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How Strategic Posture and Competitive Environment Influence Firms' Information Technology Investments: Theory and Evidence

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Abstract

This paper examines how strategic posture in IT investment with respect to industry peers (i.e., level of IT investment compared to the industry norm for IT investments) and competitive environment influence IT investments of a firm. We synthesize prior literature on determinants of IT investments and competitive dynamics to develop our theoretical framework. Using archival data for about 380 firms for the 1999 to 2006 period, we find that firms increase their IT investments under higher competitive uncertainty and higher industry competition. The results also indicate that firms differentiate from the industry norm in IT investments under higher competitive uncertainty and higher industry competition but imitate the industry norm in IT investments under higher industry dynamism and higher industry growth. Collectively, these findings provide new insights on how the competitive environment of a firm shapes strategic actions related to IT investments.

Keywords: Competitive Actions, Competitive Uncertainty, Industry Dynamism, Industry Competition, Industry growth, IT investments, IT strategy, Strategic Posture

Introduction

Information technology (IT) investments are a key component of a firm's strategy because IT investments create digital options, strengthen organizational capabilities and influence firm performance (Aral and Weill 2007; Barua and Mukhopadhyay 2000; Brynjolfsson and Hitt 1996; Dedrick, Gurbaxani and Kraemer 2003; Kohli and Devaraj 2003; Lucas 2008; Mithas and Jones 2007; Mithas, Krishnan and Fornell 2005; Mithas et al. 2008b; Rai, Patnayakuni and Seth 2006; Sambamurthy, Bharadwaj and Grover 2003; Tafti, Mithas and Krishnan 2008; Whitaker, Mithas and Krishnan 2007). Researchers have argued that appropriately deployed IT can enhance the efficiency and effectiveness of strategic levers of firms and provide a platform for undertaking disruptive moves in hypercompetitive and turbulent environments (Boynton 1993; Pavlou and El Sawy 2006; Sambamurthy 2000). IT investments, similar to other strategic actions such as those relating to R&D or marketing, are likely to be shaped by a firm's strategic posture (Smith, Ferrier and Ndofor 2001) but we know very little about why and how that occurs.

Although strategic posture can be viewed at multiple levels and from multiple perspectives (e.g., Chari, Devaraj and David 2008; Dewan, Michael and Min 1998; Miles et al. 1978; Porter and Millar 1985; Rust, Moorman and Dickson 2002; Sabherwal and Chan 2001), we focus here on strategic posture with respect to IT investments (i.e., level of IT investment compared to the industry norm). For example, amidst forecasts of economic recession, American Airlines invested in software that enhanced fuel efficiency by tailoring routes, flight paths, and baggage loading. This was clearly a strategic move as well as part of a newly developing industry norm to which other firms would be compelled to respond by imitation or differentiation (Lohr 2008). Yet, few studies have focused on how strategic posture of a firm and competitive environment affect IT investments, and how competitive environment moderates the relationship between strategic posture and IT investments.

In this paper, we study the influence of a firm's strategic posture with respect to IT investment and competitive environment (e.g., industry competitiveness, competitive uncertainty, industry dynamism, and industry growth) on firms' IT investments. We draw on previous research on competitive dynamics (Smith et al. 2001) and antecedents of IT investments (Dewan et al. 1998; Harris and Katz 1991; Sobol 1993) to develop our conceptual framework. While prior work provides useful insights on firm level determinants of IT (Dewan et al. 1998; Harris and Katz 1991; Sobol 1993), our goal here is to understand how firms determine their IT investments with respect to the industry norm, and how such strategic behavior is moderated by the competitive environment of a firm.

We define strategic posture of a firm as its relative positioning with respect to the industry norm in terms of levels of IT investments as percentage of sales. For example, depending on their theory of business and value discipline (Treacy and Wiersema 1993), firms may decide to spend more or less than the industry norm on IT investments. Firms are likely to maintain this strategic posture or relative position compared to the industry norm if they feel that differentiating with respect to the industry norm is a more desirable strategy. Conversely, firms will tend to gravitate towards the industry norm in their discretionary expenditure if they feel that isomorphism and "going along with industry competition" is likely to be a winning strategy.

In contrast to approaches focusing on the dyad of focal and rival firms, we consider normative forces in which managers respond not just to a single competitor but rather to the larger set of industry competitors. We believe this has particular salience in the case of IT investment for two reasons. First, managers often have relatively better information on an industry norm for IT investments than on the actions of a particular competitor. For example, while many research firms (e.g., Gartner, Forrester, IDC) and business publications (e.g., InformationWeek, Computerworld) publish average industry investments on IT, they usually do not reveal details on the IT investments of a specific competitor. Second, it is well known that managers have imperfect information and limited foresight on the optimal level of IT investments that they should make, due to the underlying complexities of IT-enabled business processes and inherent uncertainties regarding IT business value (Barney 1991; Mata, Fuerst and Barney 1995; Rumelt 1984). Under conditions of complexity and uncertainty, managers look to industry peers for frames of reference in determining firm strategy (Feigenbaum and Thomas 1994). We examine how firms respond to the industry norms of IT investment by updating their own IT investment in the subsequent year either towards or away from the norm. We also examine how firms' responsiveness to the industry norm is influenced by industry dynamics. Results suggest that normative signals exist and are influential, but firms' response to such signals depend upon industry concentration, dynamism, competitive uncertainty, and industry growth.

To our knowledge this is the first study that establishes the links between competitive actions, competitive environment, and IT investments. We extend prior work on competitive actions which has largely focused on more visible, externally focused, relatively frequent, discrete (firm either responds or does not respond to a competitive move) decisions such as pricing, capacity, geographic, marketing and product introductions (Chen and Miller 1994; Derfus et al. 2008; Smith et al. 2001; Young, Smith and Grimm 1996). Smith et al. (2001 p. 340) note that prior competitive dynamics studies "excluded the firm's internal actions (such as using new information systems, …)". This paper makes this contribution by examining strategic decisions related to IT investments that are more subtle, less visible, internal to a firm, more continuous in nature (as opposed to binary decisions such as whether to match the price cut or not) and typically visited less frequently (e.g., IT investment decisions may be considered annually compared to pricing adjustment decisions which may require weekly frequency) by top management team of a firm.

We structure the remainder of the paper as follows. Section 2 provides a description of the theoretical framework and research hypotheses. Section 3 describes the research design and methodology, and section 4 provides data analysis and results. We discuss the findings in section 5, followed by concluding remarks.

Theoretical Framework

One of the central questions in the information systems literature and managerial press relates to the extent to which IT investments are "strategic" (Carr 2003). Often, the "strategic" nature of IT investments is debated based on the extent to which IT systems allow firms to differentiate themselves from competition in their business processes and service offerings (Porter and Millar 1985). The Schumpeterian framework suggests an alternative approach to assess the strategic nature of IT investments by examining the extent to which firms are responsive to competitive moves (or industry norm in our case) in their external environment (Barnett and McKendrick 2004).

In a Schumpeterian context, firms attain a favorable market position by means of competitive moves—such as an innovation, a new product, an investment, an advertising campaign, or a pricing move. At least in the short term, the firm attains an advantage in sales or reputation over its competitors. Because these competitive moves are often externally observable, competitors try to match or exceed the action—destroying the advantage of the first-mover firm. It is through this dynamic that competitive advantages are continually created and destroyed. These notions are consistent with the idea of hypercompetition that pervades the modern economy; a phenomenon characterized by high industry clock-speeds (or industry dynamism), and low durations of market leadership (Brown and Eisenhardt 1997). It characterizes some industries, such as technologically-intensive industries, better than others.

Applying these notions to the firm's strategic decisions with respect to IT investments, many IT investments are externally observable—especially when manifested as products, services, or consumer-facing channels (ATMs, web sites, etc.) that are highly publicized (Dos Santos and Peffers 1995; Liang and Tanniru 2006-07). In addition, technological advances in IT, as well as broadly administered surveys that measure annual firm IT investment (aggregated at industry levels), are published in trade magazines such as InformationWeek. Hence, it is possible for firms to observe the industry norm in IT investments and formulate appropriate strategies in terms of differentiating from or imitating the industry norm. Because IT investments can help firms to create a competitive advantage or render old advantages obsolete, firms are likely to take appropriate IT investment decisions to shield themselves against the erosion of competitive advantage.

Against this backdrop, we ask the following questions: Are firms responsive to the industry norm in setting their IT investments? And, how does the competitive environment determine whether responsiveness takes the form of imitation to or differentiation from the industry norm in IT?

How Strategic Posture of a Firm Affects IT Investments: Do Firms Differentiate from or Imitate the Industry Norm?

IT investment decisions involve numerous complex and inter-related factors which make it difficult for managers to foresee all investment outcomes or to determine the optimal levels of investment. Since managers have imperfect information and limited foresight regarding the level of IT investment that is optimal, they look for signals from their competitive surroundings to ascertain the industry norm. The industry norm provides a frame of reference which managers can use to determine their subsequent strategic actions to either seek greater conformity to or differentiation from the norm. If managers are responsive to normative signals of IT investment, in either moving away or towards the norm, this will suggest not only that the normative signals are present, but also that there exists a strategic element in determining IT investment in relation to the industry competition. However, if managers are

unresponsive to normative signals, this will suggest that such signals are weak or imperceptible, or that IT investments are independent of strategic moves of other players in the industry (as reflected in the industry norm for IT investments) and are largely driven by internal efficiency or effectiveness considerations.

While the notion of IT investment as a strategic move suggests that firms respond to the industry norm in IT investments, prior theory provides conflicting arguments regarding whether the direction of response is towards or away from the mean. On one hand, since the underlying complexities of IT-enabled business processes make it difficult to determine the optimal levels of IT investment (Barney 1991; Mata et al. 1995; Rumelt 1984), the normative signals provided by industry peers can serve as a guidepost to managers. Normative pressures can arise as managers participate in professional organization functions or conferences, and relay information to one another regarding key firm investments (DiMaggio and Powell 1983). The inclination to follow industry trends becomes dominant in the relative absence of clear guidelines regarding decision making processes in which internal complexities are confounded with environmental uncertainty and volatility. Following the norm may be a consequence of risk-averse behavior among managers, who may believe that imitating the industry norms can make them less vulnerable to being singled out and held to blame should their investment decisions later prove to be sub-optimal. Further, it is understood that IT investments are often seen not just as potential source of competitive advantage, but also as a competitive necessity (Clemons and Row 1991). A firm may not be inclined to make a certain type of IT investment at first, such as offering a certain kind of free online service which can be costly. However, if other competitors are offering such a service, then following the suit becomes a matter of survival.

On the other hand, there is also a line of reasoning that suggests that firms will tend to diverge further from the industry norm as a means of enhancing their competitive positions as distinct and unique from others. Just as firms maintain their competitive positioning through differentiation in prices, product quality, or service, it is conceivable that firms may seek to further entrench themselves in unique competitive positions with respect to their IT investments. If industry peers are investing in certain IT systems that provide a particular type of service to customers, a firm that may find itself to be a laggard in such investments may choose to further reallocate resources away from IT and instead devote itself to establishing a niche in the offline substitute of that service. For example, when an airline finds itself to be a laggard in the IT investments geared towards cost reduction by improving flight routing or baggage delivery, it may instead choose to focus on premium services such as large leather seats and fancy onboard meals. On the other hand, when the industry peers are laggards in IT investments compared to the focal firm, that firm will seize upon the opportunity to become an IT investment leader so that it can provide unique products, services, or cost-reductions that would give it a strategically sustainable niche in the competitive environment (Craig and Tinaikar 2006; Puri 2007).

How Competitive Environment Affects IT Investments

Prior research in industrial economics and strategic management literature argues that the competitive environment of a firm has significant impact on its strategic actions and performance (Dess and Beard 1984; Keats and Hitt 1988; Scherer and Ross 1990; Smith et al. 2001). Extending the insights of this literature, IS researchers have also argued that the competitive environment of a firm will have significant impact on its IT investments (Dewan et al. 1998; Harris and Katz 1991; Sobol 1993). Because the competitive environment of a firm can be viewed from multiple angles and has many dimensions (e.g., see King and Sabherwal 1992; Smith et al. 2001), following prior research in IS literature, we focus here on four dimensions that are salient in our context: competitive uncertainty (Wade and Hulland 2004), industry dynamism or environmental turbulence (Melville, Gurbaxani and Kraemer 2007; Wade and Hulland 2004), industry competition or environmental complexity (Melville et al. 2007) and industry growth or environmental munificence (Wade and Hulland 2004). How are the above four dimensions of competitive environment likely to affect IT investments?

Competitive uncertainty is reflected in the heterogeneity of firm performance in a given industry—that is, the extent to which variations in performance are firm-specific and cannot be explained by market-level or industry-level variations in performance (Beckman, Haunschild and Phillips 2004; Durnev, Morck and Yeung 2004). Previous research has noted an increase in firm performance heterogeneity over time (Morck, Yeung and Yu 2000; Wei and Zhang 2006), and that IT-intensive industries feature greater firm-specific competitive uncertainty (Chun et al. 2007) . Higher competitive uncertainty may lead to higher IT investments because IT may allow firms to deal with competitive uncertainty in a more effective manner. This is because IT allows firms to become more agile, flexible and adept at reconfiguring and redeploying resources in fluid environments (Sambamurthy 2000; Sambamurthy et al. 2003). By integrating IT with key business processes and knowledge, firms are able to promote innovation in

managing production, supply chains and other key activities. Digitized enterprise work processes and work systems within organizational boundaries, and IT-enabled interorganizational relationships provide firms with flexibility to adapt to rapidly changing environments and high competitive uncertainty.

Industry dynamism refers to the unpredictable change in an industry (Lu and Ramamurthy 2004; Melville et al. 2007). One way to operationalize industry dynamism is the rate at which firms enter and exit an industry normalized by the number of firms in the industry, with higher ratios indicating greater industry dynamism (Thomas and D'Aveni 2004). We posit that higher industry dynamism is likely to be associated with higher IT investments because IT can allow firms to undertake a greater number of competitive actions and a more complex action repertoire to deal successfully with dynamic environment (Sambamurthy et al. 2003). A second argument for why industry dynamism will be positively associated with IT investments comes from the information processing theory of the firm (Galbraith 1973; Tushman and Nadler 1978). Following information processing theory, one can argue that dynamic environments would require greater information processing capabilities which can be met through superior IT capabilities and higher IT investments (Lu and Ramamurthy 2004).

Industry competition refers to the extent of competitive rivalry in an industry and is typically measured by an inverse measure called the Herfindahl-Hirschman Index (Scherer and Ross 1990; Waring 1996). Although higher industry competition may reduce the ability of a firm to sustain the gains from its IT investments, we posit that firms are likely to spend more on IT under higher industry competition because of the agility and flexibility advantages that IT confers in initiating and responding to competitive moves in an industry.

Industry growth refers to the growth in demand for an industry's output, with higher growth implying relatively less competition and less strategic aggressiveness (Ferrier and Lee 2000; Smith et al. 2001). We posit that higher industry growth will affect IT investments positively because IT can allow firms to scale up their operations using a standardized and integrated IT infrastructure. On the other hand, lack of IT can become a bottleneck and may prevent firms from maintaining or growing their market share in a munificent industry environment. Cisco provides a good example of a firm that made significant IT investments in its growth phase, so much so that John Chambers, the CEO of the Cisco is said to have remarked that "IT can have an unlimited budget" if business units are willing to provide funds (McAfee, McFarlan and Wagonfeld 2006) .

How Competitive Environment Moderates the Relationship between Strategic Posture and IT Investments

Factors in the competitive environment (uncertainty, dynamism, competition, and growth) are likely to moderate the relationship between strategic posture and IT investments, affecting the degree to which firms imitate or differentiate from the norm in IT expenditure.

Competitive Uncertainty: How might competitive uncertainty moderate the relationship between strategic posture and IT investments? We posit that firms are likely to differentiate from the industry norm under high competitive uncertainty but converge to the industry norm (i.e., imitate) under low competitive uncertainty. This is because high competitive uncertainty promises supernormal performance gains for innovators (Tripsas 1998), and offers greater room for firms to differentiate from rivals. Room for differentiation stems from high firm-specific variance in performance made possible by technologically disruptive advances, in particularly those brought about by investments in IT (Chun et al. 2007). Conversely, when firms are faced with less competitive uncertainty, it may be appropriate to imitate the industry norm in IT investments.

These arguments are consistent with other perspectives in the prior literature.[1] Companies can respond to an uncertain environment by increasing their information processing capability and creating inter-organizational links (Johnston and Carrico 1988). Low levels of uncertainty increase the tendency of an organization to remain stable and avoid changes because organizations seem confident of their ability to produce future returns while maintaining the status quo (O'Neill, Pouder and Buchholtz 1998) and avoiding the selection of major strategic directives (DiMaggio and Powell 1983). This argument is also consistent with models of organizational reorientation and transformation, which show that during periods of high certainty, organizations do not adopt new patterns of behavior (Mintzberg and Waters 1985; Tushman and Romanelli 1985). In contrast, during periods of high

[1] We thank an anonymous reviewer for this discussion.

uncertainty, stakeholders take an active position to pressure management to adopt strategies involving changes in technology and innovation (Abrahamson 1996). Thus,

Hypothesis 1: Firms are likely to differentiate from the industry norm under higher competitive uncertainty but imitate the industry norm under lower competitive uncertainty.

Industry Dynamism: How might industry dynamism moderate the relationship between strategic posture and IT investments? Dynamic industries are characterized by a continuous stream of innovations and competitive actions by industry players (D'Aveni 1994; Eisenhardt and Sull 2001). In a highly dynamic industry, the dominant position of incumbents may be destroyed by rivals or new entrants who own superior knowledge about the market and/or firm resource configuration (Sambamurthy et al. 2003). Socioeconomic or technological shifts may also uncover new market opportunities, bringing new players with new advantages to replace old ones (Thomas and D'Aveni 2004). Since dynamic industries are characterized by frequent entries, exits and structural instability, this environment may make it difficult for firms to clearly determine the optimal levels of IT investment or to forecast business value outcomes. Hence, under such conditions of instability and uncertainty, normative influences may be particularly strong as firms look externally for guidance in updating their IT investment levels. In contrast, a more stable industry environment may afford firms greater clarity in determining optimal IT investment levels and greater confidence to diverge from industry norms. Therefore, we posit that under higher industry dynamism, firms are more likely to imitate the industry norm in IT investments.

Hypothesis 2: Firms are likely to imitate the industry norm under higher industry dynamism but differentiate from the industry norm under lower industry dynamism.

Industry Competition: How might industry competition moderate the relationship between strategic posture and IT investments? Industrial organization literature suggests that dominant firms in less competitive (i.e., more concentrated) industries need to acknowledge their interdependence and tacitly coordinate with each other to leverage oligopoly rents (Scherer and Ross 1990). In addition, due to greater mutual awareness in a less crowded market, firm actions in less competitive industries are more likely to be noticed and mimicked by rival firms (Bain 1951). Hence, normative signals will have greater visibility and strength in industries that are more concentrated. Since it is easy to learn and anticipate the consequences of actions in less competitive (i.e., more concentrated) industries, firms are more likely to imitate actions taken by competitors and are more likely to imitate the industry norm (Derfus et al. 2008). The more visible a strategic move is to competitors, the more likely it is to be detected and imitated (Chen and Miller 1994). In contrast, when industry competition is higher (i.e., a more crowded field), firms can act in distinct and unique ways with less danger of being noticed, and hence, they can avoid a quick retaliatory or imitative response by competitors. Consequently, firms are inclined to differentiate from the industry norm under high industry competition, and more inclined to imitate the industry norm under high industry concentration.

Hypothesis 3: Firms are likely to differentiate from the industry norm under higher industry competition but imitate the industry norm under lower industry competition.

Industry Growth: How might industry growth moderate the relationship between strategic posture and IT investments? Under conditions of high industry growth, competition is generally less intense, profitability is generally higher and incumbents face less pressure from new entrants (Smith, Grimm and Gannon 1992), a condition characterized by industry munificence (Wade and Hulland 2004). High industry growth ensures that incumbents can maintain superior performance even though some market share is taken by new entrants (McDougall et al. 1994). Previous research suggests that in rapidly growing industries, competitive repertories are simpler, patterns of competitive actions are more predictable, and there are fewer motivations to carry out a sequence of competitive actions of significant duration (Smith et al. 2001). Hence, facing high industry growth, firms are less likely to differentiate from the industry norm.

Hypothesis 4: Firms are likely to imitate the industry norm under higher industry growth but differentiate from the industry norm under lower industry growth.

We identify and control for other variables that may be correlated with our focal variables and dependent variables: free cash flow, firm size and firm diversification. According to agency theory (Jensen and Meckling 1976), managers have incentives to invest the free cash flow on resources under their control rather than pay out the free cash flow to shareholders, even if the investments are not cost effective. Firm size can also influence IT investments

because compared with small firms, larger firms have more slack resources for IT investment, are more likely to achieve economies of scale, and are more capable of bearing the risk associated with IT investment and the lag between investment and returns (Dewan et al. 1998). Diversification influences IT investments because it increases the need for new internal coordination requirements associated with resource sharing across multiple lines of business or organizational units, and consequently increases the demand for information processing and IT (Dewan et al. 1998; Hitt 1999). From a resource-based perspective, firms expanding into multiple businesses have to develop such resources as flexible IT infrastructure and IT skills to manage the heterogeneity (Zhu and Kraemer 2005).

Method

Data

The data for this study come from two sources. First, we obtained the data related to IT investment from InformationWeek (IWeek) surveys from 1999 to 2006. InformationWeek surveys are considered to be reliable, and have been used in prior academic studies (Bharadwaj, Bharadwaj and Konsynski 1999; Rai, Patnayakuni and Patnayakuni 1997; Santhanam and Hartono 2003). Respondents are Chief Information Officers, Chief Technology Officers, or other most senior-level IT executives in the firm; those in the best position to be knowledgeable of firm IT investment figures and IT practices. The IT investment figure includes not only technology hardware, software, and systems, but also salaries and recruitment of IT professionals, IT-related services and training. Given the comprehensiveness of this measure in capturing all of a firm's IT-related expenses, this construct represents overall information-intensity of a firm's operations. Although different firms are included in the InformationWeek sample in each year, a given firm is present for an average of three out of the seven years.

Second, we retrieved and derived other firm and industry level variables from the Compustat North America database. This database provides the data used in calculations of indusry-environment variables including Herfindahl index, churn, competitive uncertainty, and industry growth. The final sample size included 381 firms and 1043 firm-year observations in the unbalanced panel dataset of firms present in at least one of the *InformationWeek* (IWeek) surveys from 1999 to 2006. The firms represent 63 different industries on the 3-digit NAICS level.

Variable Definitions

IT Investment (IT**)**: We measure IT investment (or IT intensity) as a percentage of revenue, as provided in a set of *InformationWeek* surveys from 1999 through 2006. Annual IT investment represents the sum of all expenses incurred by information systems department, including capital and operating expenses for infrastructure (telecom, networking, hardware, applications maintenance, applications development, and packaged applications); Internet-based costs; salaries and recruitment; IT services and outsourcing; and training.

Strategic Posture (STRATPOSTURE**)**: We measure the difference between the prior-year average industry level IT intensity at the three-digit NAICS level and prior-year firm-level IT intensity. When calculating this difference for a firm, we excluded the focal firm's IT investments in calculating the average IT-intensity in that industry. A positive and higher value of STRATPOSTURE means that a firm has set its strategic posture as a low IT-investments firm with respect to its industry rivals. A negative and higher value of STRATPOSTURE means that a firm has set its strategic posture as a high IT-investments firm with respect to its industry rivals.

Competitive Uncertainty (COMPUNC**)***:* We measure competitive uncertainty by adapting a measure of relative firm-specific variation, described by Morck et al. (2000), Beckman et al. (2004), Durnev, Morck and Yeung (2004), and Chun et al. (2007), which is based on Schumpeter's ideas of creative destruction. This measure captures the variation in market-value returns that is not explained by industry or market factors. To calculate this measure, we first specified the following regression equation:

$$r_{firm} = \text{Const} + \beta\, r_{industry} + (\text{Year1-Year10})\ \text{dummies} + \text{Industry dummies}$$

where r_{firm} is three-year growth in market value at the firm level, and $r_{industry}$ is marketshare-weighted average market value growth at the industry level calculated as $r_{industry} = (MV_t - MV_{t-3})/ (0.5*MV_t + 0.5*MV_{t-3})$. From this regression, we obtained the firm-specific residual for each firm $\varepsilon_i = y_i - \hat{y}$ and the systematic deviation $\varepsilon_s = \hat{y} - y_{avg}$, where $\hat{y}$ is the predicted firm-level return, y_i is the observed return, and y_{avg} is the sample mean return. We computed firm-specific variation σ_i^2 as the square of the firm-specific residual, and systematic variation σ_s^2 as the square of the systematic deviation. We define relative firm-specific variation, in a manner analogous to Chun et al. (2007) as

$$\psi_i = \ln(\sigma_i^2) - \ln(\sigma_s^2).$$

We obtain the mean of this figure at the industry-year level. This is a measure of heterogeneity in firm-performance in an industry.

Industry Dynamism (INDDYN**):** Following Thomas and D'Aveni (2004), we measure industry dynamism by a variable INDDYN computed as **(***entrance* + *attrition*)/*inddens*, where *entrance* denotes the number of firms that enter a three digit NAICS segment in a given year, *exit* denotes the number of firms that exit a three digit NAICS segment in a given year and *inddens* denotes the total number of firms in a three digit NAICS segment at the end of a given year.

Industry Growth (INDGROWTH**):** Three-year growth in the sum of total sales among all firms in each three digit NAICS industry: $(MS_t - MS_{t-3})/ (0.5*MS_t + 0.5*MS_{t-3})$, where MS is market size.

Herfindahl Index (HI**):** Measure of industry competitiveness and industry concentration, following the procedure described in Hou and Robinson (2006). The Herfindahl index for some industry j is measured as follows:

$$\text{Herfindahl}_j = \sum_i s_{ij}^2 \quad \text{where } s_{ij} \text{ is the market share of firm i in industry j.}$$

Firm Size: We measure firm size by natural log of number of employees.

Free Cash Flow: Measured, according to Compustat User's Guide, as the sum of Income before Extraordinary items (#18) and Depreciation and Amortization (#14).

Related Diversification: We used the entropy measure as in Bharadwaj et al. (1999) (except that we use the more modern industry classification scheme based on NAICS instead of that based on SIC):

$$\text{Er} = \text{Et} - \text{Eu} = \sum P_t \log(1/P_t) - \sum P_u \log(1/P_u)$$

Er is related component of entropy, Et is entropy as defined at the 4-digit NAICS level, Eu is entropy as defined at the 2-digit NAICS level, Pt is percentage of sales in each 4-digit NAICS industry and Pu is percentage of sales in each 2-digit NAICS category.

Table 1 provides descriptive statistics and zero-order correlations among variables. As expected, the Herfindahl index (a measure of industry concentration and inverse measure of industry competition) is negatively correlated with industry dynamism and competitive uncertainty. Firm size is positively correlated with free cash flow, and positively correlated with Herfindahl index (and hence negatively correlated with industry competition).

Figure 1 shows year-wise trends in IT investments for selected industries. It shows that industries vary significantly in their IT investments and some industries show greater year-to-year fluctuations than others. Figure 2 shows year-wise trends in strategic posture of selected firms. This figure shows that firms vary in their strategic posture and there is also within-firm variation over time in this variable. We leverage these variations to model IT investments of firms through our econometric models, which we discuss next.

Empirical Models and Econometric Issues

Our theory and hypotheses describe a set of conditions that influence a firm's *desired* levels of IT investment: strategic posture (i.e., where it wants to be with respect to the industry norm), competitive uncertainty, dynamism, industry competitiveness and industry growth. In developing the empirical model, we consider a firm's *actual* IT investment in response to the competitive environment as a movement or adjustment towards the desired level. Due to inertia in a firm's culture, high costs of adjustment, or rigidities in technological infrastructure, we expect that a firm's actual adjustments in IT expenditure represent only a fraction of the adjustments that are desired in response to competitive environment. One general econometric framework that is often used to model this kind of scenario is referred to as the *partial adjustment model* (Feigenbaum and Thomas 1994). Following this framework, we first specify the desired level of IT investment as:

$$y_{i,t}^* = \gamma_0 + (\gamma_1 \text{HI} + \gamma_2 \text{ INDDYN} + \gamma_3 \text{ COMPUNC} + \gamma_4 \text{ INDGROWTH}) \times (\text{STRATPOSTURE})$$

$$+ \gamma_5 \text{STRATPOSTURE} + \gamma_6 \text{HI} + \gamma_7 \text{COMPUNC} + \gamma_8 \text{INDDYN} + \gamma_9 \text{INDGROWTH} + X_C \gamma_C + u_i + \varepsilon_{i,t} \quad (1)$$

where HI is industry concentration (an inverse of competitiveness) measured by the Herfindahl index, INDDYN represents churn, a measure of industry dynamism, COMPUNC represents competitive uncertainty, STRATPOSTURE represents the industry average of IT expenditure minus the firm expenditure, INDGROWTH represents industry growth. The vector γ_C represents the coefficient estimates for the control variables including free cash flow, related diversification, the log of the number of employees, year dummy variables, and industry dummy variables at the level of two-digit NAICS codes. The desired level of IT expenditure by firm i at time t is represented by $y_{i\,t}$ *; and the firm-specific component of error is u_i.

In the partial adjustment model, the firm's actual adjustment in IT expenditure is some fraction (δ) of its desired adjustment. Formally,

$$y_{i,t} - y_{i,t-1} = \delta (y_{i,t}^* - y_{i,,t-1}) + \varepsilon^0_{i,t} \quad (2)$$

Combining and re-arranging equations (1) and (2), we have

$$y_{i,t} = (1-\delta)\, y_{i,t-1} + \delta \times \gamma_0 + (\gamma_1 \delta \text{HI} + \gamma_2 \delta \text{INDDYN} + \gamma_3 \delta\, \text{COMPUNC}$$

$$+ \gamma_4\, \delta \text{INDGROWTH}) \times (\text{STRATPOSTURE}) + \gamma_5 \delta \text{STRATPOSTURE} + \gamma_6 \delta \text{HI} + \gamma_7 \delta\, \text{COMPUNC}$$

$$+ \gamma_8 \delta \text{INDDYN} + \gamma_9 \delta\, \text{INDGROWTH} + X_C \gamma_C + \delta\, u_i + \delta\, \varepsilon_{i,t} + \varepsilon^0_{i,t}$$

Consolidating the coefficient terms, we can rewrite the above equation as an equivalent empirical estimation model:

$$y_{i,t} = \beta_0 + \alpha\, y_{i,t-1} + \beta_1 \text{HI} \times \text{STRATPOSTURE} + \beta_2 \text{INDDYN} \times \text{STRATPOSTURE}$$

$$+ \beta_3\, \text{COMPUNC} \times \text{STRATPOSTURE} + \beta_4\, \text{INDGROWTH} \times \text{STRATPOSTURE}$$

$$+ \beta_5 \text{STRATPOSTURE} + \beta_6\, \text{HI} + \beta_7\, \text{COMPUNC} + \beta_8\, \text{INDDYN} + \beta_9\, \text{INDGROWTH}$$

$$+ X_C \beta_C + u_i + \varepsilon_{i,t} \quad (3)$$

The resulting model can be used to test our hypotheses: Hypothesis 1 can be tested by estimating β_3, hypothesis 2 by β_2, hypothesis 3 by β_1, and hypothesis 4 by β_4. Because of the panel nature of our dataset, use of ordinary least squares (OLS) approach will not be appropriate for estimating equations (3) and (4) because OLS residuals across time for the same firm are likely to be correlated. The preferred way to estimate the parameters more efficiently and consistently is through panel models. A Breusch-Pagan Lagrange multplier (LM) test rejected the assumption of no firm-specific errors, suggesting that panel regression estimation techniques should be used rather than OLS. We interpret the results of the random effects panel estimator to describe our main findings for IT investment results. This estimation technique accounts for possible latent AR(1) error processes, while also capturing cross-sectional as well as longitudinal variations in the data. Table 2 shows the results of empirical estimation of the model in equation (3).

We performed several diagnostic checks to ascertain the stability of our results and did not detect any significant problems (Belsley, Kuh and Welsch 1980). We accounted for heteroskedastic error distribution and calculated heteroskedasticity consistent standard errors for all of our models. We tested for multi-collinearity by computing the variance inflation factors. The highest variance inflation factor in our models was well below nine, indicating that multi-collinearity is not a serious concern. Although some multi-collinearity is seen among the industry dummy variables, in principle they do nothing to affect the consistency of estimates and only somewhat reduce the efficiency of estimates (Kennedy 2003). Since the presence of industry dummy variables reduces the possibility of specification errors by controlling for additional systematic differences among industries, we retained both time and industry dummy variables in the model.

Results

Hypothesis 1 suggested that firms are likely to differentiate from the industry norm under higher competitive uncertainty but imitate their peers under lower competitive uncertainty. We find support for this hypothesis because the coefficient estimate for COMPUNC×STRATPOSTURE is negative and statistically significant (coefficient = -0.026, $p < .01$) implying that higher competitive uncertainty creates a differentiation effect while a lower competitive uncertainty creates an imitation effect.

Hypothesis 2 predicted that firms are likely to imitate the industry norm under higher industry dynamism but differentiate from their peers under lower industry dynamism. We find support for this hypothesis because the coefficient estimate for INDDYN×STRATPOSTURE is positive and statistically significant (coefficient = 0.908, $p < .01$).

Hypothesis 3 predicted that firms are likely to differentiate from the industry norm under higher industry competition but imitate their peers under lower industry competition. In other words, we expect that firms are likely to differentiate from their peers in industries characterized by lower Herfindahl index but imitate their peers in industries characterized by higher Herfindahl index. We find support for this hypothesis because the coefficient estimate for HI ×STRATPOSTURE is positive and statistically significant (coefficient = 1.469, $p < .01$) implying that higher industry concentration (i.e., lower industry competition) is associated with the imitation effect, or conversely, lower industry concentration (i.e., higher industry competition) is associated with the differentiation effect.

Hypothesis 4 predicted that firms are likely to imitate the industry norm under higher industry growth but differentiate from the industry norm under lower industry growth. We find support for this hypothesis because the coefficient estimate for STRATPOSTURE X INDGROWTH is positive and statistically significant (coefficient = 0.743, $p < .01$) implying an imitation effect under higher industry growth and differentiation effect under lower industry growth.

Among other results, we now discuss how strategic posture and competitive factors affect IT investments at the mean values of other variables. We find that, at the mean value of industry factors in the competitive environment, firms differentiate themselves from the industry norm in IT investments because the coefficient on STRATPOSTURE is negative and significant (coefficient = -0.096, $p < .01$). At the mean level of strategic posture, firms have higher IT investments under higher competitive uncertainty and higher industry competition. The coefficient for the competitive uncertainty variable is positive and statistically significant (coefficient = 0.0004, $p < .05$), and that for the industry concentration (i.e., HI) variable is negative and statistically significant (coefficient = -0.04, $p < .05$). We did not find support for the effect of industry growth and industry dynamism on IT investments at the mean level of strategic posture because the coefficients for the industry growth (INDGROWTH) and industry dynamism (INDDYN) variables are statistically insignificant.

Table 3 provides a summary of key results.

Discussion

This study provides several new insights. First, we find evidence that, at the mean value of industry factors, firms take into consideration the industry norm in IT investments to set their own IT investments. The results indicate that firms differentiate from the industry norm in their IT investments at the mean value of industry factors (e.g., competitive uncertainty, industry dynamism, industry competitiveness, and industry growth). Second, we find that firms increase their IT investments to deal with higher competitive uncertainty and industry competition in their environment at the mean value of strategic posture. Third, firms differentiate from the industry norm in IT investments under higher competitive uncertainty and higher industry competition but imitate the industry norm in IT investments under higher industry dynamism and higher industry growth.

This study has several research implications. First, the competitive environment of a firm influences a firm's strategic actions related to IT investments. Although prior studies have argued that competitive environment matters (Chiasson and Davidson 2005; Melville, Kraemer and Gurbaxani 2004; Wade and Hulland 2004) and some studies have empirically examined one or two dimensions of the competitive environment in firm performance models (Chiasson and Davidson 2005; Lu and Ramamurthy 2004; Melville et al. 2007; Wade and Hulland 2004), this study is perhaps the first comprehensive examination of four salient features of competitive environment in how they influence IT investments. Our research tests the importance of these industry factors as argued in prior work in IS and competitive dynamics literature. To the extent IT investments influence firm performance, our study also implies how competitive environment might influence firm performance.

Second, consistent with theoretical predictions, this study finds that firms differentiate from the industry norm in IT investments under higher competitive uncertainty and higher industry competition but imitate the industry norm in IT investments under higher industry growth and higher industry dynamism.

Among managerial implications, our results suggest that normative signals of IT investment exist, and that they become increasingly influential when industry concentration and dynamism are high. The finding that firms imitate the industry norm in IT investments under higher industry dynamism suggests that managers are more attuned to normative signals when industry turbulence and instability complicate IT business value forecasts. These results provide evidence for how managers view IT as a platform for undertaking strategic actions in response to actions of industry peers.

Like any other observational study, this study has some limitations that can be overcome in future research. First, given the nature of longitudinal data and panel models that we used, our findings appear fairly robust. However, we call for further studies with respect to other strategic actions related to IT to establish generalizability of our results. Second, while this study undertaken in the U.S. context shows that competitive environment matters in determining discretionary investments, the extent to which this finding generalizes across other national contexts such as in emerging economies requires further investigation. Third, like other studies, due to data limitations, we are unable to fully account for a firm's participation in multiple industries and focus primarily on the primary industry of a firm. While better data will certainly help, to the extent this issue is uncorrelated with the strategic posture, the findings are likely to be robust.

We identify several promising areas for further research that will contribute to both the IS and competitive dynamics literature. First, it will be useful to study the effect of IT resources and capabilities on the number of competitive actions and the complexity of action repertoire leading to financial performance of firms. Researchers can use or build on conceptualizations of IT resources and capabilities (Bharadwaj, Sambamurthy and Zmud 2002; Mithas, Ramasubbu and Sambamurthy 2008a; Rai et al. 2006) and competitive actions (Smith et al. 2001) to undertake such studies.

Second, this study focused on strategic decisions related to IT investments that are relatively less visible, internal to a firm, and more continuous in nature. Following prior work (Derfus et al. 2008; Smith et al. 2001), researchers should also study actions and reactions of focal and rival firms in terms of implementation of IT systems such as CRM systems, ERP systems and KM systems, which are more visible and discrete (response or non-response to a competitive move). IT investment relative to industry average is an important aspect of strategic posture of a firm, but firms can also have strategic posture with respect to other aspects of IT strategy. For instance, a firm's choice in allocating the IT investment between IT capital and IT labor may be an important feature of its IT strategic posture because higher allocations to IT labor may indicate a firm's desire to tailor its IT systems to create uniqueness or differentiation. There is a need to study these aspects of strategic posture.

Third, while we use annual data on IT investments to infer how firms adjust these investments as they become aware of the industry norm, future research can study announcements related to specific IT investments (such as those related to customer relationship management, or other enterprise systems), how focal firms' IT announcements are matched by competitors and in turn, how such competitive reactions affect focal firms' performance (see (Derfus et al. 2008) for an example). Such studies will complement prior IS studies that use event study methodologies to assess the impact of a focal firm's IT investment announcements on its own performance (Chatterjee, Pacini and Sambamurthy 2002; Dos Santos, Peffers and Mauer 1993; Im, Dow and Grover 2001). Such studies will also further our understanding of action-response dynamics among specific firms considering their market commonality and resource similarity as suggested in prior research (Chen 1996).

Finally, while we studied the role of competitive environment in shaping differentiation versus imitation with respect to the industry norm, it will be useful to consider the extent to which top management characteristics influence strategic orientation, differentiation versus imitation decisions and organizational outcomes (Chaganti and Sambharya 1987; Finkelstein and Hambrick 1996; Groysberg, McLean and Nohria 2006; Hambrick, Finkelstein and Mooney 2005; Hambrick and Mason 1984). Studies similar to the ones by Barker and Mueller (2002) that examine the impact of CEO characteristics on R&D investments need to be done for IT investments and firm performance.

To conclude, this study examines the role of competitive environment in influencing IT investments and firm performance. We find evidence that at the mean value of industry factors, firms tend to differentiate from the industry norm in their IT investments. Results also indicate that firms have higher IT investments under higher competitive uncertainty and higher industry competition. We find that firms differentiate from the industry norm in IT investments under higher competitive uncertainty and higher industry competition but imitate the industry norm

in IT investments under higher industry dynamism and higher industry growth. These findings enrich our understanding of how strategic posture and competitive environment shape a firm's strategic choices with respect to IT investments.

Figure 1. Year-wise Trends in IT Investments in Selected Industries

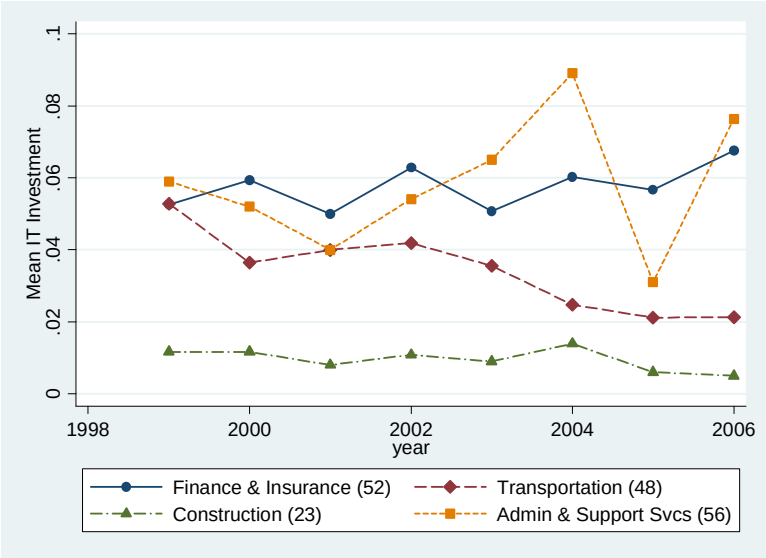
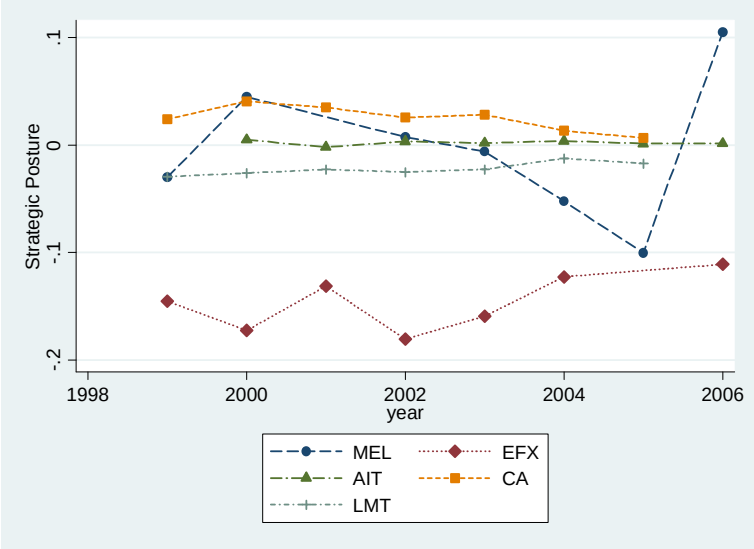


Figure 2. Year-wise Trends in Strategic Posture of Selected Firms



Notes: Strategic posture for IT is operationalized as the difference between the mean IT investments in an industry (as a percentage of sales) and a firm's IT investments. Positive values mean that a firm's IT investments is less than the mean IT investments in that industry while negative values mean that a firm spends more on IT than the mean IT investments in that industry. These charts show that (a) Equifax (EFX) stays above the mean in industry IT investments (b) Applied Industrial Tech (AIT) stays at the mean of industry IT investments (c) Mellon Financial Group (MEL) chases the mean of industry IT investments (d) Computer Associates (CA) remains at slightly below the mean of IT investments, and (e) Lockheed Martin (LMT) hovers just above the mean of industry IT investments.

Table 1. Descriptive Statistics and Correlations

	IT	STRATPOSTURE	INDDYN	Comp. Unc.	Industry Growth	Employees	Herf. Index	Free Cash Flow
IT	1.00							
STRATPOSTURE	-0.85*	1.00						
INDDYN	0.02	0.00	1.00					
Comp. Unc.	0.12*	-0.02	-0.01	1.00				
Industry Growth	0.00	-0.02	0.25*	-0.04	1.00			
Employees	-0.01	0.02	0.01	0.01	-0.07	1.00		
Herf. Index	-0.02	-0.01	-0.13*	-0.09*	-0.06	0.17*	1.00	
Free Cash Flow	0.01	0.00	0.05	0.04	0.01	0.46*	-0.06	1.00
N (observations)	1138	1138	1138	1138	1130	1138	1138	1138
Mean	0.03	0.0001	0.06	1.39	0.16	34.36	0.06	962
Std. Dev.	0.04	0.0441	0.04	2.61	0.19	49.70	0.05	2160
Min	0.00	-0.7090	0.00	-5.37	-0.47	0.09	0.01	-12300
Max	0.82	0.2603	0.27	8.84	0.78	416.50	0.41	21217

* statistically significant at $p<0.01$.

Note: IT and INDDYN are in percentages. Herf. Index is the square of a percentage. Employees are in thousands. Free Cash Flow is in millions of dollars. Competitive uncertainty is a unitless measure.

Table 2. How Strategic Posture and Competitive Environment Influence IT Investments (Dependent variable is IT investment)

	IT Investments
STRATPOSTURE (Industry Norm Minus Firm's IT Investments in Prior Period)	-0.096***
	(0.031)
β_1: STRATPOSTURE X HI	1.469***
	(0.475)
β_2: STRATPOSTURE X INDDYN	0.908***
	(0.386)
β_3: STRATPOSTURE X COMPUNC	-0.026***
	(0.008)
β_4: STRATPOSTURE X INDGROWTH	0.743***
	(0.098)
Lag Investment (IT)	0.228***
	(0.033)
Log(Employees)	0.002**
	(0.001)
INDDYN	0.024
	(0.020)
COMPUNC	0.0004**
	(0.0002)
HI	-0.04**
	(0.018)
INDGROWTH	-0.003
	(0.003)
Wald Chi-sqr	600.81***
Number of firms	381
Number of observations	1043

* significant at 10%; ** significant at 5%; *** significant at 1%; standard errors are in parentheses

The models include an intercept, free cash flow, related diversification, year and industry dummies. Variables included in interaction terms are mean centered.

Table 3: Summary of Results: How Firms Adjust their IT Investments depending on their Strategic Posture and Competitive Environment

		Competitive Environment							
		Low Competitive Uncertainty	***High Competitive Uncertainty***	***Low Industry Competition***	***High Industry Competition***	***Low Industry Dynamism***	***High Industry Dynamism***	***Low Industry Growth***	***High Industry Growth***
Strategic Posture	***More IT Investments than the Industry Norm***	Decrease in IT Investments in year t+1	Increase in IT Investments in year t+1	Decrease in IT Investments in year t+1	Increase in IT Investments in year t+1	Increase in IT Investments in year t+1	Decrease in IT Investments in year t+1	Increase in IT Investments in year t+1	Decrease in IT Investments in year t+1
	Less IT Investments than the Industry Norm	Increase in IT Investments in year t+1	Decrease in IT Investments in year t+1	Increase in IT Investments in year t+1	Decrease in IT Investments in year t+1	Decrease in IT Investments in year t+1	Increase in IT Investments in year t+1	Decrease IT in year t+1	Increase in IT Investments in year t+1
		Imitation towards the industry norm	Differentiation from the industry norm	Imitation towards the industry norm	Differentiation from the industry norm	Differentiation from the industry norm	Imitation towards the industry norm	Differentiation from the industry norm	Imitation towards the industry norm

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