Journal of International Technology and Information Management

Volume 19 | Issue 1 Article 1

2010

IT as a Resource for Competitive Agility: an Analysis of Firm Performance during Industry Turbulence

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ABSTRACT

In an increasingly fast-paced business context, agility is crucial to firm performance. Competitive agility, the ability of a firm to rapidly sense and respond to changes in its environment, is especially important during industry turbulence. This research examines whether investment in Information Technology (IT) enhances firms' competitive agility using analysis of firm performance during industry growth and contraction. The research approach addresses the causality question faced by previous IT productivity studies by focusing on ex-ante IT investment and subsequent firm performance during periods of unanticipated industry shocks. Findings indicate that IT investment enhances competitive agility but only in industries with unanticipated growth, calling for further investigation into the use of IT during unanticipated industry downturn.

INTRODUCTION

The contemporary business environment is marked by increasing intensity of competition and a fast pace of change in markets and customer expectations. It is therefore becoming increasingly crucial that firms obtain and exercise the ability to rapidly sense and respond to changes in their environment. This ability is known generally as *agility* (Dove, 2001) and has been referred to as "strategic agility" (Weill, Subramani, & Broadbent, 2002), "competitive agility" (Goldman, Nagel, & Preiss, 1995), "business agility" (Mathiassen & Pries-Heje, 2006), and "enterprise agility" (Overby, Bharadwaj, & Sambamurthy, 2006) over the course of much recent discussion about this key ingredient to success. We choose the term competitive agility since an agile business will gain a competitive advantage by quickly collecting information about and making sense of changes in its environment, and efficiently responding in kind.

Competitive agility is particularly relevant when firms operate in complex and turbulent markets. More "agile" firms attempt to seize competitive advantage in a disruptive period through innovative products, services, and alliances. As part of the endeavor to understand how IT facilitates competitive advantage (Evans & Neu, 2008; Lea, 2005), researchers hypothesize that IT capability enables firms to gather and assimilate information more quickly and effectively and

ISSN: 1543-5962-Printed Copy ISSN: 1941-6679-On-line Copy

thereby improves their competitive agility in responding to market disruptions (Overby et al., 2006; Sambamurthy, Bharadwaj, & Grover, 2003). If so, IT is an enabler of agility and investment in IT will in turn impact the ultimate success of a firm.

In fact, for many decades the relationship between investment in IT and firm performance has been tested to varying degrees of success. Researchers have cited conflicting anecdotal and case evidence with regard to the link between IT investment and firm performance. Several studies (Bharadwaj, 2000; Bharadwaj, Bharadwaj, & Konsynski, 1999; Brynjolfsson & Hitt, 1995, 1996, 2003; Dewan & Min, 1997; Melville, Kraemer, Gurbaxani, 2004) have found a positive relation between firm performance and IT expenditures. These studies measure performance in terms of firm productivity/output. A few studies with similar findings supporting the relationship between IT and firm performance have used financial measures of performance (Bharadwaj 2000; Bharadwaj et al., 1999; Kobelsky et al., 2008). Still, other studies failed to find conclusive evidence of the business value of IT (Cron & Sobol, 1983; Stiroh, 1998) and even found some cases of diminishing returns (Evans & Morton, 2004). Researchers refer to the surprising lack of empirical evidence that IT expenditures benefit firms as the "productivity paradox" which has even led to a fierce debate over whether or not IT "matters" (Carr, 2003a, 2003b).

Data problems (Brynjolfsson & Hitt, 1996), sample size, data source, and industry (Kohli & Devaraj, 2003) have all been said to affect the findings in information technology payoff studies. Furthermore, even when correlations are detected, direction of causality is often in question. The analysis that follows uses a unique methodological approach to elucidate its IT payoff findings. In addition, there has been little research that examines the impact of industry conditions on the relationship between IT investment and firm performance. Therefore, the following research study identifies this relationship specifically in times of industry turbulence (downturn or growth). Study of the relationship between IT investment and firm performance in the context of industry turbulence will give us insight into the success of IT investments in their role of enhancing the agility of the firms they serve.

RESEARCH QUESTION

Thus, the goal of the current study is to explore whether IT enhances a firm's agility. To determine this, the following research question underlies our study. Do firms that have more sophisticated and innovative IT capability (as measured by the ranking of their IT investment) perform better during times of industry turbulence than their counterparts who have less IT investment? If so, it can be concluded that the IT investments have engendered the ability for a firm to sense and respond effectively and efficiently to changes in the environment. Further, we seek to further explore the nature of IT payoff during turbulence; does the impact of IT on firm performance differ in times of industry growth as opposed to times of industry contraction? By examining firm performance in each of these contexts, we can determine the strengths and weaknesses of firms' use of IT for agility to inform decisions about IT investment and use.

THEORETICAL BACKGROUND AND HYPOTHESES

The current business environment is one where "rapid, continual, and simultaneous shifts in the states of key environmental variables" are common and there are "frequent turnovers in the general stock of knowledge possessed by market participants" (Glazer & Weiss, 1993). Rapid

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regulatory changes, technological advances and globalization also contribute to an unpredictable operating environment (Overby et al., 2006). Firm performance in this economic setting is dependent on the ability of managers to make strategic decisions at high speeds (Baum & Wally, 2003). Furthermore, fast decision makers, it has been shown, require more information than slow decision makers do (Eisenhardt, 1989). The speed and efficiency with which information flows within and among firms is therefore a prominent factor in its ability to operate successfully in the current fast-paced environment. Clearly, information systems are instrumental in providing this capability.

In fact, since information systems so often provide the "assets and capabilities that are available and useful in detecting and responding to market opportunities or threats" (Wade & Hulland, 2004), they have been identified as potential resources for managers to implement in a strategic manner to gain competitive advantage. According to the *Resource-Based View of the Firm* (RBV), a sustainable competitive advantage results when firms acquire resources that are rare, imperfectly imitable, and not substitutable by other common or imitable resources (Barney, 1991). Since IT resources such as infrastructure components are available on the open market, some might argue that IT is a commodity and does not qualify as a resource as described by the RBV theory (Carr, 2003a, 2003b). However, researchers have successfully applied RBV to information systems resources and shown that "firms can and do differentiate themselves on the basis of their IT resources" (Bharadwaj, 2000; Wade & Hulland, 2004). These studies indicate that it is not the IT components alone that facilitate competitive advantage. Rather, the know-how, effort, and time responsible for leveraging those IT components might be responsible (Pavlou & El Sawy, 2006). Or, perhaps the ability to build an integrated IT infrastructure, an IT-embracing firm culture, or convergent IT and business strategies is the IT capability that is the resource that can lead to sustainable competitive advantage (Sasidharan et al., 2006). "A firm's IT infrastructure, its human IT skills, and its ability to leverage IT for intangible benefits serve as firm-specific resources, which in combination create a firm-wide IT capability." (Bharadwaj, 2000). Thus, strategic and innovative use of IT is considered a resource as per RBV and therefore can stimulate competitive advantage. To verify this premise in the context of the current study, we hypothesize the following:

> *H1. Firms that have invested in innovative IT to a greater degree will demonstrate better financial performance than firms with less prior investment in innovative IT.*

RBV further asserts that corporate attributes become true resources only when they are "valuable", namely when they enable a firm to create or enact strategies that improve its efficiency and effectiveness and are used to "exploit opportunities or neutralize threats in a firm's environment" (Barney, 1991). In this sense, IT as an enabler of agility attests to its role as a resource for the firm. When firms dedicate their investment in IT to solutions that help them quickly collect, process and analyze information they have developed a potentially inimitable sensing capability. When their IT investments also result in information systems that provide customer-focus, innovative product and services, or cost-saving business processes, they have utilized IT to facilitate response to opportunities and challenges in their environment. From this perspective, IT in fact seems to create a resource that can help achieve a sustainable competitive advantage, as per the Resource-based View of the Firm.

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Actually, investment in IT has been said to be a major contributor to a firm's agility in a few different ways. IT impacts the agility of firms both directly and indirectly. Directly, IT provides the capacity for processing and communicating large volumes of information to help sense, make sense of, and even anticipate changes in a firm's operating environment, particularly those related to advances in technology. For response, IT is often the direct driver of new products and/or services (Overby et al., 2006). Perhaps even more importantly, however, IT indirectly provides the benefit of agility through "digital options" – the option to digitize knowledge systems and business processes (Sambamurthy et al., 2003). Digital knowledge systems help sense changes in the environment by enhancing knowledge reach and richness. For example, sophisticated decision support systems or data mining techniques provide information that is comprehensive, timely and accurate and can be used to identify and understand internal strengths and external opportunities. Digital work processes help firms respond swiftly to changes by increasing process reach and process richness. For example, digitally integrating customers and business partners into business processes can provide a competitive edge.

It is no surprise that agility has been sought through IT in many contexts. Firms have worked to develop IT infrastructures specifically designed to accommodate an agile workforce and agile organizational structures (Breu et al., 2002; Morris & McManus, 2002; van Oyen et al., 2001). In addition, models have been developed to enhance the agility in the processes of manufacturing (Bessant et al., 2001; Sanchez & Nagi, 2001; Sharifi & Zhang, 2001) and software development (Kotlarsky et al., 2008; One-Ki Lee et al., 2006). In all areas of business, firms seek to take advantage of IT capabilities in various ways to quickly sense changes in the environment and swiftly make changes in response.

Based on this theoretical development it is expected that firms who have invested in their information systems development in a strategic way have likely created a resource that ultimately positively impacts the performance of a firm. The theoretical and practical association between strategically developed information systems and the agility of a firm indicates that investment in IT is a resource when it helps a firm sense and respond to its environment. We therefore predict that:

> *H2. Firms that have invested in innovative IT to a greater degree before a period of unanticipated industry* **turbulence** *will demonstrate better financial performance during times of unanticipated industry* **turbulence** *than firms with less prior investment in innovative IT.*

While the RBV focuses on internal, firm-level resources and capabilities, additional research in this area has pointed out that external, industry-level factors also play a role in the potential of a firm to develop a competitive advantage (Fang et al., 2008). Extending RBV, researchers have theorized that firm value will be increased by internal capabilities only when they agree with environmental conditions (Eisenhardt & Martin, 2000). A firm that concentrates only on its internal capabilities and disregards its environment will likely not attain a competitive advantage. Therefore, any investigation of a firm's pursuit of competitive advantage must be examined within the firm's environmental context (Amit & Schoemaker, 1993; Fang et al., 2008). In fact, researchers have examined internal firm resources in conjunction with the environmental factors at the industry-level, identifying industry turbulence as one of the prominent context factors that potentially mediate between a firm's resources and its ultimate performance (Fang et al., 2008;

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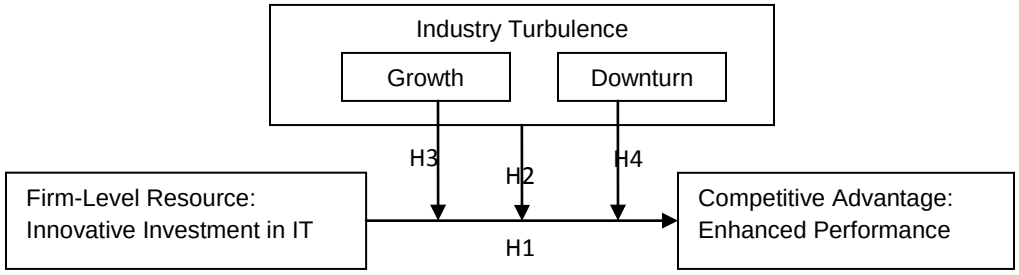
Jaworski & Kohli, 1993). Accordingly, in the examination of IT for agility as a firm resource, it is important to examine the industry conditions of the IT investments that are being made. Industry turbulence would have a major impact on the ability of a firm to respond to changes in its environment. Sudden or unexpected turns in the economic environment of a firm's industry would potentially impede the firm's process of detecting and responding to information and events in its surroundings.

Although turbulence is very often associated with industry downturn, it is important to be aware that the noted market changes can be the result of either industry downturn or industry growth. If investment in IT is successfully enhancing a firm's strategic agility, then we expect firms that have made such investments to outperform those that have not during either form of industry turbulence. Thus we hypothesize that IT investment prior to each type of unanticipated change in the industry will have a positive impact on a firm's performance during that period of turbulence. Our hypotheses to test our main research question follow.

> *H3. Firms that have invested in innovative IT to a greater degree before a period of unanticipated industry* **growth** *will demonstrate better financial performance during times of unanticipated industry* **growth** *than firms with less prior investment in innovative IT.*
>
> *H4. Firms that have invested in innovative IT to a greater degree before a period of unanticipated industry* **downturn** *will demonstrate better financial performance during times of unanticipated industry* **downturn** *than firms with less prior investment in innovative IT.*

To summarize, the current research study hypothesizes that IT is in fact a resource for a firm as per RBV because it can be used strategically to enhance a firm's agility, thereby creating a competitive advantage. Accordingly, innovative investment in IT will enhance firm performance (H1) even during times of industry turbulence (H2), which includes both periods of unanticipated industry growth (H3) and unanticipated industry downturn (H3). See Figure 1 for a summary of these hypotheses.

Figure 1: Detecting IT-based agility.



METHODOLOGY

Uncertainty in other IS productivity studies has stemmed from an ambiguity in the causality of their results. For example, Bharadwaj (2000) points out that, although there is positive association between IT investment and firm performance, the direction of causality is unclear.

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She interprets her findings as evidence that IT investment enhances a firm's competitive advantage and therefore leads to superior financial performance. An alternative interpretation would be that more profitable firms are more likely to have the resources available to make IT investments. Thus, the causality between the observed profitability and IT expenditures may be the opposite of that assumed by these studies.

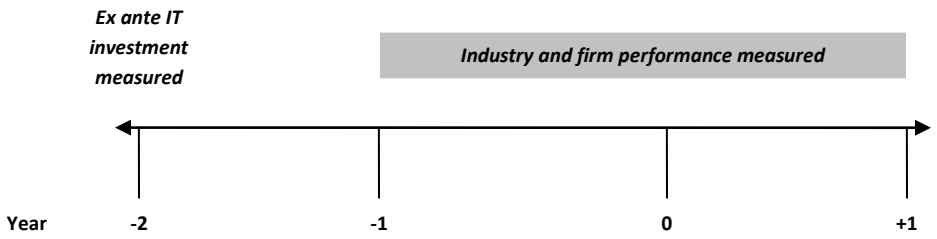
To avoid the question of causality, this study introduces a unique methodology that is new for IT payoff studies. It measures firms' IT capability in terms of IT investment *prior* to the turbulence experienced by their industry and then examines how the firms fared *during* the period of industry turbulence (either downturn or growth). This approach provides an advantage over measuring IT investment contemporaneously with firm performance because it eliminates the issue of causality. This ex ante methodology contributes a new approach to the body of literature examining the relationship between IT investment and firm performance.

To address our research question we borrow from the corporate finance literature and adapt the research methodology pioneered by Opler and Titman (1994), who investigate how firms' debt levels affect their financial performance.

Using accounting and stock return data, we identify industries (defined by 2-digit SIC) that experienced significant, *unanticipated* turbulence. We focus on both unexpected industry downturns as well as unexpected industry growth periods. An industry is identified as being economically distressed when the median sales growth (for the firms in that industry) is negative *and* when it experiences median stock returns of negative five percent or less. Similarly, an industry is identified as being in a growth period when median sales growth for the industry is positive *and* the median stock return is at least five percent. The large stock return criterion is necessary to ensure that the change in economic conditions for the industry was unanticipated by investors.

The year for which the industry economic downturn or growth criteria are satisfied is defined to be the base year. To ensure the proper causal direction and following the Opler and Titman (1994) model, our proxy for IT investment will be defined on an *ex ante* basis. We measure ex ante IT investment two years prior (year -2) to the base year (year 0) and observe firm performance from a year before (year -1) through a year after (year +1) base year. A timeline follows in Figure 2:

Figure 2: *Ex ante* measurement timeline.



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We measure the association between ex ante IT investment and three measures of two year firm performance (i) sales growth (ii) stock returns and (iii) growth in operating income. All three criteria will be measured relative to the 2-digit SIC industry median. Sales growth is used to measure the firm's success in exploiting the industry-wide disruption to increase market share. Operating income and stock returns indicate the firm's success in increasing profits and firm value by taking advantage of the industry-wide changes. Following Opler and Titman, we include research and development expenditures and capital expenditures as control variables.

Finally, we test the robustness of our results by also measuring the relation between ex ante IT investment 2 years prior and firm performance in the base year. To highlight the contribution of our approach of using ex ante IT investment we also examine the contemporaneous relationship between IT investment in the base year and firm performance during the base year.

DATA

Following prior research (Bharadwaj, 2000), we utilize the data from the annual *InformationWeek 500* issues on firms' IT expenditures. *InformationWeek* is a weekly print magazine read by nearly a half million business technology professionals. The *InformationWeek 500* has tracked the technology practices of the nation's largest and most innovative firms and is one of the most detailed sources of industry-specific IT budget information available. While the *InformationWeek 500* ranking originally was based on the size of the investment alone, it soon began to incorporate the innovation and efficiency of IT. Therefore, this ranking is an appropriate measure for IT investment as a firm resource as per the RBV (described above in the Theoretical Background section) because it takes into account both the value and the innovativeness associated with IT expenditure. We extracted the rankings (top 500 firms in terms of IT budget) from *InformationWeek 500* for the years 1990 thru 2003 yielding a total of 7,000 rank observations. These rankings serve as our proxy for innovative IT investment. We then rank the firms within their 2-digit SIC and industry-adjust all our variables by subtracting out the industry median. The data to calculate firm performance and control variables were obtained from Compustat and CRSP.

One limitation of the IT data that we use in this study is that it measures the firm's total IT investment, but does not provide us with information about the specific nature of the IT investment. It is therefore possible that some of the sample firms that we examine were investing in hardware upgrades while others were focused, for example, on ERP implementations -- which tend to spread over a long time-frame. The impact profile of these IT investments would therefore be very different.

Table 1 presents the industries represented in the full sample of 7,000 observations. Note that an individual firm may appear multiple times. For example, 3M Co. in the Paper and Allied Products industry (2 digit SIC is 26) made the top 500 ranking all 14 years covered in our study. Industries with the highest incidence of observations are: Commercial and Savings Banks (2 digit SIC is 60), Chemicals and Allied Products (2 digit SIC is 28), Electric, Gas, and Sanitary Services (2 digit SIC is 49), and Machinery and Equipment (2 digit SIC is 35).

Table 2 presents the descriptive statistics about the sample firms. Performance variable data was available for approximately 70% of the full sample. Data was far more restricted for the control

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variables, research and development expenditures and capital expenditures, therefore our multivariate tests will be based on fewer observations. The statistics reveal that much variation exists in the raw financial data with great dispersion between the minimum and maximum values and high standard deviations. The data is winsorized to the 99th and 1st percentiles before conducting the regression analyses to deal with potential outliers which could skew the results.

ANALYSIS OF RESULTS

Tables 3 through 6 report the results of our multivariate regression analyses. We rank the firms in each industry based on their IT investment, with the highest ranked firm assigned a rank of 1, the second highest ranked firm is assigned a rank of 2, etc. A positive coefficient for rank therefore indicates that the higher the number assigned for the rank (i.e. the lower the IT investment), the better the financial performance. Thus, a positive coefficient indicates a negative relationship between IT investment and firm performance. A negative coefficient for rank, on the other hand, indicates that the lower (i.e. better) the rank, the better the financial performance. Thus, a negative coefficient suggests a positive relationship between IT investment and firm performance.

Table 3 reports the results of the regression analysis used to investigate our more general hypotheses, H1 and H2, using the Opler & Titman (1994) model. To test H1, we measure ex ante IT investment (year -2) with firm performance over a 2-year period beginning with year-1 for all observations in the sample. The results, shown in Panel A, show a highly significant positive relationship in the univariate model across all independent variables. In the multivariate model, there is a significant positive relationship between IT investment and both sales and operating income before depreciation, however, there is a significant negative relationship between IT investment and returns. While investment in IT has a clear impact on performance in terms of internal firm measurements (sales and operating income), the external market evaluation of firm success does not seem to enjoy the same effect.

To test H2, we conduct the same analysis for only observations that occur during turbulent periods (both growth and downturn periods). The results, presented in Panel B, are not as strong. While we do see a significant positive relationship between IT investment and operating income after depreciation in the univariate model, the only significant relationship detected in the multivariate model is a negative relationship between IT investment and returns. Once again, the positive coefficient on returns in the multivariate model may indicate that the market underestimates the effectiveness of IT investment when looking at a larger sample. At first glance, this analysis seems to show that innovative investment in IT does not positively impact firm outcomes during times of unanticipated turbulence. However, our next analysis further investigates this issue by examining the sample based on the specific type of industry turbulence being experienced.

Tables 4 through 6 report the results of regression analyses testing the relationship between IT investment and firm performance during periods of industry growth and downturn separately (H3 and H4). Table 4 reports the regression results using the Opler & Titman (1994) model. We measure ex ante IT investment (year-2) with firm performance over a 2-year period beginning with year -1. During periods of unanticipated industry growth (Panel A), our univariate tests indicate a positive and significant relationship between IT investment and both operating income

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after depreciation and returns. Our multivariate results indicate a positive and significant relationship between IT investment and sales. During periods of unanticipated industry downturn (Panel B), however, there is a significant negative relationship between IT investment and operating income before depreciation in the univariate model, and returns in the univariate and multivariate models. These results suggest that during a period of unanticipated industry growth, firms did in fact benefit from prior IT investment expenditures. On the other hand, prior IT investment is associated with negative firm performance in a period of unanticipated industry downturn.

Table 5 reports the regression results on the association between ex ante IT investment (year -2) and base-year firm performance over a 1-year period beginning with year -1. During periods of unanticipated industry growth, there is a significant positive relationship between IT investment and both operating income after depreciation and returns in the univariate (but not multivariate) model. During periods of unanticipated industry downturn, there is a significant negative relationship between IT investment and operating income before depreciation in the univariate model, and between IT investment and returns in the univariate and multivariate models. These results are consistent with Table 4.

To test the robustness of our methodology, Table 6 reports the comparable regression results on the contemporaneous association between IT investment (year -1) and base-year firm performance over a 1-year period beginning with year -1. During periods of unanticipated industry growth, there is a significant positive relationship between IT investment and sales in the multivariate model. During periods of unanticipated industry downturn, there is a significant negative relationship between IT investment and operating income before depreciation in the univariate model, and between IT investment and both sales and returns in the univariate and multivariate models. While the results for downturn periods are consistent with Table 4, the results for growth are neither as strong nor as consistent indicating that the contemporaneous association, in fact, may not capture the full effects of IT investment.

DISCUSSION

The results of this analysis represent important contributions to the ongoing study of the value of investments in IT. From a methodological perspective, our findings suggest that examining the effects of ex-ante IT investment on firm performance does appear to yield different research results than a contemporaneous analysis. We believe that an ex-ante research approach allows for the time lag that one would expect for the IT investment to take effect and also addresses concerns about the causality of the relationship.

From a theoretical perspective, these results lend empirical support to the premise that IT is indeed a resource as defined by the Resource-Based View of the firm by showing that there is a significant positive relationship between investment in IT and firm results. Some indication that this is true even during industry turbulence in general gives mild support to the notion that the ability of IT to create agility is behind this relationship. In addition, the extended portion of the RBV theory that emphasizes the connection between internal firm resources and capabilities and the external industry environment finds support in the results of the current study. Based on the current results, there is clearly an important connection between the type of unexpected events within a firm's industry and its proficiency in using IT resources to enhance the agility that will

ISSN: 1543-5962-Printed Copy ISSN: 1941-6679-On-line Copy

help it respond. Accordingly, results show that agility is more readily detectable during times of unexpected industry growth than unexpected downturn.

In addition, our results build upon previous IT productivity literature by finding that the effect of IT investment on performance is partially determined by industry conditions, particularly the distinction between periods of growth and periods of downturn. This could be a possible explanation for the "productivity paradox" encountered by prior research. Some studies document a positive relationship between IT and performance; others do not find any relationship. Our findings indicate that the relation between IT investment and firm performance may be predicated by industry conditions and may explain the inability of prior research to find a consistent and unambiguous relationship.

From a practical perspective, strong evidence of a positive relationship between IT investment and firm performance, in the analysis of our full sample of observations, is an encouraging indication that innovative investment in IT enhances firm performance. Weaker results for the pared down sample including only those observations that occur during periods of turbulence (growth and downturn combined) seem at first to indicate that agility might not be the main means by which IT is innovated as a resource producing firm success. However, when those observations are further separated into growth and downturn periods and tested separately, we find an interesting distinction in our findings that potentially explains the weaker results in the previous analysis. In response to our main research question, as expected, our results indicate a fairly consistent pattern of beneficial impacts of IT investments during growth. This is reassuring evidence that investment in IT does in fact have the potential to enhance the competitive agility of a firm and H3 is supported. When resources are abundant, IT is clearly instrumental in allowing firms to identify and take advantage of expanding markets, new business relationships, and innovation possibilities. A mature IT portfolio helps a firm adapt to and navigate through the new opportunities.

However, our findings also indicated either negative or neutral impacts during periods of downturn. This is an indication that in times of crisis, realizing agility through IT might be a much more challenging pursuit. At the same time, although H4 is not supported, the importance of investing in IT even during economic downturn is highlighted, rather than rejected. It is probable that even though profits are masked by negative influences in the environment during economic hardship, the profits realized during growth periods make the investment in IT worthwhile. If through investment in IT firms can experience greater and longer periods of gain when industry conditions are positive, managers can remain hopeful that their continued investment in and attention to their IT portfolio will payoff in the long run even when the industry as a whole is facing difficult challenges.

It is worthwhile to note that internal measures of firm performance (such as sales and operating income) were not always consistent with the external measure of firm performance (namely, market returns) in their relationship to IT investment. For example, in the full sample, the first two indicators had a positive relationship with prior IT investment while returns showed a negative relationship. This is an indication that the market's perception of the value of IT is not consistent with its actual value in the performance of the firm. Investors seem to be undervaluing the significance of investment in IT. We are hopeful that the results of this study help to shed some light on the value and role of IT in firm performance especially during times

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of turbulent industry conditions. Since the value of IT investment specifically during times of industry growth seems to be understandably sufficiently appreciated by the market at large, we further discuss the role of IT investment during industry downturns.

While the current study does not clarify exactly how IT investment is impacted by hard economic times, the results obtained in this study are consistent with and might be elucidated by the findings of Leidner et al. (2003) who explore the cycle of IT management through changes in economic conditions. Based on interviews with CIOs, Leidner et al. describe that during times of growth, firms quickly add new IT capabilities and applications often without regard to the integration among them or the IT infrastructure that supports them. Then, as the economy slows and they are faced with cost constraints, firms curb new development and return to a focus on IT infrastructure needs. In many cases, they are even relegated to maintain the legacy environments. The current study supports and reinforces Leidner et al.'s message that unless IT organizations balance their investments between new development and infrastructure updates, they will not be able to maintain their agility through difficult economic times.

In fact infrastructure has often been highlighted as an impediment to agility (Daniel & Wilson, 2003; Weill et al., 2002). In particular, legacy systems and integration among them have been pinpointed as a major hindrance to the agility of businesses (Daniel & Wilson, 2003; Reddy & Reddy, 2002; van Oosterhout et al., 2006). While development of more adaptable IT infrastructures can be a solution to these problems (Weill et al., 2002), further research is necessary to identify if IT infrastructure is in fact underlying the difficulty to remain agile in a period of industry contraction.

A lesson that might be learned from the results of this study is that persistent attention to a well-balanced and functional IT portfolio is important even during slow economic times because it will likely payoff when the environment improves. In fact, practitioner literature in the current economic recession has echoed these sentiments: "CIOs need to ensure that IT emerges from this downturn as an integral, not marginalized, player in their firms' business strategy," (Tucci, 11/5/2008). Specifically, as indicated by related IT management research, it is further worthwhile for IT management to focus not only on added IT functionality to improve competitive advantage but to create an IT investment portfolio that will foster an IT environment that is adaptive even when new product development is not an option (for example, by investing in IT infrastructure). Another such example is the focus on agile diffusion of IT. IT-based innovations (Mathiassen & Pries-Heje, 2006) and "digital options" (Sambamurthy et al., 2003) are wonderful tools for competitive advantage. If, however, diffusion of new patterns of information flow are not easily absorbed by the rest of the organization, the advantage cannot be realized (Hovorka & Larsen, 2006; Mathiassen & Pries-Heje, 2006). Strictly developing and owning new IT solutions is not beneficial unless they are properly leveraged toward a competitive advantage (Pavlou & El Sawy, 2006).

CONCLUSION

Our research contributes to current IT literature in four distinct ways. First, it introduces a new approach to study the relation between IT investment and firm performance. Our research approach addresses the causality question by focusing on ex-ante IT investment and subsequent firm performance during periods of unanticipated industry disruptions. Second, our results

ISSN: 1543-5962-Printed Copy ISSN: 1941-6679-On-line Copy

confirm that investment in IT is a resource that can be used strategically to achieve agility for a firm and move toward a competitive advantage, as per the Resource-based View of the Firm. Third, our results indicate that industry conditions are a factor in the realized value of IT investments. Finally, we have been given reassurance that even when payoff results are not prominent because of a tumultuous environment in the industry, investment in IT is likely to encourage strong performance when more favorable conditions exist. We have also been able to learn something about the nature of IT investment for competitive agility. While agility during growth markets is fairly common, to become truly agile, a firm must focus on maintaining the competitive agility even during industry downturn. Balanced IT portfolios, adaptive infrastructure, and agile IT diffusion are all steps in the right direction.

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APPENDIX

TABLES

Table 1: Industries in sample.

N	2 digit SIC	Description
12	1	Agricultural Products
10	10	Metal Mining
14	12	Coal & Lignite Mining
88	13	Crude Petroleum & Natural Gas
17	14	Mining & Quarrying - Nonmetallic Materials
36	15	General Building Contractors
16	16	Heavy Construction Other Than Contractors
2	17	Construction - Special Trade Contractors
201	20	Food and Kindred Products
16	21	Tobacco Products
34	22	Textile Mill Products
29	23	Apparel and Other Fabric Products
40	24	Lumber and Wood Products
48	25	Furniture and Fixtures
149	26	Papers and Allied Products
146	27	Publishing and Printing
376	28	Chemicals and Allied Products
131	29	Petroleum and Coal Products
49	30	Rubber Products
24	32	Glass, Stone, and Concrete Products
114	33	Steel Works
89	34	Metal Products
314	35	Machinery and Equipment
184	36	Electronic and Other Electrical Equipment
280	37	Motor Vehicles, Aircraft, and Boats
170	38	Laboratory/Medical Instruments, Supplies, etc.
11	39	Jewelry, Toys, Musical and Sporting Products
59	40	Railroads
54	42	Trucking and Warehousing
11	44	Water Transportation
94	45	Air Transportation
12	47	Transportation Services
177	48	Communications and Broadcasting
374	49	Electric, Gas, and Sanitary Services
149	50	Wholesale-Durable Goods
113	51	Wholesale-Nondurable Goods
15	52	Retail-Building Materials, Hardware, Garden Supply
87	53	Retail-Department and Variety Stores
75	54	Retail-Food Stores
22	55	Retail-Auto Dealers and Gasoline Stations
49	56	Retail-Apparel and Accessory Stores
28	57	Retail-Home Furniture and Equipment Stores
45	58	Retail-Restaurants and Bars
78	59	Retail-Miscellaneous
410	60	Commercial and Savings Banks
73	61	Credit Institutions and Finance Services
57	62	Security and Commodity Brokers, Dealers, etc.
247	63	Insurance
28	64	Insurance Agents, Brokers, etc.
1	65	Real Estate
43	67	Patent Owners, Royalty Traders, etc.
11	70	Hotels and Other Lodging Places
7	72	Services-Personal Services
232	73	Services-Business Services
16	75	Services-Auto Repair, Services, and Parking
15	78	Services-Miscellaneous Repair Services
7	79	Services-Amusement and Recreation Services
36	80	Services-Health Services
18	87	Services-Engineering, Accounting, Research, etc.
31	99	Non-operating Establishments

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Table 2: Descriptive statistics.

Variable	N	Minimum (in millions)	Maximum (in millions)	Mean (in millions)	Median (in millions)	Std Deviation (in millions)
Assets	4,875	$ 0.96	$ 1,264,032	$ 22,681.91	$ 5,651.50	$ 69,816.96
Sales	4,876	-	257,157	9,906.00	4,368.40	18,580.34
Operating Income Before Depreciation	4,765	(5,743.00)	57,435	1,788.13	663.83	3,933.16
Operating Income After Depreciation	4,875	(7,613.00)	55,018	1,283.82	453.90	3,215.92
Research and Development Expenditures	2,461	-	8,900	410.19	82.70	959.54
Capital Expenditures	1,592	-	23,495	564.18	144.12	1,320.14
Return (1 year)	4,920	(0.99)	7.15	0.16	0.12	0.45

The total sample consists of 7,000 observations (top 500 rankings by InformationWeek for 14 years).

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Table 3: Regression results: 2 year performance - 2 year ex ante IT investment.

PANEL A: ALL OBSERVATIONS

	2 year sales			2 year operating income before depreciation			2 year operating income after depreciation			2 year returns		
	Coeff.	***t***	***Pr > t***	***Coeff.***	***t***	***Pr > t***	***Coeff.***	***t***	***Pr > t***	***Coeff.***	***t***	***Pr > t***
Univariate Model: n=7,410												
industry adjusted rank	(0.00472)	(30.96)	<.0001	(0.01286)	(6.21)	<.0001	(0.04299)	(32.80)	<.0001	(0.00627)	(36.11)	<.0001
Multivariate Model: n=1,141												
industry adjusted rank	(0.00495)	(2.72)	0.0066	0.00367	0.48	0.6283	(0.06366)	(1.75)	0.0796	0.00926	3.39	0.0007
research and dev't	0.91398	5.29	<.0001	(0.43294)	(0.60)	0.5476	2.21483	0.64	0.5204	0.23441	0.91	0.3656
capital expenditures	0.84207	2.81	0.0050	(1.06198)	(0.85)	0.3940	0.36787	0.06	0.9508	0.55156	1.23	0.2187

PANEL B: TURBULENCE OBSERVATIONS (growth and downturn combined)

	2 year sales			2 year operating income before depreciation			2 year operating income after depreciation			2 year returns		
	Coeff.	***t***	***Pr > t***	***Coeff.***	***t***	***Pr > t***	***Coeff.***	***t***	***Pr > t***	***Coeff.***	***t***	***Pr > t***
Univariate Model: n=2,858												
industry adjusted rank	0.00010	0.06	0.9502	(0.01773)	(0.63)	0.5260	(0.02779)	(1.91)	0.0562	(0.00183)	(1.19)	0.2328
Multivariate Model: n=555												
industry adjusted rank	(0.00454)	(1.61)	0.1082	0.01893	1.32	0.1876	(0.10403)	(1.40)	0.1620	0.00699	1.66	0.0974
research and dev't	1.49739	5.68	<.0001	(0.80317)	(0.60)	0.5492	5.28995	0.76	0.4463	0.33279	0.85	0.3979
capital expenditures	0.41439	0.85	0.3984	(2.66920)	(1.07)	0.2845	0.66313	0.05	0.9590	1.19857	1.64	0.1017

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Table 4: Regression Results: 2 year performance - 2 year ex ante IT investment.

PANEL A: GROWTH

	2 year sales			2 year operating income before depreciation			2 year operating income after depreciation			2 year returns		
	Coeff.	***t***	***Pr > t***	***Coeff.***	***t***	***Pr > t***	***Coeff.***	***t***	***Pr > t***	***Coeff.***	***t***	***Pr > t***
Univariate Model: n=2,677												
industry adjusted rank	(0.00002)	(0.01)	0.9891	(0.02005)	(0.68)	0.4943	(0.02663)	(2.43)	0.0153	(0.00266)	(1.70)	0.0883
Multivariate Model: n=470												
industry adjusted rank	(0.00495)	(2.72)	0.0066	0.00367	0.48	0.6283	(0.06366)	(1.75)	0.0796	0.00926	3.39	0.0007
research and dev't	0.91398	5.29	<.0001	(0.43294)	(0.60)	0.5476	2.21483	0.64	0.5204	0.23441	0.91	0.3656
capital expenditures	0.84207	2.81	0.0050	(1.06198)	(0.85)	0.3940	0.36787	0.06	0.9508	0.55156	1.23	0.2187

PANEL B: DOWNTURN

	2 year sales			2 year operating income before depreciation			2 year operating income after depreciation			2 year returns		
	Coeff.	***t***	***Pr > t***	***Coeff.***	***t***	***Pr > t***	***Coeff.***	***t***	***Pr > t***	***Coeff.***	***t***	***Pr > t***
Univariate Model: n=181												
industry adjusted rank	0.00605	0.76	0.4502	0.04928	2.79	0.0058	0.02971	0.11	0.9099	0.03280	3.44	0.0007
Multivariate Model: n=85												
industry adjusted rank	0.00702	1.01	0.3142	0.02581	1.29	0.2008	(0.56089)	(1.05)	0.2984	0.03184	2.67	0.0092
research and dev't	(0.45502)	(0.65)	0.5180	4.36357	2.16	0.0338	54.56576	1.01	0.3166	(2.02485)	(1.68)	0.0970
capital expenditures	1.73448	1.55	0.1251	5.29929	1.64	0.1046	76.89309	0.89	0.3766	0.07732	0.04	0.9681

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Table 5: Regression Results: 1 year performance - 2 year ex ante IT investment.

PANEL A: GROWTH

	1 year sales			1 year operating income before depreciation			1 year operating income after depreciation			1 year returns		
	Coeff.	*t*	*Pr > t*	*Coeff.*	*t*	*Pr > t*	*Coeff.*	*t*	*Pr > t*	*Coeff.*	*t*	*Pr > t*
Univariate Model: n=2,677												
industry adjusted rank	0.00043	0.64	0.5240	(0.01914)	(0.82)	0.4110	(0.01445)	(2.19)	0.0288	(0.00178)	(1.79)	0.0729
Multivariate Model: n=470												
industry adjusted rank	(0.00113)	(1.16)	0.2472	0.00209	0.26	0.7948	(0.02062)	(1.43)	0.1546	(0.00012)	(0.04)	0.9702
research and dev't	0.13211	1.46	0.1451	(0.22845)	(0.31)	0.7589	0.40554	0.30	0.7625	0.42813	1.45	0.1479
capital expenditures	0.49268	2.86	0.0044	(1.35393)	(0.96)	0.3390	1.58889	0.62	0.5336	0.51156	0.91	0.3628

PANEL B: DOWNTURN

	1 year sales			1 year operating income before depreciation			1 year operating income after depreciation			1 year returns		
	Coeff.	*t*	*Pr > t*	*Coeff.*	*t*	*Pr > t*	*Coeff.*	*t*	*Pr > t*	*Coeff.*	*t*	*Pr > t*
Univariate Model: n=181												
industry adjusted rank	0.00691	1.39	0.1659	0.02890	1.84	0.0674	0.01509	0.09	0.9248	0.01700	2.46	0.0147
Multivariate Model: n=85												
industry adjusted rank	0.00492	0.93	0.3551	0.02396	1.61	0.1119	(0.36689)	(1.13)	0.2603	0.02212	2.58	0.0118
research and dev't	(0.39573)	(0.74)	0.4610	0.22784	0.15	0.8802	27.63241	0.84	0.4006	(0.49151)	(0.57)	0.5726
capital expenditures	1.67273	1.96	0.0534	3.68301	1.53	0.1297	52.39135	1.00	0.3188	(1.13130)	(0.82)	0.4166

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Table 6: Regression Results: 1 year performance - contemporaneous IT investment.

PANEL A: GROWTH

	1 year sales			1 year operating income before depreciation			1 year operating income after depreciation			1 year returns		
	Coeff.	***t***	***Pr > t***	***Coeff.***	***t***	***Pr > t***	***Coeff.***	***t***	***Pr > t***	***Coeff.***	***t***	***Pr > t***
Univariate Model: n=2,493												
industry adjusted rank	0.00044	0.66	0.5112	(0.00567)	(1.18)	0.2380	(0.01352)	(1.44)	0.1514	0.00044	0.36	0.7203
Multivariate Model: n=332												
industry adjusted rank	(0.00249)	(1.68)	0.0937	(0.00404)	(0.50)	0.6174	(0.01367)	(1.37)	0.1703	0.00270	0.56	0.5739
research and dev't	0.69728	3.53	0.0005	2.30354	2.13	0.0338	2.35876	1.77	0.0770	1.29018	2.01	0.0452
capital expenditures	0.62606	2.41	0.0166	0.07126	0.05	0.9601	3.37099	1.93	0.0548	0.96595	1.14	0.2534

PANEL B: DOWNTURN

	1 year sales			1 year operating income before depreciation			1 year operating income after depreciation			1 year returns		
	Coeff.	***t***	***Pr > t***	***Coeff.***	***t***	***Pr > t***	***Coeff.***	***t***	***Pr > t***	***Coeff.***	***t***	***Pr > t***
Univariate Model: n=220												
industry adjusted rank	0.00810	2.42	0.0164	0.04930	1.98	0.0494	0.09632	0.86	0.3930	0.01877	3.81	0.0002
Multivariate Model: n=91												
industry adjusted rank	0.00602	1.92	0.0578	0.02190	1.52	0.1313	(0.00266)	(0.01)	0.9919	0.01289	1.82	0.0722
research and dev't	(0.04318)	(0.13)	0.8970	3.29613	2.16	0.0338	8.11441	0.29	0.7710	(0.55388)	(0.74)	0.4637
capital expenditures	1.00580	1.70	0.0930	4.81353	1.77	0.0804	40.78911	0.82	0.4120	0.83137	0.62	0.5366

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