MIT Sloan School of Management

**Working Paper 4418-03
April 2003**

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INFORMATION TECHNOLOGY, ORGANIZATIONAL LEARNING, AND THE MARKET VALUE OF THE FIRM

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ABSTRACT

This paper compares the mean and variance of cumulative abnormal returns following announcements of two types of information technology (IT) investments: those which entail the “exploitation” of firm’s current capabilities vs. those which involve the exploration of new capabilities. The paper addresses two understudied questions in research on the contribution of IT to firm performance: the contingent nature of those contributions and the impact on risk (or variance), as well as on return (mean). To examine these questions I first performed a standard event study analysis on a sample of 150 announcements of IT investments made by 59 publicly-traded retailers between the years 1990-1997. I performed two types of multivariate regression analysis on the event returns: ordinary least squares (to assess the impact of the two types of investments on the mean level of returns) and multiplicative heteroscedastic regression (to determine the impact on the variance of the returns). The results indicate that, as expected, IT investments “exploitative” IT investments have the same mean as, yet lower variance than, abnormal returns associated with “exploratory” IT investments. Somewhat unexpectedly, I found that both types of IT investments had a significantly negative impact on the market value of the firm. Taken together, these findings suggest that the characteristics of IT investments themselves, as well as the industry and strategic context within which they were made, are important determinants of the market value of the firm. As such, the results of this study should be of interest to researchers interested in the contribution of IT to firm performance and to MIS professionals both in the retailing sector, in particular, and other service sectors, more generally.

Ken Peffers acted as senior editor for this paper.

Hunter, S.D., “Information Technology, Organizational Learning, and the Market Value of the Firm”, *The Journal of Information Technology Theory and Application (JITTA)*, 5:1, 2003, 1-28.

INTRODUCTION

Recent empirical work has identified several organizational, strategic, and environmental factors that influence whether, how, and to what extent information technology (IT) investments impact firm performance. These include, but are not limited to: “IT capability”, i.e. the firm-specific, managerial resources and capabilities required to manage IT investments (Bharadwaj, Sambamurthy, and Zmud 2001; Bharadwaj 2000); “intangible assets”, i.e. the investments in “training, and organizational transformation” that accompany IT investments (Brynjolfsson, Hitt, and Yang 2002); characteristics of the organizational tasks, processes, and functions to which IT is applied (Barua, Kriebel, and Mukhopadhyay 1995); complementary organizational designs and human resource management practices (Brynjolfsson and Hitt 2000); the management goals or strategic intent for IT investments, e.g. whether or not they were intended to achieve “competitive advantage” (Weill 1990); organizational form (Subramani and Walden 2001) and size (Im, Dow, and Grover 2001); industry characteristics such as the level of “information intensity” (Dos Santos, Peffers, and Mauer 1993) and the degree of “IT-driven transformation” (Chatterjee, Richardson, Zmud 2001); as well as, characteristics of the investments themselves, e.g. their “innovativeness” (Dos Santos, Peffers, and Mauer 1993).

One contingency which has yet to be examined is that of organizational learning, i.e. how organizations learn from experience (March, Sproull, and Tamuz 1991). March (1991, 1995) has propounded a theory of organizational learning which describes two distinct, yet complementary, ways in which organizations learn and, thereby, change their performance. He terms them “exploration” and “exploitation” (March 1991, p. 71). Although the theory contains many testable propositions about the causal relationship between learning and performance, it has yet to be applied to the study of the consequences of information technology on firm performance. The theory has, however, recently been used in the strategic management literature to explain the impact of

CONTRIBUTION

This paper makes two important contributions to the growing body of MIS-focused event studies, as well as to the broader literature on the impact of IT on firm performance. The first contribution of this study concerns the emphasis it places upon the variance of performance associated with IT investments. Only recently has the MIS field turned its attention to the questions of risk and return associated with IT investments. The finding that different types of investment have different implications for the market value of the firm, and by extension, the reliability of firm’s future earnings suggests a previously unmentioned role for IT investments- as means by which firms can reduce the underlying variation in operational performance of core processes, and thus, of overall firm performance, as well. Secondly, as perhaps the first event study to report significantly *negative* abnormal returns associated with IT investments, this study underscores the importance of industry structure and dynamics as an important determinant of the returns to IT investments.

The results of this study should be of particular interest, first and foremost, to researchers interested in seeking to understand the contribution of IT investments to firm’s market value. The research should also be of interest to MIS professionals in and outside of the retailing sector. It is doubtful that such managers are aware that financial markets and investors attend to information contained in announcements of IT investments which pertain to the reliability of expected performance attributable to those investments, not just is mean level.

organizational learning on financial performance (Sorenson and Sorensen 2001; Sorensen 2002; Rothaermel 2001) and technological evolution (Rosenkopf and Nerkar 2001). Given that March expressly suggested that the theory might be applicable to the study of IT and firm performance (March 1991, p. 84; March 1995, p. 429), a

systematic investigation of its potential contributions certainly seems warranted. To that end this study is directed. Specifically, I test whether IT investments indicative of the two types of organizational learning March describes – exploitative and exploratory- have different consequences on firms' market value. I test my hypothesis on a sample of announcements of 150 IT investments made by 59 publicly-traded, retailing firms between the years 1990-1997. The results suggest that abnormal returns associated with "exploitative" and "exploratory" IT investments are indeed different: they have the same mean but the former has significantly lower variance.

OVERVIEW OF EXPLORATION-EXPLOITATION THEORY

March (1991, 1995) has described two fundamentally distinct, yet complementary, ways in which organizations learn and, thereby, change their performance: exploration and exploitation. While there are many bases for differentiating between these two types of learning, three of the most important are their goals and objectives; the means by which each is accomplished; and their implications for firm performance, especially the time period over which that performance is realized. Table 1, below, summarizes those differences. The objective of exploration, according to the theory, is frequently the attainment of flexibility and the development of new knowledge and new means of solving problems that the organization faces (March 1991, p. 72, March 1995, p. 432). Exploration is associated with and is accomplished by way of a host of activities which *increase* variation in organizational processes, tasks, and functions. These include complex search, basic research, invention, innovation, risk-taking, relaxed control, and loose discipline (March 1991, p. 71; March 1995, p. 432).

By contrast, the goals of exploitation are typically more objective and particular, i.e. they are intended to meet clearly-defined and short-term objectives and immediate targets; to improve short-run efficiency; to reduce slack; and to increase the reliability, accuracy, and precision of, and control over core processes and activities (March 1995, p. 431). Learning

of the exploitative variety is achieved by way of actions that emphasize the *reduction* of variation in organizational activities. These include standardization of procedures, heuristic problem solving, relatively tighter control and discipline, risk-aversion, the emulation of successes (e.g. benchmarking and best practice adoption), institutionalization, systematic reason, and by acting in an "appropriate manner" (March 1995, p. 432).

The effects of exploration and exploitation are realized in categorically-distinct changes in the performance distribution of the firm (March 1995, p. 432). The benefits or returns to exploration are described as being more uncertain than those associated with exploitation (March 1991, p. 85). This uncertainty has both spatial and temporal aspects (March 1995, p. 432). The spatial component concerns the supposition that exploration produces outcomes that tend toward both tails of the historical performance distribution. Exploitation, however, is less likely to produce performance outcomes that deviate significantly from the historical levels (March 1995, p. 432). Temporally, returns to exploration, be they positive or negative, are more remote, i.e. they lie farther in the future than those associated with exploitation. This difference has important implications. March argues that survival, let alone sustained superior performance, requires that firms engage in "sufficient" exploitation to ensure the current viability of the organization while exploring "enough" to ensure its future viability (March 1991, p. 71, 72). What constitutes "sufficient" exploitation and "enough" exploration is in large part determined by the characteristics and demands of the external environment (Sorensen 2002; Sorenson and Sorensen 2001).

LITERATURE REVIEW AND HYPOTHESIS

Retailing in the 1990's was what one commentator described as a "zero-sum" industry (Sack 1996), i.e. that growth in sales was achieved primarily at the expense of competitors. To long-time industry observers, these conditions did not come as a surprise because retailing has long been known as a highly-competitive, low-margin industry

Table 1. Key Characteristics of Exploration and Exploitation¹

Characteristic	Exploration	Exploitation
Core Features	<ul style="list-style-type: none"> • Experimenting with new ideas, paradigms, technologies, strategies, and knowledge 	<ul style="list-style-type: none"> • Elaborating on existing ideas, paradigms, technologies, strategies, and knowledge. • Improving and refining existing capabilities, technologies, etc.
Goals	<ul style="list-style-type: none"> • (To find) new alternatives that improve old ones; Flexibility; New Knowledge 	<ul style="list-style-type: none"> • (To meet) Clearly-defined, short-term objectives and immediate targets; Short-run efficiency and improvement; Legitimacy; Reduced costs; slack; Reliability
Returns	<ul style="list-style-type: none"> • Distant in Time; High Variance; Tails of performance distribution 	<ul style="list-style-type: none"> • Proximal in Time; Low Variance; Near historical mean of performance
Means/Methods of Implementation	<ul style="list-style-type: none"> • Searching for new ideas; Deviating from standards; Variation; Innovating; Inventing 	<ul style="list-style-type: none"> • Acting in an appropriate manner; Adopting standardized procedures; Assuming proper organizational form; Defining and measuring performance; Downsizing and Re-engineering; Emulating success; Pursuing legitimacy; Eliminating redundancies Tightening slack; Focusing effort; Routinizing; Specializing; Total quality management; Managing the capabilities of the organization; Tying competencies to produce joint products; Linking activities to performance measures
Other Characteristics	<ul style="list-style-type: none"> • Novel • Serendipitous • Risky 	<ul style="list-style-type: none"> • Choice • Risk-aversion • Sane (Sanity)
Facilitators	<ul style="list-style-type: none"> • Free Association; Loose Discipline; Madness; Play; Relaxed Control; (Stimulated by) Failure 	<ul style="list-style-type: none"> • Analysis; Close Attention; Control; Discipline; Execution; Focused Attention; Hard Work; Institutionalization; Precision; Production; Refined Detail; Repetition; Sharp Focus

where the opportunities for firms to achieve sustained abnormal profitability are quite limited (Hawes and Crittenden 1984). Already a highly-concentrated industry by 1990, the general merchandising segment became even more stratified during the middle years of the ensuing decade as reductions in the ranks of retailers through bankruptcy, acquisition, merger and liquidation reached record levels (Exstein and Pak 1997). By 1996, for example, five department stores, JC Penney, Federated,

May, Dillard, and Nordstrom- accounted for 87% of sales while in the discount store segment just three retailers, Wal-Mart, Kmart, and Target, aka “The Big Three”, accounted for a similar percentage of sales (Sack 1996). And because many retail sectors were already over-stored most failing retailers offered little of value to remaining rivals other than their real estate holdings (NVST, 1997). As a consequence, by 1998 acquisitions and mergers had almost come to a complete end

¹ As described in March (1991, 1995) and Levinthal and March (1993).

(Exstein and Lee 2001). And while relatively smaller retail sectors like apparel, home furnishings, and miscellaneous retail did not experience the same degree of concentration and consolidation that the department and discount store segments did, changes in these larger and more concentrated sectors strongly influenced strategies and profitability of their lesser rivals (Whitfield 1993).

In response to increasing industry concentration, many of the surviving retailers attempted to improve their competitive positions by rationalizing their internal structures and value chains through the consolidation of divisions; by eliminating redundant operations; by centralizing functions like credit card operations, data processing and accounts payable; and by reducing their degree of diversification. The results of these actions were hundreds of millions of dollars of annual costs savings (Sack 1996). Another consequence of the trend toward growing industry concentration and consolidation was the increased return to scale of operations. Perhaps the foremost advantage that increased scale afforded was the ability to achieve economies of scale in purchasing, logistics, advertising, and distribution (Monroe 1996). Once possessed, the economies of scale enabled retailers to require their vendors to provide them with further cooperative advertising, pre-shipping pricing and ticketing, and other proprietary arrangements related to logistics and distribution (Swain 1994). The imitation or forced adoption of the operational and functional strategies of their larger and more profitable competitors- particularly those of Wal-Mart- proved untenable and ultimately disastrous for many "small box" and regional retail chains (Lahage 2001). Meanwhile surviving middle tier and otherwise disadvantaged retailers found it increasingly difficult to close the growing gap between themselves and the larger and faster-growing industry leaders (Michman and Greco 1995). Not surprisingly, the median return on sales over the decade trended downward, falling to well under one percent by the year 2000 (Sack 2001) from a high of over 2% in 1992.

Investing in a broad range of information and communication technologies was one way in which many retailers responded to the increasingly competitive

conditions (Sack 1996). Among the technologies most-widely adopted were: inventory management systems for price look-up and product tracking functions; point-of-sale (POS) systems to capture data on purchases; data warehouses, on-line analytical processing, and other decision support systems to better understand purchase behavior, to uncover buying trends, and to support micro-marketing; electronic data interchange (EDI) to automate purchase order management; warehouse management systems (WMS) at distribution centers to support growing volumes and to speed order turnaround; as well as, a host of software and web-based applications designed to facilitate information exchange with and further integrate the operations of vendors, buyers, and other value-chain partners (Powell and Dent-Micallef 1997; Fiorito, May, and Straughn 1995).

While many of these systems and related applications differed with regard to their specific operational and functional objectives, it is possible to view those objectives more broadly, i.e. in light of the kind of organizational learning which they exemplified. For example, price-look up, POS, EDI, and WMS investments had as overarching objectives the increased reliability and efficiency of retailers' core processes across different stages of the value chain- the merchandising function, the "front lanes", the back office, and the logistics and warehousing functions, respectively. Operational and functional objectives such as these were achieved, in large part, through the complete automation, where possible, of the processes and functions to which the IT was applied, and through the reduction of human labor and intervention in the performance of those activities when full automation was not possible (Hammer, 1990; Fox, 1996). Such actions were deemed vital during this period as both a means to reduce costs and to meet the broader strategic objective of getting "the right merchandise to the right store at the right time at the right price" (Wal-Mart Annual Report 1999; Whitmarsh 1996; Gates 1996, 1999).

The existence of the strong cost pressures and penalties for uncertainty which made exploitative IT investments so necessary, did not preclude retailers from recognizing the

Figure 1. Median Return on Sales for Retailing Industry, 1991-2000
(Excludes Grocery, Restaurant, and Automotive-related retailing sectors)

importance of experimenting with new information technologies. Throughout the early and mid-1990's no fewer than five of the top 50 spots in every *Information Week 500* ranking of leaders in information technology usage were held by general merchandise, food, and drug retailers (e.g. Wilson 1994). Additionally, major retailing organizations were among the first to develop and deploy transactional web sites (Ward and Warshawsky 1997), to use the internet for procurement, to migrate from mainframes to client-server architectures (Kranz 1994), and to deploy data warehouses (Cole 1994). These were all types of IT investments which, at the time, were less associated with automating business processes than with "informating" them (Zuboff 1988), i.e. improving access to information, supporting managerial judgment, decentralizing decision-making, increasing the intellectual content of work, and developing new organizational capabilities.

Linking retailers' exploratory and exploitative IT investments to firm performance- however measured- requires that

we first recall the essential difference between the two forms of learning: the former is intended to produce or permit relatively increased variation, differentiation, and heterogeneity in organizational functions, processes, and tasks while the latter is intended to achieve the exact opposite- increased reliability, control, and efficiency. As essential, rather than conditional or contingent features, the most likely impact of exploratory and exploitative IT investments on firm performance would be on its *variance* rather than its expected value. Barua, Kriebel, and Mukhopadhyay (1995) have already demonstrated that the IT-related improvements in sub-firm level processes and activities do translate into improvements in financial performance at the firm level. Extending this line of reasoning to the present case, it could be expected that retailer's IT investments which were intended to decrease variation in the performance of core processes would have manifested as reduced variance in firm performance. Thus, I hypothesize that:

Abnormal returns associated with

(announcements of) “exploitative” IT investments will have lower variance, but the same mean level, as abnormal returns associated with (announcements of) “exploratory” IT investments.

Such a finding would be important for at least two reasons. First, it would indicate that investors distinguish between types of IT investments and that the technology’s impact on the reliability of the investing firm’s core processes is an important consideration. Secondly, because this finding does not posit a positive risk-return relationship, i.e. more return in exchange for accepting more risk, it would further suggest that investors may also attend to the strategic context within which the firms make the IT investments, not just the IT investments themselves (Hunter, Kobelsky, Richardson 2003).

RESEARCH METHODS

Sample Selection

The decision of which retailing firms to include in this study was a two-step process. In the first stage I identified through a search of the Compustat© annual database the names of all retailing firms which met the following criteria: publicly-traded during at least one year between 1990-1997 and belonging to one of five standard industrial classification (SIC) codes associated with the non-food and non-automotive retailing trade². In the second stage, I searched the newswire databases of the Dow Jones Interactive© news service and uncovered a total of 271 press releases from 81 firms describing their IT-related investments, i.e. the immediate or anticipated purchase and/or application of computer hardware, software or IT services and support, or the formation of strategic partnerships or electronically-mediated relationships and organizational forms. As shown in Table 2, a total of 121 press releases were eliminated for any of several reasons. A common reason for

eliminating a press release announcing an IT investment was the presence of a “confounding” event, i.e. other important announcements by the focal firm on the same day as the IT investment, on the preceding trading day, or on the one that followed (McWilliams and Seigel 1997). After the exclusion of irrelevant and confounded press releases, the remaining sample was comprised of 150 announcements of IT-related investments made by 59 retailing firms.

Table 2 Attrition of Data Sample Due to Confounding and Other Reasons

	<i>N</i>
Beginning Amount of Press Releases	271
Pure-play internet retailer (e.g. Amazon.com)	(21)
International (i.e. non-US based and/or no US operations)	(17)
Publicly-traded for less than 1-year prior to announcement	(5)
Events within 10 trading days of others IT announcements	(41)
Confounded Events, i.e. event window includes announcement of:	
<i>Monthly Comparable Sales Figures</i>	(14)
<i>Quarterly or Annual Earnings Results</i>	(12)
<i>Stock Split or Dividend Changes</i>	(3)
<i>Merger, Acquisition, Divestiture, Spinout, or Joint Venture</i>	(7)
<i>Executive Appointments</i>	(1)
Total Events Eliminated	(121)
Remaining Events	150

DEPENDENT VARIABLE

A multiple-day, cumulative abnormal return (CAR) associated with an announcement of an IT investment is the standard dependent measure employed in the MIS-related events studies upon which this research builds (e.g. Dos Santos, Peffers, and Mauer 1993; Chatterjee, Richardson, Zmud 2001; Im, Dow, and Grover 2001; Subramani and Walden 2001). The event study methodology is grounded in the efficient market hypothesis, i.e. that new information about a firm’s activities which can materially affect its current and future earnings is evaluated by investors and rapidly reflected in changes to the firm’s stock price (Fama 1976;

² Hardware and building materials (SIC = 52), General merchandisers (SIC = 53); Apparel and accessory stores (SIC = 56); Home furniture and furnishings (SIC = 57; and Miscellaneous retailers (SIC = 59).

Brown and Warner 1985; MacKinlay 1997; McWilliams and Seigel 1997). Under this view, the increase in a retailer's stock price after the release or discovery of new information about its IT investments is assumed to represent the capital markets' estimate of the net present value of the contribution to future earnings streams attributable to those investments.

The dependent variable employed in this study was the retail index-adjusted, cumulative abnormal return over a three trading-day event window around the IT investment announcement date. This measure was calculated by subtracting the return for the Standard and Poor's Retail Index³ from the return for a given retailing firm during each trading day of the holding period- in this case a three-day interval including the trading day before the investment announcement, the day of, and the trading day after it.

INDEPENDENT VARIABLE

The independent measure was a categorical variable indicating the type of learning exemplified in each announcement concerning an IT investment. Using the instructions provided in the Appendix , both I and a paid graduate research assistant, hereafter referred to as "the RA", first, independently classified all IT investments as exploratory or exploitative, based solely upon information made in the press releases. After the initial round of coding, the RA and author met to review their coding of that subset of the 150 announcements upon which they had not

initially agreed. At the end of the second round, a total of 92 and 58 events were jointly classified as exploitative and exploratory, respectively.

Table 3 describes the major types of information and communication technologies in which retailers in the sample announced IT investments during the period of observation. All of the systems and technologies were ones that were discussed frequently in the pages of the IT-focused, retail trade publication known as *Retail Systems Alert*, as well as by more general retail publications like *Discount Merchandiser* and *Chain Store Age*. For the most part, investments classified as exploitative were those which involved automating labor-intensive and highly-routine tasks particularly those that involved great deals of data collection and processing; increasing the accuracy, reliability, and operational efficiency of core retailing processes; and standardizing on common platforms and technologies across the enterprise. The systems and technologies most frequently associated with such tasks were those located at the point-of-sale, e.g. barcode scanners, check readers, electronic cash registers, and debit/payment terminals, the back office, or the warehouse. Table 4 presents text abstracted from four announcements of IT investments jointly classified as exploratory. The differences in the types of technology, the routineness of the tasks to which the technologies were applied, and in their stated objectives are quite marked when compared to investments classified as exploitative.

<i>Construct</i>	<i>Validity</i>	<i>Check.</i>
Computerized content analysis was used to confirm the validity of the coding performed by the author and the RA. A commercially-available software program called Diction5.0 TM (Hart 1997) was employed for this purpose. Thirty-one dictionaries ⁴ (word-		

³ The S&P Retail Index is a capitalization-weighted index of domestic equities traded on the New York Stock Exchange, American Stock Exchange and NASDAQ. The component stocks are weighted according to the total market value of their outstanding shares. The impact of a component's price change is proportional to the issue's total market value, which is the share price times the number of shares outstanding. These are summed for all stocks and divided by a predetermined base value. The base value is adjusted to reflect changes in capitalization resulting from mergers, acquisitions, stock rights, substitutions, etc.

⁴ The 31 dictionaries defined in Diction5.0 are: Accomplishment, Aggression, Ambivalence, Blame, Centrality, Cognition, Collectives, Communication, Concreteness, Cooperation, Denial, Diversity, Exclusion, Familiarity, Hardship,

Table 3. Major Types of Information Technology Investment Announcements Described by Retailers in Sample

Communication
<ul style="list-style-type: none"> • Telecommunications Systems • Satellite communication systems • Mobile, Video, Voice and Data Communications • Electronic data interchange** • Electronic Messaging • Wide Area and Local Area Networks
Electronic commerce- Related*
<ul style="list-style-type: none"> • Internet, Intranets, and Extranets • Web-enabled applications for on-line shopping • E-commerce partnerships
Analytical (Integrated Systems)
<ul style="list-style-type: none"> • Decision Support Systems • Transportation and merchandise management** • Relational Databases, Data warehouses* • On-line Analytical Processing (OLAP) tools* • Image remittance and speech recognition • Micro-computers, and servers, workstations • Operating systems
Transaction Processing/Data Capture**
<ul style="list-style-type: none"> • Point of sales systems • Universal Product Code (UPC), Barcode scanners • Check readers, Debit and Electronic Benefits Transfer (EBT) terminals • Data capture equipment • Electronic cash registers and terminals

* The majority of the IT investments of this kind were considered to be exploratory.

** The majority of the IT investments of this kind were considered to be exploitative.

Human Interest, Inspiration, Leveling Terms, Liberation, Motion, Numerical Terms, Passivity, Past Concern, Praise, Present Concern, Rapport, Satisfaction, Self-Reference, Spatial Awareness, Temporal Awareness, and Tenacity.

Table 4. Abstracted Text from Press Releases of Four “Exploratory” IT Investments by Hanover Direct, The Limited, Rite Aid, Shopko Stores.

Hanover Direct, a \$800 million direct retailer that markets products via a portfolio of well-know specialty catalogs, adopted OLAP with the hope that it would enable the firm to “analyze purchasing trends and buying patterns on over 30 million customers in its database”, e.g. to know “if a customer buys sheets... what else they would buy... or, if they bought sheets, are they more likely to buy curtains” (Hanover Press Release, Nov. 5, 1996). Understanding those buying preferences, they felt, would allow them to market unique promotional offerings to special customers.

Shopko Stores, a retailer operating 129 stores in 15 states concentrated in the Upper Midwest, Mountain, and Pacific Northwest regions, invested in OLAP to enable remote users to access data warehouse and decision support applications through standard Internet browsers in order to (1) provide them “with the same access to our corporate data warehouse that our local users have” (2) to access the “most granular level of data” and to perform sophisticated analyses on it (3) to simultaneously analyze sales data by multiple dimensions, e.g. department, store, vendor, and time and (4) to give managers “a better understanding of sales trends and seasonality and an improved awareness of the relative contribution to the store's overall profitability from the different item types.” (Shopko Press Release, Feb. 14, 1996).

Rite Aid, a \$5.5 billion drug store retailer with more than 2,700 stores, deployed OLAP as a means to allow category managers and analysts in purchasing, merchandising, and marketing to “quickly and easily get answers to their questions and make informed business decisions”, e.g. monitoring the performance of ad items before, during, and after a promotion. Having access to this information, it was hoped, would allow analysts to answer questions such as “What advertising medium was the most effective during the promotion?” and then to “immediately adjust our advertising/merchandising strategy to improve our bottom line” (Rite Aid Press Release, Sept. 30, 1996).

The Limited, a retailer of lingerie and women’s intimate apparel and parent company of the Victoria’s Secret chain, adopted OLAP with the to improve its ability to “manage inventory” and “analyze market demand”, to obtain a better understanding of critical information such as selling patterns and how they vary by geography, to analyze data in “new ways” and to perform ad hoc analyses (Limited Press Release, May 6, 1996).

lists) containing over 10,000 words form the core of the Diction program. The dictionaries vary considerably in size, ranging from as few as 10 words to as many as 745 words. None of those words are duplicated across the thirty-one dictionaries. Homographs are accommodated via statistical weighting procedures that partially, but not perfectly, correct for context. The output of the program consists of both raw scores (word counts) and standardized scores for each dictionary. Prior to analysis by Diction, each press release was edited to remove text unrelated to the description of the firm's IT investment, e.g. the dateline, company and vendor descriptions, contact information (telephone numbers, email addresses, and URL) for the firm and/or its public relations agency, standard (although not uniformly present) wording about "Safe Harbor" provisions protecting voluntary disclosures, and other similar disclaimers.

Tests of mean differences in the word counts associated with the 31 dictionaries were conducted for the 150 edited press releases. The results indicate that events coded as exploitation by both the author and the RA had significantly lower Spatial Awareness ($p = 0.002$), Ambivalence ($p = 0.021$), and Rapport ($p = 0.047$) scores and significantly higher Diversity ($p = 0.001$), Hardship ($p = 0.023$), Blame ($p = 0.026$), Exclusion ($p = 0.040$), Aggression ($p = 0.072$), Past Concern ($p = 0.072$), and Inspiration ($p = 0.075$) scores.⁵ Descriptions of these scores, as provided in Diction5.0, appear in the last appendix. In short, these scores suggest that the coding was consistent with the differences defined in theory: exploitative IT investments are less spatially oriented, less uncertain and less inexact. They express more concern for deviation from accepted norms, incapacity (errors) and inappropriateness; use language that connotes relatively more self-containment and self-sufficiency; describe physical activity and processes, goal-directed behavior, and task-performance. Interestingly, announcements of exploitative IT investments

contained fewer words ($p = 0.067$), fewer different words ($p = 0.064$), yet somewhat longer words ($p = 0.019$) than announcements of exploratory investments.

ESTIMATION OF DEPENDENT VARIABLE

Because the focus of the study is the variance of abnormal returns, I elected to use a technique known as Multiplicative Heteroscedastic (MH) regression, also known as variance decomposition, in addition to OLS regression analysis. This is a technique which allows simultaneous estimation of the expected value and the variance of the dependent variable using maximum likelihood methods (Weesie 1998; Greene 1997). MH regression entails the extension of the standard linear regression of the expected value of a dependent variable to include a log-linear model of the *heteroscedasticity* in the dependent variable relative to each independent variable. Coefficients of the log-linear portion of the model are interpreted in a manner similar to those of a standard OLS regression model but with an important exception: positive coefficients indicate that the values of the dependent variable move farther away from the regression line as the independent variable increases. Negative coefficients indicate that the data move closer to the regression line. These coefficients are independent of those for the standard regression coefficients, i.e. they can assume positive or negative values independently of the value of slope coefficients. If all the variables included in the estimation of the expected value of the dependent variable are also included in the estimation of the variance, then an MH estimation model will use double the number of degrees of freedom of a similarly-constructed OLS regression. Though not previously used in the IT-performance literature, the technique has been used in other studies of the impact of organizational learning on financial performance (Sorenson and Sorenson 2001; Sorenson 2002).

CONTROL VARIABLES

Because size and the scale economies and purchasing power that it affords are such important determinants of profitability and

⁵ All p-values for tests of word differences are 1-tailed.

reliability of performance in the retailing sector (Sack 1996), organizational size, as measured by the natural log of firm sales in the year of the IT investment announcement, is included as a control. Previous event studies have noted an upward trend in abnormal returns associated with IT investments since 1991 (Im, Dow, and Grover 2001; Chatterjee, Richardson, and Zmud 2001). To control for this influence, a single continuous variable representing the year of the investment announcement was included. The availability of slack resources has been linked to several aspects of firm performance, e.g. long-term viability (McKelvey and Aldrich 1983), the ability to adapt to environmental change and to innovate (Nohria and Gulati 1996), and overall financial performance (Singh 1986; Hambrick and D'Aveni 1988). To control for its influence, I included a measure for unabsorbed organizational slack, the ratio of current assets less inventory to current liabilities, or the quick ratio (Singh 1986). This is a measure of a firm's excess, uncommitted liquid resources and indicates a firm's ability to meet current obligations with liquid assets.⁶ Descriptive statistics and a correlation matrix for the key variables are found in Table 5 and 6, respectively.

RESULTS

The results strongly support my central thesis: that the exploration-exploitation distinction is one which is more relevant to differences in the variance in performance, rather than its mean. Interestingly, and somewhat surprisingly, Table 7 indicates that cumulative abnormal returns to all announcements of IT investments were significantly negative. The 3-day, retail index-adjusted abnormal return was -0.61% , an amount significantly less than zero ($t = -1.59$, $p < 0.10$, one-tailed test), as were the market-adjusted returns of -0.85% ($z = -2.80$, $p < 0.01$, one-tailed test) and the raw return of -0.77% ($t = -2.01$, $p < 0.05$). The retail-adjusted returns were even more strongly

negative when the returns were winsored at the 1st and 99th percentiles ($t = -1.84$, $p < 0.05$, one-tailed test). The index-adjusted returns were less negative than either raw or the market-adjusted returns, suggesting that retailer's IT investments were more negative relative to the market as whole than to the retailing industry. Overall, these results indicate that, on average, financial markets considered that IT investments were more likely to destroy value than to increase it. As might be expected, the returns to the retail index as a whole were not significantly different than zero. The last four columns in Table 7 provide information about differences in the mean and variance of the abnormal returns to exploitative and exploratory IT investments. The results clearly indicate that, as expected, the two types of IT investments did not have different mean returns, whether measured as market adjusted, raw, or index-adjusted returns ($-0.63 < t < 0.79$). Also as expected, despite the equal means, variance in the abnormal returns of exploitative IT investments is much lower than that for exploratory ones ($13.05 < F < 22.88$, $p < 0.001$).

Equations 1-9 of Table 8 present the results of an OLS regression of the three-day, retail-adjusted return on three sets of covariates using three different samples. Models 1 regresses the dependent variable on only the learning variable. Model 2 adds sales and the quick ratio while Model 3 adds dummy variables representing the five retail sectors. Models 4-6 are analogous to Models 1-3 but contain only the 96 observations associated with the 15 retailers which made three or more announcements. Models 7-9 are also similarly constructed and utilize only the 54 observations associated with the 44 firms which made only one or two announcements. In all three models it can be seen that the expected level of returns to exploratory and exploitative IT investments did not differ ($-1.07 < t < 1.00$). Unlike previous studies (e.g. Im, Dow, and Grover 2001) no significant impact was observed from either the year of the investment or the size of the firm as measured by the log of sales. The measure of slack resources was not a significant predictor of the expected value of abnormal returns ($-1.03 < t < 1.14$, $p > 0.10$, two-tailed test) and neither were any of the industry dummies.

⁶ This ratio is a more conservative analog of the current ratio; inventory is excluded since the liquidation price of inventory is likely to be below its book value.

Table 5. Descriptive Statistics of Independent, Control and Other Key Variables

Variable	N	Min	Max	Mean	St. Dev.
Exploitation	150	0.00	1.00	0.61	0.49
Quick Ratio	150	0.08	3.52	0.75	0.70
Log of Sales (\$M)	150	1.15	5.07	3.82	0.82
Raw Return	150	-0.22	0.21	-0.01	0.05
S&P Retail Index	150	-0.07	0.08	0.00	0.02
Retail Index- Adjusted Return	150	-0.24	0.21	-0.01	0.05
SIC 52 = Building Materials & Hardware	150	0.00	1.00	0.05	--
SIC 53 = General Merchandisers	150	0.00	1.00	0.53	--
SIC 56 = Apparel & Accessory Stores	150	0.00	1.00	0.14	--
SIC 57 = Furniture & Home Furnishings	150	0.00	1.00	0.07	--
SIC 59 = Miscellaneous Retail	150	0.00	1.00	0.21	--
Year of Investment Announcement	150	0.00	1.00	--	--
Year = 1990	6	--	--	--	--
Year = 1991	9	--	--	--	--
Year = 1992	5	--	--	--	--
Year = 1993	9	--	--	--	--
Year = 1994	9	--	--	--	--
Year = 1995	22	--	--	--	--
Year = 1996	44	--	--	--	--
Year = 1997	46	--	--	--	--

Table 6. Zero-Order Correlation Matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Exploitation											
(2) Quick Ratio	-0.001										
(3) Log Sales	0.222**	-0.261***									
(4) Raw Return	0.022	0.104	-0.031								
(5) Retail Index Return	0.028	-0.027	-0.084	0.418***							
(6) Retail Index- Adj. Return	0.025	0.081	-0.016	0.702***	-0.253**						
(7) SIC = 52	0.067	0.074	-0.129	0.08	0.041	0.078					
(8) SIC = 53	0.097	-0.133	0.605***	-0.103	-0.11	-0.074	-0.250**				
(9) SIC = 56	-0.035	0.210**	-0.166*	0.137#	0.052	0.13	-0.096	-0.426***			
(10) SIC = 57	-0.007	0.002	-0.144#	-0.022	0.051	-0.092	-0.063	-0.282***	-0.108		
(11) SIC = 59	-0.121	-0.057	-0.438***	-0.021	0.037	-0.007	-0.124	-0.549***	-0.210**	-0.139#	
(12) Year of Announcement	-0.083	0.113	-0.173	0.076	0.173*	-0.045	0.102	-0.138#	-0.024	0.04	0.109

Legend: Two-sided tests: # $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The results of the OLS regressions more strongly confirm that there was no difference in the mean level of returns between exploitative and exploratory IT investments.

In Table 9 are presented the results of nine Multiplicative Heteroscedastic (MH) regressions of the 3-day, retail- adjusted

abnormal returns on the sets of covariates shown in Table 8. The upper panel of Table 9 presents the results of the impact of exploitative IT investments on the *mean* level of returns while the lower panel indicates the impact on the *variance* in returns around that mean. The results of all nine models indicate that while exploitative IT investments do not

Table 7. Market-Adjusted, Raw , and (Retail) Index-Adjusted Cumulative Abnormal Returns Associated with IT Investment Announcements

Type of Return	Type of IT Investment	N	Positive: Negative	Equality of Proportions	Mean Return (μ)	1-Sample t-test: $\mu_{all} = 0$	Equality of Means (t): $\mu_{exploit} = \mu_{explore}$	ST. DEV (σ)	Equality of Variance (F): $\sigma^2_{exploit} = \sigma^2_{explore}$
Market-Adjusted	Exploitation	92	32:60	0.005	-0.68%	-2.38**		2.78%	
	Exploration	58	26:32	0.511	-1.11%	-1.32#		6.36%	
	All	150	58:92	0.007	-0.85%	-2.30*	0.48	4.50%	13.05***
Market-Adjusted (W)	Exploitation	92	32:60	0.005	-0.68%	-2.39**		2.78%	
	Exploration	58	26:32	0.511	-1.16%	-1.80*		4.93%	
	All	150	58:92	0.007	-0.87%	-2.83**	0.68	3.75%	14.21***
Raw	Exploitation	92	44:48	0.175	-0.54%	-1.69*		3.13%	
	Exploration	58	30:28	0.896	-1.13%	-1.33#		6.48%	
	All	150	77:73	0.221	-0.77%	-2.01*	0.65	4.71%	14.88***
Raw (W)	Exploitation	92	44:48	0.175	-0.54%	-1.69*		3.13%	
	Exploration	58	30:28	0.896	-1.18%	-1.60#		5.63%	
	All	150	77:73	0.221	-0.79%	-2.26*	0.79	4.27%	15.46***
Retail Index-Adjusted	Exploitation ^{&}	92	42:50	0.175	-0.38%	-1.35#		2.70%	
	Exploration ^{&&}	58	30:28	0.896	-0.96%	-1.09		6.68%	
	All	150	72:78	0.221	-0.61%	-1.59#	-0.63	4.65%	21.09***
Retail Index-Adjusted (W)	Exploitation ^{&}	92	42:50	0.175	-0.38%	-1.35#		2.71%	
	Exploration ^{&&}	58	30:28	0.896	-0.99%	-1.32#		5.68%	
	All	150	72:78	0.221	-0.62%	-1.84*	0.76	4.10%	22.88***
S&P Retail Index	Exploitation	92	48:44	0.917	-0.16%	-0.78		1.98%	
	Exploration	58	31:27	0.694	-0.17%	-0.52		2.54%	
	All	150	79:71	0.683	-0.16%	-0.92	0.04	2.21%	2.28
S&P Retail Index (W)	Exploitation	92	48:44	0.917	-0.14%	-0.72		1.93%	
	Exploration	58	31:27	0.694	-0.21%	-0.65		2.45%	
	All	150	79:71	0.683	-0.17%	-0.97	0.18	2.14%	2.27

Legend: One-sided tests: # $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; [&] On same days as announcements classified as "Exploitative"; ^{&&} On same days as announcements classified as "Exploratory"; "W" indicates returns winsored at 1st and 99th percentile.

differ from exploratory ones with regard to an impact on the mean ($-0.72 < z < 1.26$, $p > 0.10$, two-tailed test), exploitative IT investments exhibit much lower variance in returns ($-7.59 < z < -3.29$; $0.001 < p$, one-tailed test).

The impact of the control variables on the variance in returns is quite different from that observed for the mean. The log of sales was a very strong predictor of the variance in returns around the mean (average $t = -4.16$, $p < 0.001$, one-tailed test), but not a predictor of the mean itself (average $t = 0.98$, $p > 0.10$). This pattern was reversed, however, for the sample of firms making only one or two announcements. Here size was a very strong predictor of the mean level of returns (average $Z = 3.85$, $p < 0.001$, one-tailed test) and only a weak predictor of its variance (average $z = -$

1.30 ; $p < 0.10$, one-tailed test). Also, it is notable that higher levels of slack resources were associated with significantly lower variance in returns about the mean, but only in the full sample ($z = -2.45$, $p < 0.01$, one-tailed test). The year of the IT announcement, by contrast, was positively associated with the variance in the returns about the mean (average $Z = 3.71$, $p < 0.001$, one-tailed test), thereby indicating that variance in returns increased markedly throughout the period under observation. Most of the industry dummies were also significant. All which were so had negative coefficients, indicating that abnormal returns in those sectors were less variable than those of the General Merchandise sector, the one which contained mega-retailer Wal-Mart .

Table 8. Results of Ordinary Least Squares Regression of (Retail) Index-Adjusted Cumulative Abnormal Return on Type of IT Investment and Other Covariates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Exploitation	0.0058 (0.74)	0.0036 (0.44)	0.0033 (0.40)	0.0086 (1.15)	0.0084 (1.07)	0.0083 (1.05)	0.0014 (0.08)	-0.0142 (-0.75)	-0.0199 (-1.00)
Quick Ratio		0.0037 (0.64)	0.0029 (0.49)		-0.0002 (-0.03)	-0.0022 (-0.33)		0.0116 (1.03)	0.0130 (1.14)
Log of Sales		0.0045 (0.89)	0.0068 (1.08)		-0.0017 (-0.21)	0.0039 (0.40)		0.0278# (1.93)	0.0332* (2.16)
Year		-0.0004 (-0.19)	-0.0004 (-0.19)		-0.0013 (-0.76)	-0.0014 (-0.84)		-0.0003 (-0.04)	-0.0012 (-0.20)
SIC = 52			-0.0136 (0.74)			0.0096 (0.45)			0.0013 (0.04)
SIC = 56			0.0130 (1.05)			0.0206# (1.64)			-0.0209 (-0.74)
SIC = 57			-0.0065 (-0.39)			0.2424 (1.11)			-0.0525# (-1.70)
SIC = 59			0.0061 (0.50)			0.0027 (0.19)			-0.0153 (-0.62)
Number of obs	150	150	150	96	96	96	54	54	54
Model df	1	4	8	1	4	8	1	4	8
Model F-statistic	0.55	0.39	0.43	1.33	0.47	0.69	0.01	0.98	0.9
Adj. R-squared	-0.30%	-1.65%	-3.15%	0.35%	-2.28%	-2.72%	-1.91%	-0.14%	-1.57%

Legend: Two-sided tests: # $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; Non-standardized coefficients.; z-statistics are in parentheses.

ROBUSTNESS OF ESTIMATES

All of the above OLS and MH regression analyses were also run using eleven other measures of abnormal returns and three other event windows. The other measures of abnormal returns were as follows: retail-adjusted returns winsored at the 1st and 99th percentile; market adjusted returns using an equally- and value-weighted indexes, both winsored and not; equally and value-weighted market model returns, both winsored and not; and the raw returns, both winsored and not. There were no material differences in the results associated with the use of any of these of measures.⁷ This is not surprising given that a one-way analysis of variance revealed that there were no significant differences in the means of the 12 groups ($F_{\text{test}} = 0.13$, df (between groups) = 11, $p = 0.99$).

There were some material differences when all OLS and MH regression analyses were repeated over different event windows, however. Table 10 summarizes the results of these analyses. The top three rows present the t-statistic associated with the independent variable in the nine previously-detailed OLS regressions over three different event windows: plus and minus 2, 5, and 10 trading-days around the announcement date. The bottom three rows present the z-statistics for the bottom panel of nine MH regressions of the independent variable over the same three event windows. The dependent variable in all models was the retail-adjusted abnormal return. The results of the OLS regression indicate that even over longer event windows, exploitative IT investments were not associated with a different expected value of returns than exploratory ones ($-1.54 < t < 1.08$, $p > 0.10$, two-tailed test). In the MH regressions it can be observed that the longer the event window and the more controls that were added, the less strongly the learning variable predicted the variance in returns about the mean. Still, the basic finding that exploitative IT investments were associated

⁷ Market-model and market-adjusted returns were calculated using the Event study software program Eventus ® (Cohen 2002).

Table 9. Results of Multiplicative Heteroscedastic Regression of (Retail) Index-Adjusted, Cumulative Abnormal Return on Type of IT Investment and Other Covariates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Impact on Mean									
<i>Exploitation</i>	0.0058 (0.63)	0.0071 (1.14)	0.0071 (1.30)	0.0086 (0.95)	0.0083 (1.26)	0.0042 (0.87)	0.0014 (0.07)	-0.0109 (-0.72)	-0.0012 (-0.15)
<i>Quick Ratio</i>		-0.0032 (-1.11)	-0.0013 (-0.50)		-0.0048 (-1.44)	-0.0053# (-1.73)		0.0092 (1.26)	0.0031 (0.60)
<i>Log of Sales</i>		-0.0045 (-1.21)	0.0005 (0.10)		-0.0059 (-1.06)	-0.0003 (-0.04)		0.0238* (2.25)	0.0221*** (5.54)
<i>Year</i>		-0.0014# (-1.84)	-0.0007 (-0.93)		-0.0017* (-2.16)	-0.0012 (-1.48)		0.0009 (0.28)	0.0055*** (3.23)
<i>SIC = 52</i>			0.0125 (1.44)			0.0050 (0.72)			0.0706*** (16.26)
<i>SIC = 56</i>			0.0137 (2.33)*			0.0193* (2.22)			0.0248*** (7.12)
<i>SIC = 57</i>			-0.0023 (-0.22)			0.0197** (2.59)			-0.0077* (-2.15)
<i>SIC = 59</i>			0.0087 (1.11)			-0.0075 (-0.75)			0.0240*** (5.16)
Impact on Variance									
<i>Exploitation</i>	-1.8004*** (-7.59)	-1.3809*** (-5.61)	-1.2395*** (-5.01)	-1.9941*** (-6.65)	-1.3608*** (-4.39)	-1.2106*** (-3.87)	-1.5793*** (-4.06)	-1.4165*** (-3.29)	-3.3332*** (-7.38)
<i>Quick Ratio</i>		-0.4268* (-2.45)	-0.4336* (-2.45)		-0.2361 (-0.94)	-0.4466# (-1.68)		-0.3651 (-1.43)	0.0221 (0.09)
<i>Log of Sales</i>		-1.0089*** (-6.58)	-1.3381*** (-7.07)		-1.1804*** (-3.69)	-1.9091*** (-5.05)		-0.5612# (-1.71)	-0.3049 (-0.87)
<i>Year</i>		0.1688** (2.90)	0.1723** (2.94)		0.1508* (2.27)	0.0678 (1.02)		0.3265* (2.48)	1.4291*** (10.65)
<i>SIC = 52</i>			-1.4537** (-2.63)			-3.4539*** (-4.09)			-0.7092 (-0.87)
<i>SIC = 56</i>			-1.3219*** (-3.56)			-3.0445*** (-3.53)			-1.5917* (-2.48)
<i>SIC = 57</i>			-0.8763# (-1.77)			-1.3541** (-2.71)			-3.2346*** (-4.61)
<i>SIC = 59</i>			-0.8862** (-2.42)			-1.2087* (-2.19)			-1.6826*** (-3.02)
<i>Number of observations</i>	150	150	150	96	96	96	54	54	54
<i>Model df</i>	2	8	16	2	8	16	2	8	16
<i>Model χ^2</i>	58.58***	110.45***	130.12***	46.56***	68.62***	91.86***	16.11***	29.94***	73.05***

Legend: Two-sided tests: # $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; Non-standardized coefficients.; z-statistics are in parentheses.

with lower variance, basically held for the two shorter windows.

DISCUSSION

The most important contribution of this paper concerns the link it makes between mean and the variance of performance associated with IT investments. Neither event-based nor large-scale, spending-based empirical studies have attended to the questions of risk and return associated with IT investments. This omission is significant when one considers that research in accounting and finance has

identified several negative consequences associated with earnings volatility. These include: reduced market value (Barth, Elliott, and Finn 1999); reduced ability of investors and owners to predict future cash flows (Barnea, Ronen, and Sadan 1975); increased cost of capital and reduced access to external capital markets (Badrinath, Gay, and Kale 1989); and, as a result, decreased levels of other discretionary investments, i.e. capital expenditures, R&D and advertising (Minton and Schrand 1999). These consequences, combined with the fact that top managers' compensation is frequently tied to both the

Table 10 Tests of Robustness of Estimates: Results of Additional Ordinary Least Squares and Multiplicative Heteroscedastic Regressions of (Retail) Index-Adjusted Cumulative Abnormal Returns on Type of IT Investment and Other Covariates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
OLS REGRESSOPM									
Window = [-2,+2]	0.96	0.41	0.28	0.07	0.29	0.25	1.08	0.26	-0.25
Window = [-5, +5]	-0.81	-0.91	-1.08	-0.58	-0.42	-0.55	-0.55	-1.01	-1.30
Window = [-10, +10]	-1.11	-0.66	-0.80	0.43	0.39	0.39	-1.54	-1.11	-1.32
MH Regressions									
Window = [-2,+2]	-4.23***	-2.63**	-2.82**	-3.12***	-2.26*	-2.31*	-2.38*	-1.00	-1.71#
Window = [-5, +5]	-2.34*	-1.82#	-1.21	-2.92**	-2.46*	-3.42***	-0.63	-0.66	0.27
Window = [-10, +10]	-2.19*	-0.23	0.77	-1.34	-0.77	-1.06	-0.89	0.23	2.29*

Legend: Two-sided tests: # $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

level and quality of earnings (Kaplan, Mitchell, and Wruck 1999), create strong incentives for managers to anticipate the impact of their decisions and actions on the volatility of earnings (Bartov 1993; Imhoff and Thomas 1988) and to take concerted action to reduce it via practices such as income smoothing (Bricker, Previts, Robinson, and Young 1995).

What this all suggests is that the consequences of IT investments are not limited to the immediate activities, processes and tasks to which they are applied. Rather, by providing an additional means by which managers can moderate their earnings volatility, the effects can be seen to reach all the way to the firm performance of the firm as a whole.

The results make clear that exploitative IT investments are associated with relatively greater reliability in expected earnings. All of these aforementioned benefits attendant to increased reliability have special importance for the retailing industry, given its long-noted seasonal sales volatility, its increased importance on a successful fourth quarter (the holiday season) to annual performance, and its low and declining profit margins. In such a setting, it may be the case that the most important benefits associated with IT investments are their impact on the reliability of performance. For, to the degree that they do so, they help retailers secure the advantages

attendant to greater reliability- benefits that, in turn, may make possible both IT investments and investments in the complementary assets that IT most effectively; benefits that make possible IT spending at levels that, at least, maintain competitive parity and which, at best, lay the foundation for higher mean levels of performance.

A second important contribution of this study is its unexpected finding – significantly negative cumulative abnormal returns. This finding would seem, at first blush, to contradict the findings of much recently published research on the IT-firm performance relationship. Upon closer examination it can be observed that this contradiction is more apparent than real and that the appearance of contradiction actually provides the basis for the contribution that this finding makes. In one sense, the results are consistent with findings reported in at least three event studies examining the shareholder wealth effects of IT investments and IT-related organizational change (Dos Santos, Peffers, and Mauer 1993; Im, Dow, and Grover 2001; Chatterjee, Richardson, and Zmud 2001). Each of those studies found that the mean cumulative abnormal return associated with IT announcements was, on the whole, not positive. Rather, positive returns were found only for certain *types* of IT investments, e.g. those classified as “innovative” (Dos Santos, Peffers, and Mauer 1993), and for those influenced by particular *contextual factors*,

e.g. firm size or time period (Im, Dow, and Grover 2001) and industry characteristics, e.g. whether an industry was experiencing “IT-driven transformation” (Chatterjee, Richardson, and Zmud 2001).

What the finding of strongly *negative* returns associated with announcements of IT investments adds to our understanding is this: it further highlights the importance of industry conditions as a critical contingency or determinant of the returns to IT. The retail sector in the 1990’s was one that was highly concentrated, was dominated by one particularly powerful firm (Wal-Mart), had a median level of profitability that steadily declined, and which emphasized- perhaps over-emphasized- IT for process automation- the opposite of an industry undergoing IT-driven “transformation”. Chatterjee, Richardson, and Zmud 2001) found positive returns to IT investments under such “transformational” industry conditions, while this study reports the opposite: negative returns in an industry experiencing increasing cost pressure and a high need for automation-focused IT investments. The findings may also provide new source of explanations for firms’ apparent under-investment in IT in the face of evidence of high average returns (Andersen and Banker 2003): managers may either overlook or consciously pass up opportunities to make exploratory IT investments with high and positive net present values when, for competitive or institutional reasons, the increased earnings volatility that they would engender can not be offset by a sufficient number of unrelated, exploitative investments. Were this the case, it would posit industry dynamics and firm-specific attributes as crucial, and to-date largely overlooked, moderators of the IT-performance relationship. It would also have important implications for managers and research, confirming as it does, the value of Orlikowski and Iacono’s (2002) call for more research on how context moderates IT’s use and impact.

The finding of negative returns also makes an important contribution to what has been learned from a number of large-scale, cross-sectional studies of IT and financial performance. Several such studies have investigated IT’s average (Brynjolfsson and

Hitt 1996; Dewan and Min 1997; Bharadwaj, Bharadwaj, and Konnsynski 1999) effects on financial performance and found them to be highly positive. In order to increase the generalizability of their findings, these studies have elected not to focus on IT investments within the confines of a single industry setting, as was the case here. Instead, they have controlled for differences in industry characteristics with continuous variables, e.g. industry concentration, with categorical (dummy) variables, or both.

What this study demonstrates is that while IT investments are positively associated with financial performance, industry conditions may be important mitigating factors. It is quite possible that the heavy IT spending by mega-retailers like Wal-Mart and Target raised the level of IT needed by the average retailer to effectively compete. If true, many IT investments then became either “table stakes” for the average retailer, i.e. a minimum requirement for doing business, or became a competitive necessity, i.e. something that retailers could not survive without, but which conferred no direct advantage or appreciable return (Porter 2001). And in an era where industry leaders’ use of IT was seen as essential to their success (Callon 1996; Mason and Frons 1985; Pamlieri 1995), smaller and less profitable retailers frequently sought to improve performance by adopting the *systems* believed responsible for the success. However, anecdotal evidence suggests that many lacked or were unable to acquire or develop the other valuable, firm-specific resources, structures, and capabilities that should accompany and complement those investments. The result was most likely that they achieved lower returns for their efforts, if not negative ones.

LIMITATIONS

There are three important limitations to this study which deserve to be noted. The first concerns the lack of information about the scale or size of the IT investments which were announced or about firms’ prior IT investments, particularly in their IT infrastructure. If data were available about the size of IT investments evaluated in this study, it would be possible to test whether the size of firm’s IT investments or its existing

infrastructure better explain the results reported here. Such information would also help us understand whether the results confirm or contradict the findings of studies utilizing firm-level measures of IT such, e.g. IT spending as a percentage of sales (Bharadwaj, Bharadwaj, and Konnsynski 1999) and whether the exploration-exploitation distinction might be an important omitted variable in those studies.

A second limitation comes from the fact that firm effects were not controlled. Numerous studies inside and outside of the MIS field have found that a significant proportion of the variation in firm performance is attributable to unobserved and unobservable firm characteristics (Heckman, Hotz, and Walker 1985). More research should be undertaken to better understand the role of firm specific characteristics in the IT- firm performance relationship.

Finally, there are two assumptions which must hold if the results of event studies such as this one are to be believed. First, announcements of IT investments must be reasonably good signals of retailer's actual intentions and IT investment strategies. Secondly, it must also be the case that investors are able to ascertain what are the

likely implications for firm performance from IT investments. The results of this study suggest that the first of these two assumptions is reasonable. Retailers' announcements of IT investments were qualitatively identical to those described in major retail trade publications. The second assumption is yet to be more than anecdotally substantiated, however. To date, no published event study in the MIS literature has examined whether firms' future earnings are in fact impacted in a manner consistent with the event returns. This study is no exception. Future research should be undertaken to systematically investigate whether and to what degree the impact on future earnings which capital markets expect from IT investments are realized.

Acknowledgements: The author would like to thank Roberto Fernandez, Erik Brynjolfsson, Robert Gibbons, Paul Carlile, Jesper Sorenson, Wanda Orlikowski, Vernon Richardson, Rebecca Henderson, Ed Roberts, Michael Cusumano, and Ezra Zuckerman and other participants of the MIT/Harvard Economic Sociology Seminar for helpful comments on earlier versions of this paper. This research was funded in part by the National Science Foundation grant number IIS-0085725.

BIBLIOGRAPHY

- Andersen, M., R. Banker, and S. Ravindran, "The New Productivity Paradox," *Communications of the ACM*, 2003, 46: 3, pp.91-94.
- Banker, R. D., R. J. Kauffman and R. C. Morey, "Measuring Gains in Operational Efficiency from Information Technology: A Study of the Positran Deployment at Hardee's Inc.," *Journal of Management Information Systems*, 1990, 7:1, 29-54.
- Barnea, A., J. Ronen and S. Sadan, "Classificatory Smoothing of Income with Extraordinary Items," *The Accounting Review*, 1976, 51:1, 110-22.
- Bartov, E., "The Timing of Asset Sales and Earnings Manipulation," *The Accounting Review*, 1993, 68:4, 840-55.
- Barua, A., C. Kriebel and T. Mukhopadhyay, "Information Technologies and Business Value: An Analytic and Empirical Investigation," *Information Systems Research*, 1995, 6:1, 1-23.
- Bharadwaj, A., S. Bharadwaj and B. Konnsynski, "Information Technology Effects of Firm Performance as Measured by Tobin's Q," *Management Science*, 1999, 45:6, 1008-24.
- Bharadwaj, A., "A Resource-Based Perspective on Information Technology Capability and Firm Performance: An Empirical Investigation," *MIS Quarterly*, 2000, 24:1, 169-96.
- Bricker, R., G. Previts, T. Robinson and S. Young, "Financial Analyst Assessment of Company Earnings Quality," *Journal of Accounting, Auditing and Finance*, 1995, 10:5, 541-44.
- Brown, S. and J. Warner, "Using Daily Stock Returns: The Case of Event Studies," *Journal of Financial Economics*, 1985, 14:1, 3-31.

- Brynjolfsson, E. and L. Hitt, "Productivity, Business Profitability, and Consumer Surplus: Three Different Measures of Information Technology Value," *MIS Quarterly*, 1996, 20:2, 121-42.
- Brynjolfsson, E. and L. Hitt, "Beyond Computation: Information Technology, Organizational Transformation and Business Performance," *Journal of Economic Perspectives*, 2000, 14:4, 23-48.
- Brynjolfsson, E., L. Hitt and S. Yang, "Intangible Assets: Computers and Organizational Capital," *Brookings Papers on Economic Activity*, 2002, 1:1, 137-98.
- Callon, J., "Wal-Mart's Is Success," *Datamation*, 1996, 42:23-36.
- Chatterjee, D., V. Richardson and R. Zmud, "Examining the Shareholder Wealth Effects of Announcements of Newly Created CIO Positions," *MIS Quarterly*, 2001, 25:1, 43-70.
- Cole, B., "Red Brick Targets Retailers with New Data Warehouse," *Network World*, 1994, 11:44-5.
- Dewan, S. and C. Min., "The Substitution of Information Technology for Other Factors of Production: A Firm Level Analysis," *Management Science*, 1997, 43:12, 1660-75.
- Dos Santos, B., K. Peffers and D. C. Mauer, "The Impact of Information Technology Investment Announcements on the Market Value of the Firm," *Information Systems Research*, 1993, 4:1, 1-23.
- Exstein, M. and S. Pak, *Retail Industry Review and Preview*. New York: Credit Suisse First Boston, 1997
- Exstein, M. and S. Lee, *Retail Industry Themes to Watch in 2001*. New York: Credit Suisse First Boston, 2001
- Fama, E., *The Foundations of Finance*, New York: Basic Books, 1976.
- Fiorito, S., E. May and P. Straugh, "Quick Response in Retailing: Components and Implementation," *International Journal of Retail and Distribution Management*, 1995, 23:5, 12-21.
- Fox, B., "Sears: Smarter, Not Just Softer," *Chain Store Age Executive*, 1996, 72:3, 54. March.
- Gates, W. and P. Rinearson, *The Road Ahead*, London: Penguin, 1996.
- Gates, W. and C. Hemingway, *Business @ the Speed of Thought: Succeeding in the Digital Economy*, New York, NY: Time Warner, 1999.
- Greene, W., *Econometric Analysis*, Upper Saddle River, NJ: Prentice-Hall, 1997.
- Hambrick, D. C. and R. A. D'Aveni, "Large Corporate Failures as Downward Spirals," *Administrative Science Quarterly*, 1988, 33:1, 1-23.
- Hammer, M., "Reengineering Work: Don't Automate, Obliterate," *Harvard Business Review*, 1990, 68:4, 104-12.
- Hart, R., *DICTION5.0: The Text-Analysis Program*, Thousand Oaks, CA: Sage, 1997.
- Hawes, J. and W. Crittenden, "A Taxonomy of Competitive Retailing Strategies," *Strategic Management Journal*, 1984, 5:3, 275-88.
- Heckman, J., V. Hotz and J. Walker, "The Influence of Early Fertility on Subsequent Births and the Importance of Controlling for Heterogeneity," *Bulletin of the International Statistical Institute*, 1985, 51:2, 1-15.
- Hunter, S., K. Kobelsky and V. Richardson, "Volatility and Dispersion of Earnings Following It Expenditures" *MIT Working Paper Series*, 2003, No. 4827-03, 1-40.
- Im, K., K. Dow and V. Grover, "Research Report: A Reexamination of It Investment and the Market Value of the Firm- an Event Study Methodology," *Information Systems Research*, 2001, 12:1, 103-17.
- Imhoff, G. and J. Thomas, "Economic Consequences of Accounting Standards: The Lease Disclosure Rule Change," *Journal of Accounting and Economics*, 1988, 10:2, 277-310.
- Kaplan, S. N., M. L. Mitchell and K. H. Wruck. "Clinical Exploration of Value Creation and Destruction in Acquisitions: Organization Design, Incentives and Internal Capital Markets," in S. Kaplan (ed.), *Productivity of Mergers and Acquisitions*, National Bureau of Economic Research, Cambridge, MA, 1999,
- Kranz, S., "Discounters: Choose Your Weapons," *Discount Merchandiser*, 1994, 34:44-46.
- Levinthal, D. and J. G. March, "The Myopia of Learning," *Strategic Management Journal*, 1993, 14:1, 95-112.

- Mackinlay, A. C., "Event Studies in Economics and Finance," *Journal of Economic Literature*, 1997, 35:March, 13-39.
- March, J. G., "Exploration and Exploitation in Organizational Learning," *Organization Science*, 1991, 2:1, 71-87.
- March, J. G., L. S. Sproull and M. Tamuz, "Learning from Samples of One or Fewer," *Organization Science*, 1991, 2:1, 1-13.
- March, J. G., "The Future, Disposable Organizations, and the Rigidities of Imagination," *Organization*, 1995, 2:3/4, 427-40.
- McKelvey, B. and H. Aldrich, "Populations, Natural Selection and Applied Organizational Science," *Administrative Science Quarterly*, 1983, 28:1, 101-28.
- McWilliams, A. and D. Siegel, "Event Studies in Management Research: Theoretical and Empirical Issues," *Academy of Management Journal*, 1997, 40:3, 626-57.
- Michman, R. and A. Greco, *Retailing Triumphs and Blunders: Victims of Competition in the New Age of Marketing Management*, Westport, CT: Quorum Books, 1995.
- Minton, B. A. and C. Schrand, "Does Cash Flow Volatility Affect Firm Value: Its Impact on Discretionary Investment and the Costs of Debt and Equity Financing," *Journal of Financial Economics*, 1999, 54:432-60.
- Monroe, A., "A Tough Retailing Market Won't Hurt Wall Street," *The Investment Dealers' Digest*, 1996, 62:24-26.
- Nohria, N. and R. Gulati, "Is Slack Good or Bad for Innovation?," *Academy of Management Journal*, 1996, 39:5, 1245-64.
- NVST, Weekly Corporate Industry Report: *Valuation of the Retail Store Industry*. Bellevue, WA: NVST, June 1997.
- Orlikowski, W.J. and C.S. Iacono, "Research Commentary: Desperately Seeking the "IT" in IT Research -- A Call to Theorizing the IT Artifact," *Information Systems Research*, 12, 2 (June) pp. 121-134.
- Palmieri, C., "Who's Afraid of Wal-Mart?," *Forbes*, 1995, 156:81-4.
- Porter, M., "Strategy and the Internet," *Harvard Business Review*, 2001, 79:3, 63-78.
- Powell, T. and M. Dent-Micallef, "Information Technology as Competitive Advantage: The Role of Human, Business, and Technology Resources," *Strategic Management Journal*, 1997, 18:5, 375-405.
- Rosenkopf, L. and A. Nerkar, "Beyond Local Search: Boundary-Spanning, Exploration, and Impact in the Optical Disk Industry," *Strategic Management Journal*, 2001, 22:287-306.
- Rothaermel, F., "Research Note: Incumbent's Advantage through Exploiting Complementary Assets Via Interfirm Cooperation," *Strategic Management Journal*, 2001, 22:6, 687-99.
- Sack, K., *Industry Survey: Retailing-General*. New York: Standard & Poor's, 1996/2001
- Singh, J. V., "Performance, Slack, and Risk Taking in Organizational Decision Making," *Academy of Management Journal*, 1986, 29:562-85.
- Sorensen, J., "The Strength of Corporate Culture and the Reliability of Firm Performance," *Administrative Science Quarterly*, 2002, 47:1, 70-91.
- Sorenson, O. and J. Sorensen, "Research Note: Finding the Right Mix: Franchising, Organizational Learning, and Chain Performance," *Strategic Management Journal*, 2001, 22:713-24.
- Subramani, M. and E. Walden, "The Impact of E-Commerce Announcements on the Market Value of Firms," *Information Systems Research*, 2001, 12:2, 135-54.
- Swain, P. G., "Making Room for Uncle Sam," *Business Quarterly*, 1994, 59:1, 46-51.
- Wal-Mart, Annual Report: *Letter to Shareholders*. Bentonville, AK: Wal-Mart Corporation, 1999
- Ward, J. and S. Warshawsky, "Electronic Retailing Is More Than a Web Site," *Chain Store Age*, 1997, 73:5, 64-68.
- Weesie, J., "Regression Analysis with Multiplicative Regression," *Stata Technical Bulletin*, 1998, 42:28-32.

- Weill, P., "Strategic Investment in Information Technology: An Empirical Study," *Information Technology*, 1990, 12:3, 141-7.
- Whitfield, B., "Apparel Specialty Stores Retrench and Realign," *Chain Store Age*, 1993, 69:24-26.
- Whitmarsh, J., "The Gap's Mick Connors on Streamlining the Global Supply Chain," *CIO*, 1996, Nov. 15,
- Wilson, L., "Cautious Change for Retailers," *InformationWeek*, 1994, 177-80. October 10.
- Zuboff, S., *In the Age of the Smart Machine: The Future of Work and Power*, New York: Basic Books, 1988.

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APPENDIX: CODING INSTRUCTIONS

Reasoning only from the information provided in the press release, use the following questions to help you decide whether the IT investment is exploratory or exploitative.

If one or more of the questions can be answered “yes”, the IT investment is likely an “exploratory” one.

- (A1) Is this investments in information technology new or novel for the industry, i.e. is it the first time that a firm in the industry has used IT for this purpose, task, or process?
- (A2) Is this investment new for the firm? That is, does it represent the first use of any IT by the firm for the specific purpose outlined in the announcement?
- (A3) Will the technology be used to support and aid decision making and data analysis? Will it greatly expand decision-makers’ access to information and/or data? Will it expand the number and/or range of decision makers or increase those decision-makers’ reliance upon judgment, expertise, or tacit knowledge?

If one or more of these questions can be answered in the affirmative, the IT investment is likely an “exploitative” one.

- (B1) Does this investment entail the adoption of industry standards or widely-recognized best practices, i.e. a technology whose efficacy has been already demonstrated or whose legitimacy has been established by other firms or organizations and possibly in other settings? Does anything about the investment suggest that the firm is, in any other way, following an identifiable trend or fad of some kind?
- (B2) Does the investment represent the upgrading of technology or systems in which the firm already has invested and has experience? Does it represent the use of technology the firm already possesses but in a different way? Does the investment involve the migration from one type of IT to another for the same task or process?
- (B3) Is the IT investment intended to largely eliminate or routinize manual, labor-intensive, and/or data- and transaction processing tasks?

APPENDIX 2: DICTION5.0 SEMANTIC FEATURES UPON WHICH EXPLOITATIVE AND EXPLORATORY IT INVESTMENTS DIFFERED

Spatial Awareness: Terms referring to geographical entities, physical distances, and modes of measurement. Included are general geographical terms (abroad, elbow-room, locale, outdoors) as well as specific ones (Ceylon, Kuwait, Poland). Also included are politically defined locations (county, fatherland, municipality, ward), points on the compass (east, southwest) and the globe (latitude, coastal, border, snowbelt), as well as terms of scale (kilometer, map, spacious), quality (vacant, out-of-the-way, disoriented) and change (pilgrimage, migrated, frontier.) Dictionary Size: 364 words

Ambivalence: Words expressing hesitation or uncertainty, implying a speaker's inability or unwillingness to commit to the verbalization being made. Included are hedges (allegedly, perhaps, might), statements of inexactness (almost, approximate, vague, somewhere) and

confusion (baffled, puzzling, hesitate). Also included are words of restrained possibility (could, would, he'd) and mystery (dilemma, guess, suppose, seems). Dictionary Size: 211 words

Report:: This dictionary describes attitudinal similarities among groups of people. Included are terms of affinity (congenial, camaraderie, companion), assent (approve, vouched, warrants), deference (tolerant, willing, permission), and identity (equivalent, resemble, consensus). Dictionary Size: 226 words

Diversity: Words describing individuals or groups of individuals differing from the norm. Such distinctiveness may be comparatively neutral (inconsistent, contrasting, non-conformist) but it can also be positive (exceptional, unique, individualistic) and negative (illegitimate, rabble-rouser, extremist). Functionally, heterogeneity may be an asset (far-flung, dispersed, diffuse) or a liability (factionalism, deviancy, quirky) as can its characterizations: rare vs. queer, variety vs. jumble, distinctive vs. disobedient. Dictionary Size: 308 words

Hardship: This dictionary contains natural disasters (earthquake, starvation, tornado, pollution), hostile actions (killers, bankruptcy, enemies, vices) and censurable human behavior (infidelity, despots, betrayal). It also includes unsavory political outcomes (injustice, slavery, exploitation, rebellion) as well as normal human fears (grief, unemployment, died, apprehension) and incapacities (error, cop-outs, weakness). Dictionary Size: 470 words

Blame: Terms designating social inappropriateness (mean, naive, sloppy, stupid) as well as downright evil (fascist, blood-thirsty, repugnant, malicious) compose this dictionary. In addition, adjectives describing unfortunate circumstances (bankrupt, rash, morbid, embarrassing) or unplanned vicissitudes (weary, nervous, painful, detrimental) are included. The dictionary also contains outright denigrations: cruel, illegitimate, offensive, miserly. Dictionary Size: 346 words

Exclusion: A dictionary describing the sources and effects of social isolation. Such seclusion can be phrased passively (displaced, sequestered) as well as positively (self-contained, self-sufficient) and negatively (outlaws, repudiated). Moreover, it can result from voluntary forces (secede, privacy) and involuntary forces (ostracize, forsake, discriminate) and from both personality factors (small-mindedness, loneliness) and political factors (right-wingers, nihilism). Exclusion is often a dialectical concept: hermit vs. derelict, refugee vs. pariah, discard vs. spurn). Dictionary Size: 375 words

Aggression: A dictionary embracing human competition and forceful action. Its terms connote physical energy (blast, crash, explode, collide), social domination (conquest, attacking, dictatorships, violation), and goal-directedness (crusade, commanded, challenging, overcome). In addition, words associated with personal triumph (mastered, rambunctious, pushy), excess human energy (prod, poke, pound, shove), disassembly (dismantle, demolish, overturn, veto) and resistance (prevent, reduce, defend, curbed) are included. Dictionary Size: 581 words

Past Concern: The past-tense forms of the verbs contained in the Present Concern dictionary. Dictionary Size: 95 words. The *Present Concern* dictionary contains a selective list of present-tense verbs extrapolated from C.K. Ogden's list of "general" and "picturable" terms, all of which occur with great frequency in standard American English. The dictionary is not topic-specific but points instead to general physical activity (cough, taste, sing, take), social operations (canvass, touch, govern, meet), and task-performance (make, cook, print, paint). Dictionary Size: 269 words

BIBLIOGRAPHY OF PRESS RELEASES

1. "ATS Money Systems, Inc. Enters into a Contract with Ames Department Stores to Provide Automated Cash Office Systems" *PR Newswire*, 10/21/1997.
2. "The Limited, Inc. Launches New Site on the World Wide Web" *PR Newswire*, 07/31/1997.

3. "Drug Emporium Launches DE-Direct" *PR Newswire*, 10/01/1997.
4. "Egghead, Inc. Launches Improved Web Site" *Business Wire*, 09/09/1997.
5. "Lechters Inc. Selects ODBMS, JDA Software's Client/Server Merchandising System" *Business Wire*, 07/25/1997.
6. "Paul Harris Completes New Point-of-Sale System Implementation" *PR Newswire*, 09/29/1997.
7. "Service Merchandise Uses Net Dynamics to Move Its Entire Catalog onto the Internet" *Business Wire*, 03/03/1997.
8. "Service Merchandise Selects Ca-Impact/2000 as the Jewel of Its Year 2000 Century Date Change Initiative" *Business Wire*, 10/02/1997.
9. "Checkfree Brings Integrated Reconciliation to Trend-Lines" *PR Newswire*, 06/30/1997.
10. "Barnes & Noble Announces Initiative to Launch World's Largest Bookseller Online" *Business Wire*, 01/28/1997.
11. "Barnesandnoble.Com Unveils Exclusive Alliance With Compuserve" *PR Newswire*, 10/28/1997.
12. "Circuit City Selects Staffware Workflow for Enterprise-Wide Use" *Business Wire*, 10/08/1997.
13. "Carson Pirie Scott Selects ATS CP-4000 for Its Cash Office Automation" *Business Wire*, 09/02/1997.
14. "DM Management Chooses Commercialware's Mozart" *PR Newswire*, 08/20/1997.
15. "Checkmate Announces \$270,000 Contract with Eagle Hardware & Garden" *Business Wire*, 11/19/1997.
16. "Federated Launches National Gift Registry" *Business Wire*, 01/31/1997.
17. "Federated Department Stores and QRS Corporation Sign Exclusive Agreement" *PR Newswire*, 08/18/1997.
18. "Macy's Installs Pricer Electronic Signing System" *Business Wire*, 12/18/1997.
19. "Gap Chooses Sun for Electronic Retail Projects" *Business Wire*, 01/13/1997.
20. "Telxon Awarded \$35 Million Contract from the Home Depot for New Java Powered Pen Client Solution" *PR Newswire*, 10/06/1997.
21. "Kmart Selects AT&T as Telecommunications Provider" *Business Wire*, 03/10/1997.
22. "Kmart Selects GE Information Services to Provide Total Electronic Data Interchange Solution" *PR Newswire*, 10/06/1997.
23. "Kmart Corporation Expands Web Site Super Kmart Joins Web Page" *PR Newswire*, 10/21/1997.
24. "Firstplus Announces Impending Plans to Install Home Improvement Kiosks in Lowe's Home Improvement Warehouses" *Business Wire*, 05/21/1997.
25. "Lillian Vernon Chooses Commercial Ware's Mozart" *PR Newswire*, 08/26/1997.
26. "McHugh Freeman Wins WMS Contract with Michaels Stores" *PR Newswire*, 06/30/1997.
27. "Noodle Kidoodle and CA Make It Fun to Learn on the Internet" *Business Wire*, 03/27/1997.
28. "Oshman's Sporting Goods Inc. Selects JDA Software's Mms and Retail Ideas" *Business Wire*, 10/15/1997.
29. "Payless Shoe Source and QRS Corporation Sign Exclusive Three Year Agreement" *PR Newswire*, 09/23/1997.
30. "Stores Automated Systems Adds More Rite Aid Business -- Sasi to Add Pos to 1,000 Newly Acquired Drug Stores in Western U.S." *Business Wire*, 01/09/1997.
31. "Rite Aid Selects Verifone to Provide Everest Payment Terminals" *PR Newswire*, 02/06/1997.
32. "Rite Aid Installing Symbol's Wireless Network System; Largest Number of Wireless LAN Radios in Retail Industry" *Business Wire*, 05/12/1997.
33. "Sears Selects Sun Servers for Strategic Projects" *Business Wire*, 01/27/1997.
34. "Upgraded Sears Credit Processing Platform to Support Portfolio Growth, New Products and Improved Service" *PR Newswire*, 05/12/1997.
35. "Sears Launches First E-Commerce Site with Craftsman Tools" *PR Newswire*, 10/29/1997.
36. "Shopko Unveils New Web Site" *PR Newswire*, 08/22/1997.
37. "Shopko Rolls out Verifone's Labor Management Solution" *Business Wire*, 10/07/1997.

38. "NPC Wins Exclusive Dayton Hudson Corporation Processing Contract" *PR Newswire*, 05/01/1997.
39. "Dayton Hudson Corporation Awards Systems Integration Project to Information Management Resources" *PR Newswire*, 08/13/1997.
40. "Dayton Hudson Corporation Awards Syntel Major Systems Integration Project" *Business Wire*, 11/21/1997.
41. "Toys 'R' Us Selects Insignia Systems as Sign and Label Software Vendor" *PR Newswire*, 07/29/1997.
42. "Wickes Lumber Introduces New Web Site, Expands on-Line Services" *PR Newswire*, 02/04/1997.
43. "Wal-Mart Deploys Neovista Decision Series Data Mining Software into Its Production Decision Support Environment" *Business Wire*, 05/20/1997.
44. "Hp Awarded Store Systems Upgrade by Wal-Mart" *Business Wire*, 07/07/1997.
45. "Woolworth Standardizes on Oracle(R) Universal Data Server" *PR Newswire*, 06/18/1997.
46. "Federated Department Stores to Standardize on Oracle Universal Server" *PR Newswire*, 09/30/1996.
47. "IVI Check Readers Continue to Sell Strongly among Major US Retailers" *Business Wire*, 08/21/1996.⁸
48. "Ames Now on-Line with World Wide Web Site" *Business Wire*, 03/11/1996.
49. "Elekom Releases Breakthrough Electronic Procurement Service on AT&T Network Note" *PR Newswire*, 01/19/1996.
50. "Just for Feet, Inc., Announces Successful Testing of Satellite Communications Technology" *PR Newswire*, 01/03/1996.
51. "Damark International, Inc. Announces Web Site Construction" *PR Newswire*, 06/27/1996.
52. "Spiegel Launches Industry's First Comprehensive Multi-Media Catalog CD-Rom" *PR Newswire*, 01/16/1996.
53. "Service Merchandise Introduces World Wide Web Site" *Business Wire*, 08/07/1996.
54. "Service Merchandise Rolls out New Bridal & Gift Registry Technology" *Business Wire*, 10/31/1996.
55. "More Than 7,000 Service Merchandise Catalog Items Now Available Via Internet" *Business Wire*, 12/18/1996.
56. "IVI Resumes Sales to Royal Bank and Receives Additional Orders from Consolidated Stores in the USA" *Business Wire*, 09/12/1996.
57. "GE Information Services Announces Implementation of Its Automated Freight Cost Management System by Compusa" *PR Newswire*, 11/14/1996.
58. "Dillard's Department Stores Installs Insignia Systems' Stylus Sign and Label Software" *PR Newswire*, 09/17/1996.
59. "Macy's Launches National Wedding Newsletter for Cyberspace Brides on March 15" *Business Wire*, 02/27/1996.
60. "Macy's Launches on-Line Access to Nationwide Bridal Registry" *Business Wire*, 06/27/1996.
61. "Best Internet Selected to Host Macy's West Web Site" *Business Wire*, 11/26/1996.
62. "Federated Systems Group Enters into Agreement with IBM" *Business Wire*, 12/16/1996.
63. "Cheetah and the Home Depot Developing State-of-the-Art Home Delivery System" *Business Wire*, 03/14/1996.
64. "Hanover Direct Selects DSS Agent to Analyze Buying Preferences for over 30 Million Customers" *Business Wire*, 11/05/1996.
65. "JC Penney Selects GE Spacenet to Provide a Scientific-Atlanta Satellite Digital Video Network Solution" *PR Newswire*, 04/15/1996.
66. "JC Penney Installs \$11 Million NCR Data Warehouse Solution to Support Catalog Operations" *PR Newswire*, 10/29/1996.

⁸ This announcement provided information on two retailers in the sample.

68. "Builders Square Uses Team Approach to Select Optimized Labor Scheduling System" *Business Wire*, 01/24/1996.
69. "Longs Drug Stores Uses Forte as Enterprise Application Development Platform" *Business Wire*, 09/16/1996.
70. "Victoria's Secret Stores Chooses Tandem for a Strategic Data Warehouse Solution" *Business Wire*, 04/08/1996.
71. "Catalyst International Wins Limited Distribution Services Inc. Warehouse Management Project" *PR Newswire*, 04/29/1996.
72. "Sterling Commerce to Provide Worldwide Electronic Commerce Services to the Limited" *PR Newswire*, 09/19/1996.
73. "Musicland Enters Exclusive Internet Music Partnership" *PR Newswire*, 10/15/1996.
74. "Pamida Selects Comshare Retail's Arthur; Software Will Enhance General Merchandiser's Planning" *Business Wire*, 07/09/1996.
75. "Rite-Aid Selects Microstrategy and Intrepid Systems to Deliver Merchandising Management Decision Support Solution" *Business Wire*, 09/30/1996.
76. "PSInet to Connect Internet Centers in 50 Computer City and 16 Incredible Universe Locations" *PR Newswire*, 08/19/1996.
77. "Computer City Goes on-Line; Internet Demo Stations Available in North American Stores, Free Internet Training Classes" *Business Wire*, 11/14/1996.
78. "Quintus Corp. Wins Sears, Roebuck Account" *Business Wire*, 02/20/1996.
79. "Sears Standardizes on Informix-Online Extended Parallel Server and IBM Rs/6000 Sp as Its Platform for Strategic Data Warehouse Projects" *Business Wire*, 06/26/1996.
80. "The Sharper Image Opens Its Newest Store on America Online" *Business Wire*, 09/03/1996.
81. "Shopko Stores Selects DSS Agent for Enterprise OLAP -- Applications Running on Massively Parallel IBM Sp2 / Oracle Platform" *Business Wire*, 02/14/1996.
82. "Dayton Hudson Corporation Selects Manugistics Transportation Planning Software" *PR Newswire*, 01/10/1996.
83. "International Verifact Announces Check-reader Sales to Dayton Hudson" *Business Wire*, 07/09/1996.
84. "Target Stores Introduces Automated Pharmacy" *PR Newswire*, 07/22/1996.
85. "Enterprise Solutions Limited Announces Major New Deployment of EXM Messaging Products at Wal-Mart" *Business Wire*, 12/19/1995.
86. "Highway Master Signs 350-Unit Contract with Wal-Mart" *Business Wire*, 04/08/1996.
87. "HP Solutions to Manage Wal-Mart Applications, Databases and Distributed Systems Worldwide" *Business Wire*, 08/06/1996.
88. "Wal-Mart Stores, Inc. Adds Most POS Payment Option" *PR Newswire*, 09/16/1996.
89. "Wal-Mart, First Data Announce Information, Payment Processing Venture" *PR Newswire*, 10/03/1996.
90. "Manugistics Teams to Lead Industry Initiative For Internet-Driven Collaborative Forecasting" *PR Newswire*, 10/24/1996.
91. "Home Depot Selects Vantive Helpdesk; Fortune 1000 Company Picks Vantive to Reduce Calls, Improve Service and Streamline Help Desk Operations" *Business Wire*, 08/07/1995.
92. "The Limited Installs Employer-Connect to Reduce Workers' Compensation Costs" *Business Wire*, 09/22/1995.
93. "Best Buy Chooses EIFO Switching Solution from Network Peripherals for Multimedia Kiosks" *Business Wire*, 05/11/1995.
94. "Boston University and Barnes & Noble Team up to Offer Students on-Line News, Entertainment, Debates, Celebrity Chats, Travel Tips, Career Advice, More" *Business Wire*, 09/05/1995.
95. "Gottschalks to Test Internet" *Business Wire*, 10/25/1995.
96. "Magellan & JC Penney Create Internet Site 900 Page Web Site Serves Buyers Throughout North America" *Canadian Corporate News*, 12/14/1995.
97. "Nordstrom Signs Multimillion-Dollar Agreements with MCI" *Business Wire*, 06/21/1995.

98. "Checkmate Announces Successful Pilot of Cmr400 Check Readers with Kmart Corporation" *PR Newswire*, 01/09/1995.
99. "Specialty Retailer Cites Big Benefits from Automated Labor Scheduling; Abercrombie & Fitch Saving with Campbell Staffworks" *Business Wire*, 08/30/1995.
100. "Bienvenue a Express! ; Welcome to a Women-Only Web Site" *Business Wire*, 10/10/1995.
101. "Catalogue Arm of Neiman Marcus Selects Comshare's Arthur Planning Software" *Business Wire*, 08/29/1995.
102. "Office Depot Selects Checkmate Electronics' Family of Products as Their Payment Automation Platform" *PR Newswire*, 07/11/1995.
103. "Right Start Children's Merchandiser Launches Online Store on the Internet Shopping Network" *Business Wire*, 09/13/1995.
104. "Sears Selects Imageable Client/Server Imaging Technology" *Business Wire*, 12/05/1995.
105. "IBM Announces Microage, Staples, Stream and Uarco to Link to IBM Electronic Purchasing Service" *Business Wire*, 12/05/1995.
106. "Strawbridge & Clothier Opens Home Page on the Internet Tuesday, November 7, 1995" *PR Newswire*, 11/03/1995.
107. "Interactive Computer Shopping Expanded at Dayton's, Hudson's and Marshall Field's" *Business Wire*, 04/19/1995.
108. "Toys 'R' Us Goes on the Net; World's Largest Specialty Retail Chain Unveils Interactive World Wide Web Site" *Business Wire*, 11/30/1995.
109. "Noblenet to Supply Wal-Mart with Unix and Windows EZ-RPC Tools for Advanced Client/Server Programming" *Business Wire*, 05/30/1995.
110. "Checkmate Announces Wal-Mart Agreement with ATM/Debit Terminals" *PR Newswire*, 07/27/1995.
111. "Tandem Chosen as Platform of Choice for Woolworths' Strategic Data Warehouse" *Business Wire*, 06/19/1995.
112. "Kmart Goes 'Online' America Online, Kmart, and Shoppers Express Announce Introduction of Kmart Interactive Home Shopping Service" *PR Newswire*, 12/20/1994.
113. "Lillian Vernon Introduces Catalog on CD-Rom" *Business Wire*, 04/07/1994.
114. "Merit Technologies Ltd. Receives First Order for New Intelligent Pos Workstation" *Canada NewsWire*, 07/12/1994.
115. "The Right Start Takes Children's Catalog on-Line Company Allies with Multimedia Corporation to Broaden Customer Base" *PR Newswire*, 11/21/1994.
116. "Netrix Wins \$1.5 Million Contract Extension from Revco Bringing Total Value of Pact to \$7.5 Million" *PR Newswire*, 09/19/1994.
117. "Andersen Consulting and Shopko Implement New Merchandise Management Solution for Shopko" *Business Wire*, 10/28/1994.
118. "Staples Adopts Campbell Software's Staffworks Labor Scheduling Software Chain-wide" *Business Wire*, 05/09/1994.
119. "Wal-Mart Subsidiary Selects Progress to Revamp Its Distribution System" *PR Newswire*, 01/31/1994.
120. "Checkmate Receives Major Orders for Check Readers" *PR Newswire*, 04/26/1994.
121. "Federated Launches Video Conferencing Network" *Business Wire*, 10/14/1993.
122. "Goody's Family Clothing Selects NCR Systems for Just-in-Time Inventory" *Business Wire*, 08/09/1993.
123. "JC Penney Building Digital Data Network Linking 1,300 U.S. Stores; Multi-Million Dollar Project Awarded to AT&T" *Business Wire*, 06/17/1993.
124. "Intervoice Receives Major Order from JC Penney" *PR Newswire*, 07/06/1993.
125. "Wal-Mart Selects NCR and Enterprise Solutions for Electronic Messaging System" *Business Wire*, 08/23/1993.
126. "Wal-Mart and Monarch Agreement Provides Free Software to Vendors" *Business Wire*, 09/13/1993.
127. "General Computer Announces Agreement with Wal-Mart to Provide Electronic Data Interchange Service" *PR Newswire*, 10/11/1993.

128. "Wal-Mart Stores Inc. Selects Symbol Technologies as Provider of Hand-Held Bar Code Scanners" *PR Newswire*, 11/12/1993.
129. "Wal-Mart Signs Contract with National Data Corporation for Pharmacy Processing Services" *PR Newswire*, 12/13/1993.
130. "Frank's Nursery & Crafts Select Symbol Technologies Spectrum One Network for Wireless Data Collection" *PR Newswire*, 08/07/1992.
131. "Aw Computer Systems Announces Additional 1992 Business" *Business Wire*, 05/26/1992.
132. "Toys 'R' Us Selects Symbol Technologies Spectrum One Network for Wireless Data Collection" *PR Newswire*, 08/11/1992.
133. "Fujitsu's Pos Terminals Strike the Right Note with Music and Video Chain" *Business Wire*, 01/13/1992.
134. "Wal-Mart Names Telxon to Supply Hand-Held Computer Systems" *PR Newswire*, 02/18/1992.
135. "ATS Money Systems Announces Installation of ATS Cash Office Systems" *Business Wire*, 04/19/1991.
136. "JC Penney Test of ISDN Announced: Test to Demonstrate Feasibility and Value of ISDN" *PR Newswire*, 02/06/1991.
137. "JC Penney Adds 1000th EDI Supplier" *PR Newswire*, 07/16/1991.
138. "Symbol Technologies Receives 20,000 Unit Order from JC Penney" *PR Newswire*, 11/01/1990.
139. "Nordstrom Announces Electronic Mail System for Vendor Community" *Business Wire*, 05/29/1991.
140. "Rite Aid to Expand Point-of-Sale through Sasi Inc." *Business Wire*, 05/20/1991.
141. "Wal-Mart Installs Hp Computer Systems as Part of \$44million Contract" *Business Wire*, 01/08/1991.
142. "Wal-Mart Stores Selects NCR System 3000" *Business Wire*, 03/11/1991.
143. "Fibronics Selected to Advance Open Systems Initiative at Wal-Mart" *PR Newswire*, 11/11/1991.
144. "JC Penney Awards Contracts to AT&T and MCI" *PR Newswire*, 01/09/1990.
145. "IMC Systems Group Introduces Multi-Platform Import/Export Software System, Signs Agreement with J.C. Penney" *PR Newswire*, 06/18/1990.
146. "Kmart Corporation Completes Installation of Scanning, Satellite Systems" *PR Newswire*, 11/14/1990.
147. "Wal-Mart Stores Inc. Selects NCR Scanners and PCs" *Business Wire*, 08/06/1990.
148. "Wal-Mart Stores Adopts X/Open's XPG Compliance for Information Technology Purchases" *PR Newswire*, 08/20/1990.
149. "Retail Technologies Corp. Signs Worldwide Software Contract with Woolworth Corp." *Business Wire*, 09/18/1990.