ESSAYS ON INFORMATION TECHNOLOGY GOVERNANCE: MEASUREMENT AND IMPACTS

by

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A dissertation submitted to the faculty of
The University of North Carolina at Charlotte
in partial fulfillment of the requirements
for the degree of Doctor of Philosophy in
Computing and Information Systems

Charlotte

2014

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ABSTRACT

PEIQIN ZHANG. Essays on IT governance: measurement and impacts. (Under the direction of DR. RAM KUMAR and DR. KEXIN ZHAO)

Information Technology (IT) governance, 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 and Grembergen 2004, 2005), is an important issue in the information system field. To better understand the role of IT governance in business operations, this dissertation proposes a comprehensive measure of IT governance based on corporate governance literature and IT leadership research. Using this newly proposed measure, we are able to empirically explore its impact on IT material weaknesses (ITMWs), IT capability, and firm performance. The dissertation consists of two studies. Study 1 aims to examine the impacts of firm-level characteristics and IT governance on ITMWs according to the integrated model from general internal control research. Under the Sarbanes-Oxley (SOX) 404, all accelerated filers (companies with market capitalizations of $75 million or more) are mandated to disclose their internal control material weaknesses (MWs). If the MWs are IT related, we refer to them as ITMWs. Study 1 sheds light on whether effective IT governance helps to reduce ITMWs. Study 2 studies the effect of IT governance on IT business value based on the Resource-Based View (RBV) theory. In particular, study 2 investigates how IT governance and IT capability help to achieve firms' competitive advantage measured by both market value measure and sustainable accounting performance. The impact of IT governance on IT capability is also examined. The dissertation is useful from

research as well as managerial perspectives. It represents an important contribution to research in both Accounting Information Systems (AIS) and Management Information Systems (MIS).

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to my dissertation advisors, Dr. Ram Kumar and Dr. Kexin Zhao, for their continuous support and excellent guidance through my dissertation. I am fortunate to be taken as a student of them. It was them who gave me great support, encouragement, inspiration and understanding during my research. Without their instructive comments and intellectual inputs at every stage of my dissertation process, I would not complete my doctoral dissertation. I would also like to thank all my dissertation committee members, Dr. Sungjune Park, Dr. Xiuli He and Dr. Mohammad A. Kazemi, for their precious advice, support and insights.

In addition to my dissertation committee, I am thankful to faculty members at the Department of Business Information Systems and Operations Management who worked with me and educated me at various stages during the program.

I would like to thank all my dear family members and friends for their love and support. Special thanks to Dr. Keejae Hong and Dr. Anderson Robert for their continuous encouragement, motivation, support and help.

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CHAPTER 1: INTRODUCTION

1.1. Motivation

IT governance, 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 and Grembergen 2004, 2005), is an important issue in the IS field. The definition of IT governance from the IT Governance Institute (ITGI) also indicates that IT governance is an integral part of enterprise governance and consists of the leadership and organizational structures and processes that ensure that the organization's IT sustains and extends the organization's strategy and objectives (ITGI 2001).

Nowadays, IT governance is on the agenda of many organizations. The ultimate goal of IT governance is to achieve strategic alignment between IT and the firms' overall business to ensure that IT investment is delivering value for the business (De Haes and Grembergen 2005). There is some research on the impact of the internal and external governance on IT control quality, and the impact of IT governance on firm performance (Li et al. 2007; Boritz and Lim working paper). However, there is limited research on a comprehensive measure of IT governance and its impacts.

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. But they used survey and case study to get the data for the measurement of IT governance mechanisms. 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 internal and external governance on IT control quality (Li et al. 2007, pp.226). In their paper, they measure the IT control governance as 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 these indicators on IT controls. Boritz and Lim (working paper) measure 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 only looked at top management 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 dissertation seeks to develop a new construct called ITGOV-score 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 IT material weaknesses (ITMWs), IT capability, and the firms' market performance and sustainable accounting performance.

The dissertation is expected to be useful from the research as well as managerial perspectives. From a research perspective, this is an early attempt to propose and operationalize a new construct ITGOV with a comprehensive measure, and examine its

impacts. It represents an important contribution to research in both Accounting Information Systems (AIS) and Management Information Systems (MIS). From the managerial perspective, firms' management may use our measure and results to build an efficient IT governance committee, and effectively integrate IT resources with organizations' other resources to realize business value of IT.

1.2. Operationalization of IT Governance Construct

Based on corporate governance literature and IT leadership research (Brown and Caylor 2006; Amstrong and Sambamurthy 1999; Bassellier et al. 2003; Daily and Dalton 1993), we develop more indicators in our measurement in addition to the indicators developed by Li et al. (2007), Lim et al. (2013) and Boritz and Lim (working paper). Different from Li and Lim et al.'s and Boritz & Lim's paper, which examined the direct effects of each indicator, we categorize the indicators in our study into three groups (oversight, leadership IT background and IT leadership importance) based on corporate governance literature (Brown and Caylor 2006). This construct is related to the definition of IT governance. Leadership IT background and IT leadership importance are important factors since they are driving force for effective and efficient IT governance that help to ensure the fusion of business and IT. The reason we include oversight factors in our measurement is because the board effectiveness in its monitoring function is determined by its independence, size, and composition (insider and outsider) (John and Senbet 1998), and the oversight function helps to control the formulation and implementation of IT strategy.

We develop the IT governance matrix and calculate ITGOV-score based on corporate governance literature (Brown and Caylor 2006). In the corporate governance

literature, Gov-score is created as a summary governance measure based on 51 firm-specific provisions representing both internal and external governance. Similarly, we construct ITGOV-score as a summary IT governance measure based on 11 factors encompassing three categories representing both internal and external IT governance. Therefore, our measurement of IT governance is broader in scope, and is an improvement from the previous measure. The proposed construct is summarized in Table 1.

Table 1: The proposed construct of IT governance

Indicators	Li et al. (2007) Lim et al. (2013)	Boritz and Lim (working paper)	My dissertation
Oversight			
Big 4			✓
Independent board of directors	✓		✓
Leadership IT background			
CEO, CFO has IT experience	✓		✓
TOP management with IT experience	✓	✓	✓
Board of directors with IT experience		✓	✓
Audit committees with IT experience	✓		✓
IT leadership importance			
CIO position	✓		✓
CIO year	✓	✓	✓
CIO compensation			✓
CIO-TMT pay gap			✓
IT strategy committee		✓	✓

1.3. Research Objectives and Research Questions

The dissertation consists of two studies, described briefly below.

Study 1 focuses on the impacts of firm-level characteristics and IT governance on ITMWs according to the integrated model from general internal control research (Ashbaugh-Skaife et al. 2007; Doyle et al. 2007; Ge and McVay 2005). With the prevalence of IT in today's business environment, many organizations have put the development of an effective and efficient IT in the front of their overall IT

management. IT plays a critical role and continues to grow in importance for operational and strategic information systems of an organization in the 21st century. Global IT spending rose by eight percent, to more than $1.5 trillion year-over-year in 2010, the best growth in the IT sector since 2007 (IT black book by IDC report). IT brings us a fast, convenient and efficient environment and also provides a competitive advantage for the organizations. Nowadays, many organizations' financial processes and transactions are driven by information systems. However, with the economic improvement of IT and widespread reliance on IT for operational and financial management systems, organizations are confronting greater challenges to provide accurate, reliable, integrate, and timely information, and IT controls have long been recognized as necessary and important for organizations (ITGI 2006, pp22). In the operations process, there exist IT-related internal control problems and risks, such as IT security, access control and software errors, etc. Therefore, it is important for auditors, managers, regulators, and investors to understand ITMWs. Understanding of ITMWs by managers can help them take proper actions to remediate ITMWs in a timely manner. Understanding of ITMWs by regulators helps them enact or update policies to regulate the companies to provide the assurance of reliability and integrity of financial reporting and instills investors' confidence on the financial reporting. Understanding of ITMWs by investors helps them make their investment decisions carefully. A body of recent research has studied the role of general MWs in ensuring the integrity and reliability of firms' financial reporting, and instilling investors' confidence (Ge & McVay 2005; Doyle et al. 2007; Ashbaugh-Skaife et al. 2007). A few studies have examined the role of internal and external governance on ITMWs

(Lim et al. 2007). However, a gap exists to study the antecedents of ITMWs at both the firm level and IT governance level. There is very limited understanding of the role of IT governance in reducing ITMWs. To fill this gap, we intend to answer the following research question in study 1: *How are the firm level characteristics and IT governance associated with ITMWs?*

Study 2 intends to look at the role of IT governance on IT business value based on Resource-Based View (RBV) theory. In particular, study 2 investigates how IT governance and IT capability help to achieve firms' competitive advantage using both a market value measure and a sustainable accounting performance measure, and how IT governance affects IT capability superiority. Despite substantial research on IT capability and firm performance (Bharadwaj 2000; Santahanam et al. 2003; Wang et al. 2007; Muhanna et al. 2010), there is no research to investigate the impact of IT governance on IT capability, and to simultaneously examine the impacts of IT governance and IT capability on firm performance. To fill this gap, we intend to answer the following research questions in study 2:

(a). How is IT governance related to IT capability?

(b). How are IT governance and IT capability simultaneously associated with firm performance?

1.4. Organization of the Dissertation

The dissertation is organized as follows: Chapter 2 presents study 1. Chapter 3 demonstrates the research model, methodology, findings and expected contributions of study 2. Chapter 4 provides the summary of this dissertation and discusses some future work.

CHAPTER 2: THE IMPACTS OF FIRM CHARACTERISTICS AND IT GOVERNANCE ON IT CONTROL MATERIAL WEAKNESSES

2.1. Introduction

In this chapter, we examine the impacts of both firm characteristics and IT governance on ITMWs in internal control over financial reporting (ICOFR). Under Sarbanes-Oxley (SOX) 404, all accelerated filers (companies with market capitalizations of $75 million or more) are mandated to disclose their internal control problems. Material weakness (MW), which is the most severe internal control deficiency, is defined by Auditing Standard (AS) No. 5[1] 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). If the MWs are IT related, we refer to them as ITMWs.

ICOFR is designed to provide reasonable assurance regarding the reliability of financial reporting to instill investors' confidence. High quality and effective internal controls are necessary to ensure the reliability and integrity of companies' financial reporting for stakeholders and investors. Nowadays, firms' business and financial transactions and processes are driven by information systems. Effective internal controls over information systems are therefore necessary. If companies disclose at

[1] On July 25, 2007, the US SEC approved AS No. 5, which replaced the PCAOB's previous internal control auditing standard, AS No. 2.

least one ITMW, their IT controls are considered ineffective and of lower quality. If companies do not disclose any ITMWs, IT controls are considered effective and of high quality (Li et al. 2007). Common types of ITMWs in SOX 404 reports include deficiencies in IT environment, computer operations, accounting software, security and access control, data backup and disaster recovery.

IT plays a critical role and continues to grow in importance for organizations in the 21st century. Global IT spending rose by eight percent, to more than $1.5 trillion in 2010 (IDC report). Nowadays, with the prevalence of IT and Internet-based transactions, firms' financial reporting processes are driven by information systems. Such systems are deeply embedded in initiating, authorizing, modification, recording, processing, retrieving and reporting of financial data and transactions. Therefore, "they 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, pp19).

A number of recent studies have examined the MWs to ensure the integrity and reliability of firms' financial reporting (Ge & McVay 2005; Doyle et al. 2007; Ashbaugh-Skaife et al. 2007). Since many organizational processes and financial transactions are driven by information systems, IT-related internal control problems and risks are common in the internal control processes. For example, companies have installed accounting software that does not prevent erroneous or unauthorized changes to previous reporting periods and does not provide an adequate audit trail of entries made in the accounting software. Both auditors and management need to understand

the impact of factors associated with presence and absence of IT internal control problems. Therefore, we are motivated to study ITMWs.

According to previous research (Grant et al., 2008; Li et al., 2007), a gap exists to study the antecedents of ITMWs at both firm characteristics and IT governance. Ge & McVay (2005), Doyle et al. (2007) and Ashbaugh-Skaife et al. (2007) studied the antecedents of internal control deficiencies (ICDs) based on firm characteristics. Weill (2004) indicated that excellent IT governance can bring firms stock-market premiums. Grant et al. (2008) examined the relationship between IT internal control deficiencies and accounting errors, which they found to be positively related. Li et al. (2007) examined the effects of internal and external governance on ITMWs, and found that firms with more IT-experienced senior managers, with CIO positions or longer tenured CIO and with higher percentages of independent board of 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 less ITMWs. In addition, their results suggested that internal and external governance play significant roles in IT control quality. However, no available analysis exists to examine the antecedents of ITMWs based on both firm characteristics and IT governance. To fill this gap, we intend to answer the following research question in this study: *How are the firm characteristics and IT governance associated with ITMWs?* We believe that a better understanding of firm characteristics and IT governance factors associated with ITMWs disclosure can benefit both researchers and practitioners. Understanding of ITMWs by executives could help them take proper actions to remediate ITMWs. Understanding of ITMWs by regulators could help them enact or update policies and

standards to regulate the organizations. It could also provide the assurance of reliability and integrity of financial reporting and help instill investors' confidence of financial reporting. Understanding of ITMWs by investors can help them make better investment decisions. Our contribution made in this study is in two-fold. First, we examine the impacts of both firm characteristics and IT governance on ITMWs. Second, we propose a new construct called ITGOV, and create a new way to objectively quantify firms' IT governance based on secondary data.

The remained of study 1 is structured as follows. Section 2.2 introduces the background of SOX 404, internal control, IT internal control and IT governance. Section 2.3 provides a literature review. Section 2.4 introduces the theoretical background and develops the hypotheses. Section 2.5 describes the definition of variables and constructs the research model. Section 2.6 discusses the research methods. Section 2.7 presents the empirical findings. The final section discusses the implications of this study and provides some concluding comments.

2.2. SOX 404, Internal Control, IT Internal Control, and IT Governance

Internal control over financial reporting (ICOFR) is designed to provide reasonable assurance regarding the reliability of financial reporting to instill investors' confidence. 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).

Prior to SOX, the first legislative act, the Foreign Corrupt Practices Act (FCPA) of 1977 provided regulatory standards for internal control over financial reporting. 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 internal controls. As a reaction to these corporate scandals, the SOX Act of 2002 was enacted on July 30, 2002 to provide enhanced 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 controls systems, and they have identified material changes in internal controls (Beneish et al., 2008). Under the SOX 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 assess the effectiveness of their internal control structures and procedures over financial reporting that is attested to by the firm's public accountants. In addition, the auditor of the firms is required to provide an adverse opinion on the assessment made by the management.

Material weaknesses are the problems in the internal control process. Material weakness, which is the most severe internal control deficiencies, is defined by AS No. 5 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). For example, inconsistent application of accounting policies, lack of adequately staffed accounting departments. ITMWs are the IT-related problems in the internal control process. For example, accounting software does not prevent erroneous or unauthorized changes to previous reporting periods; ERP system contained programming errors.

Effective internal control over information systems has 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 significant components of internal controls. PCAOB Auditing Standard No. 5 (2007) discusses the relationship of IT and internal control over financial reporting and emphasizes the importance of identifying 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).

IT governance literature has emphasized the importance of the responsibilities and role of senior management leadership and boards in IT governance (Dahlberg and

Kivijärvi 2006). IT Governance Institute defines the IT governance as: “IT governance is the responsibility of the board of directors and executive management. It is an integral part of the corporate governance and comprises of the leadership, the organizational structure and processes that ensure the IT sustains of the organization and the extensional strategies and goals of the organization” (ITGL 2003). The COBIT board briefing (ITGL 2003, p6-9) defines that top management is beginning to realize the important impact of IT on the enterprise’s successfulness. As this impact relies largely on the operation of IT and the leverage of IT business value, executives and boards have to expand governance to IT and provide necessary leadership. Firms with stronger IT governance are more likely to reduce ITMWs due to the experience and knowledge in use of IT.

2.3. Literature Review

In the accounting and economics areas, a number of recent studies have dealt with the determinants of general internal control weaknesses under SOX 302 and 404 Act (Ge and McVay 2005; Doyle et al. 2007; Ashbaugh-Skaife et al. 2007). Ge and McVay (2005) found that firms with internal control problems and material weaknesses disclosure are smaller, more complex and less profitable than the firms without ICDs disclosure. Furthermore, Ge and McVay (2005) reported that 2.8% 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 weakness 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 material weaknesses are younger, growing fast, or undergoing restructuring. In addition, Ashbaugh-Skaife et al. (2007) found organizations disclosing internal control weaknesses have less resources invested in internal control, greater accounting risk exposure, more recent organizational structure change, and more complicated operations.

There is very limited research on ITMWs and the quality of IT internal controls. Weill (2004) indicated that better IT controls can bring firms stock-market premiums (Weill 2004). Grant et al. (2008) examined the relationship of IT controls on financial reporting process, focusing on accounting errors, and concluded that accounting errors occur more often in firms with ITMWs. From IT governance perspective, Li et al. (2007) examined the internal and external influences on IT controls, and suggested that companies with more IT-experienced senior managers, with CIO positions or longer tenured CIO and with higher percentages of independent board directors are less likely to have ITMWs. However, there is no research that has examined both firm characteristics and IT governance's influences on firms' reporting ITMWs at the same time. There exists a potential gap with the study of the antecedents of the ITMWs. Our study is different with the previous study in two ways. First, we investigate the antecedents of ITMWs in internal control over financial reporting from the factors of both firm characteristics and IT governance perspective using firms' SOX 404 report data. The second distinction is that we propose a new variable called ITGOV and establish a new way to capture ITGOV score based on the secondary data.

From the firm characteristics perspective, we follow the literature on determinants of general ICDs study (Doyle et al. 2007; Ashbaugh-Skaife et al. 2007) 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 ITGOV-score, a summary IT governance measure based on 11 factors representing both internal and external governance according to the corporate governance matrix proposed by Brown and Caylor (2006).

2.4. Theoretical Background and Hypotheses Development

In the previous literature, 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 since ITMWs are one special category of general ICDs. Therefore, we applied this integrated model to our study. In addition, we believe that IT governance may play an important role on the absence or presence of ITMWs. Therefore, we add IT governance as an additional factor in our model.

2.4.1. Firm Characteristics and IT Internal Control Weaknesses

Prior research has found that firms with less effective resources and profitability, or that are financially weaker may not be able to invest money and/or time in proper controls. Good internal controls require effective financial resources (Doyle et al. 2007). Financial resources refer to the capital resources available for IT and control systems investment (Chwelos et al. 2001). Investment in internal controls and information systems will depend on a firm’s financial resources and strategies (Kivijärvi & Saarinen 1995). Good internal controls and information systems 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 investment in information systems and internal controls, and more likely to have staffing issues that result in ITMWs, such as segregation of duties. Consistent with previous literature (Doyle et al. 2007; Ashbaugh-Skaife et al. 2007; Henry et al. 2011), we use two measures: loss (LOSS) and financial distress risk (RZSCORE) as proxies for financial health (HEALTH). LOSS is measured as a dummy variable. It is coded as 1 if the sum of income before extraordinary items (Compustat #18) in year t and year $t-1$ is less than zero and 0 otherwise. RZSCORE is measured as the Decile rank of Altman's z-score, where higher rank values indicate less distress risk (Altman 1968). We expect a positive relationship on LOSS and a negative relationship on RZSCORE.

H1a: Firms with losses are more likely to have ITMWs.

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

Operations complexity refers to that a firm has multiple 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 international operations, its transactions are more likely to be complicated, and result in undetectable material misstatement of the financial statements. Therefore, there is a higher need for internal controls for the firms with more complex and diversified transactions or operations since there is a higher possibility for internal control weaknesses (Doyle et al. 2007). Firm size, employee quality, risk management processes, IT systems type,

and complexity of product lines as well as many other factors can impact the internal controls type (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 (Doyle et al. 2007; Ashbaugh-Skaife et al. 2007; Henry et al. 2011), two measures: business segments (SEGs), and foreign sales (FRNSALE), are used as proxies for firms' operations complexity. SEGs are measured as the number of business segments the firm operated (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 (Non-zero value of Compustat #150) 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 consider the factor of the firms' accounting measurement application risks in applying generally accepted accounting principles (GAAP) through the level of inventory and rapid growth (Kinney & McDaniel 1989). The level of firms' inventory may lead to value changes due to obsolescence, and the manager's judgment is required in applying GAAP (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). Level of inventory (INVNTRY) is measured as inventory over total assets (Compustat #3/#6). A rapid 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 the operations, and result in outgrowing IT internal controls. Rapid growth (GROWTH) is measured as average percent change in sales in previous three years (Percentage change in Compustat #12).

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

H3b: Firms undergoing rapid growth are more likely to have ITMWs.

We consider the organizational structural change factor through mergers & acquisitions and restructurings. There is a unique need for internal controls for the particular operating environment of each firm (Doyle et al. 2007). The need for internal controls will change correspondingly with the changes of environment. In addition, restructuring of the firm often leads to departments downsizing, experienced employees loss, and general disorder during and after the firm re-engineering. Therefore, the internal controls systems have to be upgraded to keep pace with the new structures and procedures of the firms (Doyle et al. 2007). We believe that insufficient IT employees, less familiarity with the new technologies and environment as well as more adjustments estimation, are likely to result in more 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 (at least one of the following Compustat annual data items is not equal to 0: #376, #377, #378 or #379) and 0 otherwise. Firms engaging in mergers and acquisitions confront significant IT internal control difficulties when integrating their information systems, IT infrastructures, IT applications, and IT structures with those of acquired firms. Such 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 (Compustat AFTNT #1) 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.

2.4.2. IT Governance and IT Internal Control Weaknesses

According to the prior literature (Li et al. 2007; Mishra et al. 2009), we expect IT governance to play a role in ensuring firm's IT internal controls quality. Good IT governance over planning and life cycle control objectives should result in more accurate and timely financial reporting (Mishra et al. 2009). In this study, we combine two streams of study to construct IT governance score based on secondary data. We got the detail indicators from IT governance and IT leadership literature (Bassellier et al. 2003; Li et al. 2007). In contrast to previous literature (Li et al. 2007; Boritz and Lim, working paper), which examined the direct effects of each indicator, we categorize our indicators into three groups (oversight, leadership IT background and IT leadership importance). We develop our IT governance matrix based on corporate governance literature (Brown and Caylor 2006). In the corporate governance literature, Gov-score is created as a summary governance measure based on 51 firm-specific provisions representing both internal and external governance. Similarly, we construct ITGOV-score as a summary IT governance measure based on 11 factors (Big4, independent board of directors, CEO or CFO with IT experience, top management with IT experience, board of directors with IT experience, audit committee with IT experience, CIO position, CIO tenure year, CIO compensation, CIO-TMT pay gap, IT strategy

committee) encompassing three categories representing both internal and external IT governance. We code factors of Big4, IT strategy committee, CEO or CFO with IT experience, and CIO position as either 1 or 0; we code factors of top management with IT experience, audit committee with IT experience, directors with IT experience, independent board of directors 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. We then sum the 11 variables to get the ITGOV-Score.

We argue that firms with stronger oversight function are more likely to supervise top managers' behavior in IT implementation and controls. The audit committee plays a role to provide the oversight on the financial reporting process to ensure the high quality of financial reporting. Big 4 auditors are more likely to effectively oversee IT control due to their professional knowledge, practical experience, and reputation. 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 leadership in the IT domain. Top Managers, executives, board of directors and committee members are more likely to assume leadership in regard to IT when they have the appropriate IT experience and knowledge (Bassellier et al. 2003). We believe that leadership who has IT background is more likely to make sure that IT is appropriately managed and resourced. Leadership with IT knowledge and experience

may respond to IT internal control weaknesses the company face in a timely manner and remediate them appropriately. In addition, leaderships' IT background will help increase the effectiveness and efficiency of business operations. Therefore, we expect leadership with IT background have influence on IT operations and IT controls of the company.

If the companies have IT leadership importance (e.g. CIO position, longer tenured CIO, CIO with higher level of compensation, IT strategy committee), this indicates the importance of IT in the company's overall management. The more experienced CIO or CTO a company has, the more likely they can better manage IT to meet the internal control and reporting requirements of the company. In addition, a CIO or CTO with longer tenure is likely to better understand the companies' operating systems and ITMWs based on their experience. Besides the IT executive involvement in a top management team (TMT), IT executive incentives are also a fundamental factor of IT leadership for achieving business alignment. Drawn upon executive compensation literature (Masli et al. 2009), executives' incentives are motivated by compensation. So we argue that CIO's behavior is motivated by CIO compensation. And CIO compensation is regarded as an incentive alignment mechanism. CIO with higher level of compensation has higher motivation to engage in behaviors or actions towards enhancing IT controls quality and effectiveness. CIO-TMT pay gap is viewed as a proxy of CIO level of acceptance by other members of the TMT team. Higher (lower) pay gap is an indication of lower (higher) level of acceptance by the TMT. CIO with lower level acceptance may have less motivation and may contribute less on the IT controls quality and effectiveness.

H5: Better IT-governed firms are less likely to have ITMWs.

2.5. Variable Definitions and Research Model

2.5.1. Dependent and Independent Variables

Based on the hypotheses, ITMWs are influenced by firms' loss (LOSS) and distress risk (RZSCORE), which are proxies for financial health (HEALTH) of the firms; business segments (SEGs) and foreign sales (FRNSALE), which are proxies for the complexity of operations (COMPLEX); level of inventory (INVNTRY) and rapid growth (GROWTH), which are proxies for the accounting measurement application risks (AMAR) in applying GAAP; restructuring (RSTRCHA) and mergers & acquisitions (MA), which are proxies for the organizational structure change (ORGSCNG); IT governance score (ITGOV), which is proxy for the effectiveness of IT governance. Therefore, ITMWs is the dependent variable in our model, which is coded as 1 if a firm disclosed ITMWs in the SOX 404 report, 0 otherwise. The independent variables are nine influential factors including LOSS, RZSCORE, SEGs, FRNSALE, INVNTRY, GROWTH, RSTRCHA, MA and ITGOV. The research model is shown as Figure1.

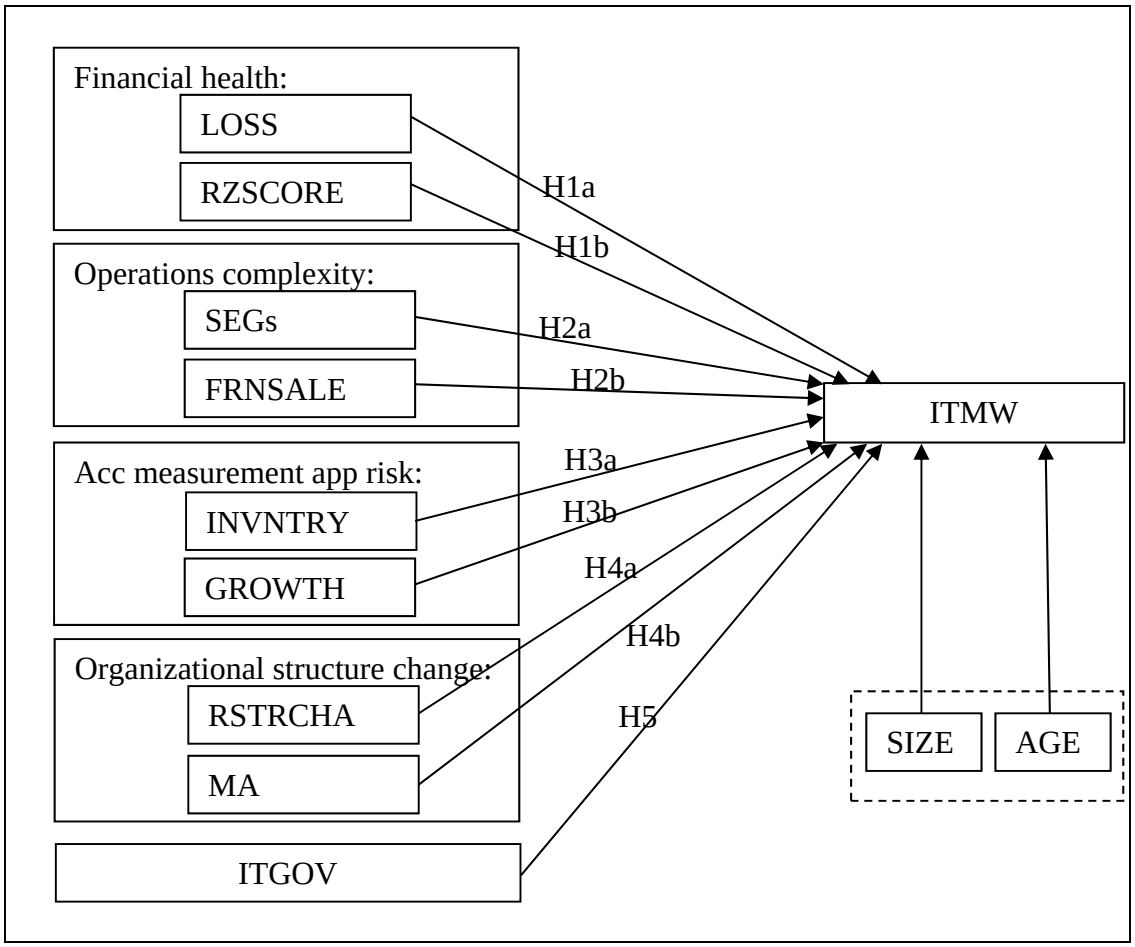

Figure 1: The research model of study 1

2.5.2. Control Variables

In our model, we control for firm size and firm age based on prior studies (e.g., Ge & McVay 2005; Doyle et al. 2007; Ashbaugh-Skaife et al. 2007). 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 (Doyle et al. 2007; Ashbaugh-Skaife et al. 2007). Unlike Doyle et al. (2007), we control for firm age since we posit that the older firms still use the old, and in some cases possibly obsolete information systems in financial transactions, reporting and other important processes. In addition, they might retain IT personnel with

outdated IT skills, and this in turn might result in misstatement of IT internal controls. Therefore, older firms are more likely to disclose ITMWs.

The definition and description of the variables in this study is summarized in Table 2. The next section introduces the basis of our model and research methods that we adopted.

Table 2: Definition of variables in study1

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

2.6. Research Methodology

A logistic regression analysis is performed to predict the ITMWs after screening the data to check for the missing values, outliers, multicollinearity, and normality of the distribution.

2.6.1. Data Sources and Collection

We start with the Audit Analytics database (SOX 404 reports) and identify the initial sample from the firms that disclose their effectiveness of internal control in their annual financial report. We examine seven years data in this study from Jan 2005 to Dec 2011 since SOX section 404 became effective for accelerated filers starting from November 15, 2004. We search firms' SEC 10-K filings from the EDGAR database to identify whether they have MWs disclosure. If the company has MWs, we then determine whether the MWs are IT-related based on whether a MW is related to information systems, IT, software errors, data or information systems security[2].

Management's reports on internal controls are coded as illustrated by the following example. Consider a firm which discloses that the internal control is not effective as of Dec 31, 2010 due to lack of segregation of duties. At this point, we have to identify if this firm has insufficient IT personnel, accounting personnel, or other personnel to finalize whether this MW is IT-related or not. If it has insufficient IT personnel, we code it as ITMW (1); otherwise, we code it as none-ITMW (0). We retrieve all financial data from annual Compustat database, such as firms' total assets, total liabilities, and total revenue. We obtain the business segment data from Compustat Segment files, and acquire firm stock data from CRSP database. We collect

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

the IT governance data from a combination of proxy statement, 10-K filings, and firms' website and Mergent online database.

Consistent with previous research, we select 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 consists of firms with non-IT related MWs but may with general MWs. Our final sample is 1112 firms: 556 firms reporting ITMWs in the ICOFR matched with 556 firms with non-IT MWs. A logistic regression analysis will be performed to predict the ITMWs after screening the data to check for the missing values, outliers, multicollinearity, and normality of the distribution.

2.6.2. Sample Data

We present some examples and categories of ITMWs reported in 10-K filings in Table 3 (Masli et al. 2009). For example, CONOLOG CORP (CIK: 0000023503), based on management's assessment of internal control over financial reporting, as of July 31, 2011, the Company's internal control over financial reporting was 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), based on 10-K filing as of December 31, 2011, there were control deficiencies that constituted material

weaknesses 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 3: 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

2.7. Data Analysis and Results

2.7.1. Univariate Analysis

The industry distribution of the 556 firms with ITMWs is provided in Table 4. 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 the IT-intensive manufacturing companies into a separate group. 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: 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		1112	100

Table 5 provides descriptive statistics and the univariate tests results. The mean, standard deviation (std.dev), median, and significance are listed in Table 5. The results of univariate analysis indicate that, compared to firms without ITMWs, the firms disclosing ITMWs significantly have higher probability of loss, operate more business segments, are more likely to have foreign sales, have higher level of inventory and undergo restructuring and mergers and acquisitions, which 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 significantly older than the firms with effective IT internal controls.

Table 5: Descriptive statistics in study 1

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

Notes: ***, **, * indicates significant level at the 0.01, 0.05, 0.10 or better, respectively based on t-statistics in means. P-values are two tailed. See Table 2 for variable definitions.

Table 6 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 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, which fall below ± 0.3, and the variance inflation factor (VIF) in the regression is less than 2, which indicates that the indicator variables in the model have distinct features, and there are no multicollinearity problems in our regression

Table 6: Pearson correlation analysis in study 1

	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 = 1112

2.7.2. Logistic Regression Analysis

A logistic regression analysis is performed to model the probability of reporting ITMWs over financial reporting as a function of 11 predictors as we discussed above. ITMW is a dependent variable. It is coded as 1 if the firm discloses ITMWs in the SOX 404 reports and 0 for control firms with effective IT internal controls. We transform GROWTH to be the decile rank of the average sales growth from year $t-2$ to year t (RGROWTH), and we also transform SEGs to the log of the number of business segments because of the documented skewness in the distribution of GROWTH and SEGs.

Table 7 provides the results of logistic regression analysis. A test of full model with all eleven predictors: 9 independent variables and 2 control variables, against a constant-only model is statistically reliable with χ^2 (11, N=1112) = 46.27, p<.001. It indicates that the predictors reliably distinguished between firms that disclosing ITMWs and not disclosing ITMWs. Predicted success is adequate, with 59.7% of the ITMWs firms and 55.0% of the effective IT internal control firms identified correctly and an overall success rate of 57.4%. Table 7 displays the regression coefficients, Wald statistics, and statistical significances p-value for each of the 11 predictors. According to the results, after controlling for the firm size and age, we find that the estimated coefficient of LOSS is significantly associated with ITMWs, and 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 as well as engaged in merges and acquisitions 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 new construct ITGOV is significantly associated with ITMWs. 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 (Ge & McVay 2005; Doyle et al. 2007; Ashbaugh-Skaife et al. 2007), 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 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 have more innovation to respond to technology change.

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). We believe this could be because older firms are more likely to use legacy systems, and possibly personnel who are not familiar with newer technology.

Table 7: 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%			
Effective ITIC firms predicted correctly	55.0%			
Overall percentage to predict correctly	57.4%			
N	1112			

2.7.3. Analysis of Recession Effects

In the proposal stage of this dissertation, we collected three years data from Jan 2008 to Dec 2010, which includes the economic recession (Q3, 2008 till Q1, 2009). The results indicate that there are some differences between the normal economic environment and the recession time period due to recession effects. First of all, LOSS seems to be significantly associated with ITMWs in the normal environment, but not significantly linked to ITMWs. One possible explanation is that firms may reduce investment in information systems and internal control systems due to the economic recession. In addition, INVTRY and RSTRCHA are not significantly associated with ITMWs in normal years, but significantly related to ITMWs in the recession period. One plausible explanation is that there are some uncertain or unexpected factors, which may be out of control during the recession. However, in the normal economic environment, firms may plan ahead to scale up the IT infrastructure and structures, set up firm-wide IT standards, and integrate a standard configuration into the IT infrastructure. This scaling of IT infrastructure to match business growth could result in INVTRY and RSTRCHA not being significant.

2.8. Discussion and Conclusion

This study is an early attempt to examine both firm level characteristics and IT governance associated with ITMWs in ICOFR. Our findings confirm some of the results reported from the previous studies of general internal control weaknesses (Ge & McVay 2005; Doyle et al. 2007; Ashbaugh-Skaife et al. 2007). We find that firms that disclose ITMWs tend to have higher probability of loss, have foreign sales, and are more likely to have mergers and acquisitions. In addition, the results provide the

evidence that firms with stronger IT governance are less likely to disclose IT internal control weaknesses.

The difference between our results and previous findings relates to firm age (AGE), business segments (SEGs), inventory (INVNTRY), rapid growth (RGROWTH) restructuring (RSTRCHA). Our findings suggest that in contrast to traditional control deficiencies, older firms are more likely to have ITMWs. This could possibly be due to legacy system problems. Our results indicate that SEGs, INVNTRY, RGROWTH and RSTRCHA are not significantly associated with ITMWs. These are interesting results and could indicate that once appropriate IT internal controls are put in place, they scale up much better compared to traditional internal controls due to the scalability and agility of IT.

The results are useful from both research as well as managerial perspectives. From a research perspective, this is one of the first studies to examine the antecedents of ITMWs from both firm characteristics and IT governance perspective. We propose and operationalize a new construct ITGOV according to corporate governance, IT leadership and IT governance literature. This study represents an important contribution to research in both Accounting Information Systems (AIS) and Management Information Systems (MIS). From a managerial perspective, our research understanding the characteristics and IT governance of organizations that are likely to have ITMWs helps management to take appropriate actions to remediate ITMWs; It could helpful for regulators to enact or update policies and standards to regulate the companies to provide the assurance of reliability and integrity of financial reporting to instill the investors' confidence; It also helps investors to make investment carefully.

A potential limitation of this study is that our data is based on secondary data. It might have some unrecorded data or the limitation of the format of data reporting. In this study, we measure ITMW as a binary variable (1 vs. 0) instead of specific severity and real number of ITMWs. IT internal control for companies with more ITMWs (e.g., two or more) would be less effective comparing to companies with only one ITMW. However, it is not proper to measure ITMWs as real number since there is no standard for the data disclosing. For example, firm A discloses that it has inadequate restricted access to information systems, segregation of duties are not implemented in systems, IT personnel access is not properly segregated, and there are logical access issues; while firm B just say it has ITMWs due to lack of access controls. Since the four ITMWs disclosed in firm A are four categories of access controls. In this case, we cannot say firm A has more ITMWs than firm B by counting the real number. Further research could consider quantifying the measure of ITMWs and explore the effects of IT governance and firm-level characteristics on the degree of ITMWs when the data reporting is standardized.

CHAPTER 3: IT GOVERNANCE, IT CAPABILITY AND FIRM PERFORMANCE: AN INTEGRATED MODEL

3.1. Introduction

In this chapter, we examine the impact of IT governance on IT capability, and effects of both IT governance and IT capability on firms' market value creation and sustainable accounting performance. A firm's IT capability refers to its ability to mobilize and deploy IT-based resources in combination or co-present with other resources and capabilities (Bharadwaj 2000). Lim et al. (2012) define IT capability as firms' ability to integrate, build, and reconfigure IT with organizational and managerial processes in order to align with a rapidly changing competitive environment (Lim et al. 2012).

The relationship between IT capability and firm performance has been studied by prior literature (Bharadwaj 2000; Santhanam and Hartono 2003; Muhanna and Stoel 2010), which concludes that firms with superior IT capability achieve superior firm performance. IT business value research (Barua and Mukhopadhyay 1995; Mukhopadhyay 1995; Bharadwaj et al. 1999; Bharadwaj 2000; Santhanam and Hartono 2003; Brynjolffson and Hitt 2000) has examined the impact of IT on business value and organizational performance. However, research to examine the effect of IT governance on IT capability is limited (Lim et al. 2012), and the information systems field lacks studies that simultaneously investigate the impacts of both IT governance

and IT capability on firms' market value creation and sustainable accounting performance.

To fill this gap, we intend to answer the following research questions in this study: *(a). How is IT governance linked to IT capability?*

(b). How do both IT governance and IT capability impact firm performance?

To answer these questions, we draw upon and integrate three research streams to develop our model: (1) Studies that investigate the impact of IT capability on firm performance (Bharadwaj 2000; Santhanam and Hartono 2003; Wang and Alam 2007; Muhanna and Stoel 2010). (2) Studies that examine the effects of corporate governance and IT governance on firm performance (Brown and Caylor 2006; Boritz and Lim working paper; Lunardi et al. 2009). (3) Study that examines the role of senior IT executives and IT governance on IT capability (Lim et al. 2012). IT business value literature (Barua and Mukhopadhyay 1995; Mukhopadhyay 1995; Bharadwaj et al. 1999; Brynjolffson and Hitt 2000) helps us understand how investment and innovation in IT impact firms' business performance and value. IT capability literature (Bharadwaj 2000; Santhanam and Hartono 2003; Wang and Alam 2007; Muhanna and Stoel 2010) illustrates that IT capability is an important factor differentiating competitive firms from less competitive firms. IT governance literature (Amstrong and Sambamurthy 1999; Bassellier et al. 2003; Li et al. 2007) provides us a guideline with a theoretical basis to investigate firms' IT resources and their ability to effectively integrate and deploy IT resources in combination with other resources to create unique competitive advantage.

Using a sample of U.S. firms ranked by Information Week based on their technology strategies and practices, we examine the impact of IT capability on firm performance. In particular, we examine how IT governance and IT capability help to achieve firms' competitive advantage using both a market value measure and a sustainable accounting performance measure. In addition, we study how IT governance affects IT capability.

This study contributes to accounting information systems (AIS) and management information systems (MIS) literature in several ways. First, this is the first study to investigate the impact of IT governance on IT capability. Second, our study contributes to the IT business value literature by simultaneously examining the differential effects of IT governance and IT capability on firms' sustainable accounting performance and market valuation. Third, our study also contributes to the AIS literature with a comprehensive measurement of IT governance. Fourth, our study represents one of the few studies that empirically test the resource-based theory in the IT governance domain.

The rest of the study 2 is structured as follows. Section 3.2 provides a literature review. Section 3.3 introduces the theoretical background and develops the hypotheses. Section 3.4 describes the definition of variables and presents the research model. Section 3.5 discusses the research methods and data collection procedures. Section 3.6 provides data analysis and the empirical results. The final section discusses the contributions and implications of the study and offers some concluding comments.

3.2. Literature Review

This section builds on three research streams within the IT business value literature, which we described in the introduction section, there still exists potential knowledge gap about the understanding of the IT governance measure and impacts, and the driver of firms' competitive advantage. The research gap can be filled by integrating three research streams on IT governance and IT capability. We review the literature as below. First, we discuss the impact of IT capability on firm performance, mainly on firms' accounting performance. Second, we review the role of senior IT executives and IT governance on firm performance. Finally, we discuss the role of senior IT executives and IT governance on IT capability.

3.2.1. IT Capability and Firm Performance

A large body of research has explored the impact of IT capability on firm performance. The pioneering empirical study by Bharadwaj (2000) suggested a link between IT capability and firms' accounting-based measures of current performance. This study contends that IT capability creates unique competitive advantages and intangible assets for a firm and firms with a high IT capability achieve and sustain superior performance based on profit- and cost-based performance measures using data in the early 1990s. Similar to Bharadwaj (2000), a subsequent analysis by Santhanam and Hartono (2003) controlled for prior financial performance, and concluded that firms with superior IT capability exhibit superior current and sustained firm performance when compared to average industry performance.

Based on post year 2000 (Y2K) data, more recent studies have investigated the impact of IT capability on firms' competitive advantage with mixed results. Wang and

Alam (2007) explored the relationship between IT capability and firm valuation, future earnings uncertainty and financial analysts' forecast accuracy, and found that IT capability is value-relevant and provides incremental explanatory power for firm valuation beyond traditional accounting information. Muhanna and Stoel (2010) used two unique archival data sets representing the immediate pre-Internet (1992-1994) and the post-Internet (1999-2006) commercialization eras to examine the effects of IT capability and IT spending on market value and actual accounting performance, and concluded that IT capability is value-relevant, and is positively associated with actual future earnings; However, Masli et al. (2011) considered the structural shifts in the return from IT capability over time, and examined the impact of superior IT capability on firm performance over the 1988-2007 period. Their findings suggested that firms with superior IT capability are able to attain higher firm performance levels until 1999. However, such performance advantage disappears in the post-1999 time period. Hence, it is necessary to better understand the impact of IT capability on firms' market valuation as well as sustainable accounting performance in the post-Internet eras.

A further investigation of the role of IT capability on firms' competitive advantage is needed. In this study, we attempt to reconcile these seemingly conflicting results and advance our understanding of the association between IT and firm performance by proposing and testing a model that focuses on market valuation as well as firms' sustainable accounting performance. A key distinguishing feature of our study is that we simultaneously examine the effects of both IT governance and IT capability on firm performance. In contrast, prior studies have focused on investigating the effects of each of these two IT-related factors in isolation from each other.

The most similar study to ours is a recent paper by Lim et al. (2012) who investigated the impact of the role of IT executives on the relationship between IT capability and firm performance. They concluded that there is a positive relationship between hierarchical power of senior IT executives and the likelihood that a firm will develop superior IT capability, and that the contribution of IT capability to a firm's competitive advantage is much stronger in firms with powerful senior IT executives. However, Lim et al. (2012) only studied IT executives' role. In contrast, in our paper, we construct a comprehensive measurement of IT governance including IT executives' role and other important factors.

3.2.2. IT Governance and Firm Performance

IT governance is defined by IT Governance Institute (ITGI) as "the responsibility of the Board of Directors and executive management. It is an integral part of enterprise governance and consists of the leadership and organizational structures and processes that ensure that the organization's IT sustains and extends the organization's strategy and objectives" (ITGI 2001). IT governance is "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 and Grembergen 2004, pp.1).

Despite considerable research on IT governance, there is limited research on the effectiveness of IT governance in deriving business value from IT investments. The few studies on this issue have obtained mixed results. Weill and Ross (2004) conducted a survey of IT governance in 256 companies worldwide during the period 1999-2003 and found that "firms with superior IT governance have at least 20% higher profits

than firms with poor IT governance, given the same strategic objectives." (Weill and Ross 2004; Gu et al. 2008; Lunardi et al. 2009). The study suggested that IT governance is strongly associated with overall firm performance. Chatterjee et al. (2001) used the event study methodology to examine market reactions to announcements of new CIO positions. Dehning and Stratopoulos (2003) examined and tested the factors that are believed to lead to a sustainable competitive advantage due to IT-enabled strategy, and suggested that managerial IT skills are positively linked to the sustainability of a firm's competitive advantage.

Boritz and Lim (working paper) investigated the relationship between effective IT governance, IT material weaknesses and firm performance, and suggested that firms with IT governance mechanisms (IT strategy committee, CIO) have higher levels of firm performance. In their paper, they measure the effectiveness of IT governance as a function of the IT knowledge of top company executives and board members, the presence of IT strategy committee, and the tenure of CIO. In contrast, in our paper, we construct a more comprehensive measure of IT governance (ITGOV-Score) with 3 categories and 11 factors.

The IT governance matrix is developed upon the corporate governance literature (Brown and Caylor 2006). In the corporate governance literature, Gov-Score is created as a summary governance measure based on 51 firm-specific provisions representing both internal and external governance. Similarly, we construct ITGOV-score based on both internal and external IT governance factors including oversight, leadership IT background, and IT leadership importance. This construct is related to the definition of IT governance. IT background and importance are factors since they are

driving force for effective and efficient IT governance to help to ensure the fusion of business and IT. The reason we include oversight factors in our measurement is because the board effectiveness in its monitoring function is determined by its independence, size, and composition (insider and outsider) (John and Senbet 1998), and the oversight function is to control the formulation and implementation of IT strategy. ITGOV-Score is broader in scope, and is an improvement of Boritz and Lim's measurement.

3.2.3. IT Governance and IT Capability

Prior research has examined the role of senior IT executives on IT capability (Khallaf and Skantz 2011, Lim et al. 2012). Khallaf and Skantz (2011) found that CIO appointments improve firm performance but the improvement in performance largely is limited to firms appointing a CIO for the first time. Lim et al. (2012) found that there is a positive relationship between the hierarchical power of senior IT executives and the likelihood that the firm will develop superior IT capability. They also suggested that the contribution of IT capability to a firm's competitive advantage is much stronger in firms with powerful senior IT executives since they are the driving force that may ensure the continuous renewal of IT capability. In our study, we propose that effective IT governance enhances the firms' ability to develop superior IT capability. Building on existing literature (Armstrong and Sambamurthy 1999, Lim et al. 2012), this study argues that there is a positive relationship between IT governance and the likelihood that the firm will develop superior IT capability.

Examining the three streams of literature, there exist potential gaps. Figure 2 summarizes the major points of review from previous literature and proposes a new

model. Figure 2 - A shows that the role of IT executives impacts firm performance through IT capability. Figure 2 - B shows that effective IT governance is positively related to firm performance through reducing IT material weaknesses. Figure 2 - C shows that corporate governance is positively linked to firm performance. From the literature, a potential gap is identified and can be filled by incorporating the streams. The resulting model is showing in Figure 2-D, and the justification of the model is illustrated in the following section.

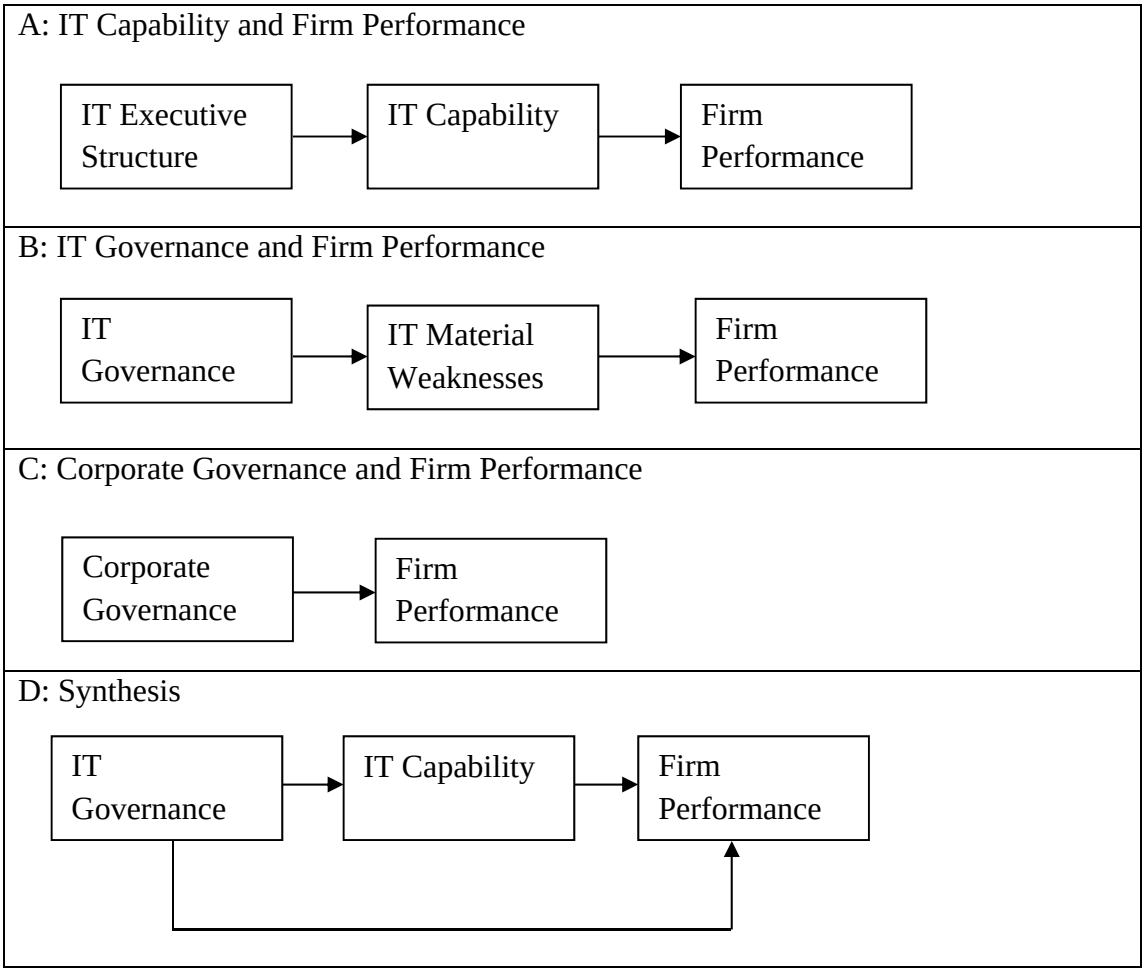

Figure 2: Literature review and synthesis

3.3. Theoretical Background and Hypotheses

The resource-based view theory (RBV) has been used in IT business value research to answer the question of IT business value and competitive advantage from IT (Mata et al. 1995; Powell and Dent-Micallef 1997; Bharadwaj 2000; Wade and Hulland 2004; Ray et al. 2005). Drawing upon RBV theory, a firm's ability to effectively build, integrate and deploy IT resources in combination with other resources, can create unique competitive advantages and intangible assets for a company (Bharadwaj 2000; Santhanam and Hartono 2003). The primary purpose of this study is to investigate how IT governance and IT capability affect the firms' market value and sustainable accounting performance. The reason that we use both market value measure and sustainable accounting performance measure is described in the section of variable definitions. To accomplish this, RBV theory, therefore, seems well positioned to inform examinations of the relationship between IT governance, IT capability and firm performance.

3.3.1. IT Governance and Firm Performance

According to previous literature of the impact of corporate governance structure on firm performance (Daily and Dalton 1993; Brown and Caylor 2006), we expect that there is a linkage between IT governance and firm performance since firms with stronger IT governance may carve out competitive advantage in driving technology decisions and remaining costs under control. IT governance is an integral part of corporate governance, and is implementing processes, structures, and relational mechanisms in the enterprise that enable both IT and business person to execute their responsibilities in support of IT/business alignment and the creation of IT business

value (Grembergen and De Haes 2009; Wilkin and Chenhall 2010). Weill (2004) indicates that all organizations have IT governance. Firms with effective governance have actively designed a set of IT governance mechanisms (e.g., committees, processes, IT organizational structure, etc.) that encourage behaviors consistent with the firms' strategies and values (Weill 2004). Good IT governance draws upon corporate governance principles to manage and use IT to achieve superior firm performance. Boritz and Lim (working paper) have examined the relationship between IT governance and firm performance, and suggests that IT governance mechanisms contribute to improved firm performance after taking into account their impact on ITMWs. IT assets have been embedded in an organization's daily operations and strategies, such as transactions, processes, services and analyses. Studies suggest that a big portion of the business value generated by IT comes from complementarities between IT and organizational practices (Brynjolfsson and Hitt 2000; Basu and Jarnagin 2008). Effective IT governance differentiates the organizations' unique assets in the use of IT, while ensuring compliance with the firms' overall mission, vision and principles. Therefore, we believe that firms with effective IT governance may maintain unique assets in human IT resources such as IT skills and experience, IT-enabled resources such as IT knowledge assets and IT processes, and are more likely to have competitive advantage to achieve superior firm performance.

Using the same measurement of IT governance in study 1, we consider three aspects of IT governance mechanisms: oversight (outside committees), leadership IT background and IT leadership importance. We believe that for firms with good oversight function, their outside and independent boards are more likely to effectively

monitor the inside boards and leadership in using IT to realize IT/business alignment and achieve business value of IT. Executive leadership has long been embraced as necessary for corporates to fully explore the benefits of IT (Freeman 1969; O'Toole 1966; Rockwell 1968; Chatterjee et al. 2001). Bassellier et al. (2003) state that the set of IT-related experiences 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 leadership in the IT domain. Top Managers, executives, board of directors and committee members are more likely to assume leadership in regard to IT when they have the appropriate IT experience and knowledge (Bassellier et al., 2003). Thus, we argue that firms with leadership IT background may have unique human IT resources (e.g. IT skills and IT experience) in using IT to realize business value of IT. We also argue that firms with IT leadership importance, say, consider the critical role of IT leadership such as CIO position and compensation, longer tenured CIO, and IT strategy committee, are more likely to be motivated to make efficient IT investment, implementation and maintenance, and have stronger IT organizational structure to achieve business value of IT investment. As a result, it may achieve superior firm performance. Therefore, we propose the following hypotheses:

H1a: IT governance will be positively associated with the firms' market valuation.

H1b: IT governance will be positively associated with the firms' sustainable accounting performance.

3.3.2. IT Capability and Firm Performance

The definition of IT capability varies. Bharadwaj defines IT capability as "its ability to mobilize and deploy IT-based resources in combination or co-present with

other resources and capabilities" (Bharadwaj 2000, pp. 171). Lim et al. refer to IT capability as firms' ability to integrate, build, and reconfigure IT with organizational and managerial processes in order to align with a rapidly changing competitive environment (Lim et al. 2012). Wang and Alam (2007) point that IT capability depends on how a firm uses IT investments with other resources in innovative ways to create unique competitive advantages and intangible assets, such as technical and managerial skills, knowledge-based assets, customer orientation and synergy (Wang and Alam 2007). In this dissertation, we refer to IT capability as firms' ability to innovatively implement and deploy IT resources in the process of business to obtain IT/business strategies and create distinctive advantages.

Organizational intangible assets have been recognized as important drivers of firms' competitive differentiates (Bharadwaj 2000). Organizations and IT users care more about whether IT investment creates intangible resources such as increased markets and sales, and bring business value for the firms. Building on RBV theory, firms' IT capability is valuable, rare, inimitable, and/or non-substitutable (Wernerfelt 1984; Newbert 2007; Lim et al. 2012). We believe that firms with superior IT capability are more likely to have compatible IT infrastructure, competent human IT resources, and effective intangible IT-enabled resources. Therefore, such firms are much better at building and integrating innovative firm-specific IT resources with other business resources and managing the technical and market risks associated with the deployment and use of those resources. In addition, due to more competent human IT resources in terms of both technical and managerial IT skills, firms with superior IT capability are better able to make the right decisions about IT spending, IT investment

and IT development, and they are more likely to turn those IT investments into true value in terms of enhanced productivity and efficiency, improved marketing reflections, increased product quality/differentiation, improved customer service, and shortened product life cycle, and so on (Bharadwaj 2000; Muhanna and Stoel 2010; Lim et al. 2012). As a result, it will enhance firms' sustainable earnings and earnings potential, and improve firms' ability to deploy IT for strategic goals. This expectation in turn should be reflected in the firm's sustainable accounting performance and market value. This leads to the following hypotheses:

H2a: IT capability will be positively associated with the firms' market valuation.

H2b: IT capability will be positively associated with the firms' sustainable accounting performance.

3.3.3. IT Governance and IT Capability

IT governance involves a set of mechanisms for ensuring the attainment of necessary IT capabilities (Loh and Venkatraman 1992; Henderson and Venkatraman 1993; De Haes and Grembergen 2005; Brown and Grant 2005). IT governance affects a firm's capability to leverage IT synergies across business units (Gu et al. working paper). Thus, we propose that there is relationship between IT governance and IT capability since IT governance has a positive impetus to achieve firms' superior IT capability.

Firms with stronger IT governance are more likely to have the business and IT knowledge needed to nurture organizational learning. Daily and Dalton (1993) stated that outside board members may enhance the firms' reputation due to their own experience, accomplishment, and exposure. In addition, outside board members are

aligned with the notion of resource independence theory indicates that the effectiveness and efficiency of the firm relies on the ability of key organizational members to act as boundary spanner and oversight function (Pfeffer and Salancik 1978; Daily and Dalton 1993). Therefore, we believe that firms with stronger oversight function, their outside board members (e.g. big 4 audit committees), are more likely to oversee the inside board members for IT activities and may enhance firms' ability to integrate IT resources in combining with other resources. In addition, if firms have more independent directors, they may have stronger monitor function to help them reduce firms' IT-related risks and lead to superior IT capability.

ITGI indicates that IT governance is as critical at the board and management level as corporate governance, and provides frameworks to assist enterprise leaders ensure that IT supports business goals and maximizes IT investment, with appropriate management of risks and opportunities (Wilkin and Chenhall 2010). Firms whose leadership teams have more IT experience and knowledge are more likely to have ability and skills to deploy IT innovations. For example, given the fast growing of technical innovation for information systems, if firms' top management has IT experience, they are more likely to implement and infuse new technology to improve business operations and customer experience.

In addition, with the organizations' operational dependence on IT, information assets (e.g. database, spreadsheet) are significant for an organization. The CIO and IT strategic committee are able to better manage critical corporate information assets since they are more likely to have the fundamental knowledge about IT, such as, IT risk, expense and competitive risk (Nolan and McFarlan 2005). Therefore, firms with IT

leadership importance (e.g. CIO position and compensation, tenured CIO and IT strategy committee, etc.) are more likely to drive technology initiatives (e.g. deployed business intelligence tools, adopted online collaboration tools) and effectively manage critical corporate information assets, and result in superior capability to integrate their IT into business operations. Thus, we propose the following hypothesis:

H3: IT governance will be positively associated with IT capability.

3.4. Variable Definitions and Research Model

Based on the hypotheses, firm performance is affected by firms' IT governance and IT capability. IT governance also plays a role in firms' IT capability superiority. The research model is shown as Figure 3.

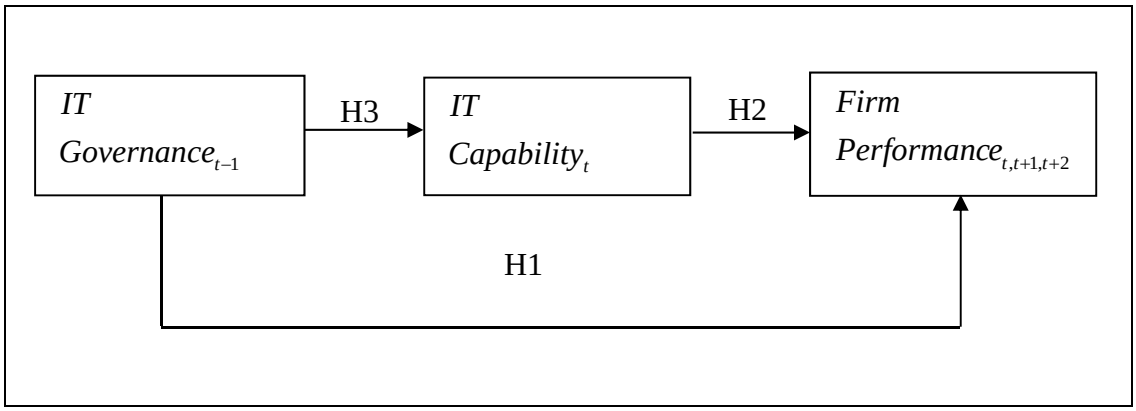

Figure 3: The research model of study 2

3.4.1. Dependent Variables (Firm Performance Measurements)

We believe that IT capability and IT governance are not only linked to actual sustainable future earnings, they may also be associated with market expectations of future earnings. Therefore, we measure the firm performance in this study from both accounting performance and market value perspectives. This is an improvement from

previous studies which take one measurement into consideration. We use two measures of firm performance: average return on assets (AROA) and Tobin's q. Return on assets (ROA) identifies a company's ability to generate profits from its assets, and has been widely used in previous studies (Hitt and Brynjolfsson 1996; Tam 1998; Barua et al. 1995; Rai et al. 1997; Floyd and Wooldridge 1990; Bharadwaj 2000; Dehning and Stratopouslos 2002). However, ROA measure only focuses on the current year profitability. To capture the long-term and sustainable profitability, we use the average of ROA over three years as the measure of sustainable accounting performance. The consideration of multiple years into the future allows for a possible time lag between investments in IT or IT capability and realization of potential value (Muhanna and Stoel 2010). It is an improved measurement of firms' accounting performance. Average ROA over three years (AROA) is calculated as $(ROA_t + ROA_{t+1} + ROA_{t+2})/3$.

In addition, we use Tobin's q as market value of firm performance, which is a forward-looking, risk-adjusted, and less susceptible to changes in accounting practices. Tobin's q has been widely used to represent the market expectations of future firm performance and can be more likely to capture and represent IT contribution to intangible value (Bharadwaj et al. 1999; Masli et al. 2011; Lim et al. 2012). Consistent with previous literature (Chung and Pruitt 1994; Masli et al. 2011; Lim et al. 2012; Bharadwaj et al. 1999), Tobin's q is a ratio of market value to book value of total assets, and is calculated as:

Tobin's q = (MVE+PS+DEBT)/TA

Where MVE = market value of equity = (closing price of share at the end of the fiscal year)*(number of common shares outstanding);

PS = liquidating value of the firm's outstanding preferred stock;

DEBT = (current liabilities – current assets) + (book value of inventories) + (long term debt), and TA = book value of total assets.

Therefore, both AROA and Tobin's q serve as dependent variables in this study.

3.4.2. Independent Variables (IT Capability Measurement)

IT capability superiority: we use the top ranking of the annual *InformationWeek 500* (*IW500)* as a proxy for firms that have superior IT capability. We code a firm as 1 if it appears in the top ranking as "IT leaders" in *IW500*; otherwise we code it as 0.

3.4.3. Independent Variables (IT Governance Score)

IT governance: we construct a comprehensive measure of IT governance called ITGOV-Score with 3 categories and 11 factors. In corporate governance literature (Brown and Caylor 2006), Gov-Score is created as a summary governance measure based on 51 firm-specific provisions representing both internal and external governance. Similarly, we construct ITGOV-score as a summary IT governance measure based on 11 factors encompassing three categories representing both internal and external IT governance. The measurement matrix is the same as Study 1.

3.4.4. Control Variables

Based upon a review of prior studies on IT investment and firm performance (Bharadwaj 2000; Santhanam and Hartono 2003; Wang and Alam 2007; Muhanna and Stoel 2010; Lim et al. 2012; Lim et al. 2013), we control for firm size and reputation (Market-to-book value ratio) which may have impact on firms' IT capability

superiority. We control for firm age and possible halo effect of prior performance, which may be related with firm performance. We also include one-year sales growth rate (SG) in our model to control for future earnings growth. In addition, we control for advertising (ADV), research and development (R&D), and capital (CAP) expenditures that are potentially value-relevant intangible assets not included on the balance sheet, and might be associated with firm performance. The definition and description of the variables in our model are summarized in Table 8.

Table 8: Definition of variables in study 2

Variables	Observable measures	Definition and description
Tobin's q		A ratio of market value [(fiscal year-end market value of equity) + (liquidating value of the firms' outstanding preferred stock) + (current liabilities)-(current assets) + (book value of inventories) + (long-term debt)] to book value of total assets.
AROA		Average return on assets over three years (t, t+1, t+2).
ITCAP		1 if a firm is ranked as "IT leaders" in *IW500*; 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.
	ROA(t-1)	One-year-lagged return on asset: earnings before extraordinary income/assets for firm j in year t-1.
	SG	One-year sales growth rate: sales for firm j in year t / sales for firm j in year t-1.
	MB	Market -to-book ratio: market valuation /book value of equity.
	ADV	Advertising expense/sales.
	R&D	Research and development expense/sales.
	CAP	Capital expenditures/sales.
AROA = Average return on assets ITCAP = IT capability superiority ITGOV = IT governance		

3.5. Research Methodology

3.5.1. Data Sources and Collection

Following the prior studies (Bharadwaj 2000; Santhanam and Hartono 2003; Muhanna and Stoel 2010; Lim et al. 2012; Lim et al. 2013), *InformationWeek 500* (*IW*500) annual ranking index is used in this study to identify firms with superior IT capability. *IW500* is a ranking system for IT investment and innovation, published annually by Information Week. *IW*500 ranks firms by the quantity of a firm's technology or service investments as well as the quality of the firm's innovative use of IT resources (*InformationWeek 500* 1995, Wang and Alam 2007). To be ranked in the *IW500*, firms with revenue of $250 million or more must complete a rigorous application on their technology strategies. The process includes quantitative and qualitative assessments of business technology innovation, whereby applicants earn points based on their responses to a questionnaire, and are also evaluated based on the achievements they outline in an essay submission. A panel of *IW* editors review the completed applications and determine the ranking based on the quantitative results and qualitative judgments (*InformationWeek 500* 2009).

In this study, due to the availability and feasibility of data collection, we use a more recent data set from the period 2009-2010 to test our hypotheses regarding the value relevance and sustainable accounting performance of IT capability and IT governance. We follow Santhanam and Hartono (2003)'s study, and use top ranking firms that rated annually as IT leaders. We argue that firms rated in the top ranking may have more innovative investment in IT resources, and stronger ability to integrate their IT resources with other resources to achieve business strategies. We generate a

total of 242 firms with superior IT capability. We select 242 control firms from Compustat data by matching the firm size and industry, and it results in 484 firms as our total sample. Table 9 summarizes the sample selection process.

We collect financial data from annual Compustat database, such as firms' total assets, earnings, and book value of equity, etc. We retrieve firm stock data from CRSP database and obtain IT governance data from a combination of proxy statement, 10-K filings, firms' website, and Mergent Online database.

Table 9: Sample selection

2009	2010	Total sample
250	250	500
		-193 (private, non-profit, no CIK)
		- 65 (missing financial data)
126	116	=242 (total test-sample)
		+242 matching sample
		=484 (total sample size)

3.5.2. Two-Stage Econometrics Methods

A two-stage econometric estimation is used to test the chain hypotheses that IT governance will affect firms' IT capability superiority, and in turn drives firm performance. Since IT capable firms are ranked by the quantity of a firm's technology or service investments as well as the quality of the firm's innovative use of IT resources based on surveys, there are some unobserved variables (disturbance terms), For instance, firms' strategies and culture, which may be correlated with firms' IT capability superiority and might also cause superior firm performance. Therefore, IT capability can be an endogenous explanatory variable, which depends on some omitted variables. If the omitted variables are not accounted for in the model, the estimation

between IT capability and firm performance will be biased, which cause endogeneity bias in the regression. In our model, IT governance causes both IT capability and firm performance. There is also a cause relationship between IT capability and firm performance. To control for endogeneity bias and model the causal structure correctly, two-stage estimation will be used in this study.

The two-stage method starts with estimating a logit regression of $IT\_capability_t$ on firm size, firm reputation, and firms' IT governance in the previous year (t-1). We believe that firms with larger size, higher reputation and stronger IT governance are more likely to receive public recognition for the quality of its IT capability, and be selected by experts as top ranking companies (Lim et al. 2011-2012; Lim et al. 2013). Following previous studies, we use natural log of total assets as a proxy for firm size; we use market-to-book value (MB) as a proxy for reputation since it captures tangible and intangible assets (Roberts & Dowling 2002; Lim et al. 2013), as well as the future growth potential. The measure of IT governance is listed in Table 8.

In the second stage, we estimate a regression of firm performance, which is measured by $AROA_{(t,t+1,t+2)}$ and Tobin's q_t, on the predicted value of $IT\_capability_t$ from the first estimation, IT governance, firm age, prior performance, one-year sales growth rate, advertising expenditure, research and development expenditure, and capital expenditure.

3.6. Data Analysis and Results

3.6.1. Descriptive statistics

Table 10 provides the descriptive statistics of all the variables used in the analysis. Panel A of Table 10 provides a sense for the data by listing the mean, standard deviation as well as median of each variable. Table 10 - Panel B provides the initial observations regarding the influence of IT governance on IT capable firms and non-IT capable firms. From the univariate tests results, firms with stronger IT governance and higher reputation (MB) seem to be more likely to have superior IT capability.

Table 10: Descriptive statistics in study 2

Panel A				
	Mean	Std.Dev	Median	N
Tobin's q_t	1.030	0.773	0.852	484
$AROA_{t,t+1,t+2}$	0.035	0.066	0.030	484
$ITCAP_t$	0.500	0.501	-	484
$ITGOV_{t-1}$	4.355	2.143	3.772	484
$SIZE_{t-1}$	9.026	1.860	9.111	484
MB_{t-1}	0.836	0.869	0.761	484
ROA_{t-1}	0.043	0.075	0.047	484
ADV_t	0.011	0.023	0.000	484
$R\ \&\ D_t$	0.028	0.062	0.000	484
CAP_t	0.069	0.117	0.035	484
SG_t	0.036	0.323	0.006	484
AGE	28.169	22.313	21.750	484
Panel B				
$ITGOV_{t-1}$: ITCAP sample Control Sample	 4.988*** 3.721	 2.067 2.031	 4.984 2.801	 242 242
$SIZE_{t-1}$: ITCAP sample Control Sample	 9.100 8.953	 1.904 1.817	 9.157 9.056	 242 242
MB_{t-1}: ITCAP sample Control sample	 0.931** 0.736	 0.823 0.907	 0.866 0.662	 242 242

Table 11 presents the Pearson correlations among the main variables. Overall, the correlation analysis confirms the univariate results that IT governance is

significantly associated with IT capability. From the correlation matrix, most of the values of correlations are very small, which fall below ± 0.3 except MB and ROA (Pearson correlation coefficient 0.345 with p-value .0000). To examine the possibility of multicollinearity, the Variance Inflation Factor (VIF) was checked and suggested to be less than 2, which are far less than 10. Therefore, there are no multicollinearity problems in the estimation.

Table 11: Pearson correlation in study 2

	ITCAP	ITGOV	SIZE	MB	ROA	ADV	R&D	CAP	SG	AGE
ITCAP	1.000									
ITGOV	.296***	1.000								
SIZE	.040	.030	1.000							
MB	.112**	.120***	-.080*	1.000						
ROA	-.005	-.108**	-.068	.345***	1.000					
ADV	-.030	.073	.017	.148***	.111**	1.000				
R&D	.114**	.256***	-.050	.168***	.119***	.032	1.000			
CAP	-.153***	-.066	-.024	-.020	-.011	-.040	-.067	1.000		
SG	-.020	-.045	.064	.072	-.035	.001	-.000	-.054	1.000	
AGE	.038	-.043	.375***	.082*	.061	.071	-.000	-.055	-.065	1.000

Notes: ***. Correlation is significant at the 0.01 level (2-tailed).
**. Correlation is significant at the 0.05 level (2-tailed).
*. Correlation is significant at the 0.1 level (2-tailed).
a. Listwise N = 484

3.6.2. Empirical Results

A two-stage estimation is performed in this study to control for the endogeneity bias in the regression. Table 12 provides the econometric results according to two different measures of firm performance: Tobins'q and AROA. Table 12 - Panel A shows the results based on using Tobins'q as the dependent variable and Table 12 - Panel B provides the results based on AROA. The results provide a strong support for Hypotheses 2a and 2b. We find a positive relationship between IT capability and firms' market valuation and sustainable accounting performance with the coefficients 0.473 (p-value < 0.01) and 0.046 (p-value < 0.01) respectively, which indicates that firms with IT capability superiority bring firms' competitive advantage from both market valuation and sustainable accounting earnings. Consistent with Hypothesis 3, we find a positive association between IT governance and IT capability with the coefficient 0.330 (p-value < 0.01), which suggests that firms with stronger IT governance are more likely to be ranked as IT capable firms.

In addition, the findings suggest that there is a negative link between IT governance and firms' market valuation and sustainable accounting performance, which do not support our Hypotheses 1a and 1b. This is an interesting but counter-intuitive result. One possible explanation is that IT governance is one aspect of corporate governance and is a subset of corporate governance; it is possible that some other factors may affect firm performance, such as, organizational practices and changes. Chatterjee et al. stated that "a strong complementarity effect seems to exist, where IT investments must be aligned with other organizational changes in order for

the potential of IT to be fully realized" (Chatterjee et al. 2001, pp. 47). Therefore, IT governance has to be aligned with other organizational resources including policies and rules, organizational practices and structure, business processes, and organizational culture, to fully create business value of IT governance investment (Brynjolfsson and Hitt 2000; Brynjolfsson et al. 2002; Melville et al. 2004). Another plausible explanation is that a proxy of IT governance may involve expenditures in CIO position, the compensation of CIO, and hiring executives with IT experience. Such expenditures might be captured as short time consumptions rather than investment, which may be reflected as negative factors in a short-term run. Thus, IT governance seems to not directly result in superior performance for organizations in the short run. A related explanation is the lag effects. Interestingly, our findings provide evidence that IT governance in previous year t-1 is more negatively associated with Tobin's q in year t comparing to the association with average return on assets in year t, t+1, and t+2, which confirms the findings from the literature that it may take several years for a company to realize value from its IT investments (Mahmood & Mann 2005; Gholami & Kohli 2012). However, the indirect impact of IT governance on firm performance mediated by IT capability is 0.156 and 0.015 respectively. This provides evidence that there is an overall positive impact of IT governance on firm performance after checking the overall coefficients effect, which indicates that IT governance may help firms build superior IT capability and indirectly create firms' distinctive advantage.

With respect to control variables, we find that firms with higher reputation are more likely to have superior IT capability. Firm performance in prior year has a significant impact on firm performance in current year and sustainable performance in

three years. Advertising expenditure is significantly associated with firm performance. R&D and capital expenditures are significantly associated with Tobins'q but not AROA. One possible explanation is that R&D and capital expenditures are considered as intangible assets as well as expenses. It might take longer time to be reflected in the actual future earnings. In addition, the results also imply that firm age is positively associated with sustainable accounting profitability. Age is proxy for a firm's life cycle stage. In an early stage of the firm development (i.e. growing stage), firms tend to spend more to build business and tend to be less profitable compared to firms in more mature stage. Therefore, more mature firms are more likely to bring firms' actual future earnings. However, it seems firm age is not significantly linked to market value expectation. One plausible reason is that unlike a more objective measure of accounting profitability, the capital market based measure Tobins'q is subject to the capital market sentiment. For example, the capital market traditionally has given a high valuation for technology stock (i.e., high market-to-book ratio or high price-to-earnings ratio) and many of IT leaders are from the technology sector, which reduce variability in Tobins'q with respect to the Age variable.

Table 12: Econometric results

	Predicted Sign	Model 1 (Firm performance: Tobins'q) Coefficient(Std. Err)	Model 2 (Firm performance: AROA) Coefficient(Std. Err)
A: First-stage logit regression $ITCAP_t$			
Intercept		-1.164 (0.834)	-1.164 (0.834)
$ITGOV_{t-1}$	+	0.330 (0.052)***	0.330 (0.052)***
$SIZE_{t-1}$	+	-0.013 (0.061)	-0.013 (0.061)
MB_{t-1}	+	0.259 (0.123)**	0.259 (0.123)**
Year dummy			
2009		0.066 (0.202)	0.066 (0.202)
Industry dummies			
2		-0.279 (0.709)	-0.279 (0.709)
3		-0.599 (0.700)	-0.599 (0.700)
4		-0.266 (0.695)	-0.266 (0.695)
5		-0.444 (0.713)	-0.444 (0.713)
6		0.075 (0.708)	0.075 (0.708)
7		-0.573 (0.695)	-0.573 (0.695)
8		-0.393 (0.897)	-0.393 (0.897)
Overall percentage to predict correctly		70%	70%
N		484	484
B: Second-stage linear regression Firm Performance (Tobin's q_t and $AROA_{t,t+1,t+2}$)			
Intercept		1.199 (0.154)***	0.057 (0.015)***
$\hat{ITCAP}_t$	+	0.473 (0.103)***	0.046 (0.010)***
$ITGOV_{t-1}$	+	-0.134 (0.033)***	-0.013 (0.003)***
ROA_{t-1}	+	3.714 (0.771)***	0.396 (0.078)***
ADV_t	+	8.521 (2.142)***	0.298 (0.134)**
$R\&D_t$	+	2.811 (0.603)***	-0.034 (0.110)
CAP_t	+	0.386 (0.134)***	-0.009 (0.014)
AGE_t	+	-0.0003 (0.001)	0.0004 (0.0001)***
$SG_{t-1,t}$	+	0.061 (0.084)	0.010 (0.008)
R^2		36%	30%
N		484	484

Notes: ***. Correlation is significant at the 0.01 level (2-tailed).
**. Correlation is significant at the 0.05 level (2-tailed).
*. Correlation is significant at the 0.1 level (2-tailed).
a. Listwise N = 484

3.7. Concluding Remarks and Discussion

IT investment has become increasingly important in strategic decisions making for organizations, and IT business value remains one of the most interesting questions for researchers and practitioners. Prior studies have argued that IT capability, a firm's ability to effectively integrate IT resources together with other organization resources, can create unique competitive advantages and intangible assets for an organization (Bharadwaj 2000; Santhanam and Hartono 2003; Muhanna and Stoel 2010). In this study we propose coupling IT governance with IT capability to evaluate their impacts on firm performance using both market-based firm valuation framework and sustainable accounting performance measurement. Our findings suggest that IT governance has positive effect on building superior IT capability. Our results also imply that superior IT capability positively affects firm performance from both firms' valuation and sustainable accounting performance perspectives. In addition, these findings provide an interesting result that IT governance is negatively associated with firm performance. One plausible explanation is that IT governance has to be aligned with other organizational practices or changes to fully create business value of IT governance investment. Another possible explanation is the lag effects. It may take several years for an organization to realize value from its IT investments (Mahmood & Mann 2005; Gholami & Kohli 2012). Although IT governance seems not directly bring superior performance for organizations, it helps to build superior IT capability and indirectly create firms' distinctive advantages.

This study is expected to make several contributions to the growing literature on the business value of IT and IT capability. First, this study documents that IT

capability adds value to a firm's forward-looking measure of firm performance and sustainable accounting performance beyond prior accounting performance. The measure of firm performance in this study is broader in scope. Second, this study also fills a void in prior literature by examining how IT governance affects IT capability, and provides evidence that firms with stronger IT governance are more likely to be ranked as IT leaders. Third, this study extends prior studies by simultaneously investigating the impacts of both IT governance and IT capability on firms' competitive advantages. Finally, in this study we demonstrate a new way to construct a comprehensive measure of IT governance using secondary data.

This study should also be of interest to professionals that guide boards and executive management and leadership teams in making IT investment decisions and using IT to create business value. Nowadays, we live in an era of information. IT has been playing a critical role on the growth and differentiation of an organization. Therefore, it is very important for firms' executives to make careful decisions in integrating IT into their business strategic making. Our study highlights the important role of IT governance in building superior IT capability, and indirectly bring firms' distinctive competitive advantages. Thus, it will help firms' senior executives make decisions on the investment of IT governance.

One potential limitation of this study is that our data is based only on recent two years' data. Due to the availability and feasibility of data collection, I use IT capability in year 2010 since the most recent financial data are publicly available in Compustat database only until year 2012. To collect the average ROA (t, t+1, t+2), we end up with year 2010. We start from year 2009 with two years data since data collection is very

time consuming. We have enough samples to run the data analysis for the two years data. Further research could go back to collect more data from previous years to confirm the results.

Another limitation is the measure of IT capability. *InformationWeek500* ranking index has been widely used as a proxy for superior IT capability (Bharadwaj 2000; Santhanam and Hartono 2003; Wang and Alam 2007; Muhanna and Stoel 2010; Lim et al. 2012; Lim et al. 2013). However, such ranking may have some bias since IT leaders are ranked based on survey, which is not an objective evaluation of a company's underlying IT resources (Bharadwaj 2000). Future research may consider the development of a more objective measure of IT capability. In addition, *InformationWeek500* ranking are limited to large companies with revenues of $250 million or more. Future research may consider generalizing the results in this study to smaller companies if there are data sources available.

CHAPTER 4: CONCLUSIONS AND FUTURE WORK

4.1. Summary

This dissertation applies empirical methodologies to examine how effective IT governance benefits organizations by improving IT internal control quality, and enhancing firms' IT capability and creating competitive advantages resulting in improved firm performances. We conceptualize and operationalize a comprehensive measurement of IT governance based on secondary data and explore its impacts.

The first study in Chapter 2 investigates the impacts of firm-level characteristics and IT governance on IT material weaknesses according to the integrated model from general internal control research. The findings suggest that firms with loss, involved in foreign sales, and engaged in mergers and acquisitions are more likely to have IT-related material weaknesses. In addition, firms with stronger IT governance may help in mitigating IT-related material weaknesses. Our results indicate that RZSCORE, business segments, inventory, rapid growth and restructuring are not associated with IT-related material weaknesses.

The second study in Chapter 3 examines the impact of IT governance on IT capability and firm performance. The findings show that effective IT governance build firms' IT capability superiority, and indirectly results in superior firm performance, but does not directly improve organizational performance. Our results illustrate that firms

with superior IT capability can create firms' competitive advantages from both market valuation and sustainable accounting performance perspectives.

4.2. Future Research

Based on this dissertation, some extensions might be possible in order to broaden the measurement of IT governance and explore its impacts from different angles, and conduct rigorous research in this area. Particularly, in Chapter 2, further research could consider quantifying the measure of ITMWs and explore the effects of IT governance and firm-level characteristics on the degree of ITMWs when the data reporting is standardized. In addition, it would be promising to examine the mediation effects of IT governance in reducing ITMWs. In Chapter 3, it would be interesting to explore further on the technical part of IT governance including structures, processes, and mechanisms. Moreover, further work could confirm the results using longer time span for data collection and examine the different lag effects for different measures.

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