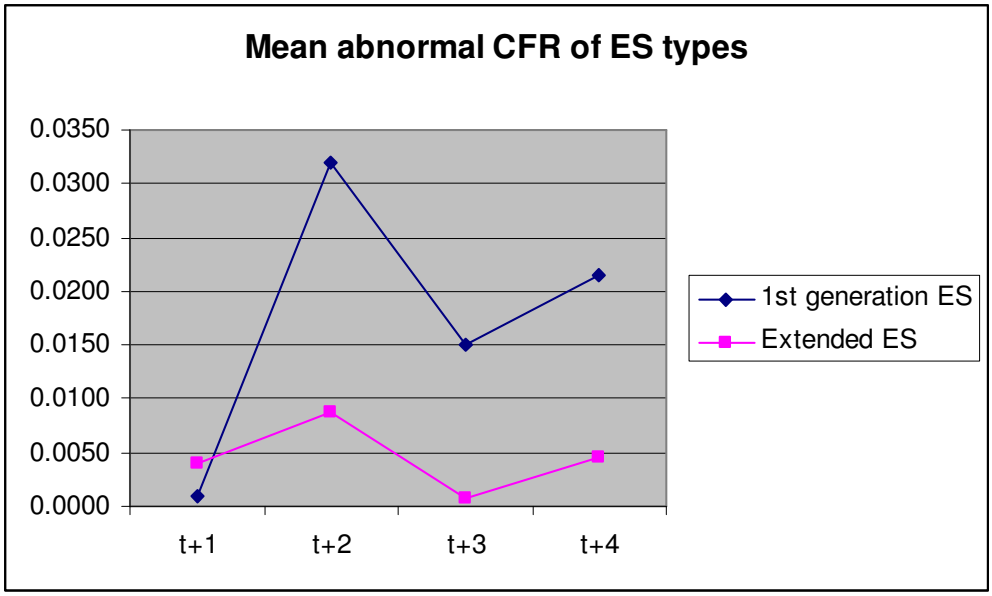

Figure 4. Differences in abnormal cash flow ratio between ES types

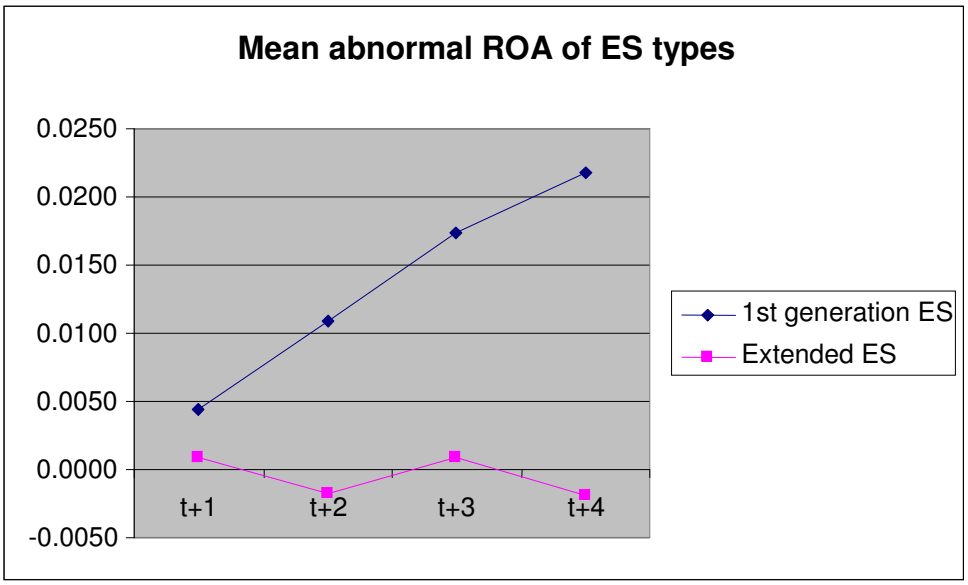

Figure 5. Differences in abnormal ROA between ES types

Firms that implemented first generation ES experienced higher abnormal CFR than firms that implemented extended ES for all years except year t+1. Related to abnormal ROA, firms that implemented first generation ES experienced higher abnormal ROA than firms than implemented extended ES for all years. Firms that implemented extended ES experienced negative abnormal ROA for t+2 and t+4 after the implementation, while firms that implemented first generation ES experienced positive and increasing abnormal ROA for all four years after the implementation. The difference in abnormal

ROA between these groups was statistically significant at t+4 (p-value=0.07). The difference in abnormal cash flow between these groups was statistically significant at t+2 (p=0.08). These results provide evidence that the payoff of the ES is higher in the long run for firms that implement first generation ES compared with firms that implement extended ES.

These tests provide significant support for using these measures of abnormal returns as proxies for the ES contribution to financial performance

CONCLUSION

This study contributes to the IT business value literature by proposing a robust method of measuring the ES contribution to long term financial performance. A potential and promising contribution of this study is the extension of ITPAY to not only other IT environments, but also any important organizational environment that might affect firm performance. While the accounting literature has robust and accepted methods for measuring the performance of events using both market and financial metrics (e.g.Barber and Lyon 1996), they do not control for industry performance tendencies over time. Thus, ITPAY can be a complement to these existing methods from the accounting literature.

The study has limitations related to data collection, measurement of variables and statistical analysis. The sample selection was not random and only public firms were included. Also note that data was obtained from multiple databases, financial reports, and news wires. Data from these sources might not be totally accurate.

Further validation of the ITPAY method is needed. This method can be compared with traditional event methods existing in the accounting literature (e.g.Barber and Lyon 1996) and with the event study methodology that examine the market reaction of events announced to the market. Then, for construct validity, the ITPAY method can be applied to not only to other types of IT innovation, but also other events that might have wide organizational impacts.

REFERENCES

1. Barber, B. M., and Lyon, J. D. (1996) Detecting abnormal operating performance: The empirical power and specification of test statistics, *Journal of Financial Economics,* 41, 3, 359-399.
2. Benaroch, M., and Kauffman, R. J. (1999) A case for using real options pricing analysis to evaluate information technology project investment, *Information Systems Research,* 10, 1, 70-86.
3. Brynjolfsson, E. (1993) The productivity paradox of information technology, *Communications of the ACM,* 36, 12, 67-77.
4. Chatterjee, D., Pacini, C., and Sambamurthy, V. (2002) The shareholder-wealth and trading-volume effects of information-technology infrastructure investments, *Journal of Management Information Systems,* 19, 2, 7.
5. Damanpour, F. (1991) Organizational innovation: A meta-analysis of effects of determinants and moderators, *Academy of Management Journal,* 34, 3, 555-590.
6. Dechow, P. M., Kothari, S. P., and Watts, R. L. (1998) The relation between earnings and cash flows, *Journal of Accounting & Economics,* 25, 2, 133-168.
7. Dos Santos, B. L., Peffers, K., and Mauer, D. C. (1993) The impact of information technology investment announcements on the market value of the firm, *Information Systems Research,* 4, 1, 1-23.
8. Fama, E. F., and French, K. R. (2006) Profitability, investment and average returns, *Journal of Financial Economics,* 82, 3, 491-518.
9. Harrison, J., Oler, D., and Allen, M. R. (2004) The limitations of event studies in assessing economic impact, *Strategic Management Society annual meeting*, October, 24, San Juan, Puerto Rico,
10. Hayes, D., C., Hunton, J., E, and Reck, J., L (2001) Market reaction to erp implementation announcements, *Journal of Information Systems,* 15, 1, 3-18.
11. Hendricks, K. B., Singhal, V. R., and Stratman, J. K. (2007) The impact of enterprise systems on corporate performance: A study of erp, scm, and crm system implementations *Journal of Operations Management,* 25, 1, 65-82.
12. Hitt, L. M., and Brynjolfsson, E. (1996) Productivity, business profitability, and consumer surplus: Three different measures of information technology value, *MIS Quarterly,* 20, 2, 121-140.
13. Hitt, L. M., Wu, D. J., and Zhou, X. (2002) Investment in enterprise resource planning: Business impact and productivity measures, *Journal of Management Information Systems,* 19, 1, 71-98.
14. Hunton, J., E, Lippincott, B., and Reck, J., L (2003) Enterprise resource planning systems: Comparing firm performance of adopters and non-adopters, *International Journal of Accounting Information Systems,* 4, 165-184.
15. Kohli, R., and Devaraj, S. (2003) Measuring information technology payoffs: A meta-analysis of structural variables in firm-level empirical research, *Information Systems Research,* 14, 2, 127-145.

16. Kumar, R. L. (2004) A framework for assessing the business value of information technology infrastructure, *Journal of Management Information Systems,* 21, 2, 11-32.
17. Lev, B., and Thiagarajan, S. R. (1993) Fundamental information analysis, *Journal of Accounting Research,* 31, 1, 190.
18. Nicolaou, A., I. (2004) Firm performance effects in relation to the implementation and use of enterprise resource planning systems, *Journal of Information Systems,* 18, 2, 79-105.
19. Piotroski, J. (2000) Value investing: The use of historical financial investment information to separate winners from losers, *Journal of Accounting Research,* 38, 1, 1.
20. Piotroski, J. (2005) Discussion of "Separating winners from losers among low book-to-market stocks using financial statement analysis, *Review of accounting studies,* 10, 2-3, 171-184.
21. Poston, R., and Grabski, S. (2001) Financial impacts of enterprise resource planning implementations, *International Journal of Accounting Information Systems,* 2, 4, 271-294.
22. Ranganathan, C., and Brown, C. V. (2006) Erp investments and the market value of firms: Toward an understanding of influential erp project variables, *Information Systems Research,* 17, 2, 145-161.
23. Reck, J., L (2004) Discussion of: Firm performance effects in relation to the implementation and use of enterprise resource planning systems, *Journal of Information Systems,* 18, 2, 107-110.
24. Sambamurthy, V. (2001) Research in information systems: What we haven't learned, *MIS Quarterly,* 25, 4, v-xv.
25. Santhanam, R., and Hartono, E. (2003) Issues in linking information technology capabilities to firm performance, *MIS Quarterly,* 27, 1, 125-153.

APPENDIX A. JUSTIFICATION OF THE PREDICTION MODEL

The prediction model uses past financial performance in the form of accounting fundamentals and ROA in order to predict future cash flow at t+1, t+2 t+3 and t+4. Accounting fundamentals have been used to suggest important signals to help investors estimate future equity market value and financial performance (Lev and Thiagarajan 1993). The version of accounting fundamental used in this study is the F-score proposed by Piotroski (2000). The F-Score is a composite score that conveys information about annual improvements of firm profitability, financial leverage, and inventory turnover. High F-scores imply potential abnormal positive returns and future growth.

The F-score originally was developed for firms with high book-to-market ratio. However, it has been found to be robust across different levels of financial health. The F-score measure has been found to be significantly associated with future firm financial performance (Piotroski 2000), asset growth and future market value (Fama and French 2006) and has been useful in differentiating "winners" versus "losers" for firms with a great variety of historical profitability levels (Piotroski 2005). Compared with other accounting fundamental scores, the F-score is simple to compute and with similar predictive power (Piotroski 2005). Therefore, it is expected that using F-score as predictor of future performance will improve accuracy to estimate future abnormal returns attributed to the ES.

The financial performance approach to study the ES business value has used pairwise t-test comparison between financial performance post and prior ES adoption (Poston and Grabski 2001) or regression models with ES adopters and a matching sample of similar firms from the same industry and similar size (Hunton et al., 2003; Nicolaou 2004). These methods control for past performance only at t-1, but do not control for industry performance tendencies. Other IT business value studies using the financial performance approach have used similar methods and have also not controlled for industry performance tendencies (e.g. Santhanam and Hartono 2003).

In the accounting and finance literature, there are established methods to measure abnormal performance attributed to specific events. Barber and Lyon. (1996) proposed 9 different models to detect abnormal accounting performance of events based on different matching sample criteria. These models basically estimate an expected future performance at t using performance measures at t-1 and an industry benchmark. To measure this expected performance, the average annual change in performance of a matching portfolio of firms is added to the incumbent firm performance at t-1. In other words, the expected performance at t is equal to performance at t-1 plus the average amount of change in performance of a matching portfolio. The present prediction model developed here is expected to be a more accurate measure than only considering one-year average changes in the industry since a group of matching firms is considered to make a forecast of future performance.

There are important features of the prediction model that the previous methods have not considered. It is argued that this model is able to predict longer future financial performance due the use of accounting fundamentals of two years prior the event. In addition, this model controls not only for past financial performance, but also for industry financial performance tendencies since it uses different sub-samples of matching firms for every ES implementer to compute the expected future financial performance.

The use of cash flow as dependent variable and ROA as independent variable in the prediction model is based on recent accounting literature. This literature stream argues that earnings –measured by net income before extraordinary items- is a better predictor of future operating cash flows than current cash flows(Dechow, Kothari and Watts 1998). In addition, consistent with the theoretical assumption of event studies, the business value of a specific event can be measured as the abnormal future cash flows attributed to the event. Consistent with this logic, the prediction model tries to identify abnormal changes in cash flow that can be attributed to the ES.