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IT Innovation Capability and Returns on IT Innovation Persistence

Jee-Hae Lim
University of Waterloo, jh2lim@uwaterloo.ca

Theophanis C. Stratopoulos
University of Waterloo, tstratop@uwaterloo.ca

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Jee-Hae Lim
University of Waterloo
Jh2lim@uwaterloo.ca

Theophanis C. Stratopoulos
University of Waterloo
tstratop@uwaterloo.ca

ABSTRACT

Prior studies have shown that the IT innovation capability, a company's ability to innovate systematically with IT, is not easily replicated (persistent), and the persistence tends to be more pronounced during periods when economy-wide IT budgets are declining (hard IT budgets), such the post-Y2K period. Building on resource based view we argue that companies that systematically innovate with IT have a sustained competitive advantage versus their competitors who are adopting an opportunistic approach to IT innovation or choose not to innovate with IT, and the advantage is stronger during periods of hard IT budgets. Both of these arguments were strongly supported when tested on a sample of 1,057 large US firms by indicating increased return on sales, return on assets, and growth..

Keywords

IT Innovation Capability, Firm Performance, Persistence, Y2K, Service.

INTRODUCTION

When it comes to the role of IT innovation on firm performance, the business perception varies over time (Stratopoulos and Lim 2007) and across industries (Nolan and McFarlan 2005). For example, more firms pursue an IT innovation strategy as a way to compete during such periods as the dot com boom than during the dot com bust immediately following. This temporal variation in managers' perception towards the role of new IT has been attributed to the hype of newly introduced technologies (Gartner 2007; Swanson and Ramiller 2004) and has been empirically validated (Stratopoulos, Lim and Wirjanto 2008). Similar variations can be found across industries. Such temporal variation leads to a distinction of firms in terms of IT innovation strategy between those that use IT in a systematic fashion versus those that use IT in an opportunistic way. In the cross section, this leads to a distinction between IT innovators and non-innovators (Swanson and Ramiller 2004; Stratopoulos et al. 2008; Stratopoulos and Lim 2007).

Prior studies have shown that IT innovation capability, i.e., the ability of a company to innovate systematically with IT is a sustainable capability. Systematic IT innovation is associated with a capability that is not easily replicated (Stratopoulos et al. 2008; Stratopoulos and Lim 2007). According to the resource-based theory of the firm, a resource or capability that is not easily replicated is a potential source of competitive advantage. While this general conclusion is well founded in strategic management and IT literature (Barney 1991; 1997; Mata, Fuerst, and Barney 1995), there is little, if any, empirical evidence to support that IT innovation capability can lead to a sustainable competitive advantage. Hence this study will bridge the gap in the literature by empirically testing the conclusion that IT innovation capability is a source of competitive advantage.

IT innovation has always been a politically charged topic. The justification for a company's decision to compete with IT or not has been at times highly controversial (Stratopoulos and Lim 2007; Carr 2003). This is to be expected if you consider that on average, large US firms spend $300-500 million/year (or 3-4% of total revenue) on IT, with $50-90 million of those dollars consistently invested in new IT products and services. It is natural that both shareholders and managers will be eager to see the expected payoffs of investments in new IT. This study will also provide empirical evidence on the competitive implications of various IT innovation strategies.

While the topic of the payoffs from IT innovation has attracted attention in the academic and professional circles, most of the positions that we have seen are theoretical in nature and based on anecdotal evidence and case studies (Carr 2003, 2004). To the best of our knowledge, this is the first attempt to compare the effects of various IT innovation strategies on firm performance, while controlling for major confounding factors. In essence, we provide a ceteris paribus 'horse race' of IT innovation strategies. Building on the previous literature on IT innovation (Swanson and Ramiller 2004; Stratopoulos et al. 2008; Stratopoulos and Lim 2007) and combining elements from the resource-based view we expect to find that companies that choose to compete with IT and to adopt a systematic approach to IT innovation are more likely to attain financial performance that is significantly higher than the industry median. Further, the superiority of the financial performance is stronger during economic downturns. Our results suggest that firms that adopt a systematic approach to IT innovation do, in fact, have financial performance above the industry median performance. We also find these results to be strongest during the dot com bust.

The remainder of the paper is organized as follows: In section two, we review the literature and develop our hypotheses. The methodology of this study is explained in section three followed by a discussion and interpretation of our results. The paper will close with a discussion of the limitations and with suggestions for future research. **PAGE SIZE**

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IHYPOTHESES DEVELOPMENT

IT Innovation and IT Innovation Capability

According to the resource-based view, companies that invest in resources and develop capabilities that are valuable, rare and difficult to imitate are likely to enjoy a sustainable competitive advantage (Barney 1991; 1997; Mata, Fuerst, and Barney 1995). For most companies, IT investment constitutes the largest capital-spending item (Digital Economy 2003). In a recent Survey of Current Business it was reported that investments in IT are getting closer to the fifty percent mark when expressed as a percentage of new capital investments (Epstein and Rejc 2005). Historically, firms have tended to justify their investment in new IT products and services on the basis of it being a means of achieving superior financial performance. New IT, the assumption goes, will improve competitiveness. Our search of the academic and professional literature, however, revealed two things. First, while there is plenty of anecdotal evidence regarding the role of IT innovation on firm performance, this evidence is conflicting (Stratopoulos and Lim 2007). Second, there is limited empirical evidence regarding the impact of IT innovation on firm performance in the academic literature (Swanson 1994; Fichman 2004).

Recently, Stratopoulos et al. (2008) have shown that within the group of large US firms, there are both IT innovative and non-innovative firms. The latter group may have adopted a strategy that does not include new IT as a way to compete for one of two reasons: because they don't think that it is necessary to innovate with IT or because they do not have the resources and capabilities to innovate with IT. Stratopoulos et al. (2008) show that if a firm has out-innovated its competitors this year, it is more likely that it will be able to continue to out-innovate their competitors in the following years. In the context of the resource-based view this means that IT innovation is valuable, heterogeneously distributed among competing firms, and companies that have developed the IT innovation capability when compared to their direct competitors are likely to out-innovate them year after year.

We argue that the implications of this finding are very important for managers and researchers. If IT innovation is persistent; some firms have a unique capability. We call this ability to out-innovate competitors year after year the *IT innovation capability*. The empirical findings of the Stratopoulos et al. (2008) study in the context of the resource based view lead to the argument that companies that have adopted an IT innovation strategy in the most recent year are likely to see the competitive benefits of this strategy on their financial performance. Hence the first contribution of this study, in the form of the following two testable hypotheses: 1) a comparison between the innovate or non-innovate strategy, and 2) a contrast between the performance effects of systematic versus opportunistic approaches to IT innovation.

This means that IT innovation has both short-term and a long-term effects. The former is based on the assumption that a company with its most recent IT innovation will try to exploit opportunities to contain cost, increase revenues or both through more efficient operations or through growth. The long-term is based on the IT literature on the cumulative and synergistic role of new IT within the organization. Current IT investments are more likely to lead to results if they build on prior IT innovations that have become embedded in the company's current processes:

H1a: The average performance of firms that have been IT innovative in the current period is higher than the average performance of all other firms in the industry in the subsequent years.

H1b: The average performance of firms that have developed the IT innovation capability is higher that the average performance of all other firms in the industry in the subsequent years.

Economy Wide Fluctuations and IT innovation Strategy

The second major finding of the Stratopoulos et al. (2008) study is that the persistence of the IT innovation capability is inversely related to economic conditions. The period from the mid-nineties up to the first few years in the new millennium define the approximate boundaries of a cycle associated with the technological hype and the following crash. Conveniently, Y2K divides the cycle into the two periods. During the first half we had two strong forces that were shaping IT strategies and budgets. The exuberance of the dot com market and Y2K combined to create a period when it was relatively easier to justify IT budgets either because it was part of the company's effort to compete in the fast paced dot com market or it could help the company avoid the risk of a Y2K driven implosion. Stratopoulos et al. (2008) borrowed the term 'soft budgets' from the economic literature and dubbed the 1997 to 2000 as the period of 'soft IT budgets.' In contrast the post-Y2K period was marked by the time of criticism and pessimism. The spirit of the period was captured in the title of an article in the market this second half of the cycle: "Does IT Matter?"

Contrasting the behaviour of large US firms during this period Stratopoulos et al. (2008) conclude that during periods of optimism the ranks of IT innovators swell with opportunists. However, these firms are less likely to maintain their ability to innovate with IT over time, as systematic innovators do. Filtering these results through a resource based view we derive implications regarding the sustainability of competitive advantage and by extension financial performance. If the IT innovation capability is stronger during periods of hard IT budgets, the capability is heterogeneously distributed and not easily replicated, hence a source of superior performance. We capture this argument in our second research hypothesis.

H2: The average performance of firms that have developed the IT innovation capability (systematic IT innovation strategy) during periods of 'hard budgets' or 'soft budgets' is higher than the average performance of all other firms in the industry. The incremental performance is stronger during periods of 'hard budgets.'

Industry Effects

There are two competing views that we want to use in order to develop the hypotheses related to the role of the industry: 1) role of IT in the industry, and 2) the "Blue Ocean" strategy (Chan-Kim and Mauborgne 2004). The former is based on the argument that for some firms and their competitors, competing through new IT is the "name of the game," whereas for others, the adoption of new IT is less of a strategic need (Nolan and McFarlan 2005). In broad terms, companies in certain industries, e.g., primary and construction, have a relatively low need for new IT. For companies in industries such as banking and financial services, however, the need to innovate and compete with IT is typically much higher. Based on this, one would expect the opportunities and payoffs from systematic IT innovation would be higher in industries that have been recognized as having a high need for IT.

On the other hand, there is plenty of anecdotal evidence that the firms in the finance industry may end up in an escalating spiral of increased spending on new IT without the desired end results (Shpilberg, Berez, Puryear and Shah 2007). Competing through IT in such industries may resemble what is called a red ocean strategy. The competition is so fierce that investment in new IT may increase productivity but not profits. A typical scenario is that consumers appropriate the benefits in the form of consumer surplus. The argument from the Blue Ocean strategy view is that companies that develop their IT innovation capability in industries where there is no need for high IT may be able to extract benefits that are not likely to be contested. Overall, we do not know which of these two argument will dominate and this is the position that we take.

H3: There is no different effect of IT capability in industries where IT plays a strategic role than in support industries and vice versa.

IMETHODOLOGY

Sample

In order to test our hypotheses we obtained data from *InformationWeek* from 1997 to 2004. This period was chosen because, as Stratopoulos and Lim (2007) have shown, it contains the approximate boundaries of a complete cycle in managers' perception regarding innovation with IT. The period was marked by a sequence of events that one can argue has driven this perception: the telecommunications deregulation in 1996, the Y2K problem, the dot com boom, the crash of NASDAQ, and 9/11. *InformationWeek* publishes an annual list of the largest US companies ranked by their innovative use of IT. Based on a detailed survey of IT executives, the publication determines the amount, type, and use of IT investments for each company. The companies are evaluated in terms of their business-technology strategies and deployment of investments in IT architecture, infrastructure, business, and e-business application. Incidentally, IT budgets are not a deciding factor in the rankings. The end result is an annual list of *Information Week 500* (IW500) firms that are classified as IT innovators because they have demonstrated a "consistent pattern of technological, procedural, and organizational innovation." (Information Week 500 Research Reports – various issues 1997-2004).

This initial step produced 4,000 records of firms (firm-entries) that have attained the IT innovator status on any year from 1997-2004. However, among those firms there were 588 entries associated with private, non-profit, foreign, or bankrupt firms for which we would not be able to produce financial performance data. Eliminating these entries reduced our records to 3,412 corresponding to 1,067 unique firms. A subsequent cross-match with the Global Vantage Key (GVKey) file from Compustat resulted in the elimination of another10 firms, not covered by Compustat. The final sample for this study consists of 1,057 firms that have attained the IT innovator status at least once in the time period from 1997 to 2002.

Given the nature of our hypotheses there was a need to identify firms as IT innovative or not and to make the distinction between systematic and opportunistic innovators. We did these using dummy variables for both of them. In our sample a firm is considered IT innovative (ITI=1) if it has attained the IT innovator status in a particular year. The classification of firms in terms of their IT innovation strategy, systematic vs. opportunistic, was done by following similar approach to the rolling-windows adopted by Stratopoulos and Lim (2007), and Stratopoulos et al. (2008).

Within the sub-periods 1997 to 2000 and 2001 to 2004 we were able to make the distinction in terms of systematic, opportunistic and non-innovators. A firm was classified as having adopted a non-innovator strategy if it did not appear in any of the fours years in the *InformationWeek* list, opportunistic if it had appeared only once, and systematic if it had appeared at least twice. The same approach was used in order to classify firms in the 2001 to 2004 period. Given the fact that the entire data set, 1997 to 2004, includes firms that have appeared at least once, we could make the distinction between systematic and opportunistic firms when we use the entire sample. The approach of the rolling four-year windows was used in order to classify firms in the entire sample period 1997 to 2004. In other words, if a firm had been classified as systematic innovator in the period 1997 to 2000 and repeated this in the period 2001 to 2004, then it was classified as a systematic IT innovator over the entire period, otherwise it was considered an opportunistic one.

Step 1	Firm-records based on initial Sample from *InformationWeek 500* from 1997 to 2004	4,000
Step 2	Firm-records eliminated because they corresponded to firms for which we would not be able to produce financial performance data (entries associated with private, non profit, foreign, bankrupt, etc)	580
Step 3	Firm-records associated with publicly traded firms	3,412
Step 4	Unique firms among the firm-records listed in step 3	1,067
Step 4	Firms eliminated due to lack of financial data in Compustat	10
Final Sample Size – Unique Firms		**1,057**

Table 1. Sample Selection (1997-2004)

Table 2 summarizes the distribution of the final sample of 1,057 firms by year (Panel A) and industry type (Panel B). Based on our classification, there are 492 firms (46.5%) that adopted a systematic IT innovation strategy during the pre-Y2K years 1997 to 2000. There were 362 (34.3%) opportunistic and 203 (19.2%) non-innovators. The euphoria of the dot com accounts for the fact that the percentage of opportunistic innovators is higher than the non-innovators and closer to the percentage of systematic innovators. As was expected, there was a change in the post-Y2K years 2000 to 2004 period. While the number (percentage) of systematic innovators remained at approximately the same level, 452 (42.8%), we observed a reverse in the distribution among opportunistic and non-innovators. The former dropped significantly, 20.1% from 34.3%, while the ranks of latter swell from 19.2% to 37.1%. Consistent with prior theoretically developed arguments and anecdotal evidence (Nolan and McFarlan 2005; Huff, Maher and Munro 2006) the service industry has the highest number of ITI firms (as the 2-digit SIC codes are greater than 6000 with 282 firms or 26.7%). This is followed by the food product and manufacturing (as the 2-digit SIC codes are 20-34 with 256 firms or 24.2%), then by as the machinery, electronic, and other equipments industry (as the 2-digit SIC codes are 20-34 with 168 firms or 15.9%).

[Insert Table 2]

Measures of Firm Performance

We examine financial performance using measures such as *Profitability* and *Growth*. Return on investment (ROI), return on equity (ROE), and return on assets (ROA) are all closely related and widely accepted profitability measures used by internal management and external analysis to evaluate performance. ROA is used in this study because it measures a firm's ability to generate profits from assets without regard to how those assets are financed (Brown et al. 1995; Dehning et al. 2007). In this sense, it is a more comprehensive measure; therefore, it is more appropriate than the other two for evaluating IT innovation persistence. A second measure of profitability, return on sales (ROS) which is consistent with a price down/cost down logic used by many firms (Brown et al. 1995; Dehning et al. 2007).

Operating ROA equals operating earnings before depreciation divided by total assets, and operating ROS equals operating earnings before depreciation divided by sales revenue. We adopt operating measures of performance because we expect IT innovation to affect operations, and not affect various non-operating items included in net income (e.g., interest income and expense, taxes, unusual write-offs and discontinued operations and extraordinary items).

	PreY2K (1997-2000)		**Post-Y2K (2001-2004)**	
Type of ITI	**Frequency**	**Percent**	**Frequency**	**Percent**
Systematic	492	46.5	452	42.8
Opportunistic	362	34.3	213	20.1
Non-Innovator	203	19.2	392	37.1
Total	**1,057**	**100**	**1,057**	**100**

Table 2. Distribution of Sample Firms from 1997 to 2004

Panel A: Distribution of Sample Firms by Year

2-Digit Codes: Industry	**Frequency**	**Percent**
10, 12, 13, 15: Metal, Mining, Oil & Natural Gas, Minerals	22	2.1
15, 16, 17: Construction	15	1.4
20-34, Food Products, Manufacturing, Papers, Chemicals, Plastics, Leather, Glass, Steel Works	256	24.2
35-39: Machinery, Equipment, Electronics, Motor Vehicles, Industrial Instruments	168	15.9
40, 42, 44, 45, 47-49: Transportation, Communication, Electronic, Gas, & Sanitary Other Service	151	14.3
50, 51: Wholesale Trade	68	6.4
52-59: Retail Trade	95	9.0
60-64, 67: Finance, Insurance, & Real Estate	162	15.3
70, 72, 73, 75,78-80, 87, 99: Hotel & Service	120	11.4
Sample Used in This Study	**1,057**	**100**
SERVICE: SIC codes are equal to or greater than 6000	282	26.7

Table 2. Distribution of Sample Firms from 1997 to 2004

Panel B: Distribution of Sample Firms by 2-Digit SIC Code

Given the adopted definition of IT innovation it is expected that IT innovation will be leveraged to support a company's growth strategy. In this study we measure growth as the percent change in sales from one year to the next.

This study obtains all the data required to calculate the accounting-based metrics from Compustat. For each metric, and for each year from 1996-2006, the median value was computed for each industry.[1] The median was used instead of the

[1] We used the entire industry control-group approach for several reasons. First, the median of the industry provides a better indicator of typical industry performance than the value of the performance metric for one selected firm. Second, the

mean because it is less influenced by an outlying data points. Industry median thus serves as a benchmark that increases the meaningfulness of the resultant performance measures (Melnyk et al. 2004). Measuring a firm's competitive performance as the difference for industry median is consistent with the approach recommended by Santhanam and Hartono (2004).

For each test firm, and for each metric, the median value of the firm's industry control group was subtracted from the value of the firm's metric, for each year from 1996-2006.[2] The change in each performance measure, from the year prior to notification of IT innovative firms to one and two years after IT innovation, are calculated as in Dehning et al. 2007 and Balakrishnan et al. 1996.

Research Model

In order to account for all proposed hypotheses we had to estimate three different models. The first one is based on the entire sample period 1997 to 2004, and it is used in order to test that the median performance of firms that have been IT innovative in the current period is higher than the median performance of all other firms in the industry in the subsequent years (H1a), that the median performance of systematic IT innovators is higher than the median performance of all other firms in the industry in the subsequent years (H1b), as well as the industry effect (H3).

To be conservative and to control for possible endogeneity problems between IT innovation capability and firm performance, we follow prior research (Klein 1998) by including the one-year lagged performance (e.g., ROA_{-1}, ROS_{-1}, or GR_{-1}). This method is appropriate because multiple regressions allow for correlations among the explanatory variables (Klein 1998). We expect to a positive coefficient of the one-year lagged performance since performance measures are positively correlated over time.

We also incorporated other control variables identified by Hitt and Brynjolfsson (1996) as having a significant impact on firm profitability that were available for the firms in this data set. Among these were included debt/equity ratio, research and development expenditures (R&D), capital investment, and advertising. Finally, we included the natural log of market capitalization to control for the size of the firm and year. The following model (6.1) examines the financial effects of the IT innovation persistence from 1997 to 2000.

(Model 6.1)

$$DV_{i,\,04\text{-}06} = \beta_0 + \beta_1 ITI_{i,04} + \beta_2 SI_{i,97\text{-}04} + \beta_3 SER + \beta_4 PreFP + \beta_5 RD/NS + \beta_6 CE/NS + \beta_7 ADV/NS + \beta_8 LNSIZE + \beta_9 YEAR + e$$

DV: Performance variables (e.g., return on sales, return on assets, and growth rate, etc)

ITI: 1 if a firm has an IT innovation status via IW500 in the most recent year

SI: 1 if a firm has a systematic IT innovation strategy; otherwise 0. Notice that in this version of the model there are not non-IT innovative firms. Hence, the intercept will capture the effect of opportunistic IT innovation strategy.

SER: 1 if firm is a member of the service industry (SIC codes are equal to or greater than 6000), 0 otherwise.

PreFP: Lagged firm performance (e.g., ROA_{-1}, ROS_{-1}, or GR_{-1})

RD/NS: Research & Development Expenditure (A46) / Net Sales (A12).

CE/NS: Capital Intensity: Capital Expenditure (A128) / Net Sales (A12).

ADV/NS: Advertising (A45) / Net Sales (A12).

LNSIZE: Natural logarithm of total market capitalization.

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matched-pairs approach is greatly affected by the choice of the control firm, and the results obtained might change dramatically if other control firms were chosen. Third, although the test firms do innovate a significant part of their IT, other firms in the industry might have also innovated IT without announcing it. If so, it would be possible unwittingly to match a test firm with a control firm that has also innovated IT (Dehning et al. 2007 and Balakrishnan et al. 1996).

[2] These dates differ from those IT innovative firms in sample (1997-2004) due to the use of change metrics, as financial data are collected one year prior and two years after each IT innovation note from InformationWeek.

Variable	Definition	Description
ROS	Return on Sales	Income Before Extraordinary Items (Compustat18) / Net Sales (Compustat12)
ROA	Return on Assets	Income Before Extraordinary Items (Compustat18) / Total Assets (Compustat6)
GR	Growth rate	(Net Sales $(Compustat12)_{t+1}$ – Net Sales$(Compustat\ 12)_{t-1}$)/ $Sales_{t-1}$
PreFP	Lagged firm performance	One-year lagged performance (e.g., ROA_{-1}, ROS_{-1}, or GR_{-1})
ITI	IT Innovation	1 if a firms has an IT innovation status via IW500 in the most recent year, otherwise 0.
SI	Systematic	1 if a firm has a systematic IT innovation strategy, otherwise 0. • **SIPre**: 1 if a firm has a systematic IT innovation strategy during pre- Y2K, otherwise 0. • **SIPost**: 1 if a firm has a systematic IT innovation strategy during post-Y2K, otherwise 0.
OPP	Opportunistic	1 if a firm has an opportunistic IT innovation strategy, otherwise 0. • **OPPPre**: 1 if a firm has an opportunistic IT innovation strategy during pre-Y2K, otherwise 0. • **OPPPost**: 1 if a firm has an opportunistic IT innovation strategy during post-Y2K, otherwise 0.
SER	Service	1 if firm is a member of the service industry (SIC codes are equal to or greater than 6000), 0 otherwise.
RD/TA	Research & Developments	Research & Development Expenditure (Compustat46) / Total Assets (Compustat12)
CE/NS	Capital Intensity	Capital Expenditure (Compustat128) / Net Sales (Compustat12)
ADV/NS	Advertisements	Advertising (Compustat45) / Net Sales (Compustat12)
LNSIZE	Control	Natural logarithm of total market capitalization
YEAR	Control	Year Control

Table 3. Variable Descriptions

The remaining two models (6.2 and 6.3) were introduced in order to account for the economy wide effects and prevailing managerial perception towards IT during the two sub-periods. As we have seen the period of 1997 to 2000 was dubbed as the period of soft IT budgets, while the post-Y2K period from 2001 to 2004 was a period of hard IT budgets. In addition to testing to the extent of the incremental contribution of systematic IT innovation strategy is stronger during periods of hard budgets, we also introduce a finer granularity of our IT innovation strategies. Working with the entire sample we make the distinction between systematic and opportunistic companies. However, when we work with sub-samples, we make the distinction among all three types of IT innovation strategy: systematic, opportunistic and non-IT innovators.

(Model 6.2): Pre-Y2K

$$DV_{i,\ 00\text{-}02} = \beta_0 + \beta_1 ITI_{i,00} + \beta_{21} SI_{i,97\text{-}00} + \beta_{22} OPP_{i,97\text{-}00} + \beta_3\, SER + \beta_4 PreFP + \beta_5 RD/NS + \beta_6 CE/NS + \beta_7 ADV/NS + \beta_8 LNSIZE + \beta_9 YEAR + e$$

(Model 6.3): Post-Y2K

$DV_{i,\,04\text{-}06} = \beta_0 + \beta_1 ITI_{i,04} + \beta_{21} SI_{i,01\text{-}04} + \beta_{22} OPP_{i,01\text{-}04} + \beta_3\, SER + \beta_4 PreFP + \beta_5 RD/NS + \beta_6 CE/NS + \beta_7 ADV/NS + \beta_8 LNSIZE + \beta_9 YEAR + e$

Notice that within each of the sub-periods we can make the distinction between three IT innovation strategies (systematic, opportunistic, and non-innovator) by using an additional dummy variable. The first one, SI_i, we capture the expected incremental effect of systematic IT innovators above and beyond that of opportunistic or non-innovators. The second one, OPP_i, we capture the unlikely possibility that opportunistic innovators may enjoy a superior performance above the non-innovators.

Descriptive statistics for all of the financial performance and control variables used in empirical tests can be found in Table 4. Correlations between the variables employed in the empirical tests (predictors and controls) can be found in Table 5. None of the correlations are above 0.42, and the highest variance inflation factor (VIF) in our regression is only 3.17, which is well below the suggested multicollinearity problem threshold of 10 (Marquandt 1980; Gujarati 1995). Our examination of the standard errors and size of the coefficients also shows that they are not sensitive to the inclusion or exclusion of the highly correlated variables, indicating multicollinearity is unlikely to be problematic (Hosmer and Lemeshow 1989).

	Min.	**Max.**	**Mean**	**SD**
ROS0002	-3.486	2.230	0.002	0.269
ROS0406	-0.480	39.628	0.081	1.552
ROA0002	-1.990	0.406	0.001	0.116
ROA0406	-0.291	0.370	0.018	0.067
GR0002	-0.455	1.912	0.065	0.212
GR0406	-0.894	1.480	0.071	0.180
ITI00	0.000	1.000	0.398	0.490
ITI04	0.000	1.000	0.376	0.485
SI	0.000	1.000	0.700	0.458
SIPre	0.000	1.000	0.465	0.499
SIPost	0.000	1.000	0.428	0.495
OPPPre	0.000	1.000	0.342	0.475
OPPPost	0.000	1.000	0.202	0.401
SER	0.000	1.000	0.266	0.442
RD/NS	0.000	0.364	0.021	0.048
CE/NS	0.000	1.293	0.054	0.077
ADV/NS	0.000	0.294	0.010	0.024
RD/TA	0.000	0.265	0.016	0.034
CE/TA	0.000	0.394	0.040	0.037
ADV/TA	0.000	0.381	0.012	0.030
LNSIZE	16.959	28.152	22.621	1.701

Table 4. Descriptive Statistics

		1	2	3	4	5	6	7	8	9	10	11	12	13	1
ROS0020	**1**	1													
ROS0406	**2**	0.329**													
ITI00	**3**	0.032	0.038												
ITI04	**4**	0.052	0.037	0.147											
SI	**5**	0.038	0.029	0.510**	0.401**										
SIPre	**6**	0.025	0.029	0.457**	0.044	0.603**									
SIPost	**7**	0.008	0.026	0.348**	0.597**	0.651**	0.167**								
OPPPre	**8**	0.069$	0.029	-0.151**	-0.259**	-0.406**	-0.673**	-0.281**							
OPPPost	**9**	0.058$	0.020	-0.043	-0.019	-0.283**	-0.124**	-0.434**	-0.114**						
SER	**10**	0.040	0.005	-0.004	0.064*	0.002	-0.059*	0.021	0.008	0.023					
PreFP	**11**	0.141**	0.028	-0.031	0.052	-0.023	-0.032	-0.007	-0.029	0.025	0.049				
RD/NS	**12**	-0.147**	-0.008	0.077*	0.037	-0.006	0.003	0.000	-0.006	0.077*	-0.007	-0.015			
CE/NS	**13**	0.010	0.052	-0.019	0.023	-0.013	-0.013	-0.074$	0.000	0.035	-0.198	0.008	-0.003		
ADV/NS	**14**	0.000	-0.019	0.048	0.032	-0.032	0.007	-0.026	-0.073$	0.073$	-0.103**	-0.003	0.051	-0.020	
LNSIZE	**15**	0.163**	-0.071$	0.065$	0.060$	0.146**	0.124**	0.051	-0.013	0.030	0.233**	0.050	-0.014	0.094*	-0.04

Table 5. Correlations[3]

[3] P-values are for two-tailed tests of significance ($ significant at the 0.1; * significant at the .05; ** significant at the .01). Variable Characteristics Defined in Table 3

		Dependent Variables											
		ROS0406 [a]		ROS0002		ROS0406		GR0406		GR0002		GR0406	
	predicted	Model 6.1		Model 6.2		Model 6.3		Model 6.1		Model 6.2		Model 6.3	
	sign	beta	t-stat	beta	t-stat	beta	t-stat	beta	t-stat	beta	t-stat	beta	t-stat
Constant	-	-0.229	-4.688**	-0.211	-1.623$	-0.224	-4.631*	-0.172	-2.293*	-0.271	-2.826**	-0.165	-2.215*
ITI	+	0.003	0.421	0.011	0.543	0.014	1.531$	0.010	0.911	0.034	2.212*	0.019	1.502$
SI	+	0.007	0.869	0.031	1.096	0.023	2.231*	0.011	0.926	0.117	5.322**	0.028	1.777$
OPP	?			0.055	2.044*	0.003	0.297			0.104	5.106**	0.022	1.737$
SER	+	0.048	5.685**	0.000	0.016	0.047	5.610*	0.006	0.452	0.000	0.023	0.005	0.405
PreFP	**Control**	0.004	0.422	0.076	2.716**	0.004	0.391	0.151	5.483**	0.102	4.937**	0.149	5.426**
RD/NS	**Control**	0.116	1.634$	-0.579	-4.374**	0.114	1.608$	-0.032	-0.302	0.478	8.426**	-0.050	-0.465
CE/NS	**Control**	0.100	2.215*	-0.369	-3.458**	0.088	1.927	0.071	1.003	0.381	4.736**	0.065	0.916
ADV/NS	**Control**	0.072	0.557	0.428	1.228	0.057	0.412	-0.340	-1.591$	0.149	0.573	-0.37	-1.751$
LNSIZE	**Control**	0.010	4.447**	0.009	1.582$	0.010	4.521**	0.012	3.455**	0.017	3.890**	0.011	3.313**
YEAR	**Include**												
	F-stat.	9.580	0.000**	19.520	0.000**	9.245	0.000**	7.653	0.000**	24.291	0.000**	7.438	0.000**
	Adj. R^2	0.093		0.177		0.100		0.073		0.218		0.079	

Table 6. Multiple Regressions Estimating the Effects of IT Innovation on Firm Performance

P-values are for two-tailed tests of significance ($ significant at the 0.1; * significant at the .05; ** significant at the .01).
[a] The results using ROS as a dependent variable are very similar to those when ROA is the dependent variable. Results for ROS are not shown for brevity.
SER: 1 if firm is a member of the service industry (SIC codes are equal to or greater than 6000), 0 otherwise.
PreFP: Lagged firm performance (e.g., ROA_{-1}, ROS_{-1}, or GR_{-1})
RD/NS: Research & Development Expenditure (Compustat 46) / Net Sales (Compustat 12).
CE/NS: Capital Intensity: Capital Expenditure (Compustat 128) / Net Sales (Compustat 12).
ADV/NS: Advertising (Compustat 45) / Net Sales (Compustat 12).
LNSIZE = Natural log total market capitalization

DISCUSSION OF RESULTS

To examine whether firm performance depends on the type of IT innovation strategy we ran regression analyses using three overall accounting-based financial performance measures as dependent variables: ROA[4], ROS, and GR. The change in each performance metric was measured over a three-year period: the last year for which we had Information Week data as well as two years after. Each performance variable was winsorized at ±3 standard deviations to control for any potential outliers.

The results of the regression analysis are presented in Table 6 and the empirical results on profitability and growth strongly support our propositions. Models 6.1, 6.2, and 6.3 effectively explain the change in ROA, ROS, and GR, with significant model *F*-statistics (p<0.001) and adjusted *R*-squares between 8-20%.

Full sample results

The first model (ROS0406 or model 6.1) uses a company's IT innovation strategy in the 1997 to 2004 period in order to predict to what extent its average profitability in the years 2004 to 2006 is above the industry median. The model shows that the intercept, the industry variable (SER), and the variables capturing the company's IT innovation status in the most recent year (ITI) and the extent to which a company has adopted a systematic IT innovation strategy (SI) have the expected signs. However only the intercept and industry variables are statistically significant.

The statistically significant intercept in this model captures the IT innovation strategy of firms that did not innovate in 2004 (ITI=0) and did not adopt a systematic IT innovation strategy from 1997 to 2004 (SI=0). Given the fact that in this model we do not capture any non-IT innovative firms, this means that with the intercept we capture the effect of opportunistic IT innovation strategy on profitability and this is negative (-.229) and significant (-4.688). In addition to this we have evidence supporting the fact that payoffs from IT innovation are likely to be higher in the finance and service industries. This is consistent with the view introduced by Nolan and McFarlan (2005) that the opportunities and the need to innovate with IT are higher in certain industries.

Pre- versus Post- Y2K

The results on the effect of the innovation strategy on profitability over the two phases of the cycle are very interesting and support our hypotheses. Hypothesis 2 is based on the finding of the Stratopoulos et al. (2008) study that the persistence of the IT innovation capability is higher during the year of economic downturn. In other words, a company that has adopted a systematic approach to IT innovation will be able to distinguish itself from its competitors during the economic downturns. As it was expected the sign of the SI variable is positive n both sub-periods, the coefficient is .031 in the pre-Y2K period and .023 in the post-Y2K., however it is statistically significant only during the 2001 to 2004 period (t-value=2.23). Interestingly enough the opportunistic IT innovation strategy (OPP=1) produced incremental profitability above that attained by non-innovators during the 1997 to 2000 period. The coefficient for OPP is .055 (*t*= 2.044) giving an unexpected managerial implication in the sense that it suggests that during periods of economic and technical hype, companies are better off been opportunistic innovators than non-innovators! This contradicts the managerial suggestion of the Stratopoulos and Lim (2007) and Stratopoulos et al. (2008) in which they have advised against opportunistic IT innovation.

The effect of IT innovation strategy on the company's growth seems to indicate that any strategy (opportunistic or systematic) is better than non-innovation both during the expansion and contraction phases of the business cycle. In both sub-periods the intercept, which captures companies with non-IT innovation strategy, is negative (-.271 and -.165) and statistically significant (*t*=-2.826 and *t*=-2.215, respectively). The effect of recent IT innovation (ITI=1) on the company's growth in sales is positive (.034 and .019) and statistically significant (2.212 and 1.502). Systematic IT innovation (SI=1) leads to more growth opportunities both pre-Y2K (.117) as well as after the Y2K (.028). Finally, opportunistic IT innovation seems to support more growth than non-IT innovation, counter to the predictions of Stratopoulos and Lim (2007) and Stratopoulos et al (2008) studies.

Overall, our empirical analysis shows that firms with superior IT innovation capability are associated with significantly higher financial performance. Perhaps the most interesting and important implication of our study is coming from the analysis of the two sub-periods. As we have seen during the period of the economic boom it is more difficult to differentiate a

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[4] The results using ROA as a dependent variable are very similar to those when ROS is the dependent variable. Results for ROA are not shown for brevity.

company with systematic IT innovation, because more and more companies spend large amounts in IT, which cannot be sustained for a long time. Thus as the aphorism goes "a rising tide lifts all boats." However, our results show that during the proverbial low tide of the post-Y2K years, some boats (i.e., firms that had adopted a systematic IT innovation strategy) continued rising.

LIMITATIONS AND OPPORTUNITIES FOR FUTURE RESEARCH

This study has several limitations. The firms in the sample are not randomly selected, but are in the sample because they issued a press release in IW500. The source of our data set – *Information Week* 500 Reports – does not disclose the exact details of their survey, so we cannot state with confidence that all firms listed each year are indeed IT innovation capable. With each annual report, *Information Week* provides an outline of the methodology of their selection process. Based on our review of these summaries for all the years in our sample, we feel comfortable that they have accounted for most of the major factors that have been identified in the existing IT innovation literature until approximately the end of the sample period 2004 (Fichman 2004). Prior versions of *Information Week* reports have been used extensively in the AIS literature (e.g., Brynjolfsson and Hitt 1996; Bharadwaj 2000; Santhanam and Hartono 2003).

In addition, the study has omitted numerous other factors that undoubtedly influence the success of IT innovation persistence strategy (e.g., executive teams, such as CEO, CFO, CIO and others, as well as board members' strategic capability and/or management). Incorporating such factors in future modeling efforts are strongly encouraged.

Stratopoulos and Lim (2007) have augmented their data set with the inclusion of firms that had not attained the IT innovator status in *Information Week*. In a future version of the paper we hope to collect the appropriate financial data for all of the competitors hence produce an empirical analysis which is more closer to the one used by the previous two studies. This might account for the unexpected results that we have observed in the opportunistic IT innovation strategy.

Prior studies have looked at the firm-specific and contextual factors that create the right environment for IT innovation (Fichman 2004). Given the distinction that we have made between 'once' and 'over-time' innovation with IT, the next step will be to look at the antecedents of IT innovation persistence. More specifically, we can look at the organizational and environmental characteristics that might explain the likelihood that a firm becomes a systematic, opportunistic, or non-IT innovator. According to Fichman (2004), prior studies rarely consider the ultimate outcomes or benefits of innovation with IT. Fichman speculates that this may be attributed to the difficulty of measuring impacts of IT innovation. Our study validates the link between persistence in IT innovation and firm performance.

CONCLUSION

Approaching IT innovation from a strategic management standpoint, this paper tries to shed light on the issue of the capability of a firm to innovate with IT over time and its implications on firm performance. ITI is a path-dependent capability that is not easily replicated and argued that companies that have developed IT innovation capability and attained IT innovator status among their peers are likely enjoy better financial firm performance. We tested a series of propositions with cross-sectional data of large US firms that have affected the financial effects from each firm's attained IT innovator status from 1997-2004. The results of our analysis seem to suggest the position that firms that innovate with IT are more likely to attain financial performance levels that are above the industry median.

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