

## Working Paper

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# Effect of Information Technology Investments on Customer Satisfaction: Theory and Evidence

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Ross School of Business Working Paper Series

Working Paper No. 971

June 2005

This paper can be downloaded without charge from the  
Social Sciences Research Network Electronic Paper Collection:  
<http://ssrn.com/abstract=901643>

15 June 2005

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Acknowledgements: We thank the Department Editor, Associate Editor, and two anonymous referees of Management Science for their help in improving this manuscript. We also thank seminar participants at the Workshop on Information Systems Economics (WISE) 2002, WISE 2003, International Conference on Information Systems (ICIS) 2004 Doctoral Consortium, University of Maryland at College Park, University of Southern California, Purdue University, Penn State University, Rensselaer Polytechnic Institute, University of Tulsa, California State University at San Marcos, Indian School of Business, Michigan State University Eli Broad College of Business, and the University of Michigan Ross School of Business for their comments. We acknowledge helpful suggestions and comments from Chris Achen, Ritu Agarwal, Rajiv Dewan, Omar El-Sawy, Alok Gupta, Il-Horn Hahn, Hank Lucas, Tridas Mukhopadhyay, V. Sambamurthy, Amit Seru, Ramanath Subramanyam, Arun Sundarajan, Phil Yetton, Bin Wang, and Jonathan Whitaker to improve this manuscript. We are grateful to InformationWeek and the National Quality Research Center at the University of Michigan for providing the data for this research. We also thank Stefan Dragolov and Eli Dragolov for their excellent research assistance. Financial support for this study was provided in part by the Michael R. and Mary Kay Hallman fellowship at the University of Michigan Ross School of Business.

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**Abstract**

This research addresses the following questions: Do information technology (IT) investments have an effect on customer satisfaction? What are the causal mechanisms that mediate the effect of IT systems on customer satisfaction? Does the effect of IT on customer satisfaction differ across industry sectors? Based on an analysis of longitudinal data on 50 U.S. firms for the period 1994-2000, we document the association between IT investments and customer satisfaction. We find support for the hypotheses that the effect of IT investments on customer satisfaction is mediated through the effect of IT on perceived quality and perceived value. Our results also indicate that the effect of IT investments on customer satisfaction differs between the manufacturing and service sectors. While prior work on the business value of IT at the firm level focused on financial and accounting measures, our research establishes the effect of IT investments on overall customer satisfaction of a firm. We propose and validate a theory of mediation effects of perceived quality and perceived value. This proposal has the potential to synthesize information systems effectiveness and marketing literature towards an integrative understanding of the relationship between IT investments and customer satisfaction.

## 1.0 INTRODUCTION

Customer relationships have emerged as a critical asset for firms, because the locus of power across industries and businesses is increasingly shifting towards customers. Firms are moving from a product-centric model to a customer-centric model to sense and meet customer demands for changes in the features of products and services, distribution channels, and pricing structure (Financial Times 2002; Nambisan 2002; Prahalad and Ramaswamy 2004; Seybold, Marshak and Lewis 2001). Customer satisfaction and customer retention have emerged as key metrics for measuring the effectiveness of IT systems and the competitive success of firms (Agarwal and Venkatesh 2002; Anderson, Fornell and Mazvancheryl 2004; Chen and Hitt 2002; Fornell and Wernerfelt 1988; Kambil et al. 2000). Research shows that higher levels of customer satisfaction have the potential to double or triple firm profits (Reichheld and Sasser 1990; Rose 1990).

To improve their customer satisfaction, firms are making greater use of IT tools in their internal and customer facing business processes (El Sawy and Bowles 1997; Srinivasan, Lilien and Rangaswamy 2002). Managers consistently rank “improvement in customer satisfaction” as one of the prime motivations for making IT investments. Significant investments in IT applications in recent years indicate the industry belief that IT applications can streamline both internal and customer-interfacing business processes (Chopra and Meindl 2003; Karimi, Somers and Gupta 2001; Romano and Fjermestad 2001). Since customer satisfaction is a leading indicator of firm performance (Ittner and Larcker 1998), it is important to understand the role of IT investments in enhancing customer satisfaction.

Much of the empirical research in business value of information systems focuses on the effect of IT expenditures on tangible measures of firm performance such as productivity or market value (Bharadwaj, Bharadwaj and Konsynski 1999; Brynjolfsson 1993; Brynjolfsson and Hitt 1996). Researchers are increasingly calling for the discovery of the effect of IT investments on intangible measures of firm performance, such as greater responsiveness to customers, more variety, and overall customer experience, which are reflected in customer satisfaction (Bharadwaj, Bharadwaj and Konsynski 1999; Brynjolfsson 1993; Brynjolfsson and Hitt 1996). Our study seeks to understand the effect of investments in IT systems on customer satisfaction by answering two primary research questions: (1) What is the effect of IT investments on customer satisfaction?, and (2) What are the causal mechanisms that mediate the effect of IT systems on customer satisfaction? We develop and validate our theoretical models using archival data on IT investments and customer satisfaction collected by reputable third-party organizations.

The remainder of the paper is structured as follows. Section 2 describes the theoretical framework and research hypotheses, and section 3 describes the research design and empirical models. We present the results in section 4, and discuss our results and provide concluding remarks in section 5.

### **2.0 THEORY AND HYPOTHESES**

Our goal in this study is to understand the effect of IT investments on customer satisfaction. In this section, we briefly review relevant prior literature on the business value of IT investments. This is followed by the theory underlying our hypotheses linking IT investments to customer satisfaction.

## 2.1 Prior Literature

The subject of business value from IT investments continues to attract significant interest in the business press and academic literature (Kohli and Devaraj 2003; The Economist 2002). Beginning with in-depth studies of specific IT applications at the firm level (Banker, Kauffman and Morey 1990; Banker and Kauffman 1991; Lucas 1975), this stream of literature now encompasses large sample empirical studies linking IT investments with outcome measures at the economy, firm, and process levels (for recent reviews of this literature, see Barua and Mukhopadhyay 2000; Dedrick, Gurbaxani and Kraemer 2003).

While previous research has provided valuable insights into the relationship between IT investments and business value, with the notable exception of Devaraj and Kohli's (2000) work in the health sector, very few studies have accounted for the customer perspective of the value gained from IT investments. Focusing on customer satisfaction is particularly relevant because customer relationships have emerged as a critical asset for firms, and customer satisfaction is positively associated with the market value of firms (Anderson, Fornell and Mazvancheryl 2004; Ittner and Larcker 1998). The quantification of intangible improvements in product quality, variety or consumption experience through a customer satisfaction index at the firm level complements the productivity-based measurement of economic growth (Waters 2004). Although information systems researchers have studied the effect of IT investments on consumer surplus and consumer welfare at the economy level (Brynjolfsson 1996; Hitt and Brynjolfsson 1996), to our knowledge there is no empirical study that links IT investments to customer satisfaction at the firm level across sectors.

## **2.2 Relating IT Investments to Customer Satisfaction**

Customer satisfaction is an important measure of firm performance because of its positive influence on customer loyalty (Anderson, Fornell and Rust 1997; Fornell 1992; Fornell 2001). Previous research has documented that increased customer loyalty secures future revenues, reduces the cost of future transactions, decreases price elasticity, and minimizes the likelihood of customer defection in the event of poor quality (Anderson 1996; Anderson and Sullivan 1993; Reichheld and Sasser 1990; Rust and Keiningham 1994). Customer satisfaction may also reduce costs related to warranties, complaints, defective goods, and field service costs (Anderson, Fornell and Lehmann 1994; Fornell 1992; Garvin 1988). Empirical evidence also suggests that customer perceptions of superior quality are associated with higher economic returns (Aaker and Jacobson 1994; Capon, Farley and Hoenig 1990; Fornell 2001; Nelson 1995). Naumann and Hoisington (2001) report positive associations between employee satisfaction, customer satisfaction, market share, and productivity measures at IBM Rochester. Several case-based research studies also find that customer satisfaction is positively associated with employee loyalty, cost competitiveness, profitable performance and long-term growth (Heskett, Sasser and Schlesinger 1997; Reichheld and Teal 1996). In a recent study of the relationship between customer satisfaction and shareholder return, Anderson, Fornell and Mazvancheryl (2004) find a strong relationship between customer satisfaction and Tobin's Q (as a measure of shareholder value) after controlling for fixed, random and unobservable factors. Finally, Fornell et al. (2005) show that firms with higher customer satisfaction provide higher stock returns with less risk.

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IT systems play an important role in enabling a firm's customer management capability. Ives and Learmonth (1984) were among the first researchers to recognize the role of information systems, and proposed a customer resource lifecycle (CRLC) model depicting how firms can deploy information technology tools to support different stages of their customers' purchasing process. They were soon followed by Porter and Millar (1985) who articulated the various roles that IT can play in the value chain of a firm to serve its customers better. More recently, in a conceptual paper, Sambamurthy, Bharadwaj and Grover (2003) provided a theoretical framework to understand the effect of IT infrastructure capabilities on the ability of firms to better manage customer knowledge. Their theory is based on the argument that deployment of the right IT systems may enable agile processes in the customer interface with firms, and thereby help in proactively managing customer information. Nambisan (2002b) presents a theoretical argument for the positive effect of an IT-enabled virtual customer environment on the effectiveness of new product development.

Among empirical studies, Rathnam, Whinston and Mahajan (1995) show how IT improves coordination among customer support teams. Similarly, Karimi, Somers and Gupta (2001) report that firms with better IT planning and integration are more effective at managing IT to improve customer service and thus at managing customer relationships. The role of IT in affecting customer satisfaction has attracted the attention of marketing researchers. In several studies, these researchers have acknowledged the potential impact of IT on the customer satisfaction performance of firms and have pointed to the need to study the relationship between IT investments and customer



satisfaction (Anderson, Fornell and Rust 1997; Bitner, Brown and Meuter 2000; Parasuraman 1996; Parasuraman and Grewal 2000). Thus,

*H1a: IT investments are positively associated with higher levels of customer satisfaction.*

### **2.3 Mediating Mechanisms of Perceived Quality and Perceived Value**

Linking IT investments with customer satisfaction requires an understanding of the antecedents of customer satisfaction at the firm level. Previous research points to several theoretical constructs as determinants of customer satisfaction at the firm level: *perceived quality*, *perceived value* and *customer expectations* (Anderson, Fornell and Rust 1997; Fornell 2001; Fornell et al. 1996). *Perceived quality*, which captures recent consumption experience, has two components: (a) customization, i.e. the degree to which the firm's offering is customized to meet heterogeneous customer needs, and (b) reliability, i.e. the degree to which a product or service is standardized and free from deficiencies. *Perceived value* refers to the perceived level of product quality vis-à-vis the price paid. Finally, *customer expectations* refer to customer perspectives on prior consumption experiences as well as customer beliefs in the firm's ability to deliver quality in the future. Empirical studies on the relative importance of these three determinants of customer satisfaction show that *perceived quality* has a significantly greater effect on customer satisfaction than does *perceived value* (Anderson and Sullivan 1993; Fornell et al. 1996), and that *customer expectations* do not play a major role in affecting customer satisfaction. Hence, this study focuses on understanding how IT influences the *perceived quality* and *perceived value* of a firm's offerings.

To establish that perceived quality and perceived value are two mediating mechanisms that explain the association between IT investments and customer

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satisfaction, we first understand how IT investments affect perceived quality and perceived value. Then we relate perceived quality and perceived value with customer satisfaction.

### **2.3.1 Effect of IT Investments on Perceived Quality and Perceived Value**

We posit that IT applications have the potential to enable firms to influence the *perceived quality* and *perceived value* of goods and services leading to an increase in customer satisfaction. For example, IT can enable both the determinants of *perceived quality* (customization and consistency of consumption experience) by capturing customer information and using such customer information to customize a firm's offerings and by providing a seamless service experience to customers. Bharadwaj, Bharadwaj and Konsynski (1999) have noted the importance of IT-enabled customization and improved customer service in creating intangible value for firms. In addition, by facilitating the seamless flow of information in an organization, IT enables business process transparency and efficient allocation of resources, shorter response times and improved quality. This in turn leads to improvement not only in the quality of the core products or services offered by a firm, but also in the quality of after sales support provided to customers. Further, IT also facilitates business process innovation by redefining and redirecting business relationships and core processes through new channels leading to significant improvements in total customer experience (Armstrong and Sambamurthy 1999). These outcomes may enhance the *perceived quality* of a firm's customer service, with a favorable impact on customer satisfaction. Thus,

*H1b: IT investments are positively associated with higher levels of perceived quality.*

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Besides its impact on *perceived quality*, IT may also affect the *perceived value* of a firm's offering. For example, IT may help in the automation of business processes leading to efficiency gains and cost reductions. Market mechanisms will transfer such efficiency gains to customers. For example, lean business processes and the effective use of IT capabilities have enabled Dell to provide higher perceived value to their customers. We argue that IT-enabled efficiency gains and cost reductions, if passed on to the consumers in the form of price reduction, may enhance the *perceived value* of a firm's offerings. In addition, even if the price of a firm's offering remains the same, IT investments in supply chain and ERP systems with end-to-end integration have the potential to improve perceived value from a customer viewpoint through quicker responses to customer inquiries and consistent order fulfillment processes. Thus,

*H1c: IT investments are positively associated with higher levels of perceived value.*

### **2.3.2 Mediating Effect of Perceived Quality and Perceived Value on Customer Satisfaction**

Customer satisfaction is a central concept in the marketing discipline, and researchers have investigated the antecedents of customer satisfaction at several levels - individual customer, transaction, firm, industry and economy (Fornell et al. 1996; Yi 1990). Although much of the early literature focused on the individual or transaction level of customer satisfaction, beginning with Fornell (1992), several studies have measured firm level customer satisfaction and its consequences for firm performance (Anderson and Fornell 2000; Anderson, Fornell and Lehmann 1994; Anderson, Fornell and Mazvancheryl 2004; Anderson, Fornell and Rust 1997; Anderson and Sullivan 1993; Fornell 1995; Fornell 2001; Fornell and Anderson 2000; Fornell et al. 1996). These

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studies basically adopt the expectation-disconfirmation paradigm and argue that *perceived quality*, which reflects recent consumption experience in terms of customization and reliability, has a positive effect on customer satisfaction. In order to make valid comparisons across firms, industries and sectors, these studies also consider the price information by including *perceived value* (i.e. perceived level of product quality vis-à-vis the price paid) in their conceptualization and models. Because several empirical studies have documented the positive effect of perceived quality and perceived value on customer satisfaction (Anderson and Sullivan 1993; Fornell et al. 1996), we do not specifically posit hypotheses linking perceived quality and perceived value with customer satisfaction in this paper. However, based on the discussion in the previous section and the foregoing discussion, we hypothesize that perceived quality and perceived value mediate the relationship between IT investments and customer satisfaction. Thus,

*H1d: The effect of IT investments on customer satisfaction is mediated by the effect of IT investments on perceived quality and perceived value.*

### **2.4 Moderating Effect of Firm Offering: Goods vs. Services**

In addition to considering the effect of IT investments on *perceived quality*, *perceived value* and *customer satisfaction*, there is a need to consider the moderating influence of the type of firm offering in these relationships. Prior research on the business value of IT has shown that the effect of IT investments may differ across manufacturing and service sectors, underscoring the need to understand these differences (Brynjolfsson and Hitt 1996; Kudyba and Diwan 2002). For example, in their study of the contribution of IT to firm output, Brynjolfsson and Hitt (1996) excluded all firms in the financial services and telecommunications industries from their sample arguing that

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their model “poorly predicted (p.549)” the output for such industries, pointing to the differences in the effect of IT across manufacturing and service firms. Several other studies also have failed to find any significant IT impact in the service sector (Quinn and Bailey 1994; Roach 1991).

Understanding the effect of IT across the manufacturing and service sectors requires examining the nature of customer interactions and experiences in each sector. Prahalad and Krishnan (1999) argue that the customer view of quality may differ between products and services. For example, customers who purchase a manufactured product may regard the conformance of the product features to specifications as important. However, in service businesses such as hospitality or airlines, customers may consider the “adaptive view of quality” (i.e., the flexibility to respond to the specific needs of individual customers) as equally or more important. Based on similar reasoning, marketing researchers have also argued that the drivers of customer equity may be different across sectors (Rust, Zeithaml and Lemon 2000). Additionally, compared to manufactured goods, it is also much more difficult to evaluate services using objective criteria because the consumption experience is very personal and subjective (Anderson, Fornell and Rust 1997). Following a similar line of reasoning, Johnson and Fornell (1991) have argued that average customer satisfaction should be higher for *goods* than for *services*.

Although services have lower *levels* of customer satisfaction, IT can play a greater role in enabling service sector companies to improve their customer satisfaction, because the service business is more information intensive. Barua and Mukhopadhyay (2000) note that the services sector may stand to gain more than the manufacturing sector

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from IT applications because services require adaptation to individual customer requirements, which can be accomplished by leveraging IT capabilities to customize product delivery and consumption experience in real time. For example, the innovative use of IT has enabled firms such as Amazon.com (retailing services) and Charles Schwab (financial services) to record high levels of customer satisfaction. Marketing researchers have also argued that IT may have greater leverage for achieving customer satisfaction in service businesses that are more information intensive (Anderson, Fornell and Rust 1997). Therefore, we expect IT investments to have a greater effect on perceived quality, perceived value and customer satisfaction for firms in the service sector compared with those in the manufacturing sector.

*H2a: IT investments will have a greater effect on perceived quality for firms in the service sector than for firms in the manufacturing sector.*

*H2b: IT investments will have a greater effect on perceived value for firms in the service sector than for firms in the manufacturing sector.*

*H2c: IT investments will have a greater effect on customer satisfaction for firms in the service sector than for firms in the manufacturing sector.*

Figure 1 shows the conceptual model used in this study.

---Insert Figure 1 about here---

### **3.0 RESEARCH DESIGN AND METHODOLOGY**

The data used in this study comprises an unbalanced panel of 50 firms during the period 1994 – 2000, for which both IT investment and customer satisfaction data are available. IT investment data comes from several annual InformationWeek surveys of top IT managers of Fortune 500 companies in North America. The data on customer

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satisfaction, perceived quality and perceived value comes from the National Quality Research Center (NQRC) at the University of Michigan Ross School of Business. The NQRC tracks more than 150 U.S. firms on their customer satisfaction performance through its American Customer Satisfaction Index (ACSI). The IT and customer satisfaction data for firms in our panel are matched to the other financial databases for data on control variables.

Table 2 provides a summary profile of the firms in our sample. Out of the 50 firms in our panel, 10 appear only once, 15 appear in twice, 15 appear three times, and the remaining 10 appear four times during a period of five years covered by 1994-1996 and 1999-2000. InformationWeek data for 1997 and 1998 is not available for any of the firms. In our panel, 28 firms belong to the manufacturing sector and 22 belong to the services sector.

### **3.1 Variable Definition**

*ACSI:* ACSI refers to the American Customer Satisfaction Index tracked by the National Quality Research Center (NQRC) at the University of Michigan Ross School of Business. An individual firm's ACSI score represents its customers' overall evaluation of their total purchase and consumption experience (Refer Fornell et al. 1996 for details of ACSI measurement, pattern and range across industries). The ACSI covers over 40% of the U.S. gross domestic product, including both the public and private sectors. Each year, the NQRC surveys a total of about 50,000 customers who purchase products from over 150 companies (200-250 customers from each company) and asks these consumers to score companies on a scale to determine overall customer satisfaction for a company. Use of the ACSI methodology ensures a uniform, independent, customer-based,

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cumulative, and comparable firm-level customer satisfaction measure across industries and sectors of the U.S. economy. Customers are contacted by random digit dialing and each respondent answers questions on 15 measurement variables on a 10-point scale that are used as indicators of six latent constructs including overall customer satisfaction, perceived quality and perceived value. ACSI is embedded in a cause-and-effect model and a version of partial least squares (PLS) is used to estimate this model. PLS estimates weights for the survey measures to maximize the explained variance in customer loyalty as the ultimate dependent variable. These estimated weights are subsequently used to form the ACSI, perceived quality and perceived value indices on a 0-100 scale.

The ACSI is considered to be a reliable indicator of a firm's customer satisfaction, and the aggregate report of this index is published by leading business publications including the Wall Street Journal and Fortune magazine. This data has also been used in a number of widely cited academic studies in the accounting and marketing literature (Anderson, Fornell and Mazvancheryl 2004; Fornell et al. 1996; Ittner and Larcker 1996; Ittner and Larcker 1998). It is important to note that ACSI measures customer satisfaction for only those products and services that are consumed by a firm's end customers, i.e. the ACSI primarily covers satisfaction with consumer transactions.

*PERQUAL*: This variable refers to the perceived quality of a firm's offerings and is obtained from the NQRC (for details on the measurement property of this variable, refer to Fornell et al. (1996). In the ACSI methodology described above, perceived quality is measured by asking customers to rate their recent experience with a product or service on overall post purchase evaluation of perceived quality, perceived customization and perceived reliability.



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*PERVAL*: This variable refers to the perceived value of a firm's offerings and is obtained from the NQRC (for details on the measurement property of this variable, refer Fornell et al. (1996)). Perceived value is measured by asking about quality relative to price, and price relative to quality. Note that perceived quality and perceived value constructs are inter-related, and the ACSI model explicitly accounts for this interrelationship through its measurement and structural model.

*ITINVPC*: This variable refers to the level of IT investment as a percentage of the firm's sales revenue. We obtained firm-level IT-investment data from the Information Week annual surveys of top IT managers in North America. Information Week is considered to be a reliable source of information, and previous academic studies have also have used data from Information Week surveys (Bharadwaj, Bharadwaj and Konsynski 1999; Kudyba and Diwan 2002; Rai, Patnayakuni and Patnayakuni 1997; Santhanam and Hartono 2003).

*MFG (Sector)*: This is an indicator variable representing whether the company belongs to the manufacturing sector or the service sector (0=service, 1=manufacturing). The service sector included firms from the hospitality, airline and financial services industries, and the manufacturing sector included firms that manufacture durable and non-durable goods..

*HHI (Industry Concentration)*: Arguably, the relative market concentration of a firm in a given industry may influence customer perceptions of its products and services and eventually affect customer satisfaction. Hence, in the marketing literature, industry concentration measures for firms are used as a control variable. We collected market share data from databases such as Compustat, Table Search and Market Share Guide to

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compute the Hirschman-Herfindahl Index (HHI), one of the widely accepted measures of market concentration (Curry and George 1983). HHI computation is based on the SIC based industry classification of firms. In most of the cases, we calculated HHI at the four digit industry level, but we also made use of market share data if it was available at a finer level for some industries in our dataset from sources such as Table Search and Market Share Guide.

*YEAR*: Year is an indicator variable (0=1994-1996; 1=1999-2000). Since firms were investing aggressively in information technology to open new Internet-based channels for conducting business from 1994-2000 and this trend is believed to have peaked during the 1999-2000 period, it is important to look for any structural shifts in the role of IT investments over time. Findings of previous studies also suggest a consideration of such structural shifts. For example, Brynjolfsson and Hitt (1996) and Bharadwaj et al. (1999) observed that IT was showing a continually declining contribution to productivity and market value, respectively, in their samples of firms. The use of this dummy indicator in our regression model allows us to control for any unobserved systematic effects during the two time periods (1994-1996 and 1999-2000).

Table 1 provides a summary of the variables and data sources used in the study. Table 2 provides summary statistics for the variables used in the study. Table 3 provides correlations among variables. As would be expected, customer satisfaction, perceived quality and perceived value have high correlations because of the valid functional relationship (they form a nomological net) among these variables. Such correlations do not pose a problem for theory testing (Podsakoff and Organ 1986). To the extent that

these correlations may have implications for the stability of parameter estimates, we conducted relevant multi-collinearity diagnostic tests as reported later.

**---Insert Tables 1-3 about here---**

### **3.2 Construct Validity**

As noted above, the customer satisfaction and related constructs such as perceived quality and perceived value used in this study have been extensively used and peer reviewed in the marketing and accounting literature (Fornell 1992; Fornell et al. 1996; Ittner and Larcker 1998). Anderson and Fornell (2000) and Fornell (1992) provide a detailed discussion of the measurement properties of these constructs including the construct validity (comprising trait and nomological validity). The ACSI methodology distinguishes between ACSI, PERQUAL and PERVAL conceptually and empirically, and at the same time accounts for the nomological net of relationships among these constructs. There is evidence for discriminant validity, because covariance between the questions measuring ACSI is higher than the covariance between the ACSI and any other construct in the model (Anderson and Fornell 2000; Fornell et al. 1996). There is also evidence for nomological validity in terms of high latent variable covariance explained in the model (Anderson and Fornell 2000; Fornell et al. 1996). Previous research has used such constructs derived from the ACSI model to study the consequences of customer satisfaction for firm performance (Anderson, Fornell and Mazvancheryl 2004; Anderson, Fornell and Rust 1997; Anderson and Sullivan 1993).

### **3.3 Empirical Models and Econometric Issues**

We use a linear model estimation approach to relate IT investments to customer satisfaction levels. Based on findings in past research, we control for other variables that

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may influence the relationship between IT investments and customer satisfaction performance such as market concentration, industry sector, and time period. Our empirical models are shown below:

$$PERQUAL = \alpha_{10} + \alpha_{11} MFG + \alpha_{12} ITINVPC + \alpha_{13} MFG*ITINVPC + \alpha_{14} HHI + \alpha_{15} YEAR + \alpha_{16} YEAR*ITINVPC + \varepsilon_{1a} \quad (1A)$$

$$PERVAL = \alpha_{20} + \alpha_{21} MFG + \alpha_{22} ITINVPC + \alpha_{23} MFG*ITINVPC + \alpha_{24} HHI + \alpha_{25} YEAR + \alpha_{26} YEAR*ITINVPC + \varepsilon_{1b} \quad (1B)$$

$$ACSI = \alpha_{30} + \alpha_{31} MFG + \alpha_{32} ITINVPC + \alpha_{33} MFG*ITINVPC + \alpha_{34} HHI + \alpha_{35} YEAR + \alpha_{36} YEAR*ITINVPC + \varepsilon_{1c} \quad (1C)$$

$$ACSI = \alpha_{40} + \alpha_{41} MFG + \alpha_{42} ITINVPC + \alpha_{43} MFG*ITINVPC + \alpha_{44} HHI + \alpha_{45} YEAR + \alpha_{46} YEAR*ITINVPC + \alpha_{47} PERQUAL + \alpha_{48} PERVAL + \varepsilon_{1d} \quad (1D)$$

With the panel nature of our dataset, the OLS approach for estimating equations (1A) – (1D) may not be appropriate, because the residuals across time for the same firms may be correlated. Since firms in our sample may be considered as a draw from a larger population of firms, an alternative and preferred way to estimate the parameters more efficiently is through random effects models. Random effects models not only allow correlations among residuals of firms across time periods, but also control for unobservable firm specific effects (Baltagi 2001). We estimated the models in equations (1A) – (1D) allowing the intercept to vary across individual firms (Greene 2000; Wooldridge 2002). We tested for the significance of random effects using the Breusch and Pagan (1980) Lagrange multiplier test. This test statistic exceeded the critical value of chi-square with one degree of freedom, rejecting the null hypothesis and favoring the random effects models.

Since the random effects models provides consistent estimates only if firm-specific effects are uncorrelated with other explanatory variables, we used the Hausman

specification test (1978) to evaluate the validity of this independence assumption. Our failure to reject the null under this test provided further justification for the appropriateness of the random effects models used in this research.

We conducted additional analyses to check the sensitivity of our results. Although random effects models typically use exchangeable covariance structure, we also specified the AR(1) covariance structure as a robustness check and obtained essentially similar results. We also estimated the fixed effects models that handle unobserved heterogeneity by computing within-firm estimates of coefficients. This approach uses only the variation within a firm across time to estimate regression coefficients rather than using between-firm variation. Hence, fixed effects models are relatively less efficient than random effects models, but relax the independence assumption used in random effects models. We obtained essentially similar coefficients in our fixed effects models, providing greater confidence in our random effects model results.

Finally, we estimated our models using simultaneous equation models that allow correlation among error terms across customer satisfaction, perceived quality and perceived value equations, and also obtained broadly similar results. However, simultaneous equation models are highly sensitive to specification errors, and a specification error in one equation has the effect of making the whole model biased and inconsistent (Greene 2000). Johnston and DiNardo (1997) specifically note “Systems methods of estimation are, in principle, more efficient than single equation methods, **provided the system specification is correct** (emphasis in original). Therein lies the rub: misspecification of a single equation can contaminate all estimates in the system (p.

318).” Furthermore, use of simultaneous equation methods such as two or three stage least squares entails making strong assumptions in the form of exclusion restrictions to identify such models. Therefore, following previous research (Barua, Kriebel and Mukhopadhyay 1995; Bharadwaj, Bharadwaj and Konsynski 1999; Brynjolfsson and Hitt 1996; Faraj and Sproull 2000), we use more conservative single equation models in this paper. The single equation random effects models used in this paper are considered as the most sophisticated and innovative way of dealing with longitudinal panel data (Greene 2000). We therefore interpret the random effects models to discuss our results.

As shown in Table 4, the explanatory power of our models is reasonable as shown by the overall R square values. For all the models shown in equations (1A) - (1D), we performed several diagnostic checks to ascertain the stability of our results. As noted above, since the correlation between PERVAL and PERQUAL may affect the stability of our model estimates, we tested for multi-collinearity by computing the variance inflation factors (Belsley, Kuh and Welsch 1980). The highest mean variance inflation factor in our models (less than 7) was lower than the threshold specified in the literature, indicating that multi-collinearity is not a serious concern in our analysis. We also calculated Hat values to check for leverage, and studentized residuals to detect outlying cases. Our analysis of measures of influence (DFbetas and Cook’s distance) did not suggest the presence of influential observations in our sample.

The results of estimation of equations (1A) - (1D) are shown in Table 4.

**---Insert Table 4 about here---**

#### 4.0 RESULTS

Hypotheses 1a, 1b and 1c predicted a positive effect of IT investments on customer satisfaction, perceived quality and perceived value, respectively. As shown in Table 4, these hypotheses were fully supported for firms in the services sector for the 1994-96 period. We find from Table 4 that the coefficients of the variable ITINVPC ( $\alpha_{12}$ ,  $\alpha_{22}$  and  $\alpha_{32}$ ) are positive and highly significant in perceived quality, perceived value and customer satisfaction models. As Table 4 shows, an increase of one percentage point in IT investments (as a percentage of sales revenues) in the service sector during 1994-96 is associated with an increase of 0.939 ( $\alpha_{12}$ ) in perceived quality, 0.598 ( $\alpha_{22}$ ) in perceived value and 1.050 ( $\alpha_{32}$ ) in ACSI scores. All these coefficients ( $\alpha_{12}$ ,  $\alpha_{22}$  and  $\alpha_{32}$ ) are statistically significant at  $p < 0.05$ . Although Table 4 shows marginally negative effects of IT investments in the manufacturing sector during the 1994-96 period ( $\alpha_{12} + \alpha_{13} = -0.036$  for perceived quality,  $\alpha_{22} + \alpha_{23} = -0.136$  for perceived value and  $\alpha_{32} + \alpha_{33} = -0.080$  for customer satisfaction), none of these effects are statistically significant at  $p < 0.05$  in the Wald tests of the joint significance.

We tested for the effect of IT investments on customer satisfaction being mediated through perceived quality and perceived value (H1d), following a procedure suggested by Baron and Kenny (1986). In this procedure, mediation is said to occur when (1) an independent variable X (such as IT investments in our case) significantly accounts for variation in a mediating variable M (e.g. perceived value or perceived quality), (2) the mediating variable M accounts for variation in the ultimate dependent variable Y (e.g. customer satisfaction), and (3) controlling for the mediating variable M reduces the previously significant relationship between X and Y when not controlling for

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M. If controlling for M causes the effect of X on Y to become insignificant, this occurrence suggests that effect of X on Y is fully mediated by M. However, we infer partial mediation if M reduces the strength of relationship between X and Y without making it insignificant. Since the effect of IT investments on customer satisfaction becomes insignificant at the conventional significance level of 5% when perceived quality and perceived value are controlled for, our results provide support to the mediation hypothesis (see Column 4 in Table 4) for the period 1994-96 for service firms. However, since the interaction term involving manufacturing and IT investments is significant at the 5% level, our results suggest that IT investments may also have direct effects on customer satisfaction, suggesting a partial mediation effect for manufacturing firms.

Our results show partial support for Hypothesis 2. We find that firms in the service sector perform significantly better than firms in the manufacturing sector in leveraging IT to improve *perceived quality* and *customer satisfaction*. The negative and statistically significant interaction term involving IT investments and industry sector (manufacturing or service) in perceived quality ( $\alpha_{13} = -0.975$ ,  $p < 0.012$ ) and ACSI models ( $\alpha_{33} = -1.130$ ,  $p < 0.009$ ) indicates that for manufacturing firms, higher IT investments are associated with relatively lower perceived quality and customer satisfaction. However, the lack of significance of the interaction term involving IT investments and industry sector in the *perceived value* model ( $\alpha_{23} = -0.734$ ,  $p < 0.130$ ) suggests that our results provide no evidence to support any differential effect of IT investments on perceived value during 1994-96 across industry sectors.



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These results provide evidence that firms in the service sector perform significantly better than firms in the manufacturing sector in leveraging IT to improve *perceived quality* and *customer satisfaction*. As noted earlier, one reason for this result may be that IT applications are enabling firms in service industries to better understand customer needs and to provide flexibility in business processes for adapting to the specific requirements of each customer. In addition, the nature of the service business is such that consumers may experience the effect of IT-enabled business processes flexibility and convenience more directly. For example, IT applications can be used in the hospitality industry to track the preferences of each customer based on past experiences and tailor new service features that will delight these customers on their next business encounter. Piccoli and Applegate (2003) lend support to this explanation and describe how Wyndham Hotels used IT to improve its customer satisfaction. Such use of IT applications in the service industry may be one of the reasons for the positive association between IT investments and customer satisfaction. In contrast, for manufacturing firms, a larger proportion of IT investments may be deployed to streamline backend business processes, such as production planning and supply chain management, which may not have a direct and visible impact on customer service and the consumption experience.

Although IT investments show a positive effect on perceived quality, perceived value and customer satisfaction for service firms for the 1994-1996 period, these results do not hold in the subsequent time period of 1999-2000 as indicated by the negative interaction term between IT investments and the YEAR dummy variable ( $\alpha_{16} = -1.011$  for perceived quality,  $\alpha_{26} = -0.884$  for perceived value and  $\alpha_{36} = -1.234$  for ACSI, all

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coefficients significant at  $p < 0.01$ ). More specifically, IT investments do not seem to have a significant effect on perceived quality, perceived value and customer satisfaction during 1999-2000 for service firms. However, IT investments show a statistically significant and negative effect for manufacturing firms during 1999-2000. These results in Table 4 showing declining returns to IT in terms of customer satisfaction over the years 1994-2000 are consistent with previous studies that found declining returns to IT in terms of productivity and market value (Bharadwaj, Bharadwaj and Konsynski 1999; Brynjolfsson and Hitt 1996).

While there may be several alternative explanations for declining returns from IT investments in terms of consumption experience over the 1994-2000 period, we discuss two plausible reasons here. The first reason relates to over-investment in IT systems by firms during the 1999-2000 period that did not directly improve the consumption experience and in fact, may have distracted firms from focusing on customers. Our data show that firms significantly increased their IT investment as a percentage of sales from 2.65% during 1994-1996 to 4.18% during 1999-2000, a relative increase of 57% during a five-year period. It was during 1999-2000 that firms aggressively invested in IT assets and adopted a plethora of hardware and software standards and platforms as part of their e-business strategy. Besides investing in IT to support their e-business strategy, firms also made significant investments in Y2K related activities by upgrading their back-end IT infrastructure significantly to alleviate widely prevailing investor and customer concerns (Anderson, Banker and Ravindran 2003). Preoccupation with e-business transformation, Y2K compliance, ERP implementation and associated organizational disruption may have shifted attention away from customers resulting in the observed

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insignificant or negative relationship between IT investments and customer satisfaction during 1999-2000. While there is some anecdotal evidence to support this argument, there is a need for further research to validate this reasoning empirically.

Second, a complementary reason for the negative effect of IT investments on customer satisfaction may be that although firms were aggressive in acquiring the latest information technologies in 1999-2000, many of these applications were directed to internal business processes that did not directly impact the customer experience. Note that our use of total IT spending in this study involves aggregation across a number of IT applications, where some applications may be relevant for customer satisfaction while others may have negative or zero impact (Banker et al. 2005; Kauffman and Weill 1989; Mukhopadhyay, Kekre and Kalathur 1995). In comparison to aggregate and internally focused applications, we would expect that customer facing IT applications are more likely to have a positive effect on customer satisfaction, consistent with the process view of IT business value that advocates examining the effect of specific IT applications in functional areas that are relatively uncoupled with other confounding business processes (Barua, Kriebel and Mukhopadhyay 1995).

## **5.0 DISCUSSION AND CONCLUSION**

Our goal in this research was to study the effect of IT investments on customer satisfaction. We developed a theoretical model for the effect of IT investments on customer satisfaction with perceived quality and perceived value as two mediating mechanisms. Our analysis of an unbalanced panel of 50 firms indicates that IT investments had a positive effect on customer satisfaction for service firms during the 1994-96 period. We find support for the hypothesis that effect of IT on customer

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satisfaction is mediated through perceived quality and perceived value. We also find that service firms are significantly better at leveraging IT investments to improve their customer satisfaction than are manufacturing firms. We observe a declining effect of IT investments on customer satisfaction from 1994-96 to 1999-2000 and these results are consistent with previous findings that suggest declining returns to IT (Bharadwaj, Bharadwaj and Konsynski 1999; Brynjolfsson and Hitt 1996).

### 5.1 Contributions and Research Implications

This study makes three contributions. First, this is perhaps one of the first studies to model the effect of IT on an intangible measure of firm performance (i.e. customer satisfaction) that in turn has significant effect on shareholder wealth (Anderson, Fornell and Mazvancheryl 2004). Unlike previous studies, which have used tangible measures of firm performance such as productivity and shareholder wealth, this study highlights the business value of IT using customer satisfaction to provide a more complete view of judging returns from IT considering relatively intangible measures. These findings extend previous research in information systems that provided justification for the effect of IT investments and IT capabilities on market value (Bharadwaj 2000; Bharadwaj, Bharadwaj and Konsynski 1999). Customer satisfaction, being an external and customer-based measure of organizational performance, has critical importance in increasingly competitive markets. Following Devaraj and Kohli (2000), who documented the effect of IT systems on customer satisfaction in the health sector, this study extends their work to a much broader cross section of firms across diverse industry sectors.

Second, unlike previous studies that examined the direct effect of IT on productivity or Tobin's Q, we theorized and empirically validated two mediating

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mechanisms that underlie the relationship between IT and customer satisfaction. Our results suggest that IT applications affect perceived quality and perceived value of a firm's offerings and these in turn affect customer satisfaction. Finally, from a methodological perspective, we use random effects models that allow us to control for unobserved time invariant heterogeneity, a problem that plagues much previous research.

Though our study provides evidence of a linkage between IT investments and customer satisfaction, there are several opportunities to extend this work. First, although our sample size is a reasonable representation of large firms, there is a need to validate these results for mid-sized and small firms. Second, case-based research within a firm along the lines of Banker, Kauffman and Morey (1990) is needed to help us better understand how specific IT investments in various industries may affect customer satisfaction. Such studies will enhance our understanding of the situational and contextual factors that are difficult to control in large-scale archival research. Third, we have classified all firms as offering either goods or services for examining how the nature of goods or services affects overall customer satisfaction as it relates to IT investments. Future research may extend our framework to a more granular measurement and classification scheme that looks closely at the nature of the consumption experience in specific industries such as automotive, airline or hospitality, to better understand the effect of IT on customer satisfaction and the consumption experience.

Finally, there is a need to study the effect of customer facing IT applications on customer-based measures of firm performance by collecting archival data on customer retention and success of cross-selling efforts. Because contextual variables such as market orientation, complementary changes in business processes and supply chain

integration may have a moderating effect on the relationship between customer facing IT applications and customer satisfaction, future research should explore such relationships by collecting primary data.

### **5.2 Managerial Implications**

This study has two managerial implications. First, this study shows that IT investments influence customer satisfaction at the firm level. Since customer satisfaction in turn has an effect on the market value of firms (Anderson, Fornell and Mazvancheryl 2004), IT managers can use potential improvements in customer satisfaction as a justification for returns on their IT investments.

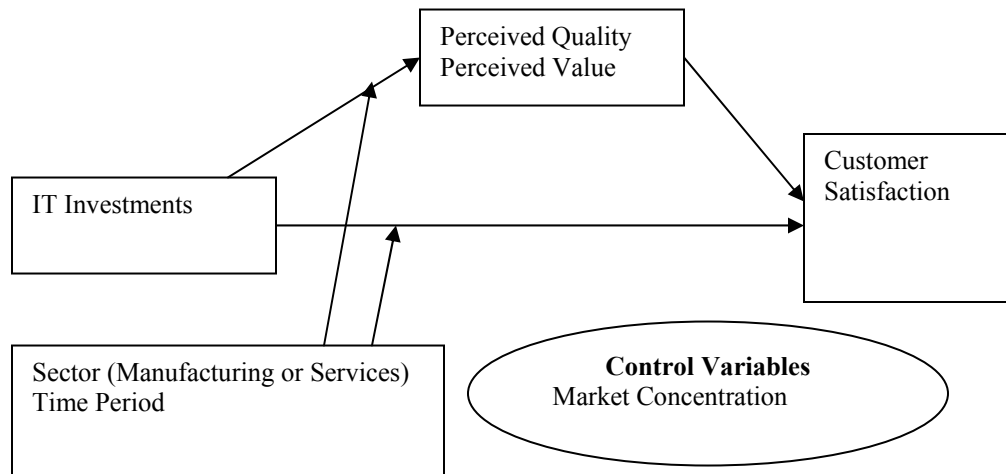
Second, since the effect of IT on customer satisfaction is mediated by perceived quality and perceived value, managers can attempt to explicitly identify the deeper linkages between IT applications and customer linking business processes to enhance perceived quality and value and reap customer satisfaction benefits. In other words, perceived quality and perceived value can act as leading indicators of a firm's customer satisfaction and by tracking these measures, managers can monitor whether their IT investments are improving customer satisfaction.

To conclude, this study developed theoretical models to understand the effect of IT investments on customer satisfaction by synthesizing the extant literature in the information systems and marketing disciplines. We empirically validated our theoretical models by using a longitudinal dataset. We show that IT applications influence customer satisfaction through their impact on perceived quality and perceived value. By taking the first steps toward linking IT with intangible measures of firm performance, we hope this study will encourage researchers to explore linkages between IT and other intangible

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measures such as organizational capabilities including process management and innovation capabilities. Despite the challenging nature of such interdisciplinary research, exploration of such linkages is crucial to achieve a better understanding of the strategic impact of IT in creating intangible assets and impacting firm performance in a service economy.

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**Figure 1. Conceptual Model**

**Table 1. Variable Definition, Construction and Data Sources**

Variable Name	Definition	Source
ACSI (Customer Satisfaction)	American Customer Satisfaction Index is an archival measure of customer satisfaction for a firm tracked by the National Quality Research Center at the University of Michigan Ross School of Business	National Quality Research Center (NQRC)
PERQUAL (Perceived Quality)	Measures perceived quality of a firm's offering as a function of customization and reliability of the consumption experience	NQRC
PERVAL (Perceived Value)	Perceived value measures perceived quality for a given price	NQRC
ITINVPC (IT Investments)	IT investments as a percent of sales revenues	Information Week
MFG (Sector)	Whether firm belongs to the Manufacturing or Services sector (Services=0, Manufacturing=1)	SIC based Classification
HHI (Market Concentration)	Measures the extent of dominance by a few firms in an industry	Table Base, Media Guide and Compustat



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**Table 2. Descriptive Statistics**

	Services			Manufacturing		
	N	Mean	SD	N	Mean	SD
ACSI	53	72.49	7.31	72	81.70***	4.12
PERQUAL	53	78.26	7.00	72	87.07***	3.84
PERVAL	53	72.96	6.40	72	81.53***	3.67
HHI	53	1665	1319	72	1740	1471
ITINVPC	53	5.49***	4.24	72	1.95	1.11

<sup>a</sup> Differences in means were tested using t-tests for all continuous variables. Significance levels are indicated on the larger of the two numbers. \*p < .10, \*\* p < .05, \*\*\*p < .01

**Table 3. Correlations Among Variables**

	1	2	3	4	5	6	7	8	9
1 ACSI	1.00								
2 PERQUAL	0.97	1.00							
3 PERVAL	0.89	0.87	1.00						
4 HHI	0.42	0.43	0.31	1.00					
5 MFG	0.63	0.63	0.65	0.03	1.00				
6 ITINVPC	-0.41	-0.40	-0.37	0.02	-0.52	1.00			
7 Interaction Term (ITINVPC*MFG)	0.36	0.37	0.48	-0.01	0.75	-0.23	1.00		
8 YEAR	-0.28	-0.30	-0.13	-0.08	-0.07	0.21	0.01	1.00	
9 Interaction Term (ITINVPC*YEAR)	-0.41	-0.42	-0.32	0.01	-0.32	0.82	-0.15	0.59	1.00

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**Table 4. Effect of IT Investments on Perceived Quality, Perceived Value and Customer Satisfaction**  
(*p values are in parentheses*)

		(1)		(2)		(3)		(4)
		Perceived Quality		Perceived Value		ACSI		ACSI
MFG (0=Services, 1=Manufacturing)	$\alpha_{11} =$	11.906*** (0.000)	$\alpha_{21} =$	10.136*** (0.000)	$\alpha_{31} =$	12.370*** (0.000)	$\alpha_{41} =$	1.710** (0.047)
ITINVPC	$\alpha_{12} =$	0.939*** (0.000)	$\alpha_{22} =$	0.598** (0.014)	$\alpha_{32} =$	1.050*** (0.000)	$\alpha_{42} =$	0.207* (0.098)
MFG*ITINVPC (INTERACTION TERM)	$\alpha_{13} =$	-0.975** (0.012)	$\alpha_{23} =$	-0.734 (0.130)	$\alpha_{33} =$	-1.130*** (0.009)	$\alpha_{43} =$	-0.454** (0.042)
HHI	$\alpha_{14} =$	0.002*** (0.000)	$\alpha_{24} =$	0.001** (0.013)	$\alpha_{34} =$	0.002*** (0.000)	$\alpha_{44} =$	0.0002* (0.068)
YEAR (0=1994-96, 1=1999-2000)	$\alpha_{15} =$	0.492 (0.453)	$\alpha_{25} =$	1.266 (0.133)	$\alpha_{35} =$	0.864 (0.244)	$\alpha_{45} =$	0.109 (0.802)
ITPINVC*YEAR (INTERACTION TERM)	$\alpha_{16} =$	-1.011*** (0.000)	$\alpha_{26} =$	-0.884*** (0.000)	$\alpha_{36} =$	-1.234*** (0.000)	$\alpha_{46} =$	-0.240* (0.053)
PERQUAL							$\alpha_{47} =$	0.678*** (0.000)
PERVAL							$\alpha_{48} =$	0.3000*** (0.000)
CONSTANT	$\alpha_{10} =$	72.780*** (0.000)	$\alpha_{20} =$	69.845*** (0.000)	$\alpha_{30} =$	66.917*** (0.000)	$\alpha_{40} =$	-3.332 (0.310)
N		125		125		125		125
Overall R square		0.665		0.521		0.656		0.949

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

### References

- Aaker, D.A., and Jacobson, R. "The financial information content of perceived quality," *Journal of Marketing Research* (31:2) 1994, pp 191-201.
- Agarwal, R., and Venkatesh, V. "Assessing a Firm's Web Presence: A Heuristic Evaluation Procedure for the Measurement of Usability," *Information Systems Research* (13:2) 2002, pp 168-186.
- Anderson, E.W. "Customer Satisfaction and Price Tolerance," *Marketing Letters* (7:3) 1996, pp 19-30.
- Anderson, E.W., and Fornell, C. "Foundations of the American Customer Satisfaction Index," *Total Quality Management* (11:7) 2000, pp S869-882.
- Anderson, E.W., Fornell, C., and Lehmann, D.R. "Customer satisfaction, market share, and profitability: Findings from Sweden," *Journal of Marketing* (58:July) 1994, pp 53-66.
- Anderson, E.W., Fornell, C., and Mazvancheryl, S.K. "Customer Satisfaction and Shareholder Value," *Journal of Marketing* (68:October) 2004, pp 172-185.
- Anderson, E.W., Fornell, C., and Rust, R.T. "Customer satisfaction, productivity, and profitability: Differences between goods and services," *Marketing Science* (16:2) 1997, pp 129-145.
- Anderson, E.W., and Sullivan, M.W. "The Antecedents and Consequences of Customer Satisfaction for Firms," *Marketing Science* (12:2) 1993, pp 125-143.
- Anderson, M.C., Banker, R.D., and Ravindran, S. "The new productivity paradox," *Communications of the ACM* (46:3), March 2003, pp 91-94.
- Armstrong, P.C., and Sambamurthy, V. "Information technology assimilation in firms: The influence of senior leadership and IT infrastructures," *Information Systems Research* (10:4) 1999, pp 304-327.
- Baltagi, B.H. *Econometric Analysis of Panel Data*, (Second ed.) John Wiley & Sons, Chichester, 2001.
- Banker, R., Kauffman, R., and Morey, R. "Measuring gains in operational efficiency from Information Technology: A Case Study of the Positran Deployment at Hardee's Inc.," *Journal of Management Information Systems* (Fall) 1990, pp 29-54.
- Banker, R.D., Bardhan, I.R., Lin, S., and Chang, H. "Plant Information Systems, Manufacturing Capabilities and Plant Performance," *MIS Quarterly* (Forthcoming) 2005.
- Banker, R.D., and Kauffman, R.J. "Case Study of Electronic Banking at Meridian Bancorp," *Information and Software Technology* (33:3) 1991.
- Baron, R.M., and Kenny, D.A. "The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations," *Journal of Personality and Social Psychology* (51:6) 1986, pp 1173-1182.
- Barua, A., Kriebel, C.H., and Mukhopadhyay, T. "Information Technologies and Business Value - an Analytic and Empirical Investigation," *Information Systems Research* (6:1) 1995, pp 3-23.
- Barua, A., and Mukhopadhyay, T. "Information Technology and Business Performance: Past, Present, and Future," in: *Framing the Domains of Information Technology Management: Projecting the Future... through the past*, R.W. Zmud (ed.), Pinnaflex Press, Cincinnati, OH, 2000, pp. 65-84.
- Belsley, D.A., Kuh, E., and Welsch, R.E. *Regression Diagnostics: Identifying influential data and sources of collinearity* John Wiley & Sons, New York, 1980.
- Bharadwaj, A. "A Resource based perspective on information technology capability and firm performance: An empirical investigation," *MIS Quarterly* (24:1) 2000, pp 169-196.
- Bharadwaj, A.S., Bharadwaj, S.G., and Konsynski, B.R. "Information technology effects on firm performance as measured by Tobin's q," *Management Science* (45:7) 1999, pp 1008-1024.
- Bitner, M.J., Brown, S.W., and Meuter, M.L. "Technology infusion in service encounters," *Journal of the Academy of Marketing Science* (28:1) 2000, pp 138-149.
- Breusch, T.S., and Pagan, A.R. "The Lagrange Multiplier Test and its application to model specification in econometrics," *Review of Economic Studies* (47) 1980, pp 239-253.
- Brynjolfsson, E. "The Productivity Paradox of Information Technology," *Communications of the ACM* (36:12) 1993, pp 67-77.
- Brynjolfsson, E. "The contribution of information technology to consumer welfare," *Information Systems Research* (7:3) 1996, pp 281-300.
- Brynjolfsson, E., and Hitt, L. "Paradox lost? Firm-level evidence on the returns to information systems spending," *Management Science* (42:4) 1996, pp 541-558.
- Capon, N., Farley, J.U., and Hoenig, S. "Determinants of Financial Performance: A Meta-Analysis," *Management Science* (36:10), October 1990, pp 1143-1159.

## Effect of IT Investments on Customer Satisfaction

- Chen, P.Y.S., and Hitt, L.M. "Measuring Switching Costs and the Determinants of Customer Retention in Internet-Enabled Businesses: A Study of the Online Brokerage Industry," *Information Systems Research* (13:3) 2002, pp 255-274.
- Chopra, S., and Meindl, P. "What will drive the enterprise software shakeout?," *Supply Chain Management Review* (January/February) 2003, pp 50-56.
- Curry, B., and George, K.D. "Industrial Concentration: A Survey," *The Journal of Industrial Economics* (31:3) 1983, pp 203-255.
- Dedrick, J., Gurbaxani, V., and Kraemer, K.L. "Information Technology and Economic Performance: A Critical Review of Empirical Evidence," *ACM Computing Surveys* (35:1) 2003, pp 1-28.
- Devaraj, S., and Kohli, R. "IT Payoff in the Healthcare Industry: A Longitudinal Study," *Journal of Management Information Systems* (16:4) 2000, pp 41-67.
- El Sawy, O.A., and Bowles, G. "Redesigning the Customer Support Process for the Electronic Economy: Insights From Storage Dimensions," *MIS Quarterly* (December) 1997, pp 457-483.
- Faraj, S., and Sproull, L. "Coordinating expertise in software development teams," *Management Science* (46:12) 2000, pp 1554-1568.
- Financial Times "A guru of old-fashioned customer satisfaction," in: *Financial Times*, 2002.
- Fornell, C. "A National Customer Satisfaction Barometer: The Swedish Experience," *Journal of Marketing* (56:1) 1992, pp 6-22.
- Fornell, C. "The quality of economic output: Empirical generalizations about its distribution and relationship to market share," *Marketing Science* (14:3) 1995, pp G203-211.
- Fornell, C. "The Science of Satisfaction," *Harvard Business Review* (March) 2001, p 118.
- Fornell, C., and Anderson, E.W. "The Customer Satisfaction Index as a Leading Indicator," in: *Handbook of Services Marketing and Management*, D. Iacobucci and T. Swartz (eds.), Sage, New York, 2000, pp. 255-270.
- Fornell, C., Johnson, M.D., Anderson, E.W., Cha, J., and Bryant, B.E. "The American Customer Satisfaction Index: Nature, purpose, and findings," *Journal of Marketing* (60:4) 1996, pp 7-18.
- Fornell, C., Mithas, S., Morgeson, F., and Krishnan, M.S. "Customer Satisfaction and Stock Prices: High Returns, Low Risk," *Journal of Marketing* (Forthcoming) 2005.
- Fornell, C., and Wernerfelt, B. "A model for customer complaint management," *Marketing Science* (7:Summer) 1988, pp 271-286.
- Garvin, D.A. *Managing Quality: The Strategic and Competitive Edge* The Free Press, New York, 1988.
- Greene, W.H. *Econometric Analysis*, (4th ed.) Prentice Hall Professional Technical Reference, New Jersey, 2000.
- Hausman, J.A. "Specification Tests in Econometrics," *Econometrica* (46:6) 1978, pp 1251-1271.
- Heskett, J.L., Sasser, W.E., Jr., and Schlesinger, L.A. *The service profit chain: How leading companies link profit and growth to loyalty, satisfaction and value* The Free Press, New York, 1997.
- Hitt, L.M., and Brynjolfsson, E. "Productivity, business profitability, and consumer surplus: Three different measures of information technology value," *MIS Quarterly* (20:2) 1996, pp 121-142.
- Ittner, C.D., and Larcker, D.F. "Measuring the Impact of Quality Initiatives on Firm Financial Performance," in: *Advances in the management of Organizational Quality, Vol 1*, S. Ghosh and D. Fedor (eds.), JAI Press, Greenwich, 1996, pp. 1-37.
- Ittner, C.D., and Larcker, D.F. "Are nonfinancial measures leading indicators of financial performance? An analysis of customer satisfaction," *Journal of Accounting Research* (36:Supplement) 1998, pp 1-35.
- Ives, B., and Learmonth, G.P. "The information system as a competitive weapon," *Communications of the ACM* (27:12) 1984, pp 1193-1201.
- Johnson, M.D., and Fornell, C. "A Framework for Comparing Customer Satisfaction Across Individuals and Product Categories," *Journal of Economic Psychology* (12:2) 1991, pp 267-286.
- Johnston, J., and DiNardo, J.E. *Econometric Methods* McGraw Hill International Editions, New York, 1997.
- Kambil, A., Laird, R., Rowe, J., Vitale, M., and Yetton, P. "Mastering value creation in the eWorld (available at [http://www.accenture.com/xdoc/en/services/sba/sba\\_ideas\\_mastering.pdf](http://www.accenture.com/xdoc/en/services/sba/sba_ideas_mastering.pdf))," Accenture.
- Karimi, J., Somers, T.M., and Gupta, Y.P. "Impact of Information Technology Management Practices on Customer Service," *Journal of Management Information Systems* (17:4) 2001, pp 125-158.

## Effect of IT Investments on Customer Satisfaction

- Kauffman, R.J., and Weill, P. "An evaluative framework for research on the performance effects of information technology investments," in: *Proceedings of the International Conference on Information Systems*, J.I. DeGross, J.C. Henderson and B.R. Konsynski (eds.), Association for Information Systems, Boston, MA, 1989, pp. 377-388.
- Kohli, R., and Devaraj, S. "Measuring Information technology payoff: A Meta Analysis of Structural Variables in Firm-level Empirical research," *Information Systems Research* (14:2) 2003, pp 127-145.
- Kudyba, S., and Diwan, R. "Research report: Increasing returns to information technology," *Information Systems Research* (13:1) 2002, p 104.
- Lucas, H.C. "Performance and the use of an information system," *Management Science* (21:8) 1975, pp 908-919.
- Mukhopadhyay, T., Kekre, S., and Kalathur, S. "Business Value of Information Technology - a Study of Electronic Data Interchange," *MIS Quarterly* (19:2) 1995, pp 137-156.
- Nambisan, S. "Designing Virtual Customer Environment for New Product Development: Toward a Theory," *Academy of Management Review* (27:3) 2002, pp 392-413.
- Naumann, E., and Hoisington, S.H. *Customer Centered Six Sigma: Linking Customers, Process Improvement, and Financial Results* ASQ Quality Press, Milwaukee, Wisconsin, 2001.
- Nelson, R.R. "Evolutionary theorizing about economic change," in: *Handbook of Economic Sociology*, N.J. Smelser and R. Swedberg (eds.), Princeton University Press, Princeton, 1995, pp. 108-136.
- Parasuraman, A. "Understanding and leveraging the role of customer service in external, interactive and internal marketing," *Frontiers in Services Conference*, Nashville, TN, 1996.
- Parasuraman, A., and Grewal, D. "The impact of technology on the quality-value-loyalty chain: A research agenda," *Journal of the Academy of Marketing Science* (28:1) 2000, pp 168-174.
- Piccoli, G., and Applegate, L. "Wyndham International: Fostering High-Touch with High-Tech," in: *Harvard Business School Case (9-803-092)*, 2003, pp. 1-42.
- Podsakoff, P.M., and Organ, D.W. "Self-Reports in organizational research: Problems and prospects," *Journal of Management* (12) 1986, pp 531-544.
- Porter, M.E., and Millar, V.E. "How Information Gives You Competitive Advantage," in: *Harvard Business Review*, 1985, pp. 2-13.
- Prahalad, C.K., and Krishnan, M.S. "The new meaning of quality in the Information Age," *Harvard Business Review* (77:5), Sep-Oct 1999, pp 109-118.
- Prahalad, C.K., and Ramaswamy, V. *The Future of Competition: Co-Creating Unique Value with Customers* Harvard Business School Press, Boston, MA, 2004.
- Quinn, J.B., and Bailey, M.N. "Information technology: Increasing productivity in services," *Academy of Management Executive* (8:3) 1994, pp 28-51.
- Rai, A., Patnayakuni, R., and Patnayakuni, N. "Technology investment and business performance," *Communications of the ACM* (40:7) 1997, pp 89-97.
- Rathnam, S., Mahajan, V., and Whinston, A.B. "Facilitating coordination in customer support teams: A Framework and its implications for design of information technology," *Management Science* (41:12), Dec 1995, pp 1900-1921.
- Reichheld, F.F., and Sasser, W.E., Jr. "Zero Defections: Quality Comes to Services," *Harvard Business Review* (68:5) 1990, pp 105-111.
- Reichheld, F.F., and Teal, T. *The loyalty effect: The hidden force behind growth, profits, and lasting value* HBS Press, Boston, 1996.
- Roach, S.S. "Services under siege-the restructuring imperative," *Harvard Business Review* (Sept-Oct) 1991, pp 82-92.
- Romano, N.C., and Fjermestad, J. "Electronic Commerce Customer Relationship Management: An Assessment of Research," *International Journal of Electronic Commerce* (6:2) 2001, pp 61-113.
- Rose, S. "The Coming Revolution in Credit Cards," *Journal of Retail Banking* (12:Summer) 1990, pp 17-19.
- Rust, R.T., and Keiningham, T.L. *Returns on Quality: Measuring the Financial Impact of your Company's quest for quality* Probus, Chicago, IL, 1994.
- Rust, R.T., Zeithaml, V.A., and Lemon, K.N. *Driving Customer Equity* Free Press, New York, 2000.
- Sambamurthy, V., Bharadwaj, A.S., and Grover, V. "Shaping Agility through Digital Options: Reconceptualizing the Role of IT in Contemporary Firms.," *MIS Quarterly* (27:2) 2003, pp 237-263.

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- Santhanam, R., and Hartono, E. "Issues in linking information technology capability to firm performance," *MIS Quarterly* (27:1), March 2003, pp 125-153.
- Seybold, P.B., Marshak, R.T., and Lewis, J.M. *The Customer Revolution* Crown Business, New York, 2001.
- Srinivasan, R., Lilien, G.L., and Rangaswamy, A. "Technological opportunism and radical technology adoption: An application to e-business," *Journal of Marketing* (66:July) 2002, pp 47-60.
- The Economist "American Productivity: A Profitless Recovery?," (362:8259 Feb 9) 2002.
- Waters, R. "The enigma within the knowledge economy: Productivity (Feb 2, 2004)," in: *Financial Times*, London (UK), 2004, p. 9.
- Wooldridge, J.M. *Econometric Analysis of Cross Section and Panel Data* The MIT Press, Cambridge, Mass, 2002.
- Yi, Y. "A critical review of consumer satisfaction," in: *Review of Marketing*, V.A. Zeithaml (ed.), American Marketing Association, Chicago, IL, 1990, pp. 68-123.