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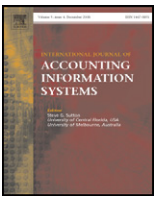

IT internal control weaknesses and firm performance: An organizational liability lens

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ABSTRACT

The information systems literature and the public press have called for organizations to more closely scrutinize their information technology (IT) controls; however, little more than anecdotal evidence exists on the business value of quality IT internal control, beyond regulatory compliance. In this paper, we (a) advance an organizational liability perspective to the question of IT internal control value; and (b) use the unique setting provided by the enactment of the Sarbanes–Oxley Act of 2002 (SOX) to investigate the relationship between IT internal control weaknesses (ICWs) and both accounting earnings (a contemporaneous measure of firm performance) and market value (a forward looking, risk-adjusted measure of firm performance). Using a data set that provides audited annual assessments of the effectiveness of both IT and non-IT internal controls for a cross-section of companies as mandated by SOX, we find that firms that report an IT ICW have lower accounting earnings compared to firms with strong IT internal controls. We also find that IT ICW moderates the association between accounting earnings and market valuation, with firms reporting weak IT internal controls having a lower earnings multiple. These results are sustained even after controlling for non-IT ICWs and firm-specific factors that are known determinants of ICWs, and are reinforced using an inter-temporal changes analysis in which we use each firm as its own control at a different point in time. Overall, our results provide empirical evidence which suggests that IT internal controls are a strategic necessity and that information systems risk is priced by the capital markets. The implications of these findings for theory and practice are discussed.

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1. Introduction

Modern enterprises are critically dependent on information technology (IT) for the conduct of business operations. This increased reliance on IT, coupled with a growing complexity and interconnected nature of IT systems and infrastructure as well as constantly changing threat and regulatory environments, entails increased risks and the need to implement IT internal controls to mitigate those risks. IT controls refer to the management, operational, and technical safeguards or countermeasures prescribed for an information system to protect the confidentiality, integrity, and availability of the system and its information (ISO/IEC 2005; ITGI 2005; NIST 2006). Numerous recent federal and state legislations, including the Health Insurance Portability and Accountability Act (HIPAA) of 1996, the Gramm–Leach–Bliley Act of 2001, and (most significantly for US listed companies) the Sarbanes–Oxley (SOX) Act of 2002, have given the issue of IT controls increased prominence among IT and business corporate executives. Despite the growing importance of IT controls, however, establishing the business case for management focus on IT controls remains a challenge and multiple perspectives for identifying and managing risks exist (Power 2009). In this paper, we develop the idea that weakness in IT controls represents an organizational liability for the firm, and we empirically investigate the performance implications of IT internal control material weaknesses.

In contrast to the vast computer science literature examining technical aspects of computer security and the fairly large stream of work on information technology standards and methods (Baskerville 1993; Dhillon 1997; Backhouse et al. 2006; Siponen and Iivari 2006), prior work focusing on the economics of IT controls is relatively sparse. Much of that work concerns models for determining the optimal amount to invest in order to protect a given set of information (Gordon and Loeb 2002), methods to identify and quantify the potential security events and estimate potential loss (Baskerville 1991; Straub and Welke 1998; Wang et al. 2008), as well as analytical and empirical studies examining the economics of software vulnerability disclosure and patching from a software vendor (as opposed to customer) perspective (Kannan and Telang 2005; Arora et al. 2007; Telang and Wattal 2007). The body of work within the information systems literature that relates most closely to ours is represented by event studies examining stock market reaction to public announcements of information security or privacy breaches (Campbell et al. 2003; Cavusoglu et al. 2004; Acquisti et al. 2006). These studies attempt to estimate the economic cost of ineffective security controls *indirectly* by focusing on one class of failure—reported security breaches—which are by their very nature conditional on vulnerabilities being exploited, discovered and publicly announced. The reported results are rather mixed. Analysis by Cavusoglu et al. (2004) finds significant negative reaction, while Campbell et al. (2003) find no significant abnormal returns. Acquisti et al. (2006) find a significant negative reaction on the day of the announcement; however, they also find that the abnormal returns become insignificant within two days and positive within five days of the announcement. Besides being inconclusive, all of those studies focus on the impact of the announcement of a breach, and do not consider the impact of IT internal control quality on business performance. Thus, in contrast to prior studies, this research aims at providing direct empirical evidence regarding the performance impact of shortcomings in the firm's IT internal controls, irrespective of the public disclosure of specific possible manifestations (e.g., breach) of those shortcomings. A number of recent published studies examine issues related to internal control weaknesses in the aggregate. Work to date has focused on investigating the determinants of internal control weakness in general (Ge and McVay 2005; Ashbaugh-Skaife et al. 2007; Doyle et al. 2007a) and on the potential impact of internal control deficiencies on accrual quality (Ashbaugh-Skaife et al. 2008). Additionally, two recent studies examining the impact on the cost of capital (Beneish et al. 2008; Ashbaugh-Skaife et al. 2009) yielded mixed results. The work that relates most closely to ours is exemplified by a number of event studies examining the market reaction to the disclosure of internal weaknesses as a whole (Hammersley et al. 2008 reviews much of that research). The results of those event studies are also mixed, with one potential rationale being that the disclosures do not provide new information to market participants, as the internal control material weaknesses have revealed themselves within the firm's performance and other irregularities. Another related possible explanation is that those prior studies have tended to focus on internal control weaknesses in the aggregate, and differences in the types of control weaknesses across sampled firms may provide an explanation for the reported mixed findings.

Several concurrent studies examine the association between IT internal control weaknesses and IT control governance (Li et al. 2007), audit fees (Canada et al. 2009), and management turnover (Masli et al. 2009). Consistent with the argument we put forward here that the presence of IT internal control weaknesses is

indicative of poor information quality, a concurrent working paper by Li et al. (2009) finds that management guidance (earnings forecasts) are less accurate for firms reporting IT material weakness in their financial reporting system. Those studies, however, have not addressed the performance impact of IT control weaknesses, which is the primary focus of our research. A question that remains open, therefore, is whether, and if so how, investing in quality IT internal controls pays off in terms of overall financial performance.

In this paper, we (a) advance an organizational liability perspective to the question of IT internal control value and the impact of weaknesses in IT internal controls; and (b) leverage the unique setting provided by the enactment of the Sarbanes–Oxley Act of 2002 (SOX) to empirically test that theoretical perspective. Using a data set of audited annual assessments of the effectiveness of both IT and non-IT internal controls for a cross-section of companies subject to internal control reporting requirement under Section 404 for fiscal years 2004 through 2008, we study the link between IT internal control material weaknesses and firm performance in two respects. First, we examine the linkage between IT internal control quality and *current* performance, measured using contemporaneous return on assets (ROA). We argue that IT internal control weaknesses adversely impact corporate performance by interfering with organizational ability to meet the essential needs for reliable information and systems to conduct daily operations and to effectively and efficiently deliver customer service, management support and productivity gains. As posited, and after controlling for potential correlated determinants of ROA and ICWs, as well as industry and year fixed-effects, we find that firms with reported material IT ICWs deliver lower ROA, on average, compared to firms with no reported material IT ICWs.

In our second analysis, we investigate the relation between the IT internal control quality and firm performance by proposing and testing a model that focuses on whether, and if so how, investors in the market impound firm-specific IT-use risks into stock prices. Specifically, using Ohlson's (1995) residual income valuation framework, we investigate both the direct and indirect impacts of IT internal control quality on the firm's market value, a forward-looking, risk-adjusted measure of firm performance that reflects market expectations of the firm's future earnings. We find no direct effect of IT internal control quality on market valuation; however, we do find that IT internal control quality negatively moderates the association between accounting earnings and market valuation. In other words, our empirical findings indicate that earnings become less useful in explaining market valuation for firms with IT ICWs, consistent with the view we advance here that IT ICWs are indicative of poor operational and financial reporting systems quality. This provides empirical evidence which suggests that information systems risk is priced by the capital markets and that information about the quality of the firm's IT controls is useful to investors beyond financial information disclosed in company filings.

One particular concern that is common to all cross-sectional "levels" analysis, where the levels of independent variables are related to the level of the dependent variable, is that failure to account for potentially important and unobserved correlated variables may bias the estimates of the coefficient on the key variable of interest. To help rule out alternative explanations, we supplement our "levels" analysis with a "changes" (inter-temporal within-firm) analysis in which we use each firm as its own control at a different point in time. Our findings using a first-difference model are consistent with those reported based on our levels specifications. Other robustness checks further verify the stability of our results.

Our study contributes to the literature in several important ways. First, we document, using a broad sample based on audited assessments of the effectiveness of IT internal controls, a significant association between IT internal control quality and firm performance (ROA and market valuation). When SOX was originally introduced, companies suggested that the legislation was unnecessary and burdensome; however, these results demonstrate potential benefits of strong IT internal controls beyond mere compliance with SOX legislation. Second, at the theoretical level, our organizational liability perspective complements that of IT-enabled "competitive advantage" theoretical lens to the question of IT business value: the focus here is not on distinctive advantages that superior use of IT can lead to, but rather on increased IT-induced risks and pitfalls concomitant with poor IT internal controls.

Third, this study contributes to the wider research questions regarding the impact of internal controls. Previous work in the accounting literature has focused on internal control weaknesses as a whole; however, those works have yielded mixed results and have not addressed the impact of IT control weaknesses in particular. Our analysis suggests that the impact on performance differs based on the type of internal control weakness and demonstrates that IT internal control material weaknesses provide additional explanatory power over and above other non-IT internal control material weaknesses. Fourth, our study contributes to the

valuation literature by showing that risks induced through a firm's reliance on IT do matter to investors—to the extent that such risks influence their expectation of future earnings.

The rest of the paper is organized as follows. In the next section, the theoretical framework and hypotheses are developed. Our research model and design are presented in Section 3. Section 4 describes the data and the data analysis. Section 5 concludes with a discussion of the results and implications for future research.

2. Institutional background, theory, and hypotheses

2.1. Institutional background: IT internal controls and the Sarbanes–Oxley Act

The Sarbanes–Oxley (SOX) Act of 2002 mandates management evaluation and independent audits of the effectiveness of internal controls over financial reporting. Prior to the passage of SOX in July 2002, the Foreign Corrupt Practices Act of 1977 required management of public companies to devise and maintain a system of internal controls in order to protect corporate assets, including information assets, and facilitate GAAP-based financial reporting, but did not require management to evaluate or certify the effectiveness of internal control. With the enactment of SOX, disclosures of internal control deficiencies became widely available for the first time. In particular, Section 404 of SOX (which became effective for accelerated filers[2] for fiscal years ending on or after November 15, 2004) requires management to document and test the efficacy of internal controls over financial reporting and to report the results of this assessment as part of the annual 10-K company filing with the SEC. The assessment must also be reviewed by the company's outside auditing firm, who then issues a separate opinion, which is also included in the annual SEC filing, attesting over management's assertions regarding the effectiveness or lack thereof of internal controls. Section 404 reports therefore provide us with a powerful "natural experiment" to examine the relation between IT internal control quality and firm performance.

The Securities and Exchange Commission (SEC) includes in its definition[3] of "internal control over financial reporting" specific references to the policies and procedures for the recording of transactions and maintenance of financial records. Since modern enterprises are heavily dependent on integrated computer-based systems that span business processes and are used to capture, record, access, change, house, process and maintain data, the "internal control over financial reporting" process regulated by the SEC must include controls over the accounting and management process as well as over the organizational IT infrastructure and systems. A similar conclusion is reached in a recent white paper by the SANS institute which notes, "while the topic of information security is not specifically discussed within the text of the act, the reality is that modern financial reporting systems are heavily dependent on technology and associated controls" (Stults 2004). Indeed, the recognition among auditing professionals of the critical role played by IT in the establishment and assessment of internal controls predates SOX. In 2001, the American Institute of Certified Public Accountants (AICPA) promulgated Statement of Auditing Standards No. 94 (SAS 94) affirming that the nature and characteristics of a company's use of information technology affect the company's internal control over financial reporting and requiring auditors to consider information technology as an integral part of overall internal controls (AICPA 2001).

Thus, conceptually and as reflected in practice, any review of internal controls over financial reporting for the purpose of SOX compliance necessarily requires the assessment of two general categories of controls: (i) non-IT (general accounting and management) controls; and (ii) IT controls. The first class of controls encompasses general accounting internal controls, which mainly pertain to the policies, personnel, and methods used to account for financial transactions and the preparation of financial statements, including documentation to justify account balances and procedures to safeguard corporate assets. It also includes management related issues such as oversight from management and the board of directors, competence and reliability of senior management, and regulatory reporting compliance. The second class of controls—IT

[2] Accelerated filers are companies that have equity market capitalization over $75 million and have filed at least one annual report with the SEC. The SEC postponed the requirement to comply with Section 404 for non-accelerated filers until fiscal years ending on or after December 15, 2007 for management assessment and to fiscal years ending on or after December 31, 2008, for audit attestation.

[3] Available at: http://www.sec.gov/rules/final/33-8238.htm.

internal controls—refers to those controls that pertain specifically to IT systems, processes and infrastructure used to capture, process and record raw transactional data corresponding to economic events as well as support the preparation of financial reports. They encompass the management, operational, and technical safeguards or countermeasures prescribed for the firm's information systems to protect the confidentiality, integrity, and availability of those systems and their information (ISO/IEC 2005; ITGI 2005; NIST 2006).

The PCAOB identifies three types of internal control problems (in increasing levels of severity): control deficiencies, significant deficiencies, and material weaknesses. The primary difference between "significant deficiencies" and "material weaknesses" is in the magnitude of the financial statement misstatements, which may result due to the existence of the weakness. Material weaknesses are the most severe ones because they indicate internal control problems that "result in more than a remote likelihood that a material misstatement of the annual or interim financial statements will not be prevented or detected" (PCAOB 2004). Consistent with prior research on internal controls, we focus on those weaknesses identified as material, in accordance with SOX disclosure requirements. We do so for two key reasons. First, by definition, material weakness are the most severe type of deficiencies in internal control and therefore the most likely to affect performance. Second, publicly-traded firms are only required to disclose material weaknesses in their SOX Section 404 reports. Thus, the SOX Section 404 reports (that Audit Analytics codes) only allow researchers to determine whether or not material weakness exists, and if so its type/nature. The IT ICW construct therefore captures the presence or absence of a material weakness in IT internal controls, and as noted in Section 3.1, we rely on Audit Analytics definition and classification scheme (described in Appendix A) to operationalize/measure the IT ICW construct. In accordance with Audit Analytics classification, IT ICWs include "deficient program controls, software programs/implementation, segregation of duties associated with personnel having access to computer accounting or financial reporting records and related problems with oversight/access to electronic data/programs."

2.2. Theoretical framework: IT ICW as an organizational liability

Explaining variation in firm performance is the central focus of much of the strategy literature. As Powell and Arregle (2007) note, "firms compete on two axes: the axis of competitive advantage, where performance is driven by the inimitable resources and capabilities of high-performing firms; and the axis of errors, where performance is driven by failures to attend to the activities, resources and opportunities that are equally available to all firms." Arend (2004) refers to such "errors" as *liabilities* (negative factors), while others have labeled the factors that detract from rents as *competitive disadvantages* (Powell 2001) and *resource weaknesses* and *distinctive inadequacies* (West and DeCastro, 2001). As a result, firms can perform differently, even in the absence of distinctive competitive advantages. Organizational liabilities (competitive disadvantages) are not the mirror image of competitive advantages: "the two are quite independent—if competitive advantage stems from inimitable, idiosyncratic resources, competitive disadvantage is not merely the non-existence of such resources (which would create economic parity), but rather the failure even to satisfy the minimum success requirements, or 'strategic industry factors' (Amit and Schoemaker, 1993), required of any firm" Powell (2001: 877). Organizational liabilities "destroy value in a firm rather than simply failing to add any" (Arend 2003), and as such, produce performance variation not attributable to competitive advantages. The research reported here investigates whether one type of organizational liability, namely material weaknesses in IT internal controls explains variation in firm performance.

Focusing on the first axis (the axis of competitive advantage), a large body of work examining the question of IT business value and competitive advantage through IT has emerged during the last two decades. Much of the recent works draw on the resource-based theory of the firm as the primary theoretical framework. The resource-based view (RBV) (Wernerfelt 1984; Barney 1991) seeks to explain sources of competitive advantage, sustained or otherwise. The theory ascribes competitive advantage to a firm's idiosyncratic resources—the tangible and intangible assets and capabilities that are used to implement firm strategies. Drawing on RBV, scholars (see, for example, Aral and Weill 2007; Bharadwaj 2000; Jeffers et al. 2008; Mata et al. 1995; Melville et al. 2004; Ray et al. 2005; Ravichandran and Lertwongsatien 2005; Wade and Hulland 2004; Wang and Alam 2007) have argued and found empirical support for the notion the IT can be a source of distinctive competitive advantage in at least two ways: (a) when the firm possesses valuable, rare, and costly to imitate IT resources/capabilities; or (b) when the firm uses IT to realize the full competitive potential of non-IT resources through complementarity and co-specialization.

It is, however, generally understood, consistent with RBV, that a firm must perform many organizational necessities and invest in resources, including IT resources, that are neither rare nor difficult to imitate (and hence generate no distinctive advantages) in order to maintain competitive parity. It is further understood, also consistent with resource-based expectations, that as standardized hardware and software as well as IT expertise become readily available in the factors market to all firms, IT increasingly becomes a commodity factor of production, the *standardized* use of which provides distinction to none (Carr 2003; Clemons 1991). This, of course, does not mean that firms should not invest in generic IT resources; investments in such resources are required for success in the modern economy, and firms that fail to adequately invest in IT and manage the associated risks will be at a competitive disadvantage. Because organizations are increasingly dependent on IT, we argue that failure to adequately attend to IT internal controls results in otherwise avoidable deficiencies that amount to a liability (competitive disadvantage) for the firm, a negative factor that accounts for variation in performance across firms.

2.3. The performance impact of IT ICWs

The integrity and reliability of data produced by organizational information systems are critical, not just for the production of reliable financial reports, but for overall business success (Krishnan et al. 2005). Whereas material weakness in the non-IT (accounting-related) controls can result in improper reporting of economic events, material weakness in IT internal controls can adversely impact both the underlying business operations (i.e., the actual execution, recording, and safeguarding of raw transaction data associated with core business activities) as well as the production of reliable financial reports. This difference would be consistent with the argument put forth by Moody's, the bond rating company, which while not making a distinction between IT and non-IT weaknesses, draws a distinction between two categories of material internal control weaknesses in determining the impact on a firm's rating. Moody's suggests that whereas account-specific weaknesses ("Category A") are identifiable by auditors through substantive testing and thus do not represent as serious a concern regarding the reliability of the financial statements, company-level weaknesses ("Category B") are more difficult to "audit around" because they are more pervasive and "call into question not only management's ability to prepare accurate financial reports but also its ability to control the business" (Doss and Jonas, 2004). While accounting (non-IT) ICWs may fall into both categories, the Public Company Accounting Oversight Board (PCAOB) Auditing Standard No. 2 specifically states that IT controls should be considered a company-level control, given the extensive and pervasive usage of IT in companies' operational and financial reporting business processes (PCAOB 2004).

The costs associated with material weaknesses in IT internal controls may have multiple components. First, there is cost of rectifying the disruption and the harm caused by unreliable and insecure systems and data, including clean-up efforts, possible lawsuits, damage to reputation, and loss of employee trust in organizational IT systems. Besides these specific expenses, problems manifested as a result of weaknesses in IT internal controls can lead to revenue reduction due to missed opportunities and dissatisfied customers and partners opting to take their business elsewhere. Given the integrated nature of today's financial, operational and decision-support systems, the presence of IT internal control material weaknesses indicates that the organization is unlikely to be able to meet its objectives of providing reliable systems and quality data necessary to support operational activities and managerial decision making and meet the availability and confidentiality expectations of its customers and suppliers. In other words, material IT ICWs effectively translate into weaknesses in the firm's operational capabilities enabled or supported by IT, a competitive disadvantage that is likely to adversely affect the firm's profitability. This leads to our first hypothesis:

Hypothesis 1. Material weakness in IT internal control is negatively associated with accounting earnings.

In addition to impacting current earnings, deficiencies in IT controls are also likely to influence investors' expectations about the firm's future prospects. Assuming efficient capital markets, a firm's market capitalization provides the best available unbiased estimate of the present value of its discounted future income stream (Fama 1970). An extensive body of research has shown that the capital markets view accounting information (in particular, earnings) to be informative about a firm's future profitability (Kothari 2001). However, current period accounting numbers do not fully reflect a firm's long-term prospects and hence do not fully explain the firm's market valuation. Prior research suggests that IT can contribute to a firm's

future performance beyond information contained in current earnings. For example, IT may enable improved customer service, higher product and service quality, support for reengineering efforts, and better flexibility. Prior research has shown that investors recognize and price such IT-enablement (Anderson et al. 2006; Bharadwaj et al. 1999; Brynjolfsson et al. 2002; Sambamurthy et al. 2003; Wang and Alam 2007). By the same token, weakness in IT internal controls can be construed as a liability reflecting a reduced ability to capture future value from IT assets, including commodity assets, as well as uncertainty about the quality of the organizational processes enabled by IT. To the extent that investors impound this weakness and potential future inabilities into stock prices, the presence of IT ICWs will be negatively associated with the firm's market value, providing incremental explanatory power beyond accounting information reported on financial statements. We, therefore, posit that in addition to their impact on current earnings (Hypothesis 1), the presence of IT ICWs has a direct negative impact on the firm's market-based value.

Hypothesis 2. Material weakness in IT internal control is value relevant (i.e., negatively associated with stock market valuation).

In addition to impacting market valuation directly, deficiencies in IT controls can also influence the degree to which reported current accounting earnings are informative to investors about future earnings and hence market value. An extensive body of research shows that accounting information (in particular, earnings) is indeed informative about a firm's future profitability and thus the firm's market value (Kothari 2001). Strong internal controls are key to credible and high quality financial reporting (Ashbaugh-Skaife et al., 2008; Doyle et al. 2007b) and to the extent that the financial reporting process in modern enterprises is itself enabled and supported by IT, the presence of material IT ICW is likely to adversely affect investors' perception of the reliability and credibility of a firm's earnings number. The reduced confidence increases the information risk associated with current earnings as a proxy for expected future earnings. Information risk, the likelihood that firm-specific information that is relevant to investor pricing decisions is noisy or of poor quality, has been linked both theoretically (e.g., Easley and O'Hara 2004) and empirically (e.g., Francis et al. 2004, 2005) to higher cost of equity capital. In summary, weakness in IT internal controls affects market expectations by signaling that reported earnings numbers are noisier, less reliable, or less persistent than previously assumed. Accordingly, we hypothesize that earnings will be less relevant for firm valuation (i.e., less useful in explaining the firm's market value) for firms with weak IT internal controls.

Hypothesis 3. Material weakness in IT internal control negatively moderates the association between accounting earnings and market valuation.

Fig. 1 depicts our research model.

3. Research methodology

3.1. Data and sample selection

The data required for this study was collected from two research databases: Audit Analytics and Compustat. Audit Analytics, which is widely used by accounting scholars (e.g., Ogneva et al. 2007; Ashbaugh-Skaife et al. 2008), tracks all SEC filings, captures management assessment of the effectiveness of internal controls and includes detailed categorization of ICWs disclosed in those annual filings. Audit Analytics codes twenty-one types of internal control weaknesses, with one of those types being IT ICWs and the remaining twenty relating to non-IT types of ICWs. Appendix A provides examples of the IT ICWs and the most frequent non-IT ICWs in accordance with Audit Analytics' classification. We believe that the reliance on Audit Analytics classifications provides a consistent methodology for considering various types of internal control weaknesses, and that errors in classification are likely to bias against finding significant results. As noted earlier in Section 2.1, consistent with prior literature, we focus only on the control weaknesses defined as material, in accordance with SOX disclosure requirements.

Our primary variable of interest, IT-related internal control material weaknesses (IT_ICW), is coded as 1 if the firm reports an IT internal control material weakness and 0 otherwise. Independent of the IT ICWs, we also capture the presence of non-IT (accounting related) internal control weaknesses (non-IT ICW). Audit Analytics codes twenty different types of non-IT ICWs, and so in order to reduce the number of required

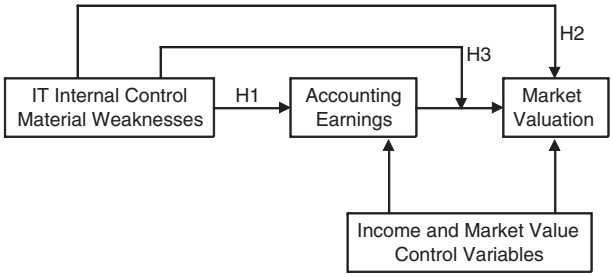

Fig. 1. The research model.[4]

control variables, we perform a factor analysis on the non-IT ICWs.[5] We retain all factors with an eigenvalue greater than unity. This results in three factors that account for over 96% of the total variance. Individual internal control types are then assigned to one of the three factors based on their highest factor loading, and each factor is given a descriptive category label/name based on the characteristics of the individual ICW types assigned to it. The resulting three categories of non-IT ICW are labeled as follows: accounting procedures, personnel and documentation (ACC_Proc_ICW); senior management competency, ethics and reliability (ACC_Mgmt_ICW); and restatement of filings or prior Section 404 reports (ACC_Res_ICW). For each of these three categories of non-IT ICWs, the corresponding indicator variable is set to 1 for firms that report any type of internal control weakness related to that factor and 0 otherwise. Separating the non-IT internal controls in this manner permits the assessment of the impact of the IT ICW on firm performance while controlling for other types of internal control weaknesses which may also impact firm performance. (The robustness of our results to alternative coding schemes or ways to control for non-IT ICWs is examined in Section 4.2.2).

Audit Analytics data set starts with filings for fiscal year 2004 and includes accelerated filers for whom SOX became effective in 2004 as well as any voluntary filers. The Audit Analytics data set is merged with the Compustat database to obtain the financial and market performance data as well as data for the control variables identified in the literature (Ashbaugh-Skaife et al. 2007; Doyle et al. 2007a). Data obtained through Compustat includes income, shares, share price, book value of equity, assets, sales, advertising expense, research and development expense, and net dividends (dividends paid less changes in contributed capital). Appendix B provides a description of the data items and the data source.

Our initial sample consists of all firm Section 404 reports on Audit Analytics (our primary source for annual audited assessment of ICWs) for 2004 through 2008.[6] We then obtained corresponding financial information on each firm from Compustat, by matching Compustat and Audit Analytics data records using Central Index Key (CIK) code. This generates a sample of 16,415 firm-year observations. Table 1 presents descriptive statistics of the initial levels sample and the correlation table. We notice that firms with IT material weaknesses tend to be smaller based on market value (MV) and related variables such as earnings level; however, prior ROA is similar. We also note that firms with IT material weakness tend to have ACC_Proc_ICWs which is the largest category of weaknesses and includes documentation issues that are reported with most firms that report any SOX material weakness.[7] As such, we focus on the pooled sample to aid in isolating the impact of the non-IT material weaknesses when there is not an IT material weakness and to include these variables as controls in the multivariate analysis.

[4] As detailed in Section 3, the control variables box in Fig. 1 includes other factors that may influence performance, other (non-IT) types of internal control material weaknesses, and potential determinants of internal control material weaknesses.

[5] The factor analysis with varimax rotation approach is used to reduce the dimensionality of the models; it results in reducing the number of additional control variables required from the original 20 non-IT ICW types to the remaining three underlying factors/categories of non-IT ICWs. We believe this is critical, since testing Hypothesis 3 would otherwise require the inclusion of 21 interaction terms between earnings and types of internal control weakness. As each interaction term shares the same multiplier, including all of the interaction terms in a single model would likely produce imprecise regression coefficients due to multicollinearity between the interaction terms.

[6] In cases where restatements exist, we dropped the initial report and used only the last restatement.

[7] The "observations without IT material weaknesses" includes firms without any material weaknesses. As there may be a difference between firms who choose to report a material weakness and those that do not, we perform a robustness test (Section 4.2.5) on a sample of only firms with a material weakness. We find similar results.

Table 1
Descriptive statistics.

	Observations with IT ICW				Observations with non-IT ICW (IT ICW = 0)				Observations without ICW (IT nor non-IT)			
	N	Mean	Median	Std dev	N	Mean	Median	Std dev	N	Mean	Median	Std dev
MV	309	1703.9	306.8	6299.7	1220	2593.6	417.6	19533.8	14885	5753.8	806.5	20576
Equity	309	759.2	137.9	3108.6	1220	965.6	192.1	5919.1	14885	2385.5	373.4	8698.8
Earnings	309	51.3	0.32	574.2	1220	106.2	7.62	1173.1	14885	326.8	31.6	1708.4
Dividends	309	55.2	3	415.1	1220	23.3	3	457.2	14885	53.2	4	1386.6
Adv	309	6.9	0	34.4	1220	18.7	0	154.8	14885	40.1	0	254.1
R&D	309	22.7	0	120.3	1220	50.4	0	370.3	14885	81.7	0	496.1
ROA	309	−0.08	0	0.33	1220	−0.02	0.011	0.27	14885	0.01	0.03	0.22
ROA_{t-1}	309	0.01	0.01	0.65	1220	−0.01	0.02	0.19	14885	0.02	0.04	0.22

Panel B—Pooled sample correlation table

Variable	MV	Equity	Earnings	Net dividends	Adv	R&D	ROA	ROA_{t-1}	IT ICW	ACC Proc ICW	ACC Res ICW
MV	1.000										
Equity	0.858***	1.00									
Earnings	0.838***	0.755***	1.000								
Net Dividends	0.060***	0.262***	−0.094***	1.000							
Adv	0.423***	0.399***	0.304***	0.018**	1.000						
R&D	0.482***	0.361***	0.346***	−0.032***	0.419***	1.000					
ROA	0.083***	0.058***	0.108***	−0.009	0.039***	0.037***	1.000				
ROA_{t-1}	0.067***	0.047***	0.055***	−0.009	0.036***	0.036***	0.582***	1.000			
IT ICW	−0.026***	−0.024***	−0.021***	0.001	−0.018**	−0.016**	−0.049***	−0.003	1.000		
ACC_Proc_ICW	−0.048***	−0.05***	−0.041***	−0.005	−0.029***	−0.022***	−0.051***	−0.031***	0.431***	1.000	
ACC_Mgmt_ICW	0.004	0.005	−0.000	0.008	−0.009	0.019**	−0.003	−0.004	0.192***	0.189***	1.000
ACC_Res_ICW	−0.017**	−0.021***	−0.021***	0.001	−0.009	−0.006	−0.027***	−0.008	0.234***	0.647***	0.179***

Data definitions: MV = Market valuation = price * shares; Earnings = Net income from current year; Equity = Equity from current year; Dividends = Common dividends + purchase of stock-sale of stock; Adv = Advertising expenditures; R&D = Research and development expenditures; ROA = Net Income/Assets; ROA_{t-1} = Net $Income_{t-1}/Assets_{t-1}$; IT ICW = IT Internal Control Material Weakness; ACC_Proc_ICW = Material Weakness in the procedure category; ACC_Mgmt_ICM = Material Weakness in the management category; ACC_Res_ICW = Material Weakness in the restatement category.

* p<.1.
** p<.05.
*** p<.01.

3.2. Empirical tests

Hypothesis 1 posits that IT ICW is negatively associated with earnings. To test this hypothesis, we focus on a scaled measure of earnings, return on assets (ROA), and use two alternative explanatory models proposed and widely used in the literature: random walk and production function. The first specification we employ is consistent with accounting studies of the time-series properties of annual earnings which suggest that earnings follow a random walk or random walk with drift process (Albrecht et al. 1977; Watts and Leftwich 1977).

$$\begin{aligned}\mathrm{ROA}_{i,t} = {} & b_0 + b_1\mathrm{ROA}_{i,t-1} + b_2\mathrm{IT\_ICW}_{i,t} + b_3\mathrm{ACC\_Proc\_ICW}_{i,t} + b_4\mathrm{ACC\_Mgmt\_ICW}_{i,t} \\ & + b_5\mathrm{ACC\_Res\_ICW}_{i,t} + b_6\mathrm{Age}_{i,t} + b_7\mathrm{Sales}_{i,t} + b_8\mathrm{Growth}_{i,t} + b_9\mathrm{Foreign\_Transactions}_{i,t} \\ & + b_{10}\mathrm{Business\_Segments}_{i,t} + b_{11}\mathrm{Inventory}/\mathrm{Assets}_{i,t} + b_{12}\mathrm{Restructuring}_{i,t} + b_{13}\mathrm{M\&A}_{i,t} \\ & + b_{14}\mathrm{Large\_Auditor}_{i,t} + b_{15}\mathrm{Auditor\_Change}_{i,t} + b_{16}\mathrm{Prior\_Loss}_{i,t} + b_{17}\mathrm{Distress}_{i,t} \\ & + \textit{industry dummies} + \textit{year dummies} + \varepsilon_{i,t}.\end{aligned} \tag{1}$$

In the second specification, following Lev and Sougiannis (1996) and Rajgopal et al. (2003), earnings are modeled as a function of a set of specific tangible and intangible assets and a measure of growth/risk (market-to-book ratio, MBR).

$$\begin{aligned}\mathrm{ROA}_{i,t} = {} & b_0 + b_1\mathrm{Advertising}/\mathrm{Assets}_{i,t} + b_2\mathrm{R\&D}/\mathrm{Assets}_{i,t} + b_3\mathrm{MBRi}_{,t} + b_4\mathrm{IT\_ICW}_{i,t} \\ & + b_5\mathrm{ACC\_Proc\_ICW}_{i,t} + b_6\mathrm{ACC\_Mgmt\_ICW}_{i,t} + b_7\mathrm{ACC\_Res\_ICW}_{i,t} + b_8\mathrm{Age}_{i,t} \\ & + b_9\mathrm{Sales}_{i,t} + b_{10}\mathrm{Growth}_{i,t} + b_{11}\mathrm{Foreign\_Transactions}_{i,t} + b_{12}\mathrm{Business\_Segments}_{i,t} \\ & + b_{13}\mathrm{Inventory}/\mathrm{Assets}_{i,t} + b_{14}\mathrm{Restructuring}_{i,t} + b_{15}\mathrm{M\&A}_{i,t} + b_{16}\mathrm{Large\_Auditor}_{i,t} \\ & + b_{17}\mathrm{Auditor\_Change}_{i,t} + b_{18}\mathrm{Prior\_Loss}_{i,t} + b_{19}\mathrm{Distress}_{i,t} + \textit{industry dummies} \\ & + \textit{year dummies} + \varepsilon_{i,t}.\end{aligned} \tag{2}$$

In addition to our variable of interest, *IT_ICW*, we include the three accounting-related (non-IT ICW) indicator variables to partial out the effects of non-IT weaknesses. We also control for several potential determinants of internal control weaknesses identified in the literature (Ashbaugh-Skaife et al. 2007; Doyle et al. 2007a; Ge and McVay 2005) that may also be correlated with the dependent variable. Specifically, Ashbaugh-Skaife et al. (2007), Ge and McVay (2005), and Doyle et al. (2007a) find that firms reporting ICWs tend to be younger, smaller, growing rapidly, have greater operational complexity, undergoing restructuring, are audited by a large audit firm, have experienced a change in auditor, and are relatively more resource constrained due to financial distress. Accordingly, we control for the following firm-specific characteristics: *Age*; *Sales* as a measure of firm size; *Growth* in sales; measures of complexity including foreign currency transaction indicator (*Foreign_Transactions*), the number of business segments (*Business_Segments*), and the level of inventory relative to assets (*Inventory/Assets*); firm restructuring as proxied by the presence of special items (*Restructuring*) and by mergers and acquisitions (*M&A*); a large auditor indicator variable (*Large_Auditor*); an indicator for change in auditor (*Auditor_Change*); a financial loss variable (*Prior_Loss*) measured as the percentage of the last three years that a firm reports losses; and a measure of financial distress (*Distress*) based on Altman's (1968) Z-score formula for predicting bankruptcy. (The computational details and specific data sources used to create these variables are provided in Appendix B.) Additionally, we include year dummies in the model to control for fixed year-effects (e.g., effects of macroeconomic factors). If correlated with the independent variables, these effects may bias the regression coefficients. Similarly, we include industry dummies to control for fixed industry-effects that may account for variation in the dependent variable across industries.[8]

To test Hypotheses 2 and 3 regarding the direct and indirect effects of IT ICW on the firm's stock market valuation, we employ a version of Ohlson's (1995) residual income valuation (RIV) model, in which the

[8] The reported results utilize 1-digit SIC codes as the industry controls. The results did not change when we reran all models using 2-digit SIC codes as controls.

market value of the firm is modeled as a function of the book value of equity, current abnormal earnings, and other information that modifies the prediction of future profitability. The model is widely used and accepted in capital markets literature, particularly in examinations of the value relevance of various non-financial components, including brand value (Barth et al., 1998), disclosure of non-financial information (Shevlin 1996), wireless networks (Amir and Lev 1996), and in valuing network advantages created by website traffic in e-commerce firms (Rajgopal et al. 2003). There are many different technical implementations of the RIV model in the literature; however we consider Rajgopal et al. (2003) as it focuses on IT issues and we also examine Ghosh et al. (2005) who investigates "earnings response coefficients" or the moderated association between earnings and market value. Consistent with these specifications, market valuation is expressed as a linear function of the book value of equity and current earnings and our valuation model is specified as follows:

$$\begin{aligned} MVE_{i,t} = {} & b_0 + b_1 Equity_{i,t} + b_2 Earnings_{i,t} + b_3 Net\,Dividends_{i,t} + b_4 Advertising_{i,t} + b_5 R\&D_{i,t} \\ & + b_6 \text{IT\_ICW}_{i,t} + b_7 \text{ACC\_Proc\_ICW}_{i,t} + b_8 \text{ACC\_Mgmt\_ICW}_{i,t} + b_9 \text{ACC\_Res\_ICW}_{i,t} \\ & + b_{10} \text{Age}_{i,t} + b_{11} \text{Sales}_{i,t} + b_{12} \text{Growth}_{i,t} + b_{13} \text{Foreign\_Transactions}_{i,t} \\ & + b_{14} \text{Business\_Segments}_{i,t} + b_{15} \text{Inventory / Assets}_{i,t} + b_{16} \text{Restructuring}_{i,t} \\ & + b_{17} \text{M\&A}_{i,t} + b_{18} \text{Large\_Auditor}_{i,t} + b_{19} \text{Auditor\_Change}_{i,t} + b_{20} \text{Prior\_Loss}_{i,t} \\ & + b_{21} \text{Distress}_{i,t} + \textit{industry dummies} + \textit{year dummies} + \varepsilon_{i,t} \end{aligned} \tag{3}$$

where $MVE_{i,t}$ is the fiscal year end market valuation for firm i for year t, $Equity_{i,t}$ is the fiscal year end book value of equity, $EARNINGS_{i,t}$ is net income, and $Net\_Dividends_{i,t}$ is dividends paid out less changes in capital contributions. We include *Advertising* and *R&D* expenditures to control for intangible assets not included on the balance sheet. We also include controls for industry, fiscal year, as well as potential determinants of internal control weaknesses identified in the literature, as discussed previously in reference to Eqs. 1 and 2.

Hypothesis 3 predicts that the presence of IT internal control material weaknesses negatively moderates the association between earnings and market valuation. To test that hypothesis, we include an interaction term between *Earnings* and *IT_ICW*. This term allows us to assess the effect of IT ICW on the earnings/firm value relationship. Our hypothesis is that the coefficient on this interaction term will be negative, indicating a diminished role of earnings in determining market value in the presence of IT ICW. To control for potential moderating role for non-IT ICWs, we also include interaction terms between *Earnings* and each of the three non-IT (accounting) ICW indicator variables, as follows:

$$\begin{aligned} MVE_{i,t} = {} & b_0 + b_1 Equity_{i,t} + b_2 Earnings_{i,t} + b_3 Net\,Dividends_{i,t} + b_4 Advertising_{i,t} + b_5 R\&D_{i,t} \\ & + b_6 \text{IT\_ICW}_{i,t} + b_7 \text{ACC\_Proc\_ICW}_{i,t} + b_8 \text{ACC\_Mgmt\_ICW}_{i,t} + b_9 \text{ACC\_Res\_ICW}_{i,t} \\ & + b_{10} \text{IT\_ICW}_{i,t} * \text{Earnings}_{i,t} + b_{11} \text{ACC\_Proc\_ICW}_{i,t} * \text{Earnings}_{i,t} \\ & + b_{12} \text{ACC\_Mgmt\_ICW}_{i,t} * \text{Earnings}_{i,t} + b_{13} \text{ACC\_Res\_ICW}_{i,t} * \text{Earnings}_{i,t} \\ & + b_{14} \text{Age}_{i,t} + b_{15} \text{Sales}_{i,t} + b_{16} \text{Growth}_{i,t} + b_{17} \text{Foreign\_Transactions}_{i,t} \\ & + b_{18} \text{Business\_Segments}_{i,t} + b_{19} \text{Inventory / Assets}_{i,t} + b_{20} \text{Restructuring}_{i,t} \\ & + b_{21} \text{M\&A}_{i,t} + b_{22} \text{Large\_Auditor}_{i,t} + b_{23} \text{Auditor\_Change}_{i,t} \\ & + b_{24} \text{Prior\_Loss}_{i,t} + b_{25} \text{Distress}_{i,t} + \textit{industry dummies} + \textit{year dummies} + \varepsilon_{i,t}. \end{aligned} \tag{4}$$

4. Results

4.1. Main analysis

The primary results for our analysis of the association between IT internal control weaknesses and return on assets are shown in Table 2. Column one and Column three present the regression results for the base random walk and production function models, while Columns two and four show the results with

Table 2
Regression results for the ROA models.

	Random walk w/ ICW	Random walk w/ determinants	Production model	Production model w/ determinants
ROA_{t-1}	.573***	.452***		
IT_ICW	−.041***	−.034**	−.032***	−.024**
ACC_Proc_ICW	−.019	.013	−.048***	.000
ACC_Mgmt_ICW	.010**	.009*	.005	.005
ACC_Res_ICW	−.012	−.020	−.004	−.016
R&D/Assets			−.583***	−.439***
Advertising/Assets			−.017	−.030**
MBR			.293***	.285***
Age		.028***		.002**
Sales		−.001		−.003
Growth		.114***		.031***
Foreign _Transactions		.019***		.028***
Segments		.002		−.029***
Inventory/Assets		−.044***		−.072***
Restructuring		−.000		−.009
M&A		−.005		−.035***
Large_Auditor		−.008		.021
Auditor_Change		−.007		−.018**
Prior_Loss		−.262***		−.313***
Distress		−.163***		−.154***
N	16415	16415	16415	16415
Adjusted R^2	.35	.43	.40	.49

Table notes: (all tests are two-tailed).
* p<.1.
** p<.05.
*** p<.01.

additional controls included in those models. The coefficient on IT_ICW is negative and significant in all models. Thus, Hypothesis 1 receives strong support.

Standardized regression coefficients are shown. Regression models include year and industry dummies which are not tabulated. Regression uses clustered standard errors. The residuals for all the models satisfied distributional assumptions. Multicollinearity, as indicated by variance inflation factors, was consistently low. Reestimating the regression equations after eliminating potential outliers (based on Cook's D) yields similar results.

Data Definitions: ROA_{t-1} = Net Income from prior year/Assets from prior year; IT_ICW = 1 if the firm reported an IT material weakness; ACC_Proc_ICW = 1 if the firm reported a material weakness within the procedures category; ACC_Mgmt_ICW = 1 if the firm reported a material weakness within the management category; ACC_Res_ICW = 1 if the firm reported a material weakness within the restatement category; R&D/Assets = Research and Development Expenditures/Assets; Advertising/Assets = Advertising Expense/Assets; MBR = Market Valuation/Equity; Age = Number of months listed on CRSP; Sales = Net sales; Growth = (Net sales − net sales from prior period)/(net sales from prior period); Foreign_Transactions = 1 if compustat 150<>0; Segments = number of reported segments in compustat segments; Inventory/Assets = Inventory/Assets; Restructuring = 1 if Compustat 376, 377, 378 or 379>0 in last 3 years; M&A = 1 if Compustat AFTNT1 non zero over last 3 years; Large_Auditor = 1 if Big 4, BDO Siedman or Grant Thornton; Auditor_Change = 1 if firm changed auditor that year; Prior_Loss = % of years with reported loss over last three years; Distress = Decile rank of Altman's (1968) z-score.

Comparing the effects of IT ICWs and non-IT (accounting) ICWs, it is interesting to note that the coefficient on IT_ICW remains significant in all models; whereas, the impact of the ACC_Proc_ICW and ACC_Mgmt_ICW variables fluctuate based on the model and control variables included. We also find that many of the control variables are significant across both models, including age, growth, foreign transactions, accounting complexity, distress and prior loss.

Table 3
Regression results for the Ohlson/RIV valuation models.

	Base model w/ ICWs	Base model w/ determinants	Interaction model	Interaction model w/ determinants
Earnings	.398***	.386**	.402***	.390***
Equity	.487***	.468***	.473***	.453***
Net_Dividends	−.026	−.024	−.027	−.024
Advertising	.046***	.041**	.050***	.046***
R&D	.145***	.141***	.141***	.138***
IT_ICW	−.001	−.001	.002	.002
ACC_Proc_ICW	−.010***	−.007***	−.007***	−.005***
ACC_Mgmt_ICW	−.002	−.001	.000	.000
ACC_Res_ICW	.007*	.006	−.004*	−.005*
IT_ICW*Earnings			−.025*	−.026*
ACC_Proc_ICW*Earnings			−.068	−.066
ACC_Mgmt_ICW*Earnings			−.003	−.003
qACC_Res_ICW*Earnings			.151**	.149**
Age		.034***		.030***
Sales		.028		.030
Growth		.000		−.000
Foreign_Transactions		.008**		.009**
Segments		.004		.001
Inventory/Assets		−.013***		−.012***
Restructuring		−.005		−.003
M&A		−.000		.000
Large_Auditor		.002		.003**
Auditor_Change		−.003		−.004**
Prior_Loss		−.000		−.000
Distress		−.008*		−.010**
N	16415	16415	16415	16415
Adjusted R^2	.84	.85	.85	.86

Table notes: (All tests are two-tailed).
* p<.1.
** p<.05.
*** p<.01.

Table 3 presents the results of the regression estimates of Eqs. 3 and 4 which are used to test the association between IT ICW and market valuation.

Standardized regression coefficients are shown. Regression models include year and industry dummies which are not reported. The residuals for all the models satisfied distributional assumptions. Multicollinearity, as indicated by variance inflation factors, was consistently low. To deal with potential heteroskedasticity and scale effects, t-statistics are all based on White's (1980) heteroskedasticity-consistent standard errors. We also run the tests using clustered standard errors; however, the resulting standard error on our primary variables of interest is smaller therefore we report the results using White standard errors. Our inferences remain unchanged when we reestimate the regression equations after eliminating potential outliers (based on Cook's D). We also rerun our analysis using an alternative version of earnings which has been adjusted for other accounting information (advertising, R&D) included separately and we find similar results.

Data Definitions: Earnings = Net Income from current year; Equity = Equity from current year; Net Dividends = common dividends + purchase of stock − sale of stock; Advertising = Advertising Expense; R&D = Research and Development Expenditures; IT_ICW = 1 if the firm reported an IT material weakness; ACC_Proc_ICW = 1 if the firm reported a material weakness within the procedures category; ACC_Mgmt_ICW = 1 if the firm reported a material weakness within the management category; ACC_Res_ICW = 1 if the firm reported a material weakness within the restatement category; Age = Number of months listed on CRSP; Sales = Net sales; Growth = (Net sales − net sales from prior period)/(net sales from prior period); Foreign_Transactions = 1 if compustat 150<>0; Segments = number of reported segments in compustat segments;

Inventory/Assets = Inventory/Assets; Restructuring = 1 if Compustat 376, 377, 378 or 379>0 in last 3 years; M&A = 1 if Compustat AFTNT1 non zero over last 3 years; Large_Auditor = 1 if Big 4, BDO Siedman or Grant Thornton; Auditor_Change = 1 if firm changed auditor that year; Prior_Loss = % of years with reported loss over last three years; Distress = Decile rank of Altman's (1968) z-score.

We find that the IT_ICW is not directly associated with market valuation (Column one and Column two of Table 3). Thus, Hypothesis 2 is not supported. However, the coefficient on the interaction term between IT_ICW and Earnings (i.e., the earnings multiple) is negative and significant (Columns three and four), indicating a diminished relevance of earnings as a determinant of market value for firms reporting IT ICWs.[9] Thus, as posited (Hypothesis 3), the evidence shows that weakness in IT internal control is a significant (negative) moderator of the relationship between earnings and market valuation.

While we do not make specific hypotheses regarding the non-IT (accounting) ICWs, the data suggests that one category of non-IT ICWs (ACC_Proc_ICW) has a negative direct association with market valuation. We also find that ACC_Res_ICW, the indicator variable representing the restatement-related non-IT ICW category, positively moderates the market value/earnings relationship. One explanation for this positive interaction is that the restatement may have reduced the information risk associated with reported earnings. This result is consistent with the improved earnings quality explanation offered by Kasznik (2004) who argues that "restatements may in fact reduce some of the uncertainty associated with the earnings quality" since some "restatements are announced after some period of uncertainty about a firm's earnings, brought about by media reports or announcements of an SEC investigation", while other "restatements are announced by new company management attempting to "clean up" accounting irregularities attributable to pervious management".

4.2. Robustness checks

4.2.1. Changes tests to account for potential endogeneity and self-selection bias

The results reported in Tables 2 and 3 are based on "levels" tests as they examine the association between the presence of ICWs and the current level of ROA or market value. Although we control for a variety of determinants of both ICWs and the level of the dependent variable in our levels tests, the correlated omitted variables problem remains a concern here as is the case in all cross-sectional "levels" specifications. In particular, the results could be potentially confounded by omitted firm-specific factors and self-selection bias.[10] To help mitigate those concerns and rule out alternative explanations, we supplement our "levels" analysis with a "changes" (inter-temporal within-firm) analysis in which we use each firm as its own control at a different point in time. In this "changes" analysis, we investigate whether firms with changes in their IT and non-IT internal control quality exhibit changes in ROA and market value and in the degree of informativeness of changes in earnings.

The changes specifications we employ essentially mirror our levels specifications (Eqs. 1 through 4), with the exception that each variable is measured in terms of its change from year $t-1$ to year t. A key advantage of a changes (first-difference) specification (over a levels specification) is that all unmeasured/omitted variables that vary across firms but are not significantly different for any single firm from one year to the next, are eliminated by the differencing. In this way, potentially confounding firm-specific factors (which are not included in the levels specification) are effectively controlled for in the changes analysis, to the extent that they do not vary dramatically for the same firm from one year to the next. Another important advantage of the changes specification is that it provides an additional robustness check since it allows us to assess both the impact of initial disclosures of ICWs as well as the remediation of previously reported ICWs. If, as hypothesized, the existence of an IT ICW negatively impacts performance, then successful remediation (as affirmed by the external auditor's SOX

[9] Incremental F-tests confirm the significance of the change in R^2 between the models with the interaction terms and the models without the interaction terms.

[10] For example, one potential firm-specific factor is corporate governance. Our inferences remained unchanged when we added the G-index (Gompers et al. 2003) as a measure of corporate governance to our "levels" tests. Our inter-temporal "changes" analysis effectively controls for this and all other unmeasured/omitted variables that vary across firms but are not significantly different for any single firm from one year to the next.

§404 0pinion) of those internal control problems should on average have an effect roughly similar in magnitude, albeit in the opposite direction. Accordingly, we estimate the following models[11]:

$$\begin{aligned}\Delta ROA_{i,t,t-1} = {} & b_0 + b_1\Delta ROA_{i,t-1,t-1} + b_2\Delta IT\_ICW_{i,t,t-1} + b_3\Delta ACC\_Proc\_ICW_{i,t,t-1} \\ & + b_4\Delta ACC\_Mgmt\_ICW_{i,t,t-1} + b_5\Delta ACC\_Res\_ICW_{i,t,t-1} + b_7\Delta Sales_{i,t,t-1} \\ & + b_8\Delta Growth_{i,t,t-1} + b_9\Delta Foreign\_Transactions_{i,t,t-1} + b_{10}\Delta Business\_Segments_{i,t,t} - 1 \\ & + b_{11}\Delta Inventory / Assets_{i,t,t-1} + b_{12}\Delta Restructuring_{i,t,t-1} + b_{13}\Delta M\&A_{i,t,t-1} \\ & + b_{14}\Delta Large\_Auditor_{i,t,t-1} + b_{15}\Delta Auditor\_Change_{i,t,t-1} + b_{16}\Delta Prior\_Loss_{i,t,t-1} \\ & + b_{17}\Delta Distress_{i,t,t-1} + industry\ dummies + year\ dummies + \varepsilon_{jt}\end{aligned} \tag{5}$$

$$\begin{aligned}\Delta ROA_{i,t,t-1} = {} & b_0 + b_1\Delta Advertising / Assets_{i,t,t-1} + b_2\Delta R\&D / Assets_{i,t,t-1} + b_3\Delta MBR_{,t,t-1} + b_4\Delta IT\_ICW_{i,t,t-1} \\ & + b_5\Delta ACC\_Proc\_ICW_{i,t,t-1} + b_6\Delta ACC\_Mgmt\_ICW_{i,t,t-1} + b_7\Delta ACC\_Res\_ICW_{i,t,t-1} \\ & + b_9\Delta Sales_{i,t,t-1} + b_{10}\Delta Growth_{i,t,t-1} + b_{11}\Delta Foreign\_Transactions_{i,t,t-1} \\ & + b_{12}\Delta Business\_Segments_{i,t,t-1} + b_{13}\Delta Inventory / Assets_{i,t,t-1} + b_{14}\Delta Restructuring_{i,t,t-1} \\ & + b_{15}\Delta M\&A_{i,t,t-1} + b_{16}\Delta Large\_Auditor_{i,t,t-1} + b_{17}\Delta Auditor\_Change_{i,t,t-1} + b_{18}\Delta Prior\_Loss_{i,t,t-1} \\ & + b_{19}\Delta Distress_{i,t,t-1} + industry\ dummies + year\ dummies + \varepsilon_{jt}\end{aligned} \tag{6}$$

$$\begin{aligned}\Delta MVE_{jt,t-1} = {} & b_0 + b_1\Delta Equity_{jt,t-1} + b_2\Delta Earnings_{jt,t-1} + b_3\Delta Net\_Dividends_{jt,t-1} + b_4\Delta Advertising_{jt,t-1} \\ & + b_5\Delta R\&D_{jt,t-1} + b_6\Delta\ IT\_ICW_{jt,t-1} + b_7\Delta ACC\_Proc\_ICW_{i,t,t-1} + b_8\Delta ACC\_Mgmt\_ICW_{i,t,t-1} \\ & + b_9\Delta ACC\_Res\_ICW_{i,t,t-1} + b_{11}\Delta Sales_{i,t,t-1} + b_{12}\Delta Growth_{i,t,t-1} \\ & + b_{13}\Delta Foreign\_Transactions_{i,t,t-1} + b_{14}\Delta Business\_Segments_{i,t,t-1} \\ & + b_{15}\Delta Inventory / Assets_{i,t,t-1} + b_{16}\Delta Restructuring_{i,t,t-1} + b_{17}\Delta M\&A_{i,t,t-1} \\ & + b_{18}\Delta Large\_Auditor_{i,t,t-1} + b_{19}\Delta Auditor\_Change_{i,t,t-1} + b_{20}\Delta Prior\_Loss_{i,t,t-1} \\ & + b_{21}\Delta Distress_{i,t,t-1} + industry\ dummies + year\ dummies + \varepsilon_{jt}\end{aligned} \tag{7}$$

$$\begin{aligned}\Delta MVE_{jt,t-1} = {} & b_0 + b_1\Delta Equity_{jt,t-1} + b_2\Delta Earnings_{jt,t-1} + b_3\Delta Net\_Dividends_{jt,t-1} + b_4\Delta Advertising_{jt,t-1} \\ & + b_5\Delta R\&D_{jt,t-1} + b_6\Delta IT\_ICW_{jt,t-1} + b_7\Delta ACC\_Proc\_ICW_{i,t,t-1} + b_8\Delta ACC\_Mgmt\_ICW_{i,t,t-1} \\ & + b_9\Delta ACC\_Res\_ICW_{i,t,t-1} + b_{10}\Delta\left(Earnings_{jt,t-1} * IT\_ICW_{jt,t-1}\right) \\ & + b_{11}\Delta\left(Earnings_{jt,t-1} * ACC\_Proc\_ICW_{i,t,t-1}\right) + b_{12}\Delta\left(Earnings_{jt,t-1} * ACC\_Mgmt\_ICW_{i,t,t-1}\right) \\ & + b_{13}\Delta\left(Earnings_{jt,t-1} * ACC\_Res\_ICW_{i,t,t-1}\right) + b_{15}\Delta Sales_{i,t,t-1} + b_{16}\Delta Growth_{i,t,t-1} \\ & + b_{17}\Delta Foreign\_Transactions_{i,t,t-1} + b_{18}\Delta Business\_Segments_{i,t,t-1} \\ & + b_{19}\Delta Inventory / Assets_{i,t,t-1} + b_{20}\Delta Restructuring_{i,t,t-1} + b_{21}\Delta M\&A_{i,t,t-1} \\ & + b_{22}\Delta Large\_Auditor_{i,t,t-1} + b_{23}\Delta Auditor\_Change_{i,t,t-1} + b_{24}\Delta Prior\_Loss_{i,t,t-1}\cdot \\ & + b_{25}\Delta Distress_{i,t,t-1} + industry\ dummies + year\ dummies + \varepsilon_{jt}\end{aligned} \tag{8}$$

We use the first SOX reporting year, 2004, as the starting (first t − 1 period), and as required by the first-difference specification, we only include firms that have Section 404 reports in at least one instance of two consecutive years. This reduces our sample to 11,529 firm-year observations. Because our analysis focuses on changes, the (IT and non-IT) ΔICW variables will have a value of 1 if a new internal control weakness of a given type is reported, 0 if there has been no change, and a −1 if the internal control weakness has been remediated. We also include both year dummies to control for fixed year-effects (e.g., effects of macroeconomic factors) as well as industry dummies to control for fixed industry-effects. Regression estimates for the four difference models are shown in Table 4.

Standardized regression coefficients are shown. Regression models include year and industry dummies which are not reported. The residuals for all the models satisfied distributional assumptions. Multi-collinearity, as indicated by variance inflation factors, was consistently low. The ROA models use clustered

[11] The Age control is removed from the changes specification as this would be a constant for all observations. We maintain the numbering on beta coefficients to be consistent with prior equations. Similarly, industry and year dummies may also be removed due to the changes specification; however, we maintain these dummies to account for industry or year specific shocks in the pooled sample. Their inclusion does not change the interpretation of the results.

Table 4
Results of change analyses.

	Random walk w/ determinants	Production model w/ determinants		Ohlson model w/ determinants	Ohlson model w/ determinants and interactions
Δ ROA_{t-1}	−.270***		Δ Earnings	.132*	.141*
Δ IT_ICW	**−.020***	**−.023****	Δ Equity	.441***	.437***
Δ ACC_Proc_ICW	.005	.005	Δ Net_Dividends	−.128*	−.128*
ΔACC_Mgmt_ICW	.011	.010	Δ Advertising	.018	.018
Δ ACC_Res_ICW	−.020	−.026**	Δ R&D	.018	.021
Δ R&D/Assets		−.375***	Δ IT_ICW	**−.003**	**−.002**
Δ Adv/Assets		−.081***	Δ ACC_Proc_ICW	−.005	−.001
Δ MBR		−.001	ΔACC_Mgmt_ICW	.004	−.001
Δ Sales	.004	−.001	Δ ACC_Res_ICW	.006	−.001
Δ Growth	.003	.001	Δ (IT_ICW*Earnings)		**−.039****
Δ Foreign Transactions	−.009	−.009	Δ (ACC_Proc_ICW*Earnings)		−.040*
Δ Segments	−.006	−.004	Δ(ACC_Mgmt_ICW*Earnings)		.044
Δ Inv./Assets	−.049***	−.039***	Δ (ACC_Res_ICW*Earnings)		.053
Δ Restructuring	−.034***	−.024***	Δ Sales	−.171**	−.170**
Δ M&A	−.006	−.004	Δ Growth	−.005***	−.005***
Δ Large_Auditor	−.021	−.012	Δ Foreign Transactions	−.001	−.001
Δ Auditor_ Change	−.006**	−.024**	Δ Segments	.015	.013
Δ Prior_Loss	−.246***	−.197***	Δ Inv./Assets	.013*	.013*
Δ Distress	.020	−.028	Δ Restructuring	−.009	−.009
N	11529	11529	Δ M&A	−.002	−.003
Adjusted R^2	.14	.15			
			Δ Large_Auditor	.002	.002
			Δ Auditor_Change	−.002	−.001
			Δ Prior_Loss	.024***	.025***
			Δ Distress	−.034***	−.034***
			N	11,529	11,529
			Adjusted R^2	.28	.29

Table notes: (all tests are two-tailed).
* p<.1.
** p<.05.
*** p<.01.

standard errors and the market valuation models use White's (1980) heteroskedasticity-consistent standard errors. We also run market valuation models using clustered standard errors; however, the resulting standard error on our primary variable of interest is smaller. Our inferences remain unchanged when we re-estimate the regression equations after eliminating potential outliers (based on Cook's D).

Data Definitions: Δ ROA t−1 = ROA (Net Income/Assets) from prior year − ROA from t−2 year; Δ IT_ICW = IT material weakness report for current year − IT material weakness report from prior year.; Δ ACC_Proc_ICW = Material weakness within the procedures category for current year − material weakness within the procedures category for prior year; Δ ACC_Mgmt_ICW = Material weakness within the management category for current year − material weakness within the management category for prior year; Δ ACC_Res_ICW = Material weakness within the restatement category for current year − material weakness within the restatement category for prior year; Δ R&D/Assets = Research and Development/Assets from current year − R&D/Assets from prior year; Δ Adv/Assets = Advertising/Assets from current year − Advertising/Assets from prior year; Δ Earnings = Net Income from current year − Net Income from prior year; Δ Equity = Equity from current year − Equity from prior year; Δ Net Dividends = common dividends + purchase of stock − sale of stock; Δ Advertising = Advertising Expense from current year − Advertising Expense from prior year; Δ R&D = Research and Development Expenditures from current year − R&D from prior year; Δ Sales = Net sales of current year − net sales of prior year; Δ Growth = Growth of current year (Net sales − net sales from prior period)/(net sales from prior period) − growth of prior year; Δ Foreign _Transactions = Foreign transaction (1 if compustat 150<>0) for current year − foreign transaction of prior year; Δ Segments = number of reported segments in compustat for current year − number of segments reported in prior year; Δ Inventory/Assets =

Inventory/Assets for current year − Inventory/Assets for prior year; Δ Restructuring = Restructuring (1 if Compustat 376, 377, 378 or 379>0 in last 3 years) for current year − restructuring for prior year; Δ M&A = M&A (1 if Compustat AFTNT1 non zero over last 3 years) for current year − M&A for prior year; Δ Large_ Auditor = large auditor (1 if Big 4, BDO Siedman or Grant Thornton) for current year − large auditor for prior year; Δ Auditor_Change = auditor change in current year − auditor change in prior year; Δ Prior_Loss = Prior loss (% of years with reported loss over last three years) for current year − prior loss for prior year; Δ Distress = Distress (Decile rank of Altman's (1968) z-score) for current year − distress for prior year.

Overall, the findings reinforce the results found using our levels specifications. As expected, consistent with Hypothesis 1, the coefficient on the ΔIT_ICW variable is negative and significant in the ROA changes tests (Eqs. 5 and 6) with a stronger reaction in the production model test. The negative sign indicates that a new IT ICW (a positive ΔIT_ICW) contributes to a decrease in ROA, while successful remediation (a negative ΔIT_ICW) is associated with an increase in ROA. In a separate (untabulated) test, we split the Δ IT_ICW variable into two separate variables: one for new IT ICWs (0 or 1) and one for remediation of IT ICWs (0 or 1). We find the coefficients on both indicators significant, with similar magnitude except that the sign on the new IT ICW is negative and the sign on the remediated IT ICW is positive.

Focusing on the market value models (Eqs. 7 and 8), our changes tests finds no significant direct effect for any of the ICW variables. At the same time, consistent with Hypothesis 3, the interaction term involving changes in IT_ICW and changes in earnings, is negative and significant and the result is stronger than in the levels model. Notably, the interaction terms involving ACC_PROC_ICW is also negative. Collectively, our changes and levels analyses provide evidence consistent with poor IT internal controls causing investors to assess higher information risk associated with reported earnings as a proxy for future earnings, effectively diminishing the role of earnings as a determinant of the firm's market value.

4.2.2. Construction of the non-IT ICW variables

As discussed in Section 3.1, in order to isolate the effect of IT ICW, we control for the presence on non-IT ICWs using three dichotomous variables representing three categories of non-IT ICWs based on a factor analysis involving twenty different types of non-IT ICW coded in the Audit Analytics database. One weakness with this approach is that it does not take into account the specific number or types of non-IT ICWs. To determine if our primary regression results are sensitive to this treatment, we replace each of the three dichotomous variables with a variable that represents the number of reported different types accounting ICWs associated with that category/dimension, and reran our models. The results are not materially different from those reported in Tables 3 and 4. Additionally, similar to the arguments put forth in this paper that the type of ICW may affect the relationship with financial performance, it is possible that certain types of accounting (non-IT) ICW may have greater influence and the impact may be muted when factored into a common (dichotomous) variable. Therefore, we modify our models to include separate control variables for each type of non-IT ICW, and, again, our inferences remain unchanged.

4.2.3. Scale effects and abnormal earnings

There have been many different tests of the Ohlson RIV model which have created debates about the appropriate empirical implementation. One concern regarding the levels specification of Ohlson's RIV model is that scale differences may confound the inferences. To address the scale issue, some authors have suggested deflating variables by a size related metric; whereas, others have suggested that it would be best to simply add a control for size (Barth and Kallapur 1996, Easton and Sommers 2003). We do both. Our specification, following Rajgopal et al. (2003), uses un-scaled variables while also controlling for size. We also rerun our model using alternative specifications where the variables are deflated by assets. Our inferences remain unchanged: we do not find a direct significant relationship between IT ICW and market valuation, but we do find a negative significant relationship between (deflated) market value and the interaction term involving IT ICW and (deflated) earnings.

An additional empirical question with the use of the Ohlson model is the appropriate specification of earnings. Ohlson (1999) specifies that the RIV model should include abnormal earnings; however, this requires estimation of the cost of equity and our main model follows prior research in using current earnings (examples include Barth et al. 1999; Ghosh et al. 2005; Rajgopal et al. 2003). We rerun our market valuation analyses using abnormal earnings (earnings less a charge for beginning period equity) and find a similar pattern of results; however, the p-value of the IT material weakness and earnings interaction term in the levels model with

abnormal earnings is a bit stronger ($p<.05$) and the p-value of the IT material weakness and earnings interaction term in the changes model with abnormal earnings is a bit weaker ($p<.10$) for higher values of the charge for equity. We believe that this set of results provides additional confidence in the robustness of our results.

4.2.4. Mediation and simultaneity tests

The ROA and Ohlson "levels" specifications we employ follow prior literature and are consistent with the approach for testing for mediation recommended by MacKinnon et al. (2007).[12] However, since earnings (in scaled form) is used as the dependent variable in the ROA models while earnings itself is treated as an exogenous in the second (market value) equation, one concern is the possibility that the disturbance terms in the two equations might be correlated with each other. To mitigate this concern, we follow the approach proposed by Preacher et al. (2007) who test for conditional indirect effects using a seemingly unrelated regression (SUR). Specifically, we re-estimate the two equations jointly using SUR, where ROA model forms the first SUR equation while the second SUR equation includes all terms from the first equation as well as the independent variables from the Ohlson's model. The results (not tabulated) of this estimation are consistent with those reported based on OLS estimation.

Finally, as discussed earlier, Doyle et al. (2007a) examines possible determinants of internal controls and argues that firms with prior loss may be more likely to report future internal control weaknesses. Our tests (Table 3) control for financial distress and prior loss and find that IT_ICW does provide incremental explanatory power, and the results of our changes analysis are consistent with IT_ICW causally influencing ROA. Nevertheless, we examine the potential for simultaneous relationships between internal control weaknesses and return on assets by following the process described by Heckman (1978) and Maddala (1983) and implemented in STATA by Keshk (2003).[13] The (untabulated) results of our two-stage analysis for a simultaneous relationship show that (the predicted) IT_ICW is negatively associated with ROA, further reinforcing our findings.

4.2.5. Sub-sample tests

Our main results reported in Tables 2 and 3 utilize a sample consisting of firms who have reported material weaknesses (IT or otherwise) and firms with no reported weaknesses. One potential concern may be that there is a difference between firms who choose to report a material weakness and other firms. Our main analyses include variables identified from prior research to control for the likelihood of certain firms to report a material weakness; however, we also rerun our analysis by limiting the sample to only firms that reported a material weakness. We find similar results in that the IT material weakness is directly associated with ROA and indirectly associated with market value.

5. Conclusion

The primary objective of this paper has been to examine the relationship between IT control quality and firm performance. We find that firms that report an IT internal control weakness (ICW) have lower return on assets and lower earnings multiple compared to firms with strong IT internal controls. These results are sustained even after controlling for non-IT ICWs and firm-specific factors that are known determinants of ICW. The results are also generally robust to potentially confounding firm-specific effects (omitted variables) and self-selection bias using a changes analysis. They are also robust across several estimation procedures. Overall, our results provide empirical evidence which suggests that IT controls are an organizational necessity and that information systems-related risk is priced by the capital markets. We believe this study is first in documenting the fundamental link between IT ICWs and current performance while also offering an explanation for how (and evidence of the mechanism through which) IT ICWs impacts investors' assessment of the firm's future

[12] McKinnon et al. (2007) recommended test of mediation assesses the statistical significance of the initial variable (IT_ICW) to mediator (earnings) relation and then the mediator (earnings) to outcome (MVE) relation, which is the approach we have taken here. If both are statistically significant, as our analysis shows (Tables 3 and 4), there is evidence of mediation. Although the bivariate (zero-order) correlation between IT_ICW and MVE is significant (Table 2B), we do not find a significant direct relationship between IT ICW and MVE when earnings is not included in the regression model (Step 1 of in the causal steps approach outlined by Baron and Kenny (1986)). McKinnon et al. (2007) argue, like most analysts today (e.g., Zhao et al. 2010), that Step 1 need not be met to establish mediation; the essential steps in establishing mediation are Steps 2 and 3 of Barron and Kenny.

[13] Keshk (2003) details the CDSIMEQ function and its implementation of the two-stage probit least squares.

performance. Our findings support the organizational liability perspective advanced in this study, in which we argued that effective IT internal controls are essential to realizing the full potential of IT while reducing associate risks, and that deficiencies in IT internal controls adversely impacts performance. As posited, we document that this negative impact is manifested at two levels: the business operations level (lower ROA), and the financial reporting level (reduced informativeness of earnings on market value). For researchers investigating questions related to the business value of IT, our organizational liability perspective complements that of IT-enabled "competitive advantage" theoretical lens: the focus here is not on distinctive advantages that superior use of IT can lead to, but rather on increased IT-induced risks and pitfalls concomitant with poor IT internal controls.

Our focus on IT ICWs is based on the view that IT ICWs are company-level (vs account specific) material weaknesses as defined by PCAOB. Our analysis also empirically demonstrates the differential impact of IT ICW compared with other non-IT ICWs. Although non-IT ICWs were included only as covariates in our models, the results regarding the association between the non-IT ICWs and return on assets are mixed across model specifications—in sharp contrast to our consistent finding with respect to the impact of IT ICWs on operating performance. Therefore, one avenue for future research would be to examine more fully the differential effects of various types of non-IT ICWs. Specifically, some types of non-IT ICWs may be more focused on account specific issues and easily audited around; whereas, other non-IT ICWs may be company-level weaknesses. Identification of each of these types of weaknesses may better inform managers and investors of the potential performance implications of the internal control weakness.

One strength of this research lies in our use of audited assessment data that is mandated by SOX to examine the value and impact IT internal controls. Like all studies, however, our study is not without limitations. First, while we supplement our association (levels) tests with a changes analysis, a longer sampling period would allow a longitudinal analysis to more directly address the question of causality. Second, the use of an aggregated measure of IT ICW neglects the possibility that different types of IT ICWs may differentially impact performance. To our knowledge, there is no specific research that proposes differential performance benefits or detriments based on specific classes of IT resources or processes. One of the closest articles may be Wade and Hulland (2004) who argue that there may be possible moderators on the effectiveness of IT capabilities. Our specific research in this article is aimed at identifying an overall impact of IT material weaknesses (ala Bharadwaj 2000 and IT capabilities); however, additional research is needed to classify and investigate the impact of various types of IT ICWs as well as potential contingency factors that influence the magnitude of their impact.

For practitioners, our study highlights the performance implications of IT internal controls and contributes to the debate over the implementation of SOX. Our analysis suggests that even though SOX requires the assessment of IT internal controls, compliance should be viewed as a vehicle to help the firm manage its many risks, and quality IT internal controls should be viewed as being financially beneficial and not as mere additional costs with no benefit. Accordingly, firms should carefully assess the level of IT internal controls necessary to secure its IT systems and infrastructure, recognizing that effective IT controls are necessary to more fully realize the value-adding potential of IT investments while mitigating concomitant risks.

Appendix A. Internal control weakness definitions and examples from audit analytics

IC—Information technology, software, security and access issue

Definition

Deficiencies in this category include deficient program controls, software programs/implementation, segregation of duties associated with personnel having access to computer accounting or financial reporting records and related problems with oversight/access to electronic data/programs.

Example: SIGMA DESIGNS INC

The Company had inadequate controls over its management information systems related to program changes, segregation of duties, and access controls.

The Company had inadequate access and change controls over end-user computing spreadsheets. Specifically, the Company's controls over the completeness, accuracy, validity and restricted access and

review of certain spreadsheets used in the period-end financial statement preparation and reporting process were not designed appropriately or did not operate as designed.

Example: IPIX CORP

As of December 31, 2004, the Company did not maintain effective control related to its computer data backup and restore practices. The Company does not perform data backups onto removable media (e.g., tape or portable disk) which are then stored offsite. The Company did not perform and retain month-end or year-end data backups of any of its computer systems including the accounting and financial systems.

As of December 31, 2004, the Company did not maintain effective controls relating to security of its accounting and financial systems. The Company's practices do not meet the control objective of a comprehensive assessment of security. Regular monitoring of security devices, logging of security activity and reporting of security incidents or breaches to management are not performed. Additionally, the Company does not require regular password changes for the key financial reporting systems.

Example: MOBILEPRO CORP

Management has identified and included in its assessment the following material weaknesses as of March 31, 2007: the management of the customer information database utilized by the customer care and customer billing functions of one of our companies is performed offsite by a subcontracted consultant without proper controls over access to the data or changes to the system. In addition, controls have not been established to document the control over changes made to certain proprietary information systems that supply transactions amounts. Lastly, appropriate controls are not in place at all subsidiaries for the establishment and maintenance of individual access codes and passwords.

Example: CECO ENVIRONMENTAL CORP

The Company did not maintain effective controls over financial reporting related to information technology applications and infrastructure. Specifically, the following deficiencies in the aggregate constitute a material weakness:

- The Company did not maintain effective design of controls over access to financial reporting applications and data. Controls do not limit access to programs and data to only authorized users. In addition, controls lack the requirement of periodic reviews and monitoring of such access.
- The Company did not maintain effective controls to communicate policies and procedures governing information technology security and access. Furthermore, the Company did not maintain effective logging and monitoring of servers and databases to ensure that access was both appropriate and authorized.
- The Company did not maintain effective controls designed to ensure that information technology program and data changes were authorized. In addition, the Company's controls did not ensure that the information technology program data changes were adequately tested for accuracy before implementation.
- The Company did not maintain effective controls over end user computing applications, such as spreadsheets, used in the Company's financial reporting process. Specifically, controls were not designed to ensure that access was restricted to appropriate personnel, and that unauthorized modification of the data or formulas within spreadsheets was prevented.

These deficiencies have had a pervasive impact on the Company's information technology control environment. Additionally, these deficiencies could result in a misstatement of account balances or disclosure to substantially all accounts that could result in a material misstatement to the consolidated financial statements that would not be prevented or detected.

Non-IT (accounting related) internal control weaknesses

The following categories represent the most reported internal control weaknesses within Audit Analytics.

IC—Accounting documentation, policy and/or procedures

Definition

Represents material weaknesses deriving from internal control systems that do not contain adequate documentation, policies or other means of justifying account balances. These issues may also include

failures to ensure that accounts are recorded based on GAAP, SAB, FASB and/or the appropriate accounting methodology are followed. They may also include failures in policies or procedures designed to gather the correct information on a timely basis or problems with the y/e close process. It also includes failures to employ proper procedures over journal entries, non-routine transactions and other common procedural failures.

Example: AUDIBLE INC

The Company's policies and procedures were not sufficient to ensure that all customers participating in the Company's retail promotion programs were appropriately identified in order to properly recognize the related promotional expense.

IC—Accounting personnel resources, competency/training

Definition

Consists of problems with accounting personnel resources, competency, training, experience and/or adequacy in any way. To meet these criteria, such an indication would have to be contained in the filing or in the remediation plan.

Example: AUTOBYTEL INC

As of December 31, 2004, the Company did not maintain a sufficient complement of personnel with an appropriate level of accounting knowledge, experience and training in the application of generally accepted accounting principles commensurate with the Company's financial reporting requirements.

IC—Material and/or numerous auditor/YE adjustments

Definition

Represents circumstances where one of the explanations for a material weakness opinion was the number and/or size of year-end adjustments including those proposed by the auditor. These adjustments also consider footnote and related errors that need to be corrected by the auditor at year-end. Too many, or auditor initiated year-end adjustments are consider prima facie evidence of a potential material weakness in financial reporting.

Example: AAIPHARMA INC

A combination of control deficiencies relating to aaiPharma Inc.'s period end financial statement close process. All accounts are affected by this material weakness as numerous adjustments were recorded to aaiPharma Inc.'s 2004 annual financial statements as a result of our audit.

IC—Restatement or non-reliance of company filings

Definition

Consists of material weakness opinions deriving from problems that led to restatements. Restatements are often evidentiary of prima-facie internal control material weaknesses.

Example: ADVENT SOFTWARE INC

As of December 31, 2004, the Company did not maintain effective controls over the valuation of its property and equipment accounts, including the related restructuring provision. Specifically, the Company's impairment analysis of its property and equipment accounts related to its decision to vacate a facility failed to identify and include all applicable assets.

IC — Untimely or inadequate account reconciliations

Definition

In reviewing internal control assertions or opinions it is often the case that inadequate account reconciliations are identified as the reason for material or numerous adjustments. This category seeks to specifically identify such circumstances.

Example: AES CORP

Management has concluded that a material weakness existed in our internal control over financial reporting as of December 31, 2004, due to lack of appropriate controls related to income tax accounting. Specifically, we lacked effective controls related to timely and detailed reconciliation of the components of our foreign subsidiaries' income tax assets and liabilities to related consolidated balance sheet accounts.

Appendix B. Data definitions

Main model variables

Variable	Date source and computation details
IT Internal Control Material Weakness (IT_ICW)	= 1 if the firm reported a material IT ICW that year, and 0 otherwise. (Source: Audit Analytics)
Non-IT Internal Control Material Weakness (non-IT ICWs)	Three distinct categories/variables representing non-IT ICWs. A variable is coded as 1 if the firm reported an ICW that year that falls within the corresponding category; 0 otherwise. (Source: Audit Analytics)
Market Valuation (MVE)	Compustat 199 (price) * Compustat 25 (shares)
Book value of equity (Equity)	Compustat 60 (total common equity)
Earnings	Compustat 172 (net income or loss)
Net_Dividends	Compustat 21 (common dividends) + Compustat 115 (purchase of stock) − Compustat 108 (sale of stock)
Advertising expense (Advertising)	Compustat 45 (advertising expense)
Research and development expense (R&D)	Compustat 46 (research and development expense)
Return on Assets (ROA)	Compustat 172 / Compustat 6
Market-to-Book Ratio (MBR)	Compustat 199 (price) * Compustat 25 (shares) / Compustat 60 (total common equity)

Additional control variables

Variable	Date source and computation details
Age	# of months on CRSP
Sales (as a measure of size)	Compustat 12 (net sales)
Growth	Compustat 12 $_{t}$ (net sales) − Compustat 12 $_{t-1}$ (net sales) / Compustat 12 $_{t-1}$ (net sales)
Foreign_Transactions	= 1 if Compustat 150<>0 = 0 otherwise
Complexity based on business, operating, and geographic *segments*	Number of reported segments in Compustat segments
Complexity based on *inventory to assets* ratio	Compustat Data 3 (inventory) / Compustat Data 6 (assets)
Restructuring	= 1 if Compustat items 376, 377, 378, or 379>0 over last 3 years
Merger or Acquisition (M&A)	= 1 if Compustat AFTNT1 non zero over last 3 years
Large_Auditor	= 1 if Big4 + BDO Siedman or Grant Thornton; 0 otherwise. (Source: Audit Analytics)
Auditor_Change	= 1 if the firm changed auditor that year; 0 otherwise. (Source: Audit Analytics)
Prior_Loss	% of years with loss (comp #172) over last 3 yrs
Distress	Decile rank of Altman's (1980) z-score measure of financial distress, where higher rank values represent greater financial distress (likelihood of bankruptcy).

Appendix C. Internal control weaknesses by type

Our sample consists of 16,415 firm-year observations between 2004 and 2008 for level analyses and 11,529 firm-year observations for the change analyses. The following table provides detail of the level sample.

	FY2004	FY2005	FY2006	FY2007	FY2008
Observations without ICW	1992	2887	3249	3447	3311
Observations with an IT ICW	78	70	55	71	35
Observations with a least one non-IT ICW (no IT ICW)	303	346	268	205	98
Total	2373	3303	3572	3723	3444

The following table gives the frequency (by year) of the major types of non-IT (accounting-related) ICW reported within our sample based on the Audit Analytics classifications. (As a firm may have multiple internal control weaknesses, the sum of this detailed chart will be greater than the counts provided above.)

Non-IT (Accounting related) ICW Type	FY2004	FY2005	FY2006	FY2007	FY2008
ACC_Proc_ICW					
Accounting documentation, policy and/or procedures	349	407	318	274	133
Material and/or numerous auditor /YE adjustments	204	234	214	186	89
Accounting personnel resources, competency/training	187	201	150	170	82
Untimely or inadequate account reconciliations	121	125	84	66	33
Other[a]	235	223	148	127	41
ACC_MGMT_ICW					
Senior management competency, tone, reliability issues	25	21	22	22	2
Ethical or compliance issues with personnel	17	23	20	21	5
Other[a]	27	24	28	33	20
ACC_RES_ ICW					
Restatement or non-reliance of company filings	204	223	117	83	25
Other[a]	80	71	47	28	9

[a] represents a tally of other categories designated by Audit Analytics that occur less frequently.

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