The Interrelationships between Information Technology Expenditures, CEO Compensation and Firm Value*

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May 2009

*We would like to acknowledge valuable comments from Steve Balsam, Jeff Boone, Som Bhattacharya, Carolyn Callahan, Fred Davis, Bruce Dehning, James Groff, Charlene Henderson, Suzanna Hicks, Lorin Hitt, Jim Hunton, Kevin Kobelsky, Likoebe Maruping, Austin Reitenga, Viswanath Venkatesh, Bob Zmud and the workshop participants at the 2008 American Accounting Association Midyear meeting (IS Section), the University of Arkansas and the University of Texas at San Antonio. We would also like to thank InformationWeek for providing the IT expenditure data.
Abstract: CEOs and their management teams decide how much a firm will spend on IT. Though managers make IT spending decisions with the intent of generating value, such benefits are risky and not guaranteed (Dewan et al. 2007). While CEOs may perceive that IT spending could translate into competitive advantage and increase productivity, they also realize that IT expense will reduce current net income and contain non-diversifiable risks. Our results suggest that boards of directors consider IT spending an important contribution to the firm’s investment opportunity set and consequently provide incentives for CEOs to invest in IT. First, we find that IT expenses are associated with higher ratios of equity compensation, which suggests that boards of directors understand the uncertainty and risk profile of some IT spending and therefore tie CEO compensation to future outcomes by placing greater weight on equity compensation. Second, we find that IT expenses are unrelated to CEO cash compensation, which suggests that BODs shield CEO cash compensation from the income-decreasing effects of IT spending. Third, we find that firms with both higher IT spending and higher ratios of equity to total CEO compensation have higher market values. We conclude that the synergistic relationship between IT spending and CEO equity compensation impacts firm market value.

Key Words: IT Investments, CEO Compensation, Shielding, IT Value
I. INTRODUCTION

Prior accounting research establishes that the use of CEO equity incentives (i.e., those stemming from stock option grants or restricted shares) varies according to the firm’s investment opportunity set and strategy (Holthausen et al. 1995; Gaver and Gaver 1993; Baber et al. 1996; Ittner et al. 1997).¹ For example, both Gaver and Gaver (1993) and Baber et al. (1996) document strong associations between firms’ investment opportunity sets and the use of equity compensation.

In this paper we examine the associations between information technology (IT) spending and CEO compensation, and the impact of the relationships of both IT spending and CEO equity incentives on firm market value. Our examination is motivated by a nascent line of research suggesting that IT initiatives have become key contributors to the firm’s investment opportunity set and overall business strategy (Earl and Feeny 2000; IT Governance Institute 2005b). To illustrate, recent research shows that IT spending is economically significant (approximately 40% of a firm’s capital expenditures), pervasive across a broad range of industries, and positively associated with accounting and market-based performance measures (e.g., Henderson et al. 2008; Kobelsky et al. 2008a; Ranganathan and Brown 2006; Bharadwaj et al. 1999).

Two additional characteristics of IT spending further motivate our study. Related research shows that investments in IT are significantly riskier than other discretionary strategic expenditures, such as research and development (R&D) (see e.g., Kobelsky et al. 2008b; Dewan et al. 2007; Benarocch 2002; Clemons and Weber 1990), which could

¹ Of course, prior accounting research also establishes the widespread use of net income, or related measures such as earnings per-share or profit margin, is the primary determinant of CEO cash compensation (see e.g., Murphy 1999; Natarajan 1996; Lambert and Larcker 1987; Dechow et al. 1994; Ittner et al. 1997; Gaver and Gaver 1998; Murphy 1999; Boschen et al. 2003; Adut et al. 2003; Core et al. 2003; Cheng 2004; Cheng and Warfield 2005).
hinder the CEO’s willingness to invest in IT. Furthermore, U.S. generally accepted accounting (GAAP) principles require that firms immediately expense most IT spending, thereby reducing current income and negatively affecting the CEO’s contemporaneous cash compensation.

Thus, from an agency perspective, IT spending decisions present an interesting dilemma. Both CEOs and board of directors (BOD) likely consider IT an important contributor to the firm’s investment opportunity set (IT Governance Institute 2008). However, since CEOs are risk-averse (Jensen and Meckling 1976) and myopic (e.g., Graham et al. 2005; Matsunaga and Park 2001), the risk associated with IT spending, coupled with the accounting treatment, can create agency costs due to underinvestment in IT and the potential adverse impact on future firm performance.

Motivated by theory and literature in accounting and financial economics (e.g., Prendergast 2002; Milgrom and Roberts 1995; Amihud and Lev 1981; Holmström 1979; Jensen and Meckling 1976), we begin our analysis by modeling the agency costs that may arise as the CEO invests in IT spending under the assumption that IT spending is an important contributor to the firm’s investment opportunity set and hence firm value. Our models suggest that BODs can mitigate agency costs resulting from differences in risk-preferences between the shareholders and the CEO by associating IT spending with performance-contingent equity compensation (i.e., options and stock grants). Greater

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2 For instance, Dewan et al. (2007) find that the relation between IT spending and both stock return and earnings variability is significantly higher than that of R&D, advertising and other non-IT capital expenditures, mainly due to the irreversible nature of the investment, its rapid obsolescence, and the extended time lags to return on investment.

3 Current accounting rules require expensing of the vast majority of IT investments. Stated differently, accounting rules allow firms to capitalize only the tangible asset portion (e.g., hardware) of the IT expenditure and prohibit capitalization of the intangible asset portion (e.g., software development costs etc.). According to our estimations, the intangible portion accounts for approximately 75% of overall IT spending.
equity compensation encourages a risk-averse CEO to accept higher risk and commit more effort toward long-term firm performance objectives. Our empirical tests confirm the predicted theoretical association between IT spending and CEO equity compensation, a result that holds after controlling for other important economic determinants of equity compensation. Our model also suggests that to mitigate myopic behavior, BODs should shield CEOs’ cash compensation from the income-decreasing effects of IT spending.\(^4\)

Again, the empirical results are consistent with the analytical prediction.

We then consider the collective impact of IT spending and CEO compensation on firm valuation, relating both to firm value using standard accounting valuation models (Ohlson 1995; Feltham and Ohlson 1995). These valuation models are appropriate in our setting because they are forward-looking and are based on expected firm performance, conditional on the information likely available to boards of directors (i.e., projected IT spending and expected payoffs) when they make compensation decisions. After controlling for other important economic determinants, we find that IT spending and CEO compensation are both related to firm value, suggesting that BODs use CEO compensation to create effective incentives for IT spending as well as complementary changes in business practices to achieve benefits from IT investments.

Our main results are consistent with the notion that BODs recognize the contribution of between IT spending to the investment opportunity set, so they structure CEO compensation to create the proper incentives to optimize the payoff from IT

\(^4\) We refer to shielding as the act of removing the IT expense from earnings for purposes of CEO cash compensation. To illustrate, consider the following example. Firm A’s net earnings (IT expense) for the period is $100 ($10). If the board of directors elects to shield fully the CEO’s cash compensation from IT expense, then adjusted net earnings would become $110 (i.e., they would remove the IT expense from earnings). On the other hand, if it elects to shield partially (e.g., the board only removes 50% of the IT expense) the CEO’s cash compensation, then adjusted net earnings would become ($105). Other studies that use this definition are Dechow et al. (1994) and Duru et al. (2002).
spending. In complementary ancillary tests we examine the effectiveness of equity compensation to motivate future IT spending. Using the framework advanced by Kobelsky et al. (2008a), we find that the level as well as the change in equity compensation is associated with subsequent IT budgets, suggesting that executive compensation is an important additional organizational determinant of IT budgets.

Our study contributes to both the management accounting and the accounting information systems literatures. To our knowledge, our study is the first to show theoretically and empirically that the relationships between IT spending and CEO compensation are complementary in their relationship with firm value for a large cross-section of firms. Prior related research had solely focused on the pay practices on “new economy” (Ittner et al. 2003; Murphy 2003) or “Silicon Valley” firms (Anderson et al. 2000). In addition, we contribute to the literature by documenting that BODs exercise discretion by shielding cash compensation from the earnings-decreasing effects of strategic expenses such as restructuring charges (i.e., Dechow et al. 1994) and R&D expenses (Duru et al. 2002; Cheng 2004). Our analysis is incremental in that we provide a more complete picture by examining the interrelationships between alternative components of CEO compensation (not just cash compensation) and the joint relations between pay and performance. Our study is the first paper to consider both cash and equity incentives related to a specific strategic expenditure. Finally, our study provides an incremental contribution to recent accounting information systems research (Kobelsky, et al. 2008a) by suggesting that CEO compensation affects the level of future IT spending (budgets).
II. BACKGROUND AND THEORETICAL FRAMEWORK

The firm’s investment opportunity set and CEO compensation

Myers (1977) describes firm value as a function of the assets in place and the present value of future growth opportunities. The firm’s investment opportunity set represents the range of projects available to the firm that will allow it to grow (e.g., Myers 1977; Kallapur and Trombley 1999; Jones et al. 2000). Thus, the investment opportunity set determines the extent to which a firm’s value is determined by its future discretionary expenditures (Kallapur and Trombley 1999).

Theoretical research examining principal-agency relationships suggests that moral hazard problems arise when the actions and effort of the agent cannot be observed (Prendergast 2002; Holmström 1979). Agency costs arise when the CEO’s unobservable actions, such as suboptimal investment decisions, harm the shareholders (Amihud and Lev 1981). These types of problems are particularly severe as the investment opportunity set increases (Smith and Watts 1992). Consequently, BODs attempt to link CEO compensation to observable output measures (e.g., net income or firm value) expected to be consistent with long term shareholder objectives (Prendergast 2002; Core and Qian 2002). Consistent with this notion, Baber et al. (1996) and Gaver and Gaver (1993) document a positive association between equity-based compensation and the investment opportunity set.

We assume that BODs consider IT spending to be an important contributor to the firm’s investment opportunity set, and thus, they create proper incentives for the CEO (via its CEO compensation policies) to implement IT investments effectively, minimize
agency costs, and ultimately attain positive value from IT spending.\(^5\) Below, we describe theoretical relations between IT spending and both CEO equity and cash compensation, and their consequential contribution to the shareholder’s objective of firm value maximization.

**Relation between IT spending, CEO equity compensation and firm market value**

First, we examine the link between CEO equity compensation and IT spending. The basic tenets of finance establish the value of the firm as the discounted present value of future earnings (e.g., Miller and Modigliani 1961; Copeland et al. 2000), and current market values therefore reflect investors’ expectations about future earnings (e.g., Lamont 1998). Prior research (Kobelsky et al. 2008a; Henderson et al. 2008; Dewan et al. 2007; Brynjolfsson et al. 2002) associates firm market values and IT spending. Kobelsky et al. (2008a) show that IT spending is related to both future operating performance and market returns. Henderson et al. (2008) further show that IT spending is related to both current market values and the net present value of future earnings. Based on these results, we assume that the BOD believes that the firm’s market value, \(z\), is a function of its prospects for long term profitability based on current operating income and IT spending as follows:

\[
z = x + \lambda_{it} + j,\tag{1}\]

\(^5\) This assumption is supported by mounting anecdotal evidence suggesting that BODs should address IT initiatives like any other strategic agenda item of the board (Haes and Grembergen 2004; IT Governance Institute 2008; Bank for International Settlements 1999). For example, a recent IT Governance Institute (2008) survey documents that the frequency of IT strategy discussion in board meetings has increased 10% from 2003.

\(^6\) Equation (1) could also be represented as an accounting valuation model such as those developed by Ohlson (1995) and Feltham and Ohlson (1995). These models explain firm market value using the following linear approximation: \(MV = BV + b_1 x + b_2 v\), where \(BV\) (book value of equity) and income \(x\) represents operational assets and activities, and \(v\) is a vector of other intangible factors that determine the excess between book value and market values.
where $x$ is current operating income, $it$ is current IT spending, $\lambda$ is the sensitivity of market value to IT spending, and $j$ is other factors affecting market values.

As $\lambda$ increases, IT spending takes on greater strategic importance for the firm (i.e., its impact on the investment opportunity set increases). However, IT payoffs are both long-term and risky (Dewan et al. 2007; Kobelsky et al. 2008a), and a risk-averse CEO may be reluctant to undertake potentially value-enhancing projects that would require him/her to bear more non-diversifiable risk (Jensen and Meckling 1976; Amihud and Lev 1981). The BOD mitigates potential costs associated with this conflict by granting equity compensation (i.e., stock options and restricted shares) to encourage the CEO to accept higher risk and commit more effort toward long-term firm performance objectives. Thus, the BOD opts to associate current equity compensation (EC) with both IT spending and current income, as shown in the following linear model.

$$EC(x, it, j) = \alpha_e + \varphi x + \varphi'it + \delta j,$$

where $\alpha_e$ represents some base amount of equity compensation, $\varphi$ is weight the BOD places on current operating income, $\varphi'$ is the corresponding weight placed on IT spending necessary to align CEO incentives with the expected relation between IT and market values shown in Equation (1), and $\delta$ represents the weight on other factors that affect market value.

Prior research shows that $\varphi$ is positive; income is an important determinant of equity compensation (see e.g., Carter et al. 2007). We predict that $\varphi'$ is also positive and increases as $\lambda$ increases, reflecting the BOD’s expectations about the contribution of IT to

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7 Relative to the CEO, shareholders can afford to be more risk-seeking because they are able to diversify unsystematic risk by including various securities in their investing portfolio. On the other hand, CEOs are risk-averse due to their inability to diversify the unsystematic risk arising to their employment with their current firm (i.e., they cannot diversify their human capital by working in various firms simultaneously).
the firm’s investment opportunity set (and hence expected firm performance), and their desire to align incentives. The equity incentives promote development of complementary organizational resources, and share risk by tying CEO compensation to the outcome of the investment. The CEO could also find this form of compensation appealing, because s/he may have advanced knowledge about the potential contribution of IT investments to firm value. Additionally, the use of equity compensation, such as stock options, protects him/her against any increase in stock price volatility associated with IT spending, since the payoff is asymmetric, i.e., the value of options-based equity compensation is always greater than or equal to zero. Thus, the CEO receives equity compensation in the current period for anticipated but unrealized IT investment gains (Leone et al. 2006).

Collectively, these arguments lead to the following hypothesis in alternate form:

**H1: IT spending is positively associated with equity compensation.**

**IT spending and cash compensation shielding**

Next, we examine the relationship between IT spending and CEO cash compensation. Due to their economic prominence and accounting treatment, IT spending could negatively impact CEO cash compensation. IT spending represent a significant expenditure, averaging approximately three (40) percent of a firm’s total sales (capital expenditures) (Henderson et al. 2008; Ranganathan and Brown 2006). According to GAAP, most operating IT costs (e.g., software, system implementation, upgrades, training, and maintenance) represent recurrent operating expenses which reduce net income for the current period. Only hardware acquisitions are routinely capitalized.

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Therefore, the immediate impact of IT spending on operating income, and consequently on CEO cash compensation, can be substantial.

Prior compensation research documents that net income, or related measures such as earnings per-share or profit margin, is the primary determinant of CEO cash compensation (see e.g., Murphy 1999; Natarajan 1996). To the extent that IT spending decreases current income, CEOs may be reluctant to undertake potentially value-enhancing IT strategic initiatives (Duru et al. 2002; Dechow et al. 1994), and instead may be motivated to make decisions that maximize their short-term income-based cash compensation (see e.g., Watts and Zimmerman 1986; Graham et al. 2005; Matsunaga and Park 2001). Thus, short-term cash compensation motives could contribute to IT underinvestment.

We illuminate this expectation in an agency theory framework. First, since the BOD cannot directly observe the CEOs efforts (see e.g., Prendergast 2002; Holmström 1979; Murphy 1999), it instead establishes cash compensation based on observable outcomes, e.g., operating income (Murphy 1999), as shown in the following linear model:

\[
C(x,y) = \alpha_c + \beta x + \gamma y, \quad (3)
\]

where \(\alpha_c\) reflects a fixed salary, \(\beta\) represents an operating income incentive rate greater than 0, \(y\) might measure some other factors, such as industry profitability, and \(\gamma\) represents the sensitivity of CEO compensation to the external factor (see e.g., Milgrom and Roberts 1995, p. 216).
We then assume that the BOD also believes that operating income, \(x\), is a linear function of CEO effort on operational (non-IT) activities, \(a_1\), and current IT spending, \(it\), similar to the analysis of Duru et al. (2002) in an R&D setting.

\[
x = a_1 + \mu it, \tag{4}
\]

where \(\mu\) indicates the sensitivity of operating income to current IT spending. Since accounting rules require firms to expense most IT spending in the current period, \(\mu\) is likely negative.\(^9\) Consequently, the BOD understands that increasing IT spending may decrease operating income.

Substituting for \(x\) into Equation (3), we see that CEO compensation depends in part on the current level of IT spending and \(\mu\):

\[
C(a_1, it, y) = \alpha_c + \beta(a_1 + \mu it) + \gamma y. \tag{5}
\]

Thus, if \(\mu\) is less than zero, cash compensation decreases as IT spending increases, and to maximize current cash compensation, the CEO prefers to reduce IT spending.

Equation (2) shows that CEO equity compensation is increasing with IT spending. Equation (5) suggests that CEO current cash compensation can decrease with IT spending. We next examine the impact of IT spending on the CEO’s total compensation, defined as current cash compensation plus equity compensation:

\[
TC = C(x, y) + EC(x,it,j), \tag{6}
\]

and substituting for \(x\):

\[
TC = \alpha_c + \beta(a_1 + \mu it) + \gamma y + \alpha_e + \varphi(a_1 + \mu it) + \varphi'it + \delta j. \tag{7}
\]

\(^9\) Prior research (Kobelsky et al. 2008; Dao et al. 2008) documents that the impact of IT on future operational profitability manifests itself over one to three years, so we believe that the positive impact of IT on current income is likely fairly small. Nevertheless, it is possible that IT-related changes to business processes could produce positive short term returns, and in this case, \(\mu\) is greater than zero.
Assuming Equation (7) is differentiable; the derivative with respect to \( i_t \) reveals the overall sensitivity of CEO compensation to IT activities:

\[
TC' = \beta(\mu) + \phi(\mu) + \phi'.
\]  

Equation (8) indicates that IT spending increases CEO total compensation if \( \mu \) is positive or \( \phi' > (\beta + \phi)(\mu) \). If \( \mu \) is negative, then IT spending reduces the CEO’s current cash compensation, although it may increase the CEO’s total compensation depending on the value of \( \phi' \) (the sensitivity of equity compensation to IT).

Despite the prospect of greater wealth from IT spending and the corresponding impact on total compensation, the CEO may be unsure of the potential future payoffs from current IT activities for a variety of reasons. IT projects are risky ventures that can fail. Other changes within the firm or the competitive environment can negate the effect of IT on future profitability as indicated by the \( j \) in Equation (1). Under these circumstances, the CEO may expect that the practical effect of \( \phi' \) on compensation is close to zero. Consequently, a risk-averse CEO can elect to maximize current cash compensation by minimizing IT spending despite equity compensation incentives.

If, however, the BOD recognizes IT’s potential contribution to the investment opportunity set and hence expected long-term firm performance, the BOD can structure the compensation contract to reduce perverse incentives to underinvest in IT due to the CEO’s myopia (Graham et al. 2005; Matsunaga and Park 2001). The BOD then shields CEOs’ cash compensation from the income-decreasing effects of IT spending, given that those investments contribute to firm value (see e.g., Adut et al. 2003; Duru et al. 2002; Dechow et al. 1994). Specifically, the BOD weights IT spending differently for the CEO’s current cash compensation as shown in this alternate version of Equation (5):
\[ C(a_1, \mu, y) = \alpha_c + \beta a_1 + \beta' \mu + \gamma y. \]  

When operating income is more sensitive to the negative impact of IT spending, i.e., as \( \mu \) becomes more negative, the BOD sets \( \beta' \) closer to 0 to shield CEO cash compensation from the impact of strategic IT spending. Thus, \( 0 \leq \beta' < \beta \). This leads to our next hypothesis in alternate form.

\[ H2: \text{CEO cash compensation (salary plus bonus) is shielded from the earnings decreasing effects of IT spending.} \]

**Complementary effects of CEO equity compensation and IT spending on firm value**

Our discussion assumes that BODs understand that IT investments generate incremental business value (i.e., these investments are integral part of the investment opportunity set). To avoid agency costs resulting from current accounting rules and CEO risk aversion, they i) associate IT spending and equity compensation, and ii) shield CEO cash compensation from the income decreasing effects of IT spending. This implies that the BOD realizes that IT spending and CEO compensation are complementary in their relationship with firm value. The BODs expectation shown in Equation (1) that strategic IT spending will produce market value translates into CEO equity compensation in Equation (2) that aligns CEO efforts with that view. We therefore make the following predictions:

\[ H3a: \text{Current IT spending is positively related to the market value of equity after controlling for current net income, book value of equity, and equity compensation.} \]

\[ H3b: \text{Equity compensation is positively related to market value of equity after controlling for current net income, book value of equity, and IT spending.} \]
III. RESEARCH DESIGN

Sample description

The sample consists of firm-year observations during the period 1992 to 2005 for firms with available CEO compensation data from Standard & Poor’s Execucomp, financial information from Compustat, and IT spending data from InformationWeek magazine. Since 1991, InformationWeek has conducted annual surveys to gather IT spending information from a variety of large public, private, and government entities. InformationWeek graciously provided the firm-specific IT budget information for 1998 to 2005, when it was not published, for this research. The InformationWeek data represent the largest generally available sample of firm-specific IT spending used extensively in prior studies (e.g., Kobelsky et al. 2008a; Bharadwaj et al. 1999). These data are subject to measurement error since they are self-reported by the responding firms, but the presence of measurement error should bias against finding any relation between IT spending and CEO compensation.

We matched the InformationWeek data against Compustat financial information and Execucomp compensation information, resulting in a maximum total of 3,816 firm-year observations for 797 firms with IT spending, financial and CEO compensation data. The number of observations per year varies from a low of 131 in 1992 to a high of 415 in 1999. Almost 30% of the firms have less than five observations; about 40% of the firms have between five and eight observations; and the remaining 30% have more than eight observations. Since our sample comes from InformationWeek and Execucomp data sources, which generally include the largest publicly-traded firms, these findings likely generalize to other large firms.
**IT spending and IT expense**

*InformationWeek* reports total IT spending, which include both capitalized IT values and current IT expenses. Although *InformationWeek* separately identified the capitalized percentage of firms’ IT spending after 1999, they only reported total IT spending before that date. To estimate pre-1999 IT expense, we first estimated the capitalized portion of IT spending as follows: 1) median capitalized percentage of IT spending when available for the firm post 1998, or 2) median capitalized IT percentage for the industry (two-digit SIC) when available, or 3) median capitalized IT percentage for the entire sample (only 18 observations). Using the reported and estimated capitalized percentages of IT spending, we then calculated the firm IT expense:

\[
IT \text{ expense} = IT \text{ expenditure} \times (1 - \text{capitalized percentage}) \quad (10)
\]

This process produces estimates of IT expense pre-1999 that are consistent with the reported IT figures since 1999. Overall, we estimate that firms capitalized approximately 26% and correspondingly expensed approximately 74% of their IT spending. As Table 1 Panel A shows, IT expense represents 2.8% of sales on average. To the extent that firms’ spending patterns changed dramatically, this process could induce further measurement error, which should attenuate any relation between IT expenses and CEO compensation. Table 1 Panel B describes the sample by year as well as by mean IT spending and IT expenses. We also conducted all of the subsequent analyses using total IT spending instead of our estimated IT expense and found qualitatively similar results.

**Sample descriptive statistics**

Table 1 Panel A shows that on average the sample firms are large and profitable. Mean (median) sales is $10.6 billion ($4.9 billion). Mean (median) return on sales,
defined as earnings before extraordinary items (eb ei) divided by sales, is 5.6% (5.3%),
while mean (median) annual market return is 6.6% (5.3%). Also, sample firms have
substantial investment opportunities, as indicated by the mean market-to-book ratio
(mkt bk) of 3.5. As documented by prior studies (e.g., Henderson et al. 2008;
Ranganathan et al. 2006), the level of IT spending is significant: mean (median) IT
expense (it sls) is 2.1% (1.6%) of total sales. On average, CEOs in the sample have been
in office (tenure) for approximately four years and about 37% of the CEOs are
approaching traditional retirement age.

Table 1 Panel A also shows that mean cash compensation approaches $2 million
annually while mean total compensation exceeds $6 million annually. Since the average
base salary is approximately $800 thousand, CEO total compensation appears strongly
influenced by performance incentives, such as cash bonuses and equity compensation.
Table 1 Panel B describes the sample by year as well as by mean IT spending and IT
expenses. The number of firm-year observations goes from 131 (1992) to 415 (1999).
Panel C presents selected descriptive statistics partitioned by industry. In general,
industries with the highest average CEO compensation also have the largest ratios of
equity to total compensation. This highlights the importance of controlling for size in our
multivariate models.

**IT expense and compensation characteristics by industry**

It is possible that any relationship between IT expense and executive
compensation is due in part to the nature of competition within industries. Panel C of
Table 1 describes IT spending, IT expense, average CEO cash compensation, average
CEO total compensation, and the ratio of equity compensation to total compensation by
industry. We use industry descriptions from Fama and French (1997), who map SIC
codes to summary industry categories. Panel C shows differences in IT spending among
industries and suggests a relation between IT spending and the ratio of equity to total
compensation across industries. Compare, for example, the IT spending (3.7% of sales) in
the Business Equipment industry and the corresponding equity ratio (61%) against IT
spending (2.2% of sales) in the Consumer Non-Durables industry and the corresponding
equity ratio of 49%.

The association between IT expense and compensation across industries suggests
that external industry-related forces could affect both firm IT expense and compensation.
To control for this potential simultaneity, we create industry-based instruments for firm
IT expense. Specifically, we regress firm IT expense on mean industry IT expense (for all
other firms in the industry) and use the fitted values from those regressions to instrument
for firm IT (following Lev and Sougiannis 1996; Hanlon et al. 2003). We use both Fama
and French (1997) industry categories and two-digit SIC to define industries with similar
results.10

**IT expense, compensation, and excess market values**

Our analysis of the relation between IT spending and executive compensation
relies on the assumption that BODs believe that current IT spending is an important
contributor to the firm’s investment opportunity set and is therefore reflected in current
market values. Equations (1) and (2) present the assumed relationships. To examine those
assumptions informally, we formed five portfolios each year based on IT spending

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10 We report results using the Fama and French (1997) industry categories, because those categories
provided a greater number of firms with enough observations to produce the instrument. Information on the
industry categories is available on Professor French’s web site:
intensity. Portfolio 1 includes the 20% of firms with the lowest IT spending and Portfolio 5 includes the 20% of firms with the highest IT spending each year. We then examined executive compensation and market-to-book ratios for each of those portfolios.

Table 2 presents mean values of 1) the ratio of CEO equity compensation to total compensation, 2) CEO total cash compensation, and 3) market-to-book ratios for the five IT portfolios. In general, the ratio of equity to total compensation increases across the five portfolios. Firms in the highest portfolio have a 10% higher equity ratio than firms in the lowest IT portfolio. Similarly, CEOs for firms in the highest portfolio receive greater cash compensation than in the lowest portfolio, but the change in cash compensation is clearly not linear across the portfolios. CEOs in Portfolio 1 firms have higher cash compensation than CEOs in Portfolios 2, 3, and 4.

Importantly, market-to-book ratios increases almost linearly across the five IT portfolios, starting with a ratio of 3.3 for Portfolio 1 and increasing to 3.8 for Portfolio 5. The market-to-book values for Portfolio 5 are significantly higher than market-to-book values for firms in Portfolios 1, 2, and 3 (p < 0.05, one-tailed t-tests and median tests). Prior research often uses market-to-book, or equivalently book-to-market, ratios as a measure of firm’s investment opportunity sets. For example, Kallapur and Trombley (1999) examine various proxies for the investment opportunity set and find that the book-to-market ratio is consistently positively related to growth. Thus, Table 2 suggests that firm’s investment opportunity sets are increasing in IT, which is consistent with our maintained assumption.

We found similar (untabulated) results using 10 and 20 portfolios and alternative measures of excess market value, such as market-to-sales ratios, which are less likely to
be driven by relatively small book values for highly leveraged firms. We also found generally similar results if we formed portfolios based on ratios of CEO equity compensation to total compensation. These preliminary results suggest that as the sensitivity of market values to IT spending [$\lambda$ in Equation (1)] increases, CEO equity compensation [$\varphi'$ in Equation (2)] also increases, which coincides with our overall expectations of the relation between IT spending, CEO compensation, and firm market values.

**Research design for Hypothesis 1**

We design our multivariate tests of hypotheses to resemble closely our analytical models described in section II. Hypothesis 1 states that the IT spending is positively associated with CEO equity compensation. We test this hypothesis by estimating the following specification:

$$eq\_comp_{it} = a + b_1 \text{adj\_ebi\_sls}_{it} + b_2 \text{it\_sls}_{it} + b_3 \log\text{sls}_{it} + b_4 \text{ret}_{it} + b_5 \text{trend}_{it} + b_6 \text{tenure}_{it} + b_7 \text{horizon}_{it} + e_{it}, \quad (11)$$

where $eq\_comp$ is measured as the ratio of equity to total compensation. Equation (11) operationalizes Equation (2). Thus, Equation (11) describes CEO equity compensation as a function of current earnings, adjusted for IT and other spending separately included in the model, and other factors expected to influence CEO compensation. Consistent with prior research examining the determinants of CEO compensation (e.g., Wu and Tu 2007; Hanlon et al. 2003; Anderson et al. 2000; Balkin et al. 2000; Core et al. 1999; Murphy 1999), we include the following control variables: natural logarithm of sales ($\log\text{sls}$) and annual size decile-adjusted market returns ($\text{ret}$) to control for firm size effects and other contemporaneous performance factors. We also control for CEO tenure ($\text{tenure}$) and
horizon effects (horizon) because these two factors have been found to influence the level of CEO compensation (e.g., Cheng 2004; Dechow and Sloan 1991). We follow Cheng (2004) in measuring horizon equal to one if the CEO is at least 63 years old, and zero otherwise, to control for changes in compensation as the CEO approaches retirement age. Finally, we include a linear time trend (trend) to control for the general growth in executive compensation over time (Adut et al. 2003).

Our variable of interest is IT expense, scaled by sales (it\_sls) and measured using an instrument formed using the predicted values resulting from regressions of firm IT on industry IT, as previously described. According to H1, the it\_sls coefficient (b2) is expected to be positive and significant, implying that the magnitude of IT expense is positively associated with the equity-based portion of CEO compensation. To contrast this research against related research examining the relation between R&D expenditures and CEO compensation, we also include R&D and advertising expense scaled by sales in alternative forms of Equation (13). To control further for possible correlated omitted variables, we include the lagged value of the equity ratio in alternative forms of Equation (11). Since the IT instrument is formed by industry, we do not include separate industry controls.

**Research design for Hypothesis 2**

Hypothesis 2 states that CEO cash compensation (salary plus bonus) is shielded from IT spending. We test this hypothesis by estimating the following basic specification, similar to Equation (11):

\[
\text{cash\_comp}_{it} = a + b_1 \text{adj\_ebi\_sls}_{it} + b_2 \text{it\_sls}_{it} + b_3 \text{logsls}_{it} + b_4 \text{ret}_{it} + b_5 \text{tenure}_{it} \\
+ b_6 \text{trend}_{it} + b_7 \text{horizon}_{it} + e_{it}. \tag{12}
\]
Compensation shielding involves protecting CEO cash compensation from the income decreasing effects of IT expense (i.e., the portion of spending that is not capitalized per existing GAAP rules). Equation (11) operationalizes Equation (5). Equation (12) again includes adjusted income (income before extraordinary items plus IT and other expenses included separately in the model) scaled by sales (adj\_ebei\_sls). Including adj\_ebei\_sls allows us to test the relative weight placed on a dollar of adjusted earnings relative to a dollar of IT spending, and is consistent with prior tests of shielding in the context of other discretionary expenses such as restructuring charges (Adut et al. 2003; Dechow et al. 1994) and R&D and advertising expenses (Duru et al. 2002). All the other variables are defined as before.

To support H2, the coefficient on it\_sls (b2) is expected to be insignificant, implying that BODs remove the IT expenses from income to protect the CEOs’ cash compensation. We also include R&D and advertising expense as independent variables to contrast our results against research examining the relation between R&D and advertising spending and CEO cash compensation. Again, to control for possible correlated omitted variables, we also include the lagged value of the cash compensation in alternative forms of Equation (12).

Research design for Hypotheses 3a and 3b

Hypotheses 3a and 3b propose that both the CEO equity compensation and IT spending are positively related to firm value. We consider the possibility that CEO long-term compensation incentives and IT spending have a synergistic effect on firm value. The long-term compensation incentives motivate the CEO to consider complementary
investments and process changes to improve IT value. The IT spending deliver the positive net present value benefits in that context.

BODs make compensation decisions based on expected returns. To capture firm value in Equation (1), we propose to use a measure that is forward-looking and based on expected future firm performance. This measure of shareholder value should reflect information that BODs are likely to use, i.e., either market or accounting-based performance measures. We therefore propose to link IT spending and equity compensation to the market value of the firm using standard accounting valuation models, such as those developed by Ohlson (1995) and Feltham and Ohlson (1995). In general, these models explain firm market value in terms of accounting book value and the net present value of future income:

\[ MV_t = BV_t + \sum_{i=1}^{\infty} \frac{1}{(1 + r)^i} E(x_{t+i}), \]  

(13)

where \( MV \) is market value of equity, \( BV \) is book value of equity, \( r \) is discount rate, and \( x \) is income.\(^\text{11}\) Ohlson develops this model and then formulates a linear approximation:

\[ MV_t = BV_t + \alpha_1 x_t + \alpha_2 v_t, \]  

(14)

where \( x_t \) is income at time \( t \) and \( v_t \) is a vector of other information expected to explain the difference between book value and market values. Thus, Equation (16) describes market value in terms of the firm’s current accounting book value, its current earnings, and the other intangible factors that determine the excess of market over book value. To be consistent with our theoretical predictions, we decompose income into the income before IT and use IT expense and equity compensation as other information.

\[ MV_{it} = BV_{it} + \alpha_{1a} \text{adj\_ebi\_sls\_it} + \alpha_{it\_sels\_it} + \alpha_2 \text{eq\_comp\_it}, \]  

(15)

\(^{11}\) More precisely the model specifies residual income (earnings in excess of the required return on equity), but in practice many researchers use either earnings or return on equity.
where *eq_comp* is again defined as the ratio of equity to total compensation. Significant positive coefficients on the IT expense (*it_sls*) and equity compensation (*eq_comp*) variables indicate that IT spending and long-term incentive compensation both contribute to firm value, after controlling for current book value and earnings.

To control for the likelihood that IT spending and CEO equity compensation are simultaneously determined, we also use a two stage approach. First, we estimate CEO compensation using Equation (11), and then we include the predicted and residual values from that model in Equation (15). This is conceptually similar to a simultaneous equations approach, such as three stage regression, but it allows us to examine the effect of residual equity compensation in addition to predicted values.

**Other econometric issues**

Panel data often present issues of serial correlation, which can result in biased standard errors. In a recent study, Peterson (2009) compared the performance of various approaches used in the literature to deal with serial correlation and potentially omitted firm effects. He found that using standard errors clustered by firm produces unbiased and correctly sized confidence intervals in the presence of both serial correlation and heteroskedasticity. Additionally, Prais-Winsten regressions address serial correlation directly by adjusting variables in the models for the estimated serial correlation in the residuals (Wooldridge 2003). As a conservative approach, we use both Prais-Winsten regressions and clustered standard errors (Stata 2008). We also find similar results when we employ OLS with clustered standard errors.
IV. RESULTS

**Multivariate tests of Hypothesis 1**

Table 3 presents the results for tests of H1. Our variable of interest is IT expense, measured by the instrument \( \text{inst}_{\text{it}} \), which is scaled by sales. Column (1) presents results for the basic model described in Equation (11). Consistent with H1, we find that the coefficient on \( \text{inst}_{\text{it}} \) is positive and significant. We adjust current income \( \text{ebei}_{\text{sls}} \) for IT, R&D and advertising expenses. Note that the instrument serves a dual purpose; it addresses potential endogeneity and also provides an industry control. In separate untabulated analysis, we included industry dummies and actual IT expense scaled by sales in the models shown in columns (1) and (2) with similar results.

In column (2) we include the CEOs’ prior equity ratio to control for possible correlated omitted variables. These results can be interpreted as the factors contributing to the change in equity ratio. Again, the IT instrument is significantly positively related to equity ratio, controlling for R&D and advertising expense. Consistent with prior research, the results in both columns also show that CEO equity compensation increases over time, increases with firm R&D spending and size, and decreases when the CEO is more than 62 years. Other variables, adjusted earnings, returns, and CEO tenure, have little effect on equity ratio.

**Multivariate tests of Hypothesis 2**

Table 4 examines the link between IT expense and CEO cash compensation. In column (1) we estimate the basic model, described in Equation (12), relating IT expense to CEO cash compensation. The coefficient on \( \text{inst}_{\text{it}} \) is insignificant, suggesting that CEO compensation is fully shielded from the earnings-decreasing effects of IT expenses.
and lending support to H2. As expected from prior research, the coefficients on R&D and advertising are also insignificant, confirming that CEO cash compensation is also shielded from the income decreasing effects of those expenses.

In columns (2) and (4), we include expenses, i.e., cost of goods sold and SG&A expense (adjusted for IT, R&D, and advertising expenses) in lieu of income. The coefficients on both expenses are negative and strongly significant. Thus, CEOs are penalized for the income decreasing effects of those expenses, but CEOs are not generally penalized for the income decreasing effects of spending, such as IT, R&D, or advertising, that can be considered strategically important for firms’ long term performance.

Columns (3) and (4) included lagged CEO cash compensation as an additional independent variable. Again, consistent with prior research, earnings, size, and current market returns are significantly positively related CEO current cash compensation. However, IT and advertising expenses are unrelated to the change in cash compensation. R&D expense is negatively related to current cash compensation in column (3) but not column (4). Overall, the results in Table 4 confirm Hypothesis 2: cash compensation (salary plus bonus) is shielded from the earnings decreasing effects of IT expense.

**Multivariate tests of Hypotheses 3a and 3b**

Table 5 examines the relation between IT expense and equity ratio and firm value using Equation (15). We scale the accounting and market value variables and well as the IT instrument by lagged book value to mitigate heteroskedasticity. The use of lagged book value as a scalar also provides an advantage in interpreting the results. Specifically, this model explains firms’ market-to-book ratios as a function of growth in book value
and current return on equity. In untabulated analysis, we also used sales, shares outstanding, and lagged market values as scaling variables with similar results.

Column (1) shows that both IT spending and CEO equity compensation are significantly positively related to market values after controlling for current financial performance. In untabulated results we also included current R&D and advertising expense and capital expenditures, also scaled by lagged book value, in the model, since there is a substantial body of research that shows those variables represent firm intangible assets. The results with respect to IT spending and equity compensation remained qualitatively unchanged.

In column (2) we include the predicted and residual values of equity compensation obtained from Table 3 (column 1) tests of Equation (11). The predicted equity compensation ratio therefore includes the effect of IT spending on CEO compensation. The residual equity ratio represents idiosyncratic firm level equity compensation. Both the predicted and residual equity ratios are significantly positively related to market value. Importantly, our instrumented IT spending variable also remains significantly positively related to market value. These results suggest a synergistic effect of higher IT spending and greater CEO incentives on expected long-term performance. As a number of researchers have argued (e.g., Kohli and Grover 2008; Brynjolfsson 2003), IT spending contributes most to firm value when the firm makes complementary organizational changes.

Additional tests of the relation between current CEO equity compensation and subsequent IT spending
Recent research by Kobelsky et al. (2008) establishes a cross-sectional set of organizational, environmental, and technological determinants of IT budgets. To the extent that compensation contracts effectively motivate the CEO to choose long-term value-enhancing investments, we expect the CEO’s current equity ratio and changes to that equity ratio to result in increased subsequent IT spending. Thus, we test whether CEO equity compensation is significantly related to subsequent IT spending in the context of Kobelsky et al.’s model as follows.

\[
IT_{\text{sls}}_{it} = \beta_0 + \beta_1 \text{ind_conc_ratio}_{it} + \beta_2 \text{uncertainty}_{it} + \beta_3 \text{related_diversity}_{it} \\
+ \beta_4 \text{unrelated_diversity}_{it} + \beta_5 \text{op_ros}_{it} + \beta_6 \text{debt_ratio}_{it} \\
+ \beta_7 \text{sales_growth}_{it} + \beta_8 \text{automate}_{it} + \beta_9 \text{transform}_{it} \\
+ \beta_{10} \text{hi_tech}_{it} + \beta_{11} \text{lo_tech}_{it} \\
+ \beta_{12} \text{eq_comp}_{it-1} + \beta_{13} \Delta \text{eq_comp}_{it} + \varepsilon_{it}. 
\] (16)

We use IT expense in place of total IT expenditures. All variables except prior equity compensation, \(eq\_\text{comp}_{it-1}\), and the change in equity compensation, \(\Delta eq\_\text{comp}_{it}\), are defined as in Kobelsky et al. (2008), \(i\) and \(t\) indicate the firm and year. Specifically, \(\text{ind_conc_ratio}\) is the four firm industry concentration ratio for each four-digit SIC, \(\text{uncertainty}\) is the standard deviation of earnings (net income before extraordinary items) for the previous five years deflated by sales in year \(t-1\), \(\text{related_divers}\) and \(\text{unrelated_divers}\) are measures of related and unrelated diversification for the firm’s reported business segments, \(\text{op_ros}\) is operating income before depreciation divided by sales in year \(t\), \(\text{debt_ratio}\) equals long-term debt divided by total assets, \(\text{sales_growth}\) equals the average sales growth (current year sales divided by previous year sales) for years \(t\) and \(t-1\), \(\text{automate}\) and \(\text{transform}\) are dummy variables indicating the strategic role

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12 We found similar results using total IT expenditures.
of the industry per InformationWeek, and hi\_tech and lo\_tech are dummy variables indicating that the industry (three-digit SIC) is high tech or low tech.

Table 6 presents the results of the determinants model, estimated using OLS with clustered standard errors for consistency with Kobelsky et al. (2008). Although we employ IT expense instead of IT expenditures and have data for 1998 to 2005 in addition to their 1991 to 1997 sample, the results are remarkably similar to their results. Their model explained approximately 28 percent of the variance in IT expenditures, and we explain approximately 30 percent of the variance in IT spending. The uncertainty, \( \text{op\_ros} \), and transform variables remain positively related to IT spending, and \( \text{sales\_growth} \), \( \text{debt\_ratio} \), and \( \text{unrelated\_divers} \) are negatively related to IT spending. In our results, the hi\_tech, lo\_tech, and ind\_conc\_ratio variables are not significantly related to IT spending, perhaps reflecting diminished industry differences in IT spending.

Importantly, both prior equity compensation and the change in equity compensation are positively associated with IT spending.\(^{13}\) This suggests that CEOs with greater equity incentives elect to invest more in IT both to achieve personal wealth objectives as well as generate value for other shareholders. It also suggests that the use of equity incentives is effective in motivating future IT spending, consistent with our original assumption that boards of directors expect IT spending to increase the firm’s investment opportunity set.

V. CONCLUDING REMARKS

\(^{13}\) We did not use the predicted and residual equity values employed in Table 5, since predicted equity compensation is based in part on contemporaneous IT spending, albeit measured using the instrumental variable. However, in untabulated results we confirmed that both predicted and residual equity ratios are significantly positively related to subsequent IT spending.
CEOs and their management teams decide how much a firm will spend on IT. Though managers make IT spending decisions with the intent of generating value, such benefits are risky and not guaranteed (Dewan et al. 2007). While CEOs may perceive that IT spending could translate into competitive advantage and increased productivity, they also realize that IT expense will reduce current net income and contain non-diversifiable risks. Thus, different risk preferences between the CEO and the BODs, as well as the impact of accounting standards that require immediate expensing of most IT costs, may cause CEOs to depart from the optimal level of IT spending that would maximize firm value. Our results suggest that BODs consider IT to be a strategic investment and therefore set CEO cash and equity compensation to provide incentives for CEOs to invest in IT. In addition, we conclude that the synergistic relationship between IT spending and CEO equity compensation impacts firm market value.

Our empirical analysis yields several important insights. First, we find that IT expenses are associated with higher ratios of equity compensation. This result is consistent with the notion that BODs understand the uncertainty and risk profile of some IT spending; hence, they tie CEO compensation to future outcomes by placing greater weight on equity compensation. Interestingly, we show that while other recurring operating expenses (i.e., COGS and SG&A) are negatively related to CEO cash compensation, IT expenses are unrelated to CEO cash compensation (i.e., it is fully shielded), which highlights the value that BODs place on IT. Third, we find that firms with both higher IT spending and higher ratios of equity to total CEO compensation have higher market values.
Kohli and Grover (2008) suggest that there are still opportunities for studies on IT value to expand their scope since the “how” and “why” IT creates value question has remained understudied. In addition, others authors have also observed that theoretical frameworks have yet to explain fully how and why IT investments enhance firm performance (Murali et al. 2008). Thus, this study attempts to help address this issue by empirically examining the impact of CEO compensation incentives on the association between IT spending and firm value.

Collectively, our results are consistent with the notion that BODs understand the business value generated by IT and set compensation arrangements in such a way as to maximize shareholder value. Bridging the two research streams of business value of IT and CEO compensation, our study contributes to both the information systems and accounting literature by providing the initial analysis on how the link between IT expenses and CEO compensation contracts significantly impacts firm value.
REFERENCES


IT Governance Institute. 2005b. *IT Alignment: Who is in Charge?*.


**Table 1**
Descriptive Statistics

**Panel A: All observations**

<table>
<thead>
<tr>
<th>variable</th>
<th>Mean</th>
<th>sd</th>
<th>25th percentile</th>
<th>median</th>
<th>75th percentile</th>
<th>N</th>
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</thead>
<tbody>
<tr>
<td>salary</td>
<td>821.2</td>
<td>349.3</td>
<td>618.6</td>
<td>793.9</td>
<td>988.1</td>
<td>3816</td>
</tr>
<tr>
<td>bonus</td>
<td>1133.0</td>
<td>1692.0</td>
<td>300.0</td>
<td>700.0</td>
<td>1344.3</td>
<td>3816</td>
</tr>
<tr>
<td>tcc</td>
<td>1954.2</td>
<td>1860.9</td>
<td>982.7</td>
<td>1475.6</td>
<td>2300.0</td>
<td>3816</td>
</tr>
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<td>equity_comp</td>
<td>4858.5</td>
<td>14249.6</td>
<td>770.4</td>
<td>2168.5</td>
<td>5061.4</td>
<td>3816</td>
</tr>
<tr>
<td>tdc</td>
<td>6812.7</td>
<td>14827.6</td>
<td>2033.8</td>
<td>3876.0</td>
<td>7469.6</td>
<td>3816</td>
</tr>
<tr>
<td>eq_ratio</td>
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<td>0.253</td>
<td>0.383</td>
<td>0.575</td>
<td>0.728</td>
<td>3816</td>
</tr>
<tr>
<td>it_sls</td>
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<td>0.017</td>
<td>0.009</td>
<td>0.016</td>
<td>0.026</td>
<td>3816</td>
</tr>
<tr>
<td>inst_it</td>
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<td>0.010</td>
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<td>2362.7</td>
<td>4885.5</td>
<td>11153.5</td>
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<td>ebei_sls</td>
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<td>0.022</td>
<td>0.053</td>
<td>0.092</td>
<td>3816</td>
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<tr>
<td>cogs_sls</td>
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<td>0.189</td>
<td>0.530</td>
<td>0.691</td>
<td>0.800</td>
<td>3816</td>
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<tr>
<td>sga_sls</td>
<td>0.170</td>
<td>0.141</td>
<td>0.052</td>
<td>0.151</td>
<td>0.261</td>
<td>3816</td>
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<tr>
<td>rd_sls</td>
<td>0.014</td>
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<td>0.000</td>
<td>0.000</td>
<td>0.011</td>
<td>3816</td>
</tr>
<tr>
<td>adv_sls</td>
<td>-0.072</td>
<td>0.349</td>
<td>-0.217</td>
<td>-0.051</td>
<td>0.105</td>
<td>3516</td>
</tr>
<tr>
<td>sret</td>
<td>3.994</td>
<td>2.651</td>
<td>2.000</td>
<td>3.000</td>
<td>6.000</td>
<td>3816</td>
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<td>tenure</td>
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<td>3.344</td>
<td>1.594</td>
<td>2.438</td>
<td>3.912</td>
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<td>horizon</td>
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<td>0.483</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>3816</td>
</tr>
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</table>

salary = salary compensation in $000  
bonus = bonus compensation in $000  
tcc = total cash compensation (salary plus bonus) in $000  
equity_comp = value of options in $000 (calculated using Black-Scholes 1973) and other equity-based compensation  
tdc = total compensation in $000 (tcc plus equity_comp)  
eq_ratio = ratio of equity compensation to total compensation  
it_sls = IT expense scaled by sales  
inst_it = instrument for IT variable; predicted values from regressions of firm it_sls on industry it_sls  
sales = annual sales in $ millions  
ebei_sls = earnings before extraordinary items scaled by sales  
cogs_sls = cost of goods sold scaled by sales  
sga_sls = SG&A expense scaled by sales  
rds_sls = R&D expense scaled by sales  
adv_sls = advertising expense scaled by sales  
sret = annual size decile adjusted market return cumulated from monthly returns for calendar year  
tenure = years as CEO (since 1992)  
mkt_bk = market value of equity divided by book value of equity  
horizon = 1 if CEO age >= 63, 0 otherwise
Table 1 (continued)
Descriptive Statistics

Panel B: Selected variables by year

<table>
<thead>
<tr>
<th>Year</th>
<th>IT spending % of sales</th>
<th>IT expense % of sales</th>
<th>Total cash compensation $(000)</th>
<th>Total compensation $(000)</th>
<th>Equity Ratio</th>
<th>N</th>
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<tbody>
<tr>
<td>1992</td>
<td>0.026</td>
<td>0.020</td>
<td>1371.9</td>
<td>2748.4</td>
<td>0.375</td>
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<tr>
<td>1993</td>
<td>0.023</td>
<td>0.018</td>
<td>1348.3</td>
<td>2574.5</td>
<td>0.370</td>
<td>177</td>
</tr>
<tr>
<td>1994</td>
<td>0.022</td>
<td>0.017</td>
<td>1558.8</td>
<td>3459.2</td>
<td>0.447</td>
<td>180</td>
</tr>
<tr>
<td>1995</td>
<td>0.021</td>
<td>0.016</td>
<td>1615.8</td>
<td>3756.4</td>
<td>0.456</td>
<td>327</td>
</tr>
<tr>
<td>1996</td>
<td>0.022</td>
<td>0.017</td>
<td>1633.8</td>
<td>4218.2</td>
<td>0.492</td>
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<tr>
<td>1997</td>
<td>0.022</td>
<td>0.017</td>
<td>1771.5</td>
<td>6156.3</td>
<td>0.532</td>
<td>164</td>
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<td>1998</td>
<td>0.028</td>
<td>0.020</td>
<td>1689.0</td>
<td>7860.3</td>
<td>0.538</td>
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<tr>
<td>1999</td>
<td>0.028</td>
<td>0.020</td>
<td>2038.6</td>
<td>7427.2</td>
<td>0.562</td>
<td>415</td>
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<td>2000</td>
<td>0.031</td>
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<td>2121.2</td>
<td>10584.4</td>
<td>0.614</td>
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<td>0.032</td>
<td>0.023</td>
<td>1939.7</td>
<td>9355.9</td>
<td>0.628</td>
<td>345</td>
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<tr>
<td>2002</td>
<td>0.032</td>
<td>0.023</td>
<td>2022.0</td>
<td>7605.3</td>
<td>0.586</td>
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<td>2003</td>
<td>0.032</td>
<td>0.024</td>
<td>2432.9</td>
<td>7266.4</td>
<td>0.567</td>
<td>312</td>
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<tr>
<td>2004</td>
<td>0.033</td>
<td>0.025</td>
<td>2474.0</td>
<td>8035.4</td>
<td>0.570</td>
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<tr>
<td>2005</td>
<td>0.036</td>
<td>0.027</td>
<td>2903.5</td>
<td>8714.3</td>
<td>0.577</td>
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<tr>
<td>Total</td>
<td>0.028</td>
<td>0.021</td>
<td>1954.2</td>
<td>6812.7</td>
<td>0.538</td>
<td>3816</td>
</tr>
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</table>
Table 1 (continued)
Descriptive Statistics

*Panel C: Selected variables by industry (Fama and French Industry Categories)*

<table>
<thead>
<tr>
<th>Industry Description</th>
<th>IT spending % of sales</th>
<th>IT expense % of sales</th>
<th>Total cash compensation $(000)</th>
<th>Total compensation $(000)</th>
<th>Equity Ratio</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer Non-durables</td>
<td>0.022</td>
<td>0.015</td>
<td>1,708.7</td>
<td>4,826.8</td>
<td>0.493</td>
<td>310</td>
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<tr>
<td>Consumer Durables</td>
<td>0.025</td>
<td>0.019</td>
<td>1,576.1</td>
<td>4,918.9</td>
<td>0.554</td>
<td>318</td>
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<tr>
<td>Manufacturing</td>
<td>0.021</td>
<td>0.016</td>
<td>1,671.1</td>
<td>4,852.5</td>
<td>0.516</td>
<td>627</td>
</tr>
<tr>
<td>Oil, Gas, and Coal</td>
<td>0.015</td>
<td>0.012</td>
<td>2,649.7</td>
<td>6,630.1</td>
<td>0.471</td>
<td>178</td>
</tr>
<tr>
<td>Chemicals and Allied Products</td>
<td>0.020</td>
<td>0.016</td>
<td>1,765.3</td>
<td>4,994.5</td>
<td>0.569</td>
<td>202</td>
</tr>
<tr>
<td>Business Equipment</td>
<td>0.037</td>
<td>0.028</td>
<td>1,851.6</td>
<td>10,830.8</td>
<td>0.611</td>
<td>533</td>
</tr>
<tr>
<td>Telephone and Television</td>
<td>0.053</td>
<td>0.033</td>
<td>3,022.6</td>
<td>12,094.1</td>
<td>0.609</td>
<td>109</td>
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<tr>
<td>Utilities</td>
<td>0.022</td>
<td>0.016</td>
<td>1,334.7</td>
<td>3,436.8</td>
<td>0.440</td>
<td>231</td>
</tr>
<tr>
<td>Wholesale and Retail</td>
<td>0.017</td>
<td>0.012</td>
<td>1,521.9</td>
<td>4,848.5</td>
<td>0.496</td>
<td>554</td>
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<tr>
<td>Healthcare, Medical Equip, and Drugs</td>
<td>0.029</td>
<td>0.022</td>
<td>2,349.0</td>
<td>11,687.9</td>
<td>0.632</td>
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</tr>
<tr>
<td>Finance</td>
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<td>0.035</td>
<td>2,917.2</td>
<td>8,624.7</td>
<td>0.550</td>
<td>548</td>
</tr>
<tr>
<td>Total</td>
<td>0.028</td>
<td>0.021</td>
<td>1,954.2</td>
<td>6,812.7</td>
<td>0.538</td>
<td>3816</td>
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<tr>
<td>it_sls portfolios</td>
<td>ratio of equity to total compensation</td>
<td>total cash compensation ($ 000s)</td>
<td>market-to-book ratio</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------</td>
<td>--------------------------------------</td>
<td>-------------------------------</td>
<td>---------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 (lowest)</td>
<td>0.491</td>
<td>1930.646</td>
<td>3.325</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>785</td>
<td>785</td>
<td>749</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2</td>
<td>0.539</td>
<td>1807.113</td>
<td>3.382</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>753</td>
<td>753</td>
<td>728</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0.516</td>
<td>1811.700</td>
<td>3.429</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>763</td>
<td>763</td>
<td>730</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0.553</td>
<td>1877.446</td>
<td>3.568</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>759</td>
<td>759</td>
<td>735</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 (highest)</td>
<td>0.591</td>
<td>2346.111</td>
<td>3.832</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>756</td>
<td>756</td>
<td>734</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>0.538</td>
<td>1954.214</td>
<td>3.507</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3816</td>
<td>3816</td>
<td>3676</td>
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Table 3
Regression Analysis of the Relation between IT expense and the Ratio of CEO Equity Compensation to Total CEO Compensation

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>eq_ratio_{it-1}</td>
<td>0.346</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(11.69)****</td>
<td></td>
</tr>
<tr>
<td>inst_it_{it}</td>
<td>1.510</td>
<td>1.018</td>
</tr>
<tr>
<td></td>
<td>(3.53)****</td>
<td>(3.07)****</td>
</tr>
<tr>
<td>ebei_sls_{it}</td>
<td>0.028</td>
<td>0.069</td>
</tr>
<tr>
<td></td>
<td>(0.32)</td>
<td>(0.96)</td>
</tr>
<tr>
<td>rd_sls_{it}</td>
<td>0.938</td>
<td>0.621</td>
</tr>
<tr>
<td></td>
<td>(4.76)****</td>
<td>(3.91)****</td>
</tr>
<tr>
<td>adv_sls_{it}</td>
<td>0.443</td>
<td>0.335</td>
</tr>
<tr>
<td></td>
<td>(1.59)</td>
<td>(1.60)</td>
</tr>
<tr>
<td>logsls_{it}</td>
<td>0.046</td>
<td>0.032</td>
</tr>
<tr>
<td></td>
<td>(9.18)****</td>
<td>(8.19)****</td>
</tr>
<tr>
<td>sret_{it}</td>
<td>-0.023</td>
<td>-0.013</td>
</tr>
<tr>
<td></td>
<td>(1.67)*</td>
<td>(0.89)</td>
</tr>
<tr>
<td>trend_{it}</td>
<td>0.016</td>
<td>0.008</td>
</tr>
<tr>
<td></td>
<td>(10.19)****</td>
<td>(5.26)****</td>
</tr>
<tr>
<td>tenure_{it}</td>
<td>-0.000</td>
<td>-0.001</td>
</tr>
<tr>
<td></td>
<td>(0.21)</td>
<td>(0.62)</td>
</tr>
<tr>
<td>horizon_{it}</td>
<td>-0.038</td>
<td>-0.028</td>
</tr>
<tr>
<td></td>
<td>(3.24)****</td>
<td>(2.89)****</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.013</td>
<td>0.006</td>
</tr>
<tr>
<td></td>
<td>(0.28)</td>
<td>(0.18)</td>
</tr>
</tbody>
</table>

Observations 3516  3267
Adj R-sq 0.11  0.23
Rho 0.24

Columns (1) Prais-Winsten regressions (Rho indicates serial correlation among residuals); Column (2) OLS; robust t statistics in parentheses adjusted for intrafirm correlation
* significant at 10%; ** significant at 5%; *** significant at 1%
eq_ratio = ratio of equity compensation to total compensation
inst_it = instrument for IT variable; predicted values from regressions of firm it_sls on industry it_sls
ebei_sls = earnings before extraordinary items scaled by sales adjusted for IT, R&D, and advertising expense
rd_sls = R&D expense scaled by sales
adv_sls = advertising expense scaled by sales
logsls = log of sales ($ mm)
sret = annual size decile-adjusted market return including dividends
trend = linear time (years) trend
tenure = years as CEO (since 1992)
horizon = 1 if CEO age >= 63, 0 otherwise
i indicates firm and t indicates year
all variables, except IT portfolio dummies, logsls, trend, tenure, and horizon, winsorized 2% to eliminate outlier influence.
Table 4
Regression Analysis of the Relation between IT expense and the CEO Cash Compensation

<table>
<thead>
<tr>
<th>Model</th>
<th>Total Cash Compensation (log transformed)</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>logtcc_{it-1}</td>
<td></td>
<td>0.666</td>
<td>0.659</td>
<td></td>
<td></td>
</tr>
<tr>
<td>inst_{it}</td>
<td></td>
<td>1.632</td>
<td>0.054</td>
<td>0.129</td>
<td>-0.467</td>
</tr>
<tr>
<td>ebei_{sli}</td>
<td></td>
<td>1.774</td>
<td>0.622</td>
<td></td>
<td></td>
</tr>
<tr>
<td>cogs_{sli}</td>
<td></td>
<td>-1.480</td>
<td></td>
<td></td>
<td>-0.535</td>
</tr>
<tr>
<td>sga_{sli}</td>
<td></td>
<td>-1.692</td>
<td></td>
<td></td>
<td>-0.631</td>
</tr>
<tr>
<td>rd_{sli}</td>
<td></td>
<td>-0.726</td>
<td>1.295</td>
<td>-0.910</td>
<td>-0.126</td>
</tr>
<tr>
<td>adv_{sli}</td>
<td></td>
<td>-1.075</td>
<td>1.252</td>
<td>0.266</td>
<td>1.118</td>
</tr>
<tr>
<td>logsls_{it}</td>
<td></td>
<td>0.322</td>
<td>0.310</td>
<td>0.099</td>
<td>0.095</td>
</tr>
<tr>
<td>ret_{it}</td>
<td></td>
<td>0.245</td>
<td>0.265</td>
<td>0.372</td>
<td>0.380</td>
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<tr>
<td>trend_{it}</td>
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<td>0.035</td>
<td>0.036</td>
<td>0.010</td>
<td>0.011</td>
</tr>
<tr>
<td>tenure_{it}</td>
<td></td>
<td>0.022</td>
<td>0.021</td>
<td>0.009</td>
<td>0.009</td>
</tr>
<tr>
<td>horizon_{it}</td>
<td></td>
<td>0.055</td>
<td>0.031</td>
<td>0.018</td>
<td>0.008</td>
</tr>
<tr>
<td>Constant</td>
<td></td>
<td>4.005</td>
<td>5.494</td>
<td>1.484</td>
<td>2.062</td>
</tr>
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<td>Observations</td>
<td></td>
<td>3499</td>
<td>3499</td>
<td>3246</td>
<td>3246</td>
</tr>
<tr>
<td>Adj R-sq</td>
<td></td>
<td>0.65</td>
<td>0.65</td>
<td>0.48</td>
<td>0.48</td>
</tr>
<tr>
<td>Rho</td>
<td></td>
<td>0.39</td>
<td>0.39</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Columns (1) and (2) Prais-Winsten regressions (Rho indicates serial correlation among residuals); Columns (3) and (4) OLS; robust t statistics in parentheses adjusted for intrafirm correlation
* significant at 10%; ** significant at 5%; *** significant at 1%
logtcc = log of total cash compensation ($ thousands)
inst_{it} = instrument for IT variable; predicted values from regressions of firm it_sls on industry it_sls
ebei_{sli} = earnings before extraordinary items scaled by sales, adjusted for IT, R&D, and advertising expense
cogs_sls = cost of goods sold scaled by sales
sga_sls = SG&A expense scaled by sales, adjusted for IT, R&D, and advertising expense
rd_sls = R&D expense scaled by sales
adv_sls = advertising expense scaled by sales
logsls = log of sales ($ mm)
ret = annual size decile-adjusted market return including dividends
trend = linear time (years) trend
tenure = years as CEO (since 1992)
horizon = 1 if CEO age >= 63, 0 otherwise; i indicates firm and t indicates year
all variables, except IT portfolio dummies, logsls, trend, tenure, and horizon, winsorized 2% to eliminate outlier influence.
<table>
<thead>
<tr>
<th></th>
<th>Market Value of Equity&lt;sub&gt;i&lt;/sub&gt;</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>book&lt;sub&gt;it&lt;/sub&gt;</td>
<td>1.613</td>
<td>1.636</td>
</tr>
<tr>
<td></td>
<td>(5.16)***</td>
<td>(4.93)***</td>
</tr>
<tr>
<td>ebei&lt;sub&gt;it&lt;/sub&gt;</td>
<td>6.986</td>
<td>7.166</td>
</tr>
<tr>
<td></td>
<td>(10.20)***</td>
<td>(9.95)***</td>
</tr>
<tr>
<td>eq_ratio&lt;sub&gt;it&lt;/sub&gt;</td>
<td>1.070</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(4.94)***</td>
<td></td>
</tr>
<tr>
<td>predicted_eq_rat&lt;sub&gt;it&lt;/sub&gt;</td>
<td></td>
<td>3.760</td>
</tr>
<tr>
<td></td>
<td>(4.19)***</td>
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</tr>
<tr>
<td>residual_eq_rat&lt;sub&gt;it&lt;/sub&gt;</td>
<td></td>
<td>0.868</td>
</tr>
<tr>
<td></td>
<td>(3.73)***</td>
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<tr>
<td>inst_it&lt;sub&gt;it&lt;/sub&gt;</td>
<td>13.073</td>
<td>11.968</td>
</tr>
<tr>
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<td>(6.36)***</td>
<td>(5.38)***</td>
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<td>Constant</td>
<td>-0.666</td>
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</tr>
<tr>
<td></td>
<td>(2.22)***</td>
<td>(3.88)***</td>
</tr>
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<td>3092</td>
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<tr>
<td>Adj R-sq</td>
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<td>0.44</td>
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<tr>
<td>Rho</td>
<td>0.52</td>
<td>0.51</td>
</tr>
</tbody>
</table>

Prais-Winsten regressions (Rho indicates serial correlation among residuals); robust t statistics in parentheses adjusted for intrafirm correlation

* significant at 10%; ** significant at 5%; *** significant at 1%
book = book value of common equity
ebei = earnings before extraordinary items adjusted for IT
eq_ratio = ratio of equity compensation to total compensation predicted_eq_rat = predicted equity ratio from model (1) in Table (3)
residual_eq_rat = residual equity ratio from model (1) in Table (3); eq_ratio<sub>it</sub> – predicted_eq_rat<sub>it</sub>
inst_it = instrument for IT variable
market, book, ebei, inst_it scaled by lagged book value of equity
i indicates firm and t indicates year
all variables, except predicted_eq_rat and residual_eq_rat, winsorized 2% to eliminate outlier influence.
Table 6
Analysis of the Relation between the Ratio of Equity Compensation to Total Compensation and Subsequent IT Spending

<table>
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<th>IT_slsit (2)</th>
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<td>uncertainty&lt;sub&gt;it&lt;/sub&gt;</td>
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<td>0.001</td>
</tr>
<tr>
<td></td>
<td>(4.03)***</td>
<td>(3.57)***</td>
</tr>
<tr>
<td>unrelated_diversity&lt;sub&gt;it&lt;/sub&gt;</td>
<td>-0.002</td>
<td>-0.002</td>
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<tr>
<td></td>
<td>(2.46)**</td>
<td>(2.44)**</td>
</tr>
<tr>
<td>related_diversity&lt;sub&gt;it&lt;/sub&gt;</td>
<td>0.002</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>(2.00)**</td>
<td>(1.98)**</td>
</tr>
<tr>
<td>op_ros&lt;sub&gt;it&lt;/sub&gt;</td>
<td>0.041</td>
<td>0.041</td>
</tr>
<tr>
<td></td>
<td>(8.11)***</td>
<td>(8.04)***</td>
</tr>
<tr>
<td>debt_ratio&lt;sub&gt;it&lt;/sub&gt;</td>
<td>-0.015</td>
<td>-0.014</td>
</tr>
<tr>
<td></td>
<td>(5.35)***</td>
<td>(5.29)***</td>
</tr>
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<td>0.002</td>
<td>0.002</td>
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<tr>
<td></td>
<td>(0.88)</td>
<td>(0.77)</td>
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<td>sales_growth&lt;sub&gt;it&lt;/sub&gt;</td>
<td>-0.009</td>
<td>-0.009</td>
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<tr>
<td></td>
<td>(3.85)***</td>
<td>(3.88)***</td>
</tr>
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<td>automate&lt;sub&gt;it&lt;/sub&gt;</td>
<td>-0.002</td>
<td>-0.001</td>
</tr>
<tr>
<td></td>
<td>(1.44)</td>
<td>(0.93)</td>
</tr>
<tr>
<td>transform&lt;sub&gt;it&lt;/sub&gt;</td>
<td>0.010</td>
<td>0.010</td>
</tr>
<tr>
<td></td>
<td>(8.95)***</td>
<td>(8.93)***</td>
</tr>
<tr>
<td>hi_tech&lt;sub&gt;i&lt;/sub&gt;</td>
<td>0.002</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>(1.41)</td>
<td>(1.15)</td>
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<tr>
<td>lo_tech&lt;sub&gt;i&lt;/sub&gt;</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>(0.60)</td>
<td>(0.46)</td>
</tr>
<tr>
<td>Δeq_ratio&lt;sub&gt;it&lt;/sub&gt;</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>(2.96)***</td>
<td></td>
</tr>
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</tr>
<tr>
<td></td>
<td>(2.51)**</td>
<td></td>
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<tr>
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<td>(7.35)***</td>
<td>(6.65)***</td>
</tr>
<tr>
<td>Observations</td>
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<td>3306</td>
</tr>
<tr>
<td>Adj R-sq</td>
<td>0.30</td>
<td>0.31</td>
</tr>
</tbody>
</table>

Robust t statistics in parentheses, adjusted for intrafirm correlation
* significant at 10%; ** significant at 5%; *** significant at 1%
Number of observations limited in column (1) to equal those available for column (2).
Restricted to observations less than 3 standard deviations from the mean (absolute studentized residual less than or equal to 3) to limit the influence of outliers.

IT_sls = IT expense scaled by sales

uncertainty = standard deviation of earnings before extraordinary items for previous 5 years scaled by sales and log transformed

unrelated divers = measure of firm operations in unrelated industries
related divers = measure of firm operations in related industries

op_ros = operating earnings (before interest, tax, depreciation) scaled by sales
debt_ratio = ratio of long-term debt to total assets
ind_conc_ratio = four firm industry concentration ratio for 4-digit SIC

sales_growth = mean percentage sales growth for previous two years
automate = 1 if firm in automate industry, 0 otherwise
transform = 1 if firm in transform industry, 0 otherwise
hi_tech = 1 if firm in high tech industry, 0 otherwise
lo_tech = 1 if firm in low tech industry, 0 otherwise

Δeq_ratio = change in CEO equity ratio
eq_ratio = ratio of CEO equity to total compensation

i indicates firm and t indicates year

all variables, except size and uncertainty, winsorized 2% to eliminate outlier influence.