Journal of Organizational and End User Computing
Volume 30 • Issue 2 • April-June 2018

The Impact of Firm Characteristics and IT Governance on IT Material Weaknesses

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ABSTRACT

Accurate and timely reporting of organizational performance is becoming increasingly important and highly regulated. However, organizations face a variety of challenges in seeking to provide accurate and reliable information due to the existence of IT control problems. Hence it is important for end users including auditors and managers to understand how to manage IT material weaknesses (ITMWs). While there is extensive accounting research on general material weaknesses (MWs), ITMWs are under researched. This article identifies key firm characteristics that appear to be related to ITMWs. In addition, the authors suggest that IT governance may help firms mitigate such problems. To gain a deeper understanding of IT governance effects, this article proposes a model which includes an innovative construct, ITGOV, operationalized using secondary data. The authors empirically validate the proposed model based on a data set of 1,112 firms. Their study illustrates the differences between ITMWs and general MWs. These results can also help end users computing by offering insights into better management of ITMWs.

KEYWORDS

IT Governance, IT Internal Controls, IT Material Weaknesses, SOX 404

1. INTRODUCTION

High quality and effective internal controls are necessary to ensure the reliability and integrity of companies' financial reporting. In response to high-profile corporate fraud cases such as Enron and WorldCom, the Sarbanes-Oxley (SOX) Act was enacted by the US congress in order to set more rigorous auditing standards, and has had a significant impact on firms' internal control practices. Under section 404 of the SOX Act, all publicly traded companies are mandated to disclose deficiencies in internal controls over financial reporting (ICOFR)[1]. The most severe type of internal control deficiencies (ICDs) is referred to as material weakness (MW). It is defined by Auditing Standard (AS) No. 5[2] as "a significant deficiency, or combination of significant deficiencies, that results in more than a remote likelihood that a material misstatement of the financial statements would not be prevented or detected on timely basis by the company" (PCAOB, 2007, A. 1-11). The most commonly used guidance for internal control is the Committee of Sponsoring Organization's Internal Control-Integrated framework (COSO), which is important for SOX assessment of internal control (Klamm & Watson 2009). Public firms in the U.S. rely on COSO framework in compliance with MWs under SOX act.

DOI: 10.4018/JOEUC.2018040105

Given the current prevalence of computerized business transactions, firms' financial reporting processes are highly dependent on information systems (Carter et al., 2012; Stoel & Muhanna, 2011). These systems are deeply embedded in initiating, authorizing, modifying, recording, processing, retrieving, and reporting a wide range of financial data and transactions. Traditional paper-based files, such as source documents, ledgers and journals, have been, and continue to be digitized and stored in large electronic databases (Hall, 2011, p. 10). "Information systems are inextricably linked to the overall financial reporting processes and need to be assessed, along with other important processes for compliance with the SOX" (ITGI 2004, p. 19; ITGI 2006). Hence, some MWs relevant to SOX compliance are likely to be IT-related. Effective internal controls over information systems, such as enterprise resourcing planning (ERP) systems and various databases, are thus seen as important. Information system research has begun to examine issues of IT-related MWs, or ITMWs (Grant et al., 2008; Klamm & Watson, 2009; Li et al., 2007; Li et al., 2012; Stoel & Muhanna, 2011). If companies disclose at least one ITMW, their IT controls are considered ineffective and of low quality (Li et al., 2007). Common types of ITMWs in SOX 404 reports include deficiencies in the IT environment, computer operations, accounting software, security and access control, data backup and disaster recovery.

Previous research has examined antecedents of MWs in general, and ITMWs in particular, from two different perspectives (Grant et al., 2008; Klamm & Watson, 2009; Li et al., 2007; Li et al., 2012; Stoel & Muhanna, 2011). One stream of research examines characteristics of firms that are associated with MWs disclosure (Ashbaugh-Skaife et al., 2007; Doyle et al., 2007; Ge & McVay, 2005). A second stream of research examines whether effective governance implemented by companies can help firm mitigate ITMWs. However, prior research has not integrated both perspectives in an effort to examine the antecedents of ITMWs. To fill this gap, we intend to answer the following research question in the current study: How are firm characteristics and IT governance related to ITMWs? To answer this question, we draw upon multiple streams of research including general internal control MWs, ITMWs, corporate governance, and IT governance to develop an effective research model. Our model highlights the important role of IT governance, which ensures the quality of a firm's IT internal controls. Effective IT governance over planning and the system development life cycle should result in more accurate and timely financial reporting (Masli et al. 2009). Further, we propose and operationalize a new IT governance construct called ITGOV based on publicly available secondary data. Such a construct helps to objectively measure the overall effectiveness of IT governance in organizations.

We empirically validate our proposed model which examines the joint impacts of firm characteristics and IT governance on ITMWs using data about 1,112 firms collected from the Audit Analytics database (SOX 404 reports) over a seven-year period (Jan 2005 to Dec 2011). We find that firms that have a higher probability of loss, have foreign sales, and undergo mergers and acquisitions are more likely to disclose ITMWs. In addition, we provide empirical evidence suggesting that effective IT governance is useful in mitigating ITMWs. However, contrary to results found in prior general internal control research (Doyle et al., 2007; Ge & McVay, 2005), we find that older firms are more likely to have ITMWs. Furthermore, we find that the number of segments a firm operates in, its inventory level, and the presence of rapid growth and restructuring are not significantly associated with ITMWs. We thus suggest that our study's results demonstrate interesting and important differences between ITMWs and general MWs.

This study offers important contributions to research in Information Systems as well as Accounting. Our research is one of the first studies that examine the impacts of both firm characteristics and IT governance on ITMWs. In order to facilitate such a study, we propose a new construct, ITGOV, which creates an innovative and practical way to objectively quantify firms' IT governance based on secondary data. Our findings also have important implications for multiple stakeholders including company executives and regulators.

The remainder of the paper is structured as follows. The next section introduces the background of SOX 404, internal controls, and IT internal controls. The subsequent section reviews related literature. Section four discusses the theoretical background and develops hypotheses. The research methods are discussed in section five. Section six presents empirical results. The final section discusses the implications of this study, and provides concluding comments, including limitations of the effort, and possible directions for future research.

2. SOX 404, INTERNAL CONTROLS, AND IT INTERNAL CONTROLS

ICOFR are designed to provide reasonable assurance regarding the reliability of a company's financial statement to instill confidence in investors. ICOFR are defined by U.S. Securities and Exchange Commission (SEC) as:

A process designed by, or under the supervision of, the registrant's principal executive and principal financial officers, or persons performing similar functions, and effected by the registrant's board of directors, management and other personnel, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles and includes those policies and procedures…… (SEC, 2003, S. 2.1.3).

Prior to SOX, the first legislative act, the Foreign Corrupt Practices Act (FCPA) of 1977 provided regulatory standards for ICOFR. The Federal Deposit Insurance Corporation Improvement Act (FDICIA) of 1991 expanded the regulatory authority over internal controls, and required banks to establish and maintain a documented internal controls system. However, those regulatory oversights over internal controls were limited in scope. Massive business failures and accounting frauds in companies such as Enron and WorldCom eroded investors' confidence due to the lack of adequate internal controls. As a reaction to these corporate scandals, the SOX Act of 2002 was enacted on July 30, 2002 to provide enhanced and more rigorous standards, and expanded the scope to all public companies.

Under the SOX Act of 2002 section 302, the executives of companies are required to certify in the periodic reports (10Qs and 10Ks) that they have reviewed the report and the effectiveness of the internal control systems, and they have identified material changes in internal controls (Beneish et al., 2008). Under the SOX Act of 2002 section 404, all accelerated filers (companies with market capitalizations of $75 million or more) are mandated to disclose their internal control problems. Management is required to provide an internal control report and to assess the effectiveness of their internal control structure and procedures over financial reporting that is attested to by the firm's public accountants. In addition to the assessment made by the management, the auditors of the firms are required to provide a report expressing their opinion on the assessment made by the management (Shan & Troshani, 2014).

A MW is the most severe ICD. Examples of MWs include inconsistent application of accounting policies and lack of adequately staffed accounting departments. ITMWs are the IT-related problems in the internal control process. For example, a company has ITMWs if its accounting software does not prevent erroneous or unauthorized changes; and/or its ERP system contains programming errors.

Effective internal controls over information systems have been recognized as an integral part of reliable financial reporting by managers, regulators, and auditors in today's computer-intensive world. IT controls are considered key components of internal controls (Carter et al., 2012). Public Company Accounting Oversight Board (PCAOB) Auditing Standard No. 5 (2007) discusses the relationship of IT and ICOFR and emphasizes the importance of implementing IT controls and testing their design and operational effectiveness (PCAOB, 2007). Companies are mandated to report significant ITMWs by following the SOX requirements and PCAOB auditing standards (Grant et al., 2008). The auditors

are required to assess the extent of IT involvement in the period-end financial reporting process. The identification of risks and controls within IT is an integral part of the top-down approach used to identify significant accounts and disclosures and their relevant assertions (PCAOB, 2007).

3. LITERATURE REVIEW

3.1. General Internal Control MWs and ITMWs

In the accounting and economics areas, a number of studies have dealt with the determinants of general MWs under SOX 302 and 404 Act (Ashbaugh-Skaife et al., 2007; Doyle et al., 2007; Ge & McVay, 2005; Rice & Weber, 2012). Ge and McVay (2005) found that firms with internal control problems are smaller, more complex and less profitable than the firms without ICDs disclosure. Furthermore, Ge and McVay (2005) reported that 2.8 percent of technology issues are reflected in the 493 material weakness disclosures, such as access controls and documentation issues. Doyle et al. (2007) investigated the determinants of internal control MWs over financial reporting and verified the results reported by Ge and McVay (2005). Doyle et al. (2007) added more characteristics, such as growth, undergoing restructuring, and corporate governance. They found that organizations reporting internal control MWs are younger, growing fast, or undergoing restructuring. In addition, Ashbaugh-Skaife et al. (2007) found organizations disclosing internal control MWs have less resources invested in internal controls, greater accounting risk exposure, more recent organizational structure changes, and more complicated operations.

Research on ITMWs and the quality of IT internal controls is limited and still at its early stage. A few recent studies have examined IT controls and ITMWs from different perspectives (Grant et al., 2008; Klamm & Watson, 2009; Li et al., 2007; Li et al., 2012; Stoel & Muhanna, 2011). Weill (2004) indicated that better IT controls can bring firms stock-market premiums (Weill, 2004; Weill & Ross, 2004). Grant et al. (2008) examined the impact of IT controls on the financial reporting process, focusing on accounting errors, and concluded that accounting errors occur more often in firms with ITMWs. From the IT governance perspective, Li et al. (2007) examined the governance influences on IT controls, and suggested that companies with more IT-experienced senior managers, with CIO positions or longer tenured CIOs and with higher percentage of independent board directors are less likely to have ITMWs. The findings in Li's study also partially indicated that more IT-experienced audit committee members are linked to few ITMWs. In addition, their results suggested that governance play significant roles in IT control quality. Klamm and Watson (2009) investigated IT and non-IT internal controls in relation to the five components of Committee of Sponsoring Organization's Internal Control-Integrated Framework (COSO 1992), and suggested the negative impact of weak IT controls on control environment, risk assessment, and monitoring. Stoel and Muhanna (2011) examined the performance impact of ITMWs through accounting earnings and stock market valuation, and found that firms with ITMWs have lower accounting earnings. They also provided evidence that ITMWs moderate the association between accounting earnings and market valuation. Li et al. (2012) studied the consequences of ITMWs through forecast accuracy of information quality, and found evidence that management forecasts are less accurate for firms with ITMWs.

Our study is different from the previous studies in two ways. First, we integrate both firm characteristics and IT governance in order to better understand the antecedents of ITMWs using firms' SOX 404 report data. To the best of our knowledge, there is no research that has examined both firm characteristics and IT governance's influences on firms' ITMWs disclosure at the same time. The second distinction is that we propose a new measurement called ITGOV, which comprehensively assesses firms' IT governance effectiveness based on the secondary data.

From the firm characteristics perspective, we follow the literature on the determinants of general ICDs (Ashbaugh-Skaife et al., 2007; Doyle et al., 2007; Rice & Weber, 2012) to identify relevant firm level characteristics associated with ITMWs. According to Ashbaugh-Skaife et al. (2007), eight

firm level characteristics are identified as antecedents of ICDs. We hypothesize that they are also the influential risk factors of ITMWs. From the IT governance perspective, we create the ITGOV-score, a composite IT governance measure, based on eleven factors according to the corporate governance matrix proposed by Brown and Caylor (2006). We discuss our new IT governance measure in detail in the following subsection.

3.2. IT Governance

IT governance is defined as "the organizational capacity exercised by the Board, executive management and IT management to control the formulation and implementation of IT strategy and in this way, ensure the fusion of business and IT" (De Haes & Grembergen, 2004, 2005, p. 1; Jewer & McKay, 2012). IT governance deals primarily with the connection between an organization's strategic objectives and IT management.

Nowadays, effective IT governance is a key success factor in the implementation and benefits realization of organizations' IT investments. IT governance literature has emphasized the responsibilities and the important role of senior management leadership in IT governance (Dahlberg & Kivijärvi, 2006; Lee et al., 2013). The ultimate goal of IT governance is to achieve strategic alignment between IT and the firms' overall business to ensure that IT investments are delivering value for the business, and reduce the risks associated with IT (De Haes & Grembergen, 2005; Hall, 2011; Vessey & Ward, 2013; Wilkin, 2012). The board briefing on IT governance highlights that top management is beginning to realize the important impact of IT on the enterprise's success (ITGI, 2003). Since the impact of IT on the success of the organization relies largely on the operation of IT and the leverage of IT business value, executives and boards need to expand governance to IT and provide necessary leadership, structures and processes to ensure that the firm's IT sustains its strategies and objectives (ITGI, 2003; Jewer & McKay, 2012; Lee et al., 2013; Wilkin, 2012). Effective IT governance is the way that executive management interacts and communicates with IT leaders to ensure that the investments in IT enable the business strategy achievement in an effective and efficient manner (Rau, 2004). The broad involvement of board of directors and executive management increases the likelihood that IT decisions will be in compliance with user needs, organization policies, and internal control requirements under SOX (Hall, 2011). Therefore, we believe that firms with effective IT governance are more likely to mitigate ITMWs because of more effective IT controls that are in place due to the governance structures and processes. There is some research that studies the impact of governance on IT control quality, and the impact of IT governance on firm performance (Boritz & Lim, 2008; Jewer & McKay, 2012; Li et al., 2007).

De Haes and Grembergen (2004, 2005) described IT governance and its mechanisms, and indicated that IT governance can be deployed using a mixture of various structures, processes and relational mechanisms. They used survey and case study methods and quantified IT governance based on subjective perceptions from managers. In our study, we use objective data collected from financial statements that are publicly available to assess the effectiveness of IT governance. Li et al. (2007) examined the influence of senior management, the board of directors, and audit committee regarding IT control governance, and provided evidence on the effects of governance on IT control quality (Li et al., 2007, p. 226). In their paper, they measured the IT control governance as a function of CEO or CFO with IT experience, with CIO position, longer tenured CIO, other senior management with IT experience, percentages of independent directors, and audit committee member with IT experience. They looked at the direct effects of various individual indicators of IT controls. Boritz and Lim (2008) measured the IT governance effectiveness as a function of the IT knowledge of top company executives and board members, the tenure of CIO and the presence of an IT strategy committee. They looked at top management's IT background, board members' IT background, the length of the CIO's tenure and the presence of an IT strategy committee for the measurement of IT governance.

After reviewing previous literature about IT governance measures, this study seeks to develop and operationalize a comprehensive measure of IT governance based on public available secondary data.

Using this newly proposed measure, we empirically explore the impact of IT governance on ITMWs. Since IT governance is an integral part of corporate governance (Wilkin, 2012; Wilkin & Chenhall, 2010), the methodology of corporate governance measurement can be extended and applied to IT governance area. We therefore construct the measure of IT governance based on the methodology suggested in the corporate governance literature (Brown & Caylor, 2006). Based on corporate governance literature and IT leadership research (Amstrong & Sambamurthy 1999; Bassellier et al. 2003; Brown & Caylor 2006; Daily & Dalton 1993), we add additional indicators to those developed by Li et al. (2007), Lim et al. (2013) and Boritz and Lim (2008). Also, in a manner that is different from prior research, which examined the direct effects of each indicator, we summarize all indicators into one composite index to measure the overall impacts of IT governance.

We develop the IT governance matrix and calculate ITGOV-score based on corporate governance literature (Brown & Caylor 2006). In the corporate governance literature, Gov-Score is created as a summary governance measure based on 51 firm-specific provisions encompassing eight categories (audit, board of directors, charter/bylaws, director education, executive and director compensation, ownership, progressive practices, and state of incorporation). Since this study focuses on IT, we use the IT-related items from corporate governance and integrate them with additional indicators suggested by IT leadership literature. Similar to the measurement of corporate governance, we construct ITGOV-score as a summary IT governance measure. ITGOV-score incorporates eleven factors encompassing three categories. They are oversight, leadership IT background and IT leadership importance. The categories are proposed based on the definition of IT governance and prior literature (De Haes & Grembergen, 2004, 2005; Jewer & McKay, 2012). Oversight factors are included in our measurement, because the board effectiveness in its monitoring function is determined by its independence, size, and composition (insider and outsider) (John & Senbet, 1998), and the oversight function controls the formulation and implementation of the IT strategy. Leadership IT background indicates the extent of IT experience and knowledge of the executives, board of directors and audit committees. IT leadership importance indicates the importance of IT in the firms' overall management. Leadership IT background and IT leadership importance are incorporated since they are the driving force for effective and efficient IT governance that help ensure the fusion of business and IT. The eleven factors are identified from prior literature (Bassellier et al., 2003; Li et al., 2007), and they are Big4, independent directors on the board, CEO or CFO with IT experience, top management (TMT) with IT experience, board of directors with IT experience, audit committees with IT experience, CIO position, CIO tenured year, CIO compensation, CIO-TMT pay gap, and IT strategy committee. Table 1 provides the complete list of the eleven factors under each category. Table 1 also indicates that our measure of IT governance is more comprehensive than prior studies.

The coding of each factor is as follows. Big4 are the four largest international services networks including Delloitte, Ernst & Young, PricewaterhouseCoopers and KPMG. We code Big4 as 1 if a firm uses external auditors from the Big4 companies and 0 otherwise. IT strategy committee should ensure that IT governance is adequately addressed in order to provide advice on strategic direction (ISACA), and it is coded as 1 if a company has IT strategy committee and 0 otherwise. IT-related experience is derived from U.S. SEC-filed proxy statements, which require firms to disclose each director's biographical information including name, title, and experience (Lim et al., 2013; Klein, 2002). In the proxy statements, we treat IT-related degrees (CS, CIS, software engineering, and electronical engineering), or work experience in IT as indicating IT experience. This treatment applies to 4 items (CEO or CFO, Top management, Board of directors, and audit committees with IT experience. The factor of CEO or CFO with IT experience is coded as 1 if the CEO or CFO has IT-related experience and 0 otherwise. we code factors of top management with IT experience, audit committee with IT experience, directors with IT experience, independent directors on the board and CIO-TMT pay gap as a ratio between 0 and 1; we code CIO tenure year and CIO compensation as Decile rank of real number, then divide by 10 to get the ratio between 0 and 1. Table 2 provides the detail coding description of each factor. Since all eleven factors are coded as a number between 0 and

1, we then summarize them to get the composite ITGOV-Score, which is the same approach as the Gov-Score calculated in the finance literature. As explained in the previous paragraphs, we identify additional indicators to quantify IT governance. In addition, we measure IT governance based on more objective secondary data. Our measurement of IT governance is broader in scope, and hence is an improvement over previous measures. Table 1 below highlights the difference between our research and two closely related studies, and also provides theoretical support for all of our indicators.

4. HYPOTHESES DEVELOPMENT

Ashbaugh-Skaife et al. (2007) have proposed a model to investigate the antecedents of ICDs from the firm characteristics perspective. We believe that these firm characteristics also affect ITMWs as well

Table 1. The Proposed Construct of IT Governance

Indicators	Li et al. (2007) Lim et al. (2013)	Boritz and Lim (2008)	Our study	Additional Research Support
Oversight				
Big 4			✓	Chen et al. (2014); Li et al. (2007); Li et al. (2012)
Independent directors on the board	✓		✓	Daily and Dalton (1993); Li et al. (2007); Lim et al. (2013)
Leadership IT background				
CEO, CFO has IT experience	✓		✓	Amstrong & Sambamurthy (1999); Li et al. (2007); Lim et al. (2013)
TOP management with IT experience	✓	✓	✓	Amstrong & Sambamurthy (1999); Bassellier et al. (2001); Bassellier et al. (2003); Boritz and Lim (2008); Li et al. (2007); Lim et al. (2013)
Board of directors with IT experience		✓	✓	Boritz and Lim (2008)
Audit committees with IT experience	✓		✓	Li et al. (2007); Lim et al. (2013)
IT leadership importance				
CIO position	✓		✓	Amstrong & Sambamurthy (1999); Bassellier et al. (2003); Chatterjee et al. (2001); Li et al. (2007); Lim et al. (2013)
CIO year	✓	✓	✓	Boritz and Lim (2008); Li et al. (2007); Lim et al. (2013)
CIO compensation			✓	Kwon et al. (2013); Yayla and Hu (2008)
CIO-TMT pay gap			✓	Kwon et al. (2013); Yayla and Hu (2008)
IT strategy committee		✓	✓	Boritz and Lim (2008)

since ITMWs are one special category of general ICDs. Therefore, we adopt this integrated model in our study. In addition, we believe that IT governance may play an important role in managing ITMWs. Therefore, we add IT governance as an additional antecedent of ITMWs in our model.

4.1. Firm Characteristics and ITMWs

Based on Ashbaugh-Skaife et al.'s model (2007), the firm level factors can be categorized into four groups: financial health, operational complexity, accounting measurement application risk, and organizational structure changes. In this subsection, we discuss factors in each group respectively.

Prior research has found that firms with few financial resources, or financially weaker ones, may not be able to invest money and/or time in proper controls. Investments in internal controls and information systems will depend on a firm's financial resources and strategies (Chwelos et al., 2001; Doyle et al., 2007; Kivijärvi & Saarinen, 1995). Specifically, good IT internal controls require adequate financial investments in the IT infrastructure, IT applications, and other important IT resources. Therefore, we posit that there are more ITMWs in firms that perform poorly, or have higher financial distress risks since they are less likely to have adequate investments in information systems. These firms are also more likely to have staffing issues that result in ITMWs. For instance, they may not have adequate personnel to allow for segregation of duties. System development and maintenance should be segregated form IT operations. System development professionals should create systems for users, and have no involvement in data entry, running applications, managing the IT infrastructure, and other computer operations. Operations staff should run these systems and have no involvement in developing, writing, and maintaining programs (Hall, 2011). Firms with inadequate resources are more likely to lack personnel to ensure such segregation of duties. Consistent with previous literature (Ashbaugh-Skaife et al., 2007; Doyle et al., 2007; Henry et al., 2011), we use two measures: loss (LOSS) and financial distress risk (RZSCORE) as proxies for financial health (HEALTH). Financial health is poorer if a firm has highest loss and bankruptcy risk. LOSS is measured as a dummy variable. It is coded as 1 if the sum of income before extraordinary items in year t and year $t-1$ is less than zero and 0 otherwise (Doyle et al., 2007). Sum of income before extraordinary items represents firms' aggregate earnings. RZSCORE is measured as the Decile rank of Altman's z-score. The z-score is a formula for predicting the probability of bankruptcy proposed by Altman. Higher rank values indicate less bankruptcy risk (Altman, 1968; Ashbaugh-Skaife et al., 2007; Doyle et al., 2007). We expect a positive relationship on LOSS and a negative relationship on RZSCORE.

H1a: Firms with more losses are more likely to have ITMWs.
H1b: Firms with higher distress risk are more likely to have ITMWs.

Operational complexity increases if a firm has more geographic or business divisions (Doyle et al., 2007). As a firm operates in many business segments and diversified geographic segments, such as different industries and/or international markets, its transactions are more likely to be complicated, resulting in undetectable material misstatement of the financial reports. Therefore, there is a higher need for internal controls for the firms with more complex and diversified transactions or operations (Doyle et al., 2007; Lewis, 2004). We expect that there are more ITMWs for firms whose operations are more complex due to multiple product lines and business segments. Consistent with previous literature (Ashbaugh-Skaife et al., 2007; Doyle et al., 2007; Henry et al., 2011), two measures, business segments (SEGs) and foreign sales (FRNSALE), are used as proxies for firms' operational complexity. SEGs are measured as the number of business segments a firm operates (Compustat Segment file) in year t. FRNSALE is measured as a dummy variable. It is coded as 1 if a firm reports foreign sales in year t and 0 otherwise.

H2a: Firms with more diverse segments are more likely to have ITMWs.

H2b: Firms involved in foreign sales are more likely to have ITMWs.

We use two measures, the inventory level and the extent of rapid growth, to quantify a firm's accounting measurement application risks in applying generally accepted accounting principles (Kinney & McDaniel, 1989). A firm's high inventory level may lead to more value changes due to obsolescence (Henry et al., 2011). Firms with a higher level of inventory confront increased IT internal control risks related to the accurate recording and measurement of inventory (Ashbaugh-Skaife et al., 2007). The level of inventory (INVNTRY) is measured as inventory over total assets.

A rapidly growing firm may require more time to establish new procedures and set up IT infrastructures and applications. As a result, it may incur many IT internal control problems (Kinney & McDaniel, 1989; Stice, 1991). Moreover, rapidly growing firms are more likely to encounter personnel, processes, and technology issues with the expansion of the scope and complexity of their operations, leading to more deficiencies in IT internal controls. Rapid growth (GROWTH) is measured as average percent change in sales in previous three years.

H3a: Firms with a higher level of inventory are more likely to have ITMWs.
H3b: Firms undergoing more rapid growth are more likely to have ITMWs.

We assess the organizational structural change factor through two measures: mergers & acquisitions and restructurings. There is a unique need for internal controls for the specific operating environment of each firm (Doyle et al., 2007). The need for internal controls will change correspondingly with changes in a firm's external environment. In addition, firms going through the restructuring process often face departmental downsizing, experienced employee loss, and general disorder during and after the major re-engineering. These firms have to upgrade internal controls to keep pace with the new structures and procedures (Doyle et al., 2007). We believe that firms with insufficient IT employees, less familiarity with the new technologies and environment as well as more adjustments estimation, are more likely to have ITMWs. Restructuring (RSTRCHA) is measured as a dummy variable. It is coded as 1 if a firm has been involved in a restructuring in previous three years and 0 otherwise. Firms engaging in mergers and acquisitions confront significant IT internal control difficulties when integrating their information systems, IT infrastructures, and IT applications with those of acquired firms. These firms are more likely to have IT internal controls problems. Mergers and acquisitions (MA) is measured as a dummy variable. It is coded as 1 if a firm has been involved in a merger or acquisition over the previous three years and 0 otherwise.

H4a: Firms undergoing restructuring are more likely to have ITMWs.
H4b: Firms engaging in mergers and acquisitions are more likely to have ITMWs.

4.2. IT Governance and ITMWs

According to the prior literature (Li et al., 2007; Masli et al., 2009), we expect IT governance to play an important role in ensuring the quality of a firm's IT internal controls. Effective IT governance over planning and the system development life cycle should result in more accurate and timely financial reporting (Masli et al., 2009).

We argue that firms with stronger oversight function are more likely to supervise top managers' behavior in IT implementation and controls. Specifically, the audit committee provides the oversight on the financial reporting process to ensure the quality of financial reporting. "Part of audit committee's role is to look for ways to identify risk. In general, it becomes an independent guardian of the entity's assets" (Hall, 2011, p. 5). Auditors are involved with systems development life cycle since auditors are experts in financial transactions and can provide significant input into the accounting information systems regarding controls, integrity, and timeliness (Hall, 2011). The involvement of auditors in

the system design regarding to auditability, security, and controls enable them to identify IT-related problems. Due to the reputation of Big4 accounting and auditing companies, they are more likely to train their auditors better. Therefore, auditors from the Big4 companies are more likely to effectively find out potential IT control risks due to their professional knowledge, practical experience, and training. Boards with more independent directors better execute board oversight.

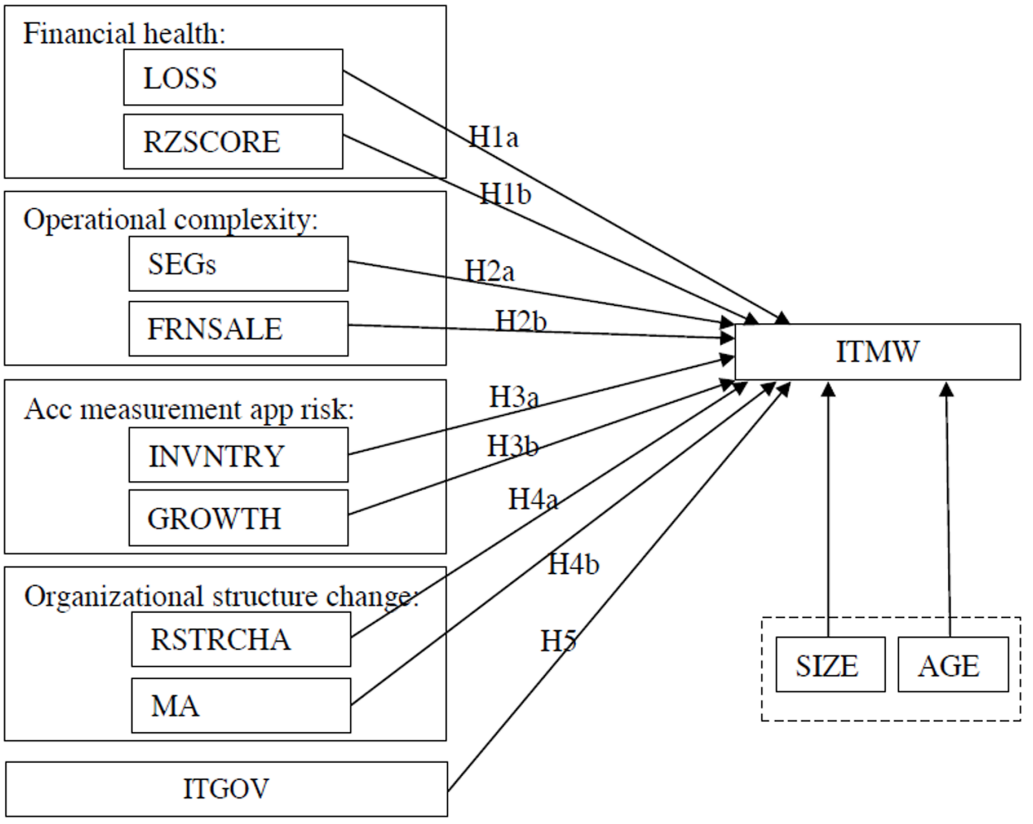
Bassellier et al. (2003) stated that the set of IT-related experience that executives possess enables them to exhibit IT leadership in their area of business. IT experience increases their understanding of IT, which in turn enables them to increase their ability to handle IT related issues. Senior managers, executives, board of directors and committee members are more likely to assume IT leadership when they have relevant experience and knowledge (Bassellier et al., 2003). We believe that leaders who have IT background are more likely to make sure that IT is appropriately managed and resourced. Leaders with IT knowledge and experience may respond to IT internal control weaknesses the company faces in a timely manner and remediate them appropriately. In addition, leaders' IT background will help increase the effectiveness and efficiency of digitalized business operations. Therefore, we expect that leadership with IT background can positively influence a company's IT operations and controls.

If IT leadership is considered important within a company (e.g. with a CIO position, with a longer tenured CIO, a CIO with higher level of compensation, having an IT strategy committee), the company is more likely to implement effective IT controls. If a company has a CIO or CTO position, it will have an executive who is accountable to manage IT and critical corporate information assets. The CIO or CTO with longer tenure is likely to better understand the company's operating systems and related IT issues based on their experience. Besides his/her involvement in a top management team, the IT executive's incentives also affect IT and business alignment. Earlier management theorists have proposed to monitor employees and control their behaviors through compensation (Dulebohn & Werling, 2007). Extensive studies have indicated that personal compensation has been recognized as an important motivation/inventive of top executives (Balkin et al., 2000; Carpenter & Sanders, 2004; Kwon et al., 2013; Yayla & Hu, 2008; Wang & Kaarst-Brown, 2014). Kwon et al. (2013) identified two types of compensation: behavior-based (i.e., salary) and outcome-based (i.e., bonuses, stock awards) compensation. They argued that IT executives prefer a behavior-based contract due to the uncertainties of IT, such as technological changes, economic climate, and government regulations. Their findings indicated that behavior-based compensation plays a more important role in motivating IT executives comparing to outcome-based compensation. Therefore, we argue that an IT executive's, such as a CIO's, behavior can be motivated through his/her compensation. A CIO with a higher level of compensation is more likely to have stronger motivation to engage in behaviors or actions towards enhancing the quality and effectiveness of IT controls. The CIO-TMT pay gap is viewed as a proxy of IT-business alignment (Yayla & Hu, 2008; Yayla & Hu, 2014). If the compensation gap between functional heads is low, this indicates that the strategic resource allocation is more balanced, and the IT and business strategies are better aligned (Carpenter & Wade, 2002; Kwon et al., 2013; Yayla & Hu, 2008). A low CIO-TMT pay gap suggests that CIO leadership is accepted to be part of top management. This, in turn, results in an improved IT governance and hence to lower ITMWs (Wilkin & Chenhall, 2010).

H5: Firms with more effective IT governance are less likely to have ITMWs.

In summary, ITMWs is the dependent variable in our model, which is coded as 1 if a firm discloses ITMWs in the SOX 404 report in year t, and 0 otherwise. The independent variables are nine antecedents including LOSS, RZSCORE, SEGs, FRNSALE, INVNTRY, GROWTH, RSTRCHA, MA and ITGOV. Figure 1 shows the research model.

Figure 1. The research model



4.3. Control Variables

In addition to variables identified in hypotheses, our model also controls for firm size and firm age based on prior studies (Ashbaugh-Skaife et al., 2007; Doyle et al., 2007; Ge & McVay, 2005). Larger firms have more resources to invest in internal controls and information systems, and are more likely to have qualified employees to ensure adequate segregation of duties in IT applications (Ashbaugh-Skaife et al., 2007; Doyle et al., 2007).

Research in general controls suggests that older firms are less likely to have internal control deficiencies due to their experiences (Doyle et al., 2007; Ge & McVay, 2005). However, information systems face rapid technological changes. Inflexible legacy IT systems result in rigid IT infrastructure and disabled agility in the face of unpredictable rapid changes (van Oosterhout et al., 2006). We expect that older firms are more likely to disclose ITMWs since older firms and firms with an older IS department appear to be less agile (Lu & Ramamurthy, 2011). Older firms are more likely to have legacy systems implemented over years. When older firms rely on legacy systems in financial transactions, reporting and other important processes, they may face more problems with rigid IT architectures. In addition, they may need to integrate multiple generations of systems and their IT personnel might not have current IT skills, leading to higher probability of ITMWs. Table 2 summarizes the definition and description of the variables used in this study.

Table 2. Definition of Variables

Variables	Observable measures	Definition and description
ITMWs		1 if the firm disclosed ITMWs in the SOX 404 report; 0 otherwise.
HEALTH	LOSS	Indicator Variable coded as 1 if the sum of income before extraordinary items (Compustat #18) in year t and year t-1 is less than zero; 0 otherwise.
	RZSCORE	Decile rank of Altman's (1980) z-score, where higher rank values indicate less distress risk.
COMPLEX	SEGs	The number of business segments the firm reported (Compustat Segment file) in year t.
	FRNSALE	Indicator variable coded as 1 if a firm reports foreign sales in year t (Non-zero value of Compustat #150); 0, otherwise
AMAR	INVNTRY	Inventory over total assets (Compustat #3/ #6).
	GROWTH	Average percent change in sales in previous three years (Percentage change in Compustat #12).
ORGSCNG	RSTRCHA	Indicator variable coded as 1 if a firm has been involved in a restructuring in previous three years (at least one of the following Compustat annual data items is not equal to 0: #376, #377, #378 or #379); 0, otherwise
	MA	Indicator variable coded as 1 if a firm has been involved in a merger or acquisition over the previous three years (Compustat AFTNT #1); 0 otherwise.
ITGOV	Big4	1 if auditor is a big four, 0 otherwise.
	INDBRD	Percentage of independent directors on the board.
	CEFOIT	1 if the CEO or CFO has IT-related experience; 0 otherwise.
	MGMTIT	Percentage of top management with IT-related experience.
	BRDIT	Percentage of Board of directors with IT-related experience.
	COMMIT	Percentage of audit committee members with IT-related experience.
	CITO	1 if company has CIO or CTO position; 0 otherwise.
	CITOYR	Number of years (s) he has been the position in the company.
	lnCIOCOMP	The natural log of the CIO salary and bonus in the year of disclosing ITMWs and/or the preceding year.
	CIOTMTCOMP	The ratio of the CIO salary and bonus to the average salary and bonus of the non-IT executive.
	ITSTRCOMT	1 if company has IT strategic committee; 0 otherwise.
Control variables	SIZE	Firm size: the natural logarithm of the total assets (Compustat #6) of the firm.
	AGE	Firm age: the log of the number of years the firm has CRSP data.

ITMWs = IT material weaknesses
HEALTH = Financial health
COMPLEX = Operations complexity
AMAR = Accounting measurement application risk
ORGSCNG = Organizational structure change
ITGOV = IT governance

5. RESEARCH METHODOLOGY

To validate our model, we collected data from multiple sources. We started with the Audit Analytics database (SOX 404 reports) to identify the initial sample of the firms that disclose their effectiveness of internal controls in their annual financial reports. We examined seven years data in this study from Jan 2005 to Dec 2011.We started our data collection from 2005 since SOX section 404 became effective for accelerated filers starting from November 15, 2004. Due to the availability and feasibility of data collection, we ended our data collection in year 2011, since the most recent financial data publicly available in Compustat Database were only until year 2011 before we finalized our study. We searched firms' SEC 10-K filings from the EDGAR database to identify whether they have MWs disclosure. If the company has MWs, we then determined whether the MWs are IT-related, including a MW of information systems, software errors, data or information systems security[3].

We use the example in the Appendix to illustrate how we coded the ITMWs variable in our study. A firm discloses that its internal control was not effective as of Dec 31, 2010 due to lack of segregation of duties. At this point, we had to identify if this firm has insufficient IT personnel, accounting personnel, or other personnel to determine whether this MW is IT-related or not. The data in 10-K item 91 directly states whether they have insufficient IT personnel or accounting personnel. If it has insufficient IT personnel, we coded it as a firm with ITMWs (1); otherwise, we coded it as a firm with non-ITMWs (0).

We retrieved all financial data from the annual Compustat database, such as firms' total assets, total liabilities, and total revenue. We obtained the business segment data from Compustat Segment files, and acquired firms' stock data from CRSP database. We collected the IT governance data from a combination of proxy statements, 10-K filings, firms' website, and Mergent online database.

Consistent with previous research, we selected the control firms by matching the industry code (SIC code) and size (total assets) during the year in which ITMWs were disclosed (Li et al., 2007; Purnanandam & Swaminathan, 2004). Since all firms reporting ITMWs also have general MWs, our control group consisted of firms with non-IT related MWs but with general MWs. Our final sample was 1,112 firms: 556 firms reporting ITMWs in the ICOFR matched with 556 firms with non-IT MWs. A logistic regression analysis was performed to predict ITMWs.

6. DATA ANALYSIS AND RESULTS

6.1. Univariate Analysis

Table 3 presents the industry distribution of the 556 firms with ITMWs. We categorize the industry as 13 industry groups, which are different from previous literature with 10 groups (Li et al., 2007). In our study, we divide the manufacturing group into diverse subgroups: food, textiles, chemical and refining, computers and electronics, and miscellaneous equipment industry. Since we study the ITMWs, we categorize IT-intensive manufacturing companies into a separate group. IT-intensive firms may make extensive use of IT, and are more likely to have ITMWs. We find that the sample firms with ITMWs cover 12 out of the 13 industry groups. The service industry contains the highest number of firms with ITMWs, followed by the manufacturing industry.

Table 4 provides descriptive statistics. The mean, standard deviation (std.dev), median, and significance are listed in Table 4. The descriptive statistics indicate that, compared to firms without ITMWs, the firms disclosing ITMWs have higher probability of loss, operate more business segments, are more likely to have foreign sales, have a higher level of inventory, undergo restructuring, and undergo mergers and acquisitions. These results are all consistent with prior studies. In addition, firms with stronger IT governance seem to be less likely to have ITMWs. With respect to control variables, firms with ITMWs appear to be older than the firms with effective IT internal controls.

Table 5 presents the correlations among the variables. Some variables are correlated with one another. However, the largest correlation is 0.410 between SEGs and SIZE, followed by -0.403 between

Table 3. ITMWs Reported by Industry Segments

2 digit SIC	Industry Segments	# of ITMW Firms	% of ITMW Firms
01-09	Agriculture, forestry, fishing, hunting and trapping	1.0	0.0
10-14	Mining	89.0	8.0
15-17	Construction	4.0	0.4
20-34	Manufacturing (Food, textiles, chemical, refining, rubber)	230.0	20.7
35-36	Manufacturing (Computers and Electronic)	196.0	17.6
37-39	Manufacturing (Miscellaneous equipment)	92.0	8.3
40-49	Transportation and Communication	88.0	7.9
50-51	Wholesale trade	38.0	3.4
52-59	Retail trade	38.0	3.4
60-67	Finance, insurance and real estate	34.0	3.1
70-89	Service industry	286.0	25.7
91-97	Public administration	0.0	0.0
99	Other	16.0	1.4
Total		1,112	100

LOSS and SIZE, 0.384 between RSTRCHA and SIZE, and 0.380 between RZSCORE and INVTRY. Most of the values of all other correlations are very small (below ± 0.3). Furthermore, the variance inflation factor (VIF) in the regression is less than 2, which indicates that the independent variables in the model have distinct features, and there are no multicollinearity problems in our regression.

6.2. Logistic Regression Analysis

A logistic regression analysis is performed to model the probability of reporting ITMWs over financial reporting as a function of eleven predictors that we discussed above. ITMW is a dependent variable. We transform GROWTH to be the decile rank of the average sales growth from year $t-2$ to year t (RGROWTH). We transform SEGs to the log of the number of business segments because of the documented skewness in its distribution.

Table 6 provides the results of the logistic regression analysis. A test of full model with all eleven predictors: nine independent variables and two control variables, against a constant-only model is statistically reliable with $\chi^2(11, N = 1112) = 46.27, p < 0.001$. It indicates that the predictors reliably distinguished between firms disclosing ITMWs and firms not disclosing ITMWs. Predicted success is adequate, with 59.7 percent of the ITMWs firms identified correctly, and an overall success rate of 57.4 percent. Table 6 displays the regression coefficients, Wald statistics, and statistical significance for each of the eleven predictors. According to the results, after controlling for the firm size and age, we find that the estimated coefficient of LOSS is positive (0.39) and significantly associated with ITMWs ($p<0.01$), which suggests that firms with loss are more likely to have ITMWs. Thus, H1a is supported. The estimated coefficient of RZSCORE is not significantly associated with ITMWs. Therefore, H1b is not supported. The results also indicate that firms involved in foreign sales (the coefficient is 0.224, $p=0.087$) as well as those engaged in merges and acquisitions (the coefficient is 0.378, $p<0.01$) are more likely to have ITMWs in the ICOFR, supporting our H2b and H4b. The coefficients of SEGs, INVTRY, and RGROWTH are not significantly associated with ITMWs, providing no support for H2a, H3a, and H3b. In addition, the coefficient of our newly developed

Table 4. Descriptive Statistics

	Mean	Std.dev	Median	N
LOSS: ITMWs sample Control Sample	0.646** 0.588	0.479 0.493	- -	556 556
ZSCORE: ITMWs sample Control Sample	 -0.293 -0.854	24.844 21.265	0.785 0.719	556 556
SEGs: ITMWs sample Control Sample	2.212** 2.011	1.668 1.606	1 1	556 556
FRNSALE: ITMWs sample Control sample	0.421** 0.360	0.494 0.480	- -	556 556
INVNTRY: ITMWs sample Control sample	0.102** 0.086	0.138 0.136	0.030 0.022	556 556
GROWTH: ITMWs sample Control sample	2.942 4.610	45.471 78.979	0.109 0.101	556 556
RSTRCHA: ITMWs sample Control sample	0.385 0.329	0.487 0.470	- -	556 556
MA: ITMWs sample Control sample	0.629*** 0.538	0.483 0.499	- -	556 556
ITGOV: ITMWs sample Control sample	2.950** 3.264	2.041 2.264	2.530 2.633	556 556
SIZE: ITMWs sample Control sample	4.098 3.926	2.886 2.915	4.565 4.588	556 556
AGE: ITMWs sample Control sample	18.963*** 16.054	16.342 13.937	15.500 13.000	556 556

Notes: ***, **, * indicates significant level at the 0.01, 0.05 or better, respectively based on t-statistics in means. P-values are two tailed. See Table 2 for variable definitions.

construct, ITGOV, is negative (-0.089) and significantly associated with ITMWs ($p<0.01$). Thus, H5 is supported. The findings empirically validate the importance of IT governance in reducing ITMWs.

Our results confirm some of the results reported from previous general internal controls studies (Ashbaugh-Skaife et al., 2007; Doyle et al., 2007; Ge & McVay, 2005), and also illustrate the difference between ITMWs and MWs. Our findings suggest that there is no significant difference with the business segments operations between ITMWs firms and control firms. This is an interesting and counter-intuitive result. One possible explanation is that firms might use firm-wide IT standards to replicate and roll out information systems in various industry segments. The common and recurrent use of IT related know-how might create economies of scope, thus operating in multiple segments might not lead to ITMWs. Our findings also indicate that there is no significant difference with the higher level of inventory between ITMWs firms and control firms. One plausible explanation is that information systems may help firms to accurately deal with the data and processes due to the

Table 5. Pearson Correlation Analysis

	LOSS	RZSCORE	SEGs	FRNSALE	INVNTRY	RGROW	RSTRCHA	MA	ITGOV	SIZE	AGE
LOSS											
RZSCORE	-.230**										
SEGs	-.182**	.204**									
FRNSALE	-.063*	.042	.099**								
INVNTRY	-.041	.380**	.060*	.085**							
RGROW	-.146**	.043	-.056*	.007	.022						
RSTRCHA	.008	.108**	.241**	.139**	-.017	-.160**					
MA	-.069*	.063*	.226**	.130**	-.156**	.118*	.203**				
ITGOV	-.119**	.051*	.083**	.081**	-.072*	.049	.266**	.134**			
SIZE	-.403**	.270**	.410**	.211**	.028	.128**	.384**	.290**	.388**		
AGE	-.138**	.066*	.233**	-.060*	.104**	-.133**	.080**	.000	-.056*	.114**	

Notes: **. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
a. Listwise N = 1,112

scalability and agility of the technology. In addition, our results suggest that there is no significant difference with the rapid growth and restructuring between ITMWs firms and control firms. One possible explanation is that rapid growing and restructuring firms may be more innovative to respond to technological changes. Overall, our results suggest that establishing appropriate IT internal controls allows firms to derive economies of scale and scope.

With respect to control variables, we find that older firms are more likely to have ITMWs, which is different from the previous study of general internal control weaknesses (Doyle et al., 2007; Ge & McVay, 2005). As we discussed before, older firms are more likely to use legacy systems, and their personnel may not be familiar with newer technologies.

7. DISCUSSION AND CONCLUSION

Companies are increasingly dependent on information technology for a wide variety of business processes. However, such dependence makes firms increasingly vulnerable to ITMWs. Despite the importance of ITMWs, the relationships between firm characteristics, IT governance, and ITMWs is under researched. This study draws upon and integrates multiple research streams including general MWs, IT governance, and ITMWs in order to better understand their interactions. Our findings confirm some of the results reported from the prior studies of general MWs (Ashbaugh-Skaife et al., 2007; Doyle et al., 2007; Ge & McVay, 2005). We thus find that firms that disclose ITMWs tend to have higher probabilities of loss, have foreign sales, and are more likely to engage in mergers and acquisitions. In addition, our results provide evidence that firms with stronger IT governance are less likely to disclose ITMWs. Our findings also illustrate the difference between ITMWs and MWs. In contrast to traditional MWs, for example, older firms are more likely to have ITMWs. While older firms are likely to have better processes for controlling general MWs, they are also more likely to have older information systems. Since all firms reporting ITMWs also have general MWs, our control group consists of firms without ITMWs but with general MWs. The findings illustrate the difference between ITMWs and general MWs in terms of age. This could be the reason for the complexity of managing legacy systems in a rapidly changing technology environment. Our results also indicate that the number of segments (SEGs), level of inventory (INVNTRY), rapid growth (RGROWTH), and restructuring (RSTRCHA) are not significantly associated with the existence of ITMWs. We believe these to be interesting results that highlight the value of IT internal controls to organizations. It is surely possible that, once appropriate internal controls are put in place, they allow firms to derive economies of scale as well as scope. Economies of scale may enable firms to leverage

Table 6. Logistic Regression Analysis

	Predicted sign	Coefficients	Wald	p-value
Intercept		-.861	10.385	.001
LOSS	+	.393	7.461	.006
RZSCORE	-	.006	.058	.809
SEGs	-	.191	.595	.440
FRNSALE	+	.224	2.938	.087
INVNTRY	+	.801	2.571	.109
RGROW	+	.016	.481	.488
RSTRCHA	+	.163	1.216	.270
MA	+	.378	7.795	.005
ITGOV	-	-.089	7.800	.005
SIZE	+	.017	.331	.565
AGE	+	.013	8.291	.004
ITMWs firms predicted correctly	59.7%			
Overall percentage to predict correctly	57.4%			
N	1112			

their information system expertise, IT platform, and installed networks when firms are involved in multiple segments, and/or are growing rapidly (Bakos, 1991). Economies of scope might enable firms' technological resources and expertise acquired during the development and operation of one system to be transferred to other systems when firms undergo restructuring (Bakos, 1991). In addition, IT has a direct effect on improving inventory management, which can help reduce inventory levels (Dehning & Richardson, 2002). For example, the increased adoption of ERP systems might result in significant inventory reduction (Dehning & Richardson, 2002; Harreld, 2001), and therefore, better manage larger quantities of inventory.

This study thus makes several contributions to the literatures on ITMWs and IT governance in several ways. First, this is one of the first attempts to examine both firm level characteristics and IT governance associated with ITMWs in ICOFR. In particular, this paper investigates how IT governance is related to ITMWs, while empirically validating the importance of IT governance in reducing ITMWs. Second, this study proposes and operationalizes a new construct, ITGOV, based on publically available secondary data. Third, it highlights the differences between general MWs and ITMWs, which are possibly enabled by scale and scope effects resulting from IT investments.

Further, this study identifies several practical implications for a firm's board structures and management. To begin, executives who better understand the antecedents of ITMWs could better manage SOX compliance. Studies such as ours thus could help executives better justify IT-related internal control measures. At the same time, regulators who better understand ITMWs based on studies such as ours could enact or update policies and standards to more effectively regulate organizations for which they are responsible. Second, our results indicate that stronger IT governance helps firms mitigate ITMWs. The comprehensive IT governance measure proposed in our research provides organizations with useful guidelines to build their IT governance and leadership. Finally, our findings also suggest that firms engaging in foreign sales, and/or undergoing merger and acquisition activity, are more likely to have ITMWs. Companies may thus wish to implement adaptive IT standards and

IT infrastructures throughout the organization that can more easily facilitate mergers and acquisitions, as well as coordinate multiple international segments.

A potential limitation of this study is created by the nature of the secondary data. It might thus be limited by the presence of unrecorded data, or constrained by the format of data reporting. In this study, we measure ITMW as a binary variable (0 vs. 1) instead of specific severity and/or the actual number of ITMWs. IT internal control for companies with more ITMWs (e.g., two or more) would be less effective compared to those with only one ITMW. However, it is not appropriate to measure ITMWs by simple counting since there is no standard for data disclosure. For example, firm A may disclose that it has inadequate restricted access to information systems, segregation of duties are not implemented in its systems, IT personnel access is not properly segregated, and there are logical access issues; while firm B might just say it has ITMWs due to lack of access controls. The four ITMWs disclosed in firm A are four categories of access controls. Hence, we cannot say firm A has more ITMWs than does firm B by simply counting the number of different types of ITMW reported. Further research could consider more fine-grained measures of ITMWs and explore the effects of IT governance and firm-level characteristics on the degree of ITMWs when the data reporting is standardized. Another limitation is that our data is based on seven years' data due to the availability and feasibility of the data collection process. While we have enough samples to run the data analysis for the seven years data, further research could consider collecting more data to confirm the results. Furthermore, some firms may make little use of IT while others may make extensive use of IT. This could impact their ITMWs disclosure. We control for the industry by matching the firms in the same industry when we run the analysis. Due to the data availability issue, we could not collect the detailed firm-level data for IT investments and IT usage. In addition, this study only focuses on the relationship between ITMWs and general MWs. Since all firms disclosing ITMWs also had general MWs, we choose the control groups as those with general control MWs but not ITMWs. Future research could consider to compare those two groups of firms with those without any MWs.

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ENDNOTES

[1] The SOX Section 404(a) eventually applies to all companies that file Exchange Act period reports regardless of their size. However, during the study sample period, only the U.S. domestic accelerated filers (i.e. with a market capitalization greater than $75 million) were required to file a management report on internal controls over financial reporting beginning in fiscal years ending on, or after, November 15, 2004. The SEC allows smaller companies (i.e., with a market cap less than $75 million) to wait to comply with the provisions of Section 404(a) until their fiscal years ended on, or after, December 15, 2007.

[2] On July 25, 2007, the SEC approved AS No. 5, which replaced the Public Company Accounting Oversight Board's (PCAOB) previous internal controls auditing standard, AS No. 2.

[3] Please refer to sample data section for more examples of IT-related material weaknesses.

APPENDIX

Table 7 summarizes examples and categories of ITMWs reported in 10-K filings based on the prior literature (Masli et al., 2009). For example, management's assessment of ICOFR was conducted using the criteria set forth in *Internal Control—Integrated Framework* issued by the COSO of the Treadway Commission. Based on the assessment as of July 31, 2011, "CONOLOG CORP's (CIK: 0000023503) internal controls over financial reporting were not effective due to the following material weaknesses: (1) The Company lacks adequate segregation of duties control concerning Information Technology ("IT"); (2) IT personnel perform accounting transactions, programming function, and controls security function with the Company for IT; (3) The Company lacks appropriate environmental controls needed to ensure the security and reliability of IT equipment".
Chang-On International, Inc (CIK: 0000042136) conducted an evaluation of the effectiveness of our ICOFR as of December 31, 2011 using the criteria established in Internal Control—Integrated Framework issued by the COSO of the Treadway Commission. Based on the assessment as of December 31, 2011, there were control deficiencies as described below: "We did not implement appropriate information technology controls – As of December 31, 2011, we retain copies of all financial data and material agreements; however, there is no formal procedure or evidence of normal backup of our data or off-site storage of the data in the event of theft, misplacement or loss due to unmitigated factors".

Table 7. Examples of ITMWs

IT Categories	ITMWs Reported in SOX 404
Access Controls	• Inadequate restricted access to systems • Segregation of duties not implemented in system • IT personnel access not properly segregated • Logical access issues
Enterprise Architecture	• Inadequate information systems to support business processes • Absence of general IT policies and procedures documented • Deficiencies related to IT control design and operating effectiveness weaknesses • Lacks appropriate environmental controls
General IS/IT Controls	• Lack of controls over spreadsheet • Lack of IS/IT controls • Lack of IS/IT controls across subsidiaries
IT Capability	• Lack of understanding of key system configuration • Inadequate IS/IT support staff • Insufficient training on system • Lack of systems and accounting software
Security and Recovery	• Insufficient disaster recovery plans or back up of systems • Inadequate security • There is no IT security policy
Application Controls	• The Company did not maintain effective controls over end user computing applications, such as spreadsheets • Ineffective controls and procedures related to certain IT applications and general computer controls • Did not maintain effective controls related to IT applications and infrastructure • Lack of application controls
Application Development	• The company's ERP system contained programming errors • Limited ERP systems • Limited IT application functionality • Inadequate program/data change controls • Program change management • Program development

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