TWO ESSAYS ON INNOVATIONS AND ACCOUNTING

by

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ABSTRACT

This dissertation consists of two essays on innovations and accounting. The first essay aims to tackle the long-standing debate on the association between business risk and audit fee (e.g., Johnstone 2000; Morgan and Stocken 1998; Simunic and Stein 1994; Seetharaman, Gul, and Lynn ; 2002). Much of the prior literature on business risk focuses on litigation risk, which is the risk of incurring liability payments and the risk of damaged reputation for the service auditors provide. This study also follows the approach used in litigation risk studies but examines a topic that, to my knowledge, has not been explored in the literature. I examine whether the business risk (patent infringement risk) of innovation firms that may or may not be reflected in the financial reports, are associated with audit fees. The abstract nature of patents and institutional inefficiency of the existing patent system make patenting activities risky endeavors. First, the abstract nature of patents makes it challenging to clearly identify one patent from another; and existing patent system fails to establish clear boundaries and efficient guidelines to protect patented inventions. As a result, more than one entity can use or claim an invention at the same time, resulting in frequent and costly infringement suits. Second, patent infringement is a "strict liability" tort, and liability on patent infringements can be imposed on a party regardless of the party's knowledge or intention (such as copying or bad faith or negligence). According to the 35 U.S. Code 271**,** a patent infringement occurs when another party makes, uses, or sells a patented item without the permission of the patent holder. Consequently, everyone up and down the supply chain could be sued for infringement. i.e., distributors can be sued for selling a patented invention, whereas end users can be sued for using the invention. Therefore, patenting activities involve potential business risks almost at every stage — from invention to production, to licensing and distribution. In addition to the direct legal cost, the

aggregate costs of infringement suits include business costs such as loss of market share, management distractions, preliminary injunctions, negative publicity, temporary product boycotts, higher regulatory scrutiny and strained relationships with customers and industry members. Using the patenting activities and audit fees data of 3,688 firms in the U.S., I hypothesize and find that audit fees are higher for clients engaged in more patenting activities including the number of patents granted in a year and non-self-patent citations.

The second essay examines whether internal controls enhance or impede firm innovations. Innovations begin at the individual level; and individual knowledge is transferred to the organization's knowledge base only when it is shared and assimilated into routines, documents, and practices (Autio, Sapienza, and Almeida 2000). Therefore, as procedures designed to improve operational efficiency and effectiveness, internal control routines, documents and practices put in place can influence the innovation productivity of a firm. The COSO framework and recent studies in accounting suggest that strong internal controls increase investment efficiency and operational efficiency in a firm (COSO 1992; Cheng et. al. 2013; Feng et al. 2013). Literature from Total quality Management (TQM) and operations research also suggest that strong internal controls provide preventive mechanisms that minimize operating cost and business risk in the organization by eliminating costly and risky steps. Consequently, effective internal controls can enhance firm's innovation productivity through increased operational efficiency and effectiveness, and reduced business risk For instance, effective control and monitoring mechanisms can minimize operating costs and operational risks related to defects, waste, reworks, delays, customer dissatisfaction and system failures; whereas strong information and communication system can facilitate a smooth and speedy transfer and assimilation of knowledge within and across units of organization. On the other hand, internal controls can also impede innovations as

higher compliance costs divert scarce resources and management time from innovative undertakings. Moreover, in dynamic environments, formalized controls and monitoring routines may be far from optimal (Arthur 1994; Levitt and March 1988); and excessive focus on efficiency and effectiveness may induce certain dysfunctional behaviors in a firm that impede innovations including learning traps, structural inertia (rigidity), and compartmentalized thinking (Argyris & Schon, 1998; Dosi, 1998). Using a sample of 4,227 US firms that reported internal control under SOX 404, I find that firm innovation, measured by patenting activities, is significantly lower among firms with material internal control weaknesses relative to firms without such weaknesses. In addition, I find that firms that remediate their material internal control weaknesses subsequently experience an increase in innovation productivity.

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TABLE OF CONTENTS

LIST OF TABLES AND APPENDICES

Chapter 1: Internal Controls and Innovations

1.1. Introduction

Innovation has long been recognized as primary channel for economic development and firm growth. (e.g., Schumpeter, 1934; Porter, 1992). According to Porter (1992), firms must continuously innovate and upgrade their competitive advantages if they are to compete effectively in international markets. Empirical researches and surveys also show that firms with higher levels of innovations tend to enjoy significant competitive advantages and increase in firm values. Given the importance of innovation for firm and national growth, investigation of factors that inhibit or facilitate innovation is in order. The goal of this paper is to investigate the effect of internal controls on firm innovations.

The COSO framework and recent studies in accounting suggest that strong internal controls increase investment efficiency and operational efficiency in a firm (COSO 1992; Cheng et. al. 2013; Feng et al. 2013). Literature from Total quality Management (TQM) and operations research also suggest that strong internal controls provide preventive mechanisms that minimize operating cost and business risk in the organization by eliminating costly and risky steps. Consequently, it can be argued that internal controls can enhance firm's innovation productivity through increased operational efficiency and effectiveness, and reduced business risk. For example, effective control and monitoring mechanisms can minimize operating costs and operational risks related to defects, waste, reworks, delays, customer dissatisfaction and system failures; whereas strong information and communication system can facilitate a smooth and speedy transfer and assimilation of knowledge within and across units of organization.

On the other hand, internal controls can also impede innovations as higher compliance costs (Foley and Lardner 2005, 2007; SEC 2003) divert scarce resources and management time from innovative undertakings. Moreover, in dynamic environments, formalized controls and monitoring routines may be far from optimal (Arthur 1984; Levitt and March 1988); and excessive focus on efficiency and effectiveness may induce certain dysfunctional behaviors in a firm including learning traps, structural inertia (rigidity), and compartmentalized thinking (Argyris & Schon, 1978; Dosi, 1988).

Therefore, the objective of this study is to examine whether internal controls enhance or impede firm innovation. To evaluate this conjecture, I use sample of firms that reported internal control opinions under SOX 404 during the period 2004 to 2010. Consistent with prior research (e.g. Ashbaugh-Skaife et al. 2007, 2008, 2009; Masli et al. 2009; Ogneva et al. 2007), I use a post-SOX internal control weakness opinion (ICWs) as a signal of an ineffective internal control system and a clean post-SOX internal control opinion (non-ICWs) as a signal of an effective internal control system. Similarly, recognizing that innovation productivity can also be driven by factors other than the internal controls, I controlled for a vector of firm and industry characteristics that may affect these attributes. The control variables include firm size, firm age, investment in innovation, profitability, asset tangibility, leverage, capital expenditure, market competition, growth opportunities, financial constraints, industry and year fixed effects.

The results show that innovation productivity is significantly lower for firms with ICWs compared to firms without ICWs. This result is also consistent across analysis that accounts for the change in internal control quality. This finding is important as it provides, to my knowledge, the first empirical evidence on a positive impact of internal controls on firm innovation. Thus, firms that consider improving internal controls should not only consider whether the benefits of improved information reliability outweigh the costs of implementing internal controls, but should also consider its negative effects on firm innovations. These results are also important considering the continuous debate over the costs and benefits of SOX, and the claim that SOX has damaged U.S. companies' global competiveness. Given the decrease in firm innovation associated with stronger internal controls and that surveys and practitioner journals (e.g., CRA international 2005; Ernst & Young 2005; Harrington 2005; Wagner and Dittmar 2006; Protiviti 2012; SEC 2009), it is possible that SOX has actually weakened U.S. companies' global competiveness. This study thus contributes to more informed debates and policy decisions around the world.

The remainder of this essay is organized as follows. The next section presents the relevant literature on internal controls and innovations. The literature review is followed by the development of hypothesis, discussion of the research design and presentation of the empirical results. The essay finally concludes with a discussion of the results, contributions, limitations, and future research.

1.2. Literature Review

1.2. 1. Internal Controls

According to COSO (1992), which has been adopted by most firms subject to SOX, "Internal control is a process designed to provide reasonable assurance regarding the achievement of objectives in the following categories: [e]ffectiveness and efficiency of operations, [r]eliability of financial reporting, and [c]ompliance with applicable laws and regulations (p. 3). Therefore, COSO provides the following three categories of objectives which allow the organizations to focus on differing aspects of internal control:

i. **Operations Objectives** pertaining to effectiveness and efficiency of the entity's operations, including operational and financial performance goals, and safeguarding assets against loss.

ii. **Reporting Objectives** pertaining to internal and external financial and non-financial reporting and may encompass reliability, timeliness, transparency, or other terms as set forth by regulators, recognized standard setters, or the entity's policies.

iii. **Compliance Objectives** pertaining to adherence to laws and regulations to which the entity is subject.

1.2.1.1. Internal Controls over Financial Reporting (ICWs)

Internal controls over financial reporting are designed to assure reliability of accounting information, thereby providing external users with financial statements of potentially higher quality. The PCAOB (2004) defines ICWs as one or more deficiencies that "results in more than a remote likelihood that a material misstatement of the annual or interim financial statements will not be prevented or detected." Reported material weaknesses in internal controls over financial reporting (ICWs) encompass a wide variety of issues. Some of them can arise from specific accounting issues (e.g. revenue recognition or inventory accounting) while others are broader in scope and their effect can go beyond affecting the quality of the financial reports to affect organizational control processes indirectly. Such weaknesses could stem from the highest levels of the organization, including poor corporate governance structures and the top management's attitude toward internal controls (Ge and McVay 2005).

The Sarbanes Oxley Act of 2002 (SOX 2002) was enacted by the US congress to restore public confidence over the capital market after a series of corporate scandals led to a collapse of large companies at the turn of the 21st century. Sections 302 and 404 of the SOX 2002 are specific provisions related to internal controls which require public firms to maintain and continuously assess the effectiveness of the internal control systems.

Section 302 of SOX 2002 (effective since August, 2002), requires all the executives of SEC registrants to personally certify that they have evaluated the effectiveness of their internal controls and have notified their Audit Committee and independent auditors of any deficiencies. Similarly, section 404 of SOX 2002 (effective since November, 2004) requires an annual report which includes an evaluation of internal controls for financial reporting. The independent auditors must also certify to management's assertion of the effectiveness of its internal controls.

However, these two specific sections of SOX 2002 are also the most costly and controversial provisions of the Act. Several reports have indicated that SOX has improved corporate governance (Rittenburg and Miller 2005), internal controls (CRA international 2005; Ernst & Young 2005; Protiviti 2012; SEC 2009), fraud prevention (ACFE 2008), financial statement reliability (SEC 2009), and investor confidence (FEI 2006, 2007), and lowered the cost of equity (Benoit 2006). Yet, the costs to comply with SOX were much higher than expected (Foley and Lardner 2005, 2007; SEC 2003). Opponents argue that these high costs outweigh the benefits and that SOX has damaged U.S. companies' global competiveness (ABA 2005; AEA 2005; FEI 2006; Microsoft 2005).

In response to this debate and given the importance of this legislation, a stream of research within accounting and finance has examined the financial reporting and governance effects of SOX, including: (1) the costs to comply with SOX and the impact of those costs on organizations (e.g., Ahmed et al. 2010; Engel et al. 2007; Leuz 2007; Piotroski and Srinivasan 2008; Gao 2011); (2) the overall impact of SOX on capital markets (Coates 2007; Li et al. 2008; Rezaee and Jain 2006; Zhang 2007); and (3) anticipated benefits of SOX, more specifically whether SOX improves corporate governance (e.g., Arping and Sautner 2010; Miller 2008; Wang 2010), financial statement reliability and relevance (e.g., Ashbaugh-Skaife et al. 2008; Bedard 2006; Doyle et al. 2007a; Hossain et al. 2011; Jha 2013; Singer and You 2011), accounting conservatism (Mitra et al. 2013), and executive accountability (Collins et al. 2009), and whether it lowers the cost of equity (e.g., Ashbaugh-Skaife et al. 2009; Ogneva et al. 2007) and cost of debt (Costello and Wittenberg-Moerman 2011; Dhaliwal et al. 2011; Kim et al. 2011).

In general, there exist two research streams with regard to the SOX internal control provisions financial reporting and governance. One stream focuses on the economic factors that determine internal control weaknesses (Ge and McVay 2005; Ashbaugh-Skaife, Collins and Kinney 2007; Doyle, Ge and McVay 2007b; Hoitash, Hoitash and Bedard 2009). Another stream investigates the economic consequences of internal control weaknesses (Doyle et al. 2007a; Ogneva et al. 2007; Ashbaugh-Skaife et al. 2008; Beneish et al. 2008; Hammersley et al. 2008; Ashbaugh-Skaife et al. 2009; Feng Li and McVay 2009; Costello and Witternberg-Moerman 2011; Kim, Song and Zhang. 2009, 2011).

The first research stream examines whether certain firm characteristics affect internal control weaknesses (Ge and McVay 2005; Ashbaugh-Skaife, Collins and Kinney 2007; Doyle, Ge and McVay 2007b; Hoitash, Hoitash and Bedard 2009). These researchers assume that certain characteristics relate to internal control effectiveness. Ge and McVay (2005) find that weaknesses in internal controls are related to an insufficient commitment of resources for accounting controls, and that disclosing material weaknesses is positively associated with a firm's business complexity and is negatively associated with firm size and profitability.

Ashbaugh-Skaife et al. (2007) find that firms disclosing internal control deficiencies after Section 302 and before Section 404 typically exhibit more complex operations, recent organizational changes, greater accounting risk, more auditor resignations, and fewer resources available for internal controls. By distinguishing the internal control problems between entity wide and account specific, Doyle et al. (2007b) document that smaller, younger, and financially weaker firms tend to have more entity-wide control problems, while complex, diversified, and rapidly changing operations firms have more account-specific problems. Hoitash et al. (2009) conclude that board and audit committee characteristics also determine internal control quality.

The other research stream investigates the economic consequences of internal control weakness disclosures. The existing empirical evidence supports the view that ineffective internal controls negatively affect accruals quality (Doyle et al. 2007a; Ashbaugh-Skaife et al. 2008); analyst forecast behaviour (Kim et al. 2009); cost of equity (Ogneva et al. 2007; Beneish et al. 2008; Ashbaugh-Skaife et al. 2009); cost of private debt (Costello and Witternberg-Moerman 2011; Kim et al. 2011), management forecast (Feng et al. 2009); and stock return (Beneish et al. 2008; Hammersley et al. 2008). More specifically, Doyle et al. (2007a) examine the relation between accruals quality and internal control weakness disclosures and find that firms with material weaknesses are generally associated with lower accruals quality as measured by the extent to which accruals are realized as cash flows. Ashbaugh-Skaife et al. (2008) investigate both the effect of internal control deficiencies and their remediation on accruals quality. The authors document that firms reporting internal control deficiencies have lower accruals quality as measured by accruals noise and absolute abnormal accruals. Using a sample of firms that disclose auditor-attested evaluation of internal controls over financial reporting (under SOX 404), Kim et al. (2009) examine the effect of internal control quality on analyst forecast behaviours. The authors argue that effective internal controls improve the quality of analysts' forecasting decisions, and that analysts take into account the disclosed internal control information when making forecasts. Feng et al. (2009) first investigate the effect of internal control quality on the accuracy of management guidance. The authors find that management guidance is less accurate among firms with ineffective internal controls over financial reporting, which is consistent with their argument that ineffective internal control results in inaccurate internal management reports, thus generating biased management forecasts. Literature also finds that when a company has ICW, internal reporting usually contains more noise. Managers therefore cannot make optimal operating, investing or financing decisions (Lambert et al. 2007 and Feng, McVay and Skaife 2012).

1.2.1.2. Internal Controls beyond Financial Reporting and Governance

There is also an emerging accounting literature examining the implications of internal control beyond financial reporting and governance. For example, Feng et al. (2009) examine the effects of internal control quality on management guidance, and find that guidance is less accurate in the year of, and the two years preceding, the disclosure of ineffective internal controls. They find that the less accurate guidance persists if the internal controls remain ineffective, but is mitigated if the internal control problems are remediated. They also find the management forecast errors are larger when the internal control problems are most likely to affect interim numbers and thus guidance. In general, their study shows that internal control quality has an economically significant effect on management guidance, consistent with effective internal control leading to accurate internal management reports. Cheng et al.

(2013) also examine the investment behavior of a sample of firms that disclosed internal control weaknesses. They find that prior to the disclosure, these firms under-invest (over-invest) when they are financially constrained (unconstrained). However, after the disclosure, these firms' investment efficiency improves significantly, indicating an effective internal control positively affect investment efficiency.

Feng et al. (2013) investigate whether ineffective internal controls over financial reporting have implications on firm operations by examining the association between inventory related material weaknesses in internal controls and firms' inventory management. The authors argue that inventory-related material weaknesses in internal controls can result in suboptimal order quantities, leading to higher inventory levels and higher holding costs. In addition, inaccurate inventory tracking and internal valuation processes can lead to mismanagement of inventory, resulting in larger and more frequent inventory impairments as out-of-date or obsolete product loses market value. Consistent with their expectations, they find that firms with ineffective internal controls over inventory have systematically lower inventory turnover and a higher likelihood and magnitude of inventory impairments. Their study hence provides insights into how material weaknesses in internal control over inventory adversely affect inventory management. Collectively, their findings support the general hypothesis that internal control over financial reporting has an economically significant effect on firm operations.

Cheng et al. (2015) examine whether internal control over financial reporting affects firm operational efficiency. They find that operational efficiency is significantly higher among firms with effective internal control relative to firms with ineffective internal control. They also find that firms that remediate their material weaknesses subsequently show an improvement in operating performance and stock returns, and this effect is mainly driven by the improvement in operational efficiency. According to Cheng et al. (2015), effective internal control can have a positive effect on operational efficiency for two reasons. First, effective internal control lowers information risk, which in turn reduces agency problems and the likelihood of misappropriation of corporate resources by managers and other employees. In addition, strong internal control in the form of adequate physical security, adequate segregation of duties, and inadequate documentation further reduces possible misappropriation of resources by employees. If resources available for production are not diverted by managers and other employees for personal consumptions, the outputs generated for a given amount of inputs will be higher, leading to higher operational efficiency. Second, effective internal control can result in more accurate *internal* management reports and timely financial reporting information. Managers relying on such reports are more likely to make optimal operational decisions, reducing inefficiencies such as inventory obsolescence, increased inventory storage costs, and/or idle capacity. This can lead to higher outputs for a given amount of input costs and hence increases operational efficiency. Generally, their study documents systematic evidence on the positive effects of effective internal control on operational efficiency and firm performance.

Therefore, the literature suggests that effective internal control over financial reporting and governance can have a positive effect on operating performance of the firm for two reasons. First, effective internal control lowers information risk, which reduces agency problems and the likelihood of misappropriation of corporate resources by managers and other employees (Lambert et al. 2007). Moreover, effective internal control in the form of adequate physical security, adequate segregation of duties, and adequate documentation reduces the misappropriation of resources by employees. If resources available for production are not diverted for managers' and other employees' personal consumption, the outputs generated for a given amount of inputs will be higher, leading to higher productivity. Second, effective internal control can result in more accurate *internal* management reports and timely financial reporting information (Feng et al. 2009). Managers relying on such reports are more likely to make optimal decisions, leading to efficiencies such reduced inventory storage costs, and/or idle capacity. This can lead to higher lower operating costs incurred for a given amount of outputs and hence higher operational efficiency.

1.2.1.3. The link between Internal Controls over Financial Reporting & Operations.

While the prior discussion suggests that enhancements to internal controls over operations improve operational efficiency, it is less clear how internal controls over financial reporting, which was the focus of SOX, has a positive effect on operating performance. I next argue that (1) the control environment, risk assessment, information and communication, and monitoring components of the COSO framework are pervasive in nature and thus simultaneously affect operating performance and financial statement reliability control objectives, (2) a large majority of control activities over financial reporting also help organizations achieve objectives related to operating performance, and (3) the strength of internal controls over financial reporting serves as a proxy of internal control strength in general.

The COSO framework, in its original form, consists of five components: control environment, risk assessment, information and communication, control activities, and monitoring. These components, except control activities, are pervasive in nature and affect multiple types of objectives. For example, a control environment characterized by management with strong integrity and ethical values and commitment to organizational competence lays the foundation for strong internal controls in general, including internal controls related to both operating performance and financial reporting reliability.

Control activities are, on the other hand, typically designed and implemented at the activity-level to achieve very specific control activity objectives. However, a specific control activity objective can relate to both operating performance and financial statement reliability. For example, a control activity to "periodically count materials on hand and reconcile with perpetual records" is associated with the control activity objective that "all materials transferred from the receiving activity to other activities are recorded," which helps organizations achieve both operating performance and financial statement reliability objectives (COSO 1992). Similarly, the comparison of invoices, receiving reports, and purchase orders before authorizing payments described earlier not only enhances operating performance but also reduces the risk that liabilities and expenses presented in financial statements do not accurately reflect existing obligations and transactions that have occurred. These are fairly typical examples in that a majority of internal control objectives that allow organizations to achieve financial statement reliability objectives also allow organizations to achieve objectives related to operating performance. More specifically, 90 percent of the 40 control activity objectives that are categorized as financial statement reliability objectives in the COSO reference manual are also categorized as operating performance objectives.

The strength of internal controls over financial statement reliability might also be correlated with internal control quality in general. Organizations that have the necessary capabilities and resources to successfully design, implement, and maintain internal controls over financial statement reliability are also likely to have the necessary capabilities and resources to develop internal controls that promote operating performance. Additionally, organizations that value internal controls in general are arguable more likely to have stronger internal controls over both financial statement reliability and operating performance. Thus, the quality of internal control over financial statement reliability is a proxy for the quality of internal controls over operating performance.

1.2.2. Innovations

According to Schumpeter (1934), innovation is "the commercial or industrial application of something new—a new product, process or method of production; a new market or sources of supply; a new form of commercial business or financial organization." Similarly, Van de Ven (1986) defines innovation as "the development and implementation of new ideas by people who engage in transactions with others within an institutional order".

Innovation has also been conceptualized as an organizational learning. Different definitions of organizational learning exist in the literature. According to Cyert and March (1963), organizational learning is the process by which organizations as collectives learn through interaction with their environments. Similarly, Slater and Narver (1995) define organizational learning as the development of new knowledge or insights that have the potential to influence behavior. Furthermore, Cohen and Levinthal (1990) define organizational learning as the process of assimilating new knowledge into the organization's knowledge base.

1.2.2.1. Dimensions of Innovation

In general, organizational learning literature identifies two distinctive dimensions of innovation: adaptive and generative (Senge 1990; Slater and Narver 1995). Adaptive innovation occurs within a set of both recognized and unrecognized constraints that reflect the organization's assumptions about its environment and itself. It usually is sequential, incremental, and focused on issues or opportunities that are within the traditional scope of the organization's activities. Generative innovation occurs when the organization is willing to question long-held assumptions about its mission, customers, capabilities, or strategy. It requires the development of a new way of looking at the world based on an understanding of the systems and relationships that link key issues and events (Senge 1990; Slater and Narver 1995).

Adaptive and generative innovations are also referred to as single- and double-loop innovations, incremental and radical innovations, and exploitations and explorations, respectively (Argyris 1999; Arthur and Aiman-Smith 2001; Foil and Lyles 1985; March 1991; Slater and Narver 1995). *Single-loop learning* is a routine, incremental, conservative process that serves to maintain stable relations and sustain existing rules (Argyris 1999; Arthur and Aiman-Smith 2001; Foil and Lyles 1985). Its outcome is expected to be incremental change or adaptation carried out to further exploit existing technologies, routines, and processes in a way that does not alter underlying assumptions or values. Therefore, single-loop learning restricts itself to detect and correct errors within a given systems of rules (Argyris 1999; Arthur and Aiman-Smith 2001; Foil and Lyles 1985).

Double-loop learning is the search for and exploration of alternative routines, rules, technologies, goals, and purposes (Argyris 1999; Arthur and Aiman-Smith 2001; Foil and Lyles 1985). This type of learning resolves incompatible organizational norms by setting new priorities and weighting of norms or by restructuring norms themselves, together with associated strategies and assumptions. Double-loop learning enables organizations to break out of existing thought or behavior patterns by exploring qualitatively different ways of thinking and doing things (Argyris 1999; Arthur and Aiman-Smith 2001; Foil and Lyles 1985).

Cardinal (2001) defines radical innovation and incremental innovation from a knowledge perspective. *Radical* innovations are major changes in technology that involve the discovery of new knowledge, substantial technical risk, time, and cost. *Incremental* innovations are minor changes to existing technology that involve small advances based on an established foundation of knowledge.

Exploitation involves a routine, incremental, conservative process that serves to maintain stable relations and sustain existing rules (Argyris 1999; Arthur and Aiman-Smith 2001; Foil and Lyles 1985). Its outcome is expected to be incremental change or adaptation carried out to further exploit existing technologies, routines, and processes in a way that does not alter underlying assumptions or values. Exploitation includes refinement, choice, production, efficiency, selection, implementation, and execution. The essence of exploitation is the refinement and extension of existing competences, technologies, and paradigms; its returns are positive, proximate, and predictable. Therefore, exploitation learning restricts itself to detect and correct errors within a given systems of rules (Argyris 1999; Arthur and Aiman-Smith 2001; Foil and Lyles 1985).

Exploration involves the search for and exploration of alternative routines, rules, technologies, goals, and purposes (Argyris 1999; Arthur and Aiman-Smith 2001; Foil and Lyles 1985). This type of learning resolves incompatible organizational norms by setting new priorities and restructuring norms, together with associated strategies and assumptions. Exploration includes search, variation, risk taking, experimentation, flexibility, discovery, and innovation. The essence of exploration is experimentation with new alternatives, but its returns are uncertain, distant, and often negative. Exploration learning enables organizations to break out of existing thought or behavior patterns by exploring qualitatively different ways of thinking and doing things (Argyris 1999; Arthur and Aiman-Smith 2001; Foil and Lyles 1985).

Both exploitation and explorations are crucial for the survival and profitability of the firm. However, maintaining an appropriate balance between exploitation and exploration requires the ability to resolve the paradoxical contradictions between exploitation and exploration as they compete for scarce resources (Smith and Tushman, 2005). Exploration of new alternatives reduces the speed with which the existing skills can be improved, whereas exploitation (improvements in the existing skills) makes experimentation with other alternatives less attractive (March 1991). Conversely, too much focus on exploration does not address the problems of today, while too much focus on exploitation may not build a better tomorrow.

1.3. Hypothesis Development

1.3.1. Internal Controls and Innovation Productivity

Innovations begin at the individual level; and individual knowledge is transferred to the organization's knowledge base only when it is shared and assimilated into routines, documents, and practices (Autio, Sapienza, and Almeida 2000). Therefore, as procedures designed to improve operational efficiency and effectiveness, internal control routines, documents and practices put in place can influence the innovation productivity of a firm.

Academic research and theories from management (Agus 2005; Crosby 1979; Deming 1986; Juran 1988; Kontoghiorghes 2003; Powell 1995) and operations (McKone et al. 2001; Sharma et al. 2006) also provide a theoretical explanation as to why strong internal control system might lead to higher innovation productivity. The Total Quality Management (TQM) literature argues that by "doing it right the first time", improvements in quality and productivity can be achieved by reducing overall processing costs related to defects, waste, rework, and customer dissatisfaction (Crosby 1979; Juran 1988; Deming 1986). More recent empirical research concludes that quality improvements decrease costs because of less scrap and rework, and fewer delays and mistakes (Kontoghiorghes 2003). Similar results have been found in operations research. For example, McKone et al. (2001) find that by implementing preventive maintenance programs and controls in line with Total Productive Maintenance (TPM), organizations benefit from cost savings, higher quality, and improved performance. Similarly, Sharma et al. (2006) find that TPM improves manufacturing system efficiency by decreasing waste.

Similarly, control and monitoring procedures implemented to conduct alpha and beta testing in innovation firms can improve the quality of innovation while reducing the *cost of quality*. Horngren et al, (2012) defines *costs of quality* as "costs incurred to prevent, or the costs arising as a result of, the production of a low quality product or service". Costs of quality include *internal failure costs* (costs associated with defects found before the customer receives the product or service), *external failure costs* (costs associated with defects found after the customer receives the product or service), *appraisal costs* (costs incurred to determine the degree of conformance to quality requirements) and *prevention costs* (costs incurred to keep failure and appraisal costs to a minimum).

However, internal controls may also impede firm innovations for the following three reasons. First, internal controls divert scarce resources and management time from innovative undertakings. During the last decade, there have been several other surveys that have attempted to measure the costs of compliance of companies covered by SOX. In 2005, Financial Executives International (2005) attempted to determine the cost of complying with Section 404. For large cap companies (those with market capitalization above $750 million) the FEI found that the cost of compliance with this section averaged $4.3 million. A similar study for small cap companies found that an average cost of $ 1 million (Economist 2006). An estimate of the cumulative compliance costs for all publicly listed companies amounted to approximately $ 7 billion or 1% of their revenue (Koehn & Del Vecchio, 2004). In general, During the last decade, there have been several other surveys that have attempted to measure the costs of compliance of companies covered by SOX. In 2005, a study by the Financial Executives International (2005) attempted to determine the cost of complying with Section 404. For large cap companies (those with market capitalization above $750 million) the FEI found that the cost of compliance with this section averaged $4.3 million. A similar study for small cap companies found that an average cost of $ 1 million (Economist 2006). An estimate of the cumulative compliance costs for all publicly listed companies amounted to approximately $ 7 billion or 1% of their revenue (Koehn & Del Vecchio, 2004). In general, the compliance costs were much higher than expected (Foley and Lardner 2005, 2007; SEC 2003); and opponents argue that internal control requirements have damaged U.S. companies' global competiveness (ABA 2005; AEA 2005; FEI 2006; Microsoft 2005) as their benefit is too small to justify their high costs of compliance. (e.g., American Bankers Association, 2005; Microsoft, 2005; AEA 2015).

Second, there is a trade-off between internal controls and innovations in a firm. While internal controls involve routines intended to avoid surprises (COSO, 1992) and maintain status quo in the existing operations, innovation requires experimentations and searches for new alternatives. Therefore, strength of internal controls in a firm may indicate the degree to which innovative undertakings are compromised for efficiency and maintenance of status quo. Similarly, internal controls involve procedures designed to mitigate operational risk whereas innovations require risk taking and tolerance for failures. Therefore, the strength of internal controls in a firm may be indicative of management's lack of appetite for innovative endeavors.

Third, theories from organizational learning suggest that internal controls may create certain dysfunctional behaviors that inhibit innovation by inducing learning traps, structural inertia (rigidity), and compartmentalized thinking in a firm. Although these dysfunctional behaviors occurs in diverse settings, their effects are acute in innovation firms as innovation firms face frequent changes in customer preferences, accelerated product and process lifecycles, and surging competition (Bourgeois and Eisenhardt, 1988; Devan et al., 2005;Matson and Prusak, 2003).

Learning traps are situations in which organizations become trapped in one or more of several learning dynamics that self-destructively lead to excessive exploration or excessive exploitation (Cyert and Williams 1993; Levinthal and March 1993). High technology companies frequently fall into these traps by focusing on either too much exploitation or exploration (Martin, 2004; Christensen and Raynor, 2004; He and Wong, 2004). According to the learning trap argument, once an organization accumulates sufficient experience in a particular activity, it is natural for it to become trapped in that routine and blinded to alternative opportunities (March, 2003; Gupta et al., 2006; Holmqvist, 2004). The self-reinforcing process of the routines crystallizes current practice and forestalls change (King and West 2002; Stinchcombe 1986).

Internal controls may also induce learning myopia by increasing the tension between exploration and exploitation in an organization. Due to the emphasis on efficiency and effectiveness of the current operation, internal controls can create more conducive environment for exploitation (more certain and less remote) activities rather than exploration (less certain and more remote) activities. These tendencies to increase exploitation and reduce exploration can make the learning process myopic and self-destructive (March 1991). Levinthal and March (1993) suggest learning myopia as a major reason for the failure to excel in both their short-term and long-term performances and sustain competitive advantage of the firm. Similarly, King and West (2002) note that such myopia can make firms so blind that not only can they not see the importance of a new routine or new technology, but they also try to ignore other potential possibilities.

The notion of learning myopia is also known as the *competency trap in* the organizational learning literature. Levitt and March (1988) and Levinthal and March (1993) define competency traps as the persistence of inferior procedures. Competency traps concern the propensity of a firm to continue relying on processes that have been successful in the past even though they are no longer optimal. With a history of favorable performance, an organization tends to accumulate experience with a legacy procedure and avoids experience with newly emerging procedures (Levinthal and March 1993; Levitt and March 1988). If a new technology emerges, firms may be trapped by this maladaptive specialization (Ahuja and Lampert 2001). The result is that distinctive competence is accentuated, and organizations become specialized in niches in which their competencies yield immediate advantage. Increased specialization reduces the motivation to move to other technology bases (Levinthal and March 1993; Levitt and March 1988). Moreover, learners become increasingly removed from other bases of experience and knowledge and more vulnerable to change in their environments (Levinthal and March 1993). Therefore, the internal control procedures can keep firms from identifying the need for developing adequate experience with a superior procedure. The literature indicate that competency traps may be the most common and also potentially the most dangerous; and it is the likeliest explanation for the failure of market leaders (King and West 2002).

Internal control procedures can also create *structural inertia* or *rigidity* that inhibits organizational learnings. Inertia refers to the tendency not to move or act (Gresov, Haveman, and Oliva 1993). As organizations grow or age, and as they pass long periods without fundamental change, they become more complex, and higher interdependence develops within and between their activity systems (Tushman and Romanelli 1985). More specifically, structural inertia theory argues that organizational reliability and accountability require organizational structures that are reproducible or stable over time (Hannan and Freeman 1984). However, these structures can also generate strong resistance against change, because the organization's members seek to maintain the status quo that protects their interests.

Similarly, rigidity is defined as a restriction of information and constriction of control within a group (Harrington, Lemak, and Kendall 2002). There are two major consequences of rigidity at the organization level. First, due to an overload of communication channels and a reduction in communication complexity, there may be a restriction in the information-processing capacity of the organization. Second, due to centralization of authority and increased formalization of procedures, there may be a constriction in control. According to Staw, Sandelands, and Dutton's (1981), rigidity may increase uniformity in attitudes and beliefs within groups. However, it may influence individuals' information-processing capacities so that they ignore or screen out novel beliefs, opinions, and new perspectives.

Internal control can also induce compartmentalized thinking and reinforces the impression that the subunits are distinct. Compartmental thinking refers to the inability to think across the board, the tendency to look at each matter in isolation of other matters, while in reality they are all linked together. For example, the separation of duties in the internal controls can bring about compartmentalized thinking that hinders cooperation and knowledge sharing among individuals and across subunits because employee focus on their own goals, which are often defined within their department's role instead of the overarching organization goals. Consequently, individuals may become frustrated and disenchanted and may even leave the organizations.

In sum, the COSO framework, related researches, and theories from organizational learnings and total quality management suggest that internal controls can simultaneously enhance and inhibit firm innovation. Consequently, the following hypothesis is forwarded:

H1 – There is an association between the internal control quality and firm innovations.

1.4. Research Design

1.4.1. Data and Sample Selection.

From Audit Analytics, I first identify a sample of 29,847 firm-year observations (6,326 unique firms) with a SOX 404 disclosure in the period 2004-2010. As a result, the initial sample includes firm-year observations for accelerated filers. Accelerated filers are firms with market capitalization of at least $75 million (that have been required to file 10K, 10Q, and, 8K reports for one year or more). As a result, I exclude non-accelerated filers as they are exempt from the auditor attestation requirements in SOX 404(b). Financial data were collected from COMPUSTAT. I exclude 6,994 firm-year observations that are from financial industries, and 2,171 firm-year observations with missing data on other variables used in the analyses. The final sample consists of 19,282 firm-year observations representing 4,227 unique firms. Table 1.1 summarizes the sample selection procedure.

Table 1.1: Sample selection procedure

Description	Firm-years	Firms
Firms on Audit Analytics with an internal control disclosure for years 2004 -2010	28,447	6326
Less: firms in the financial industries	(6994)	(1,494)
Less: observations with missing value on firm characteristics	(2171)	(605)
Final Sample	19,282	4,227

Table 1.2 shows the sample distribution of firm-year observations with firms with material internal control weaknesses over time. Over the period 2004 to 2010, 11.49% of the observations have ineffective internal controls. However, there is a declining trend in the proportion of firm-year observations with ineffective inter, dropping from 16.45% in 2004 to 3.13% in 2010.

Table 1.2: Internal control effectiveness over time

	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**Total**
Total Firms	2,377	3,323	3,631	3,859	3,814	3,595	3,641	19,282
Firms with ICW	391	427	342	303	195	141	114	2,216
% of ICW	16.45%	12.85%	9.42%	7.85%	5.42%	3.92%	3.13%	11.49%

1.4.2. Measures of Innovation

The measures of innovation productivity also follow prior research. While the innovation literature acknowledges that patents are not a perfect measure of innovation—for example, many inventions are protected as trade secrets—the use of patenting activities as measures of firm innovations is widely accepted. Based on the data collected from the National Bureau of Economic Research (NBER) database, I construct two measures for firm's innovation productivity. The first measure is a firm's number of patent applications filed in a year that are eventually granted. I use a patent's application year instead of its grant year as the application year is argued to better capture the actual time of innovation (Griliches, Pakes, and Hall (1988)). However, the number of patent applications filed may not reflect the technological value of the innovation and distinguish groundbreaking innovations from incremental or marginal technological discoveries. To further assess the technological value of firm innovations, I use the number of non-self-citations each patient receives in subsequent years. "In principle, a citation of *Patent X* by *Patent Y* indicates that *Patent Y* builds upon previously existing knowledge embodied in *Patent X*" (Song et al., 2003). Patents that are cited in future developments by other firms are deemed more relevant, innovative, and important than those patents that are disregarded (Albert et al, 1991; Alcacer and Gittelman, 2005; Gittelman & Kogut, 2003). Furthermore, highly cited patents lead to more economic profits than patents that are less frequently cited (Harhoff, Narin, Scherer, & Vopel, 1999). Accordingly, the third measure of innovation is related to the economic value of the patents based on the stock market response to the news about the patents.

1.4.3. Regression Model

To test the relation between internal control effectiveness and firm innovation productivity, I estimate the following regression:

$$INNOV_{t+1} = \alpha + \beta ICW_{it} + \gamma\ CONTROLS_{it} + \varepsilon_{it}\ , (1)$$

where $INNOV_{t+1}$ refers to the measure of firm innovations, ICW_{it} is an indicator variable that equals one if firm *i* discloses internal control material weaknesses in year *t*, and zero otherwise.

CONTROLS refers to the determinants of innovations documented in prior research. I follow Fang et al. (2013) and other related studies in selecting the determinants of firm's innovation productivity. The control variables include firm size, *LN_MV*, measured by the natural logarithm of firm market capitalization; profitability, *ROA,* measured by return-on-assets ratio; investments in innovation, *RDTA*, measured by R&D expenditure over total assets; asset tangibility, *PPETA*, measured by net property, plants and equipment scaled by total assets; leverage, *LEV*, measured by total debt to total assets ratio; capital expenditure scaled by total assets, *CAPEXTA*; product market competition, *HINDEX*, measured by the Herfindahl index based on annual sales; growth opportunities, *Q*, measured by Tobin's *Q*; financial constraints, *KZINDEX*, measured by the Kaplan and Zingales (1997) five variable KZ index; and firm age, *LN_AGE,* measured by the natural logarithm of one plus the number of years the firm is listed on COMPUSTAT. Table 1.3 includes the detailed definitions of all variables used in this study.

1.4.4. Descriptive Statistics

Panel A of table 1.4 reports the number and the percentage of firms that generate at least one patent throughout the sample period of 2004 and 2010 and those of firms that generate zero patents throughout the sample period. Industry is defined following Fama and French (1997)'s 12 industry classification. Similarly, panel B and C of Table 4 report the distribution of firm innovation for the full sample and then by industry. As in previous studies (e.g., Fang et al. 2013), I find a substantial variation in innovation productivity across industries; the mean ranges from 0.20(0.39) to 0.39(1.10) patents (citations). Hence, I include industry fixed effects in all the analyses to control for inter-industry differences in innovation productivity.

Table 1.3: Distribution of firms with and without patents by industry

Industry	Firms generating at least one patent	Firms generating zero patent	Total number of firms in the sample
1. Consumer Non-Durables	61 (30.20%)	141 (69.80%)	202
2. Consumer Durables	74 (73.23%)	44 (26.77%)	118
3. Manufacturing	243 (70.72%)	192 (29.60%)	435
4. Energy	55 (70.29%)	223 (29.71%)	278
5. Chemicals & Allied Products	59 (70.10%)	55 (29.90%)	114
6. Business Equipment	607 (68.97%)	276 (31.03%)	883
7. Telephones & Television Transmission	53 (68.71%)	156 (31.29%)	209
8. Utilities	37 (65.04%)	130 (34.96%)	167
9. Wholesale, Retail, & Some Services	58 (64.44%)	349(35.56%)	407
10. Healthcare, Medical Eqt., & Drugs	414 (64.36)	206 (35.64)	620
11. Others	150 (62.81%)	644 (37.19%)	794
Total	1811(42.85%)	2416(57.15%)	4,227

Table 1.4: Firm innovation by Industry with specific innovation measures

Panel A. Number of Patents						
Industry	**25%**	**Median**	**Mean**	**75%**	**STD**	**N**
1. Consumer Non-Durables	0	0	2.56	0	10.54	978
2. Consumer Durables	0	1	71.24	11	336.04	563
3. Manufacturing	0	0	29.53	6	150.06	2,131
4. Energy	0	0	4.77	0	29.84	1,274
5. Chemicals & Allied Products	0	0	20.39	9	63.09	563
6. Business Equipment	0	2	47.13	13	238.74	3,864
7. Telephones & TV Transmission	0	0	0.541	0	33.66	849
8. Utilities	0	0	0.20	0	0.93	894
9. Wholesale, Retail, & Some Services	0	0	0.50	0	5.35	2,020
10. Healthcare, Medical Eqt., & Drugs	0	1	8.73	5	32.04	2,640
11. Others	0	0	5.96	0	118.69	3,506
Total	0	0	18.41		143.24	19,282
Panel B. Number of Citations						
Industry	**25%**	**Median**	**Mean**	**75%**	**STD**	**N**
1. Consumer Non-Durables	0	0	5.28	0	25.66	978
2. Consumer Durables	0	0	137.97	25.50	623.73	563
3. Manufacturing	0	0	54.03	10.35	271.46	2,131
4. Energy	0	0	10.96	0	74.97	1,274
5. Chemicals & Allied Products	0	0	34.06	14.83	105.71	563
6. Business Equipment	0	4.34	109.38	32.8	531.56	3,864
7. Telephones & TV Transmission	0	0	12.90	0	79.41	849
8. Utilities	0	0	0.39	0	1.85	894
9. Wholesale, Retail, & Some Services	0	0	1.10	0	9.60	2,020
10. Healthcare, Medical Eqt., & Drugs	0	1	18.69	8.93	66.20	2,640
11. Others	0	0	12.45	0	225.89	3,506
Total	0	0	39.43	4	298.05	19,282

Table 1.5 reports the mean innovation productivity by year. Similarly, there is a substantial year year-to-year variation in the innovation productivity over the sample period. As a result, I include year fixed effects in all the analyses.

Table 1.5: Mean innovation productivity over time

	2004	2005	2006	2007	2008	2009	2010	Total
Total Firms	2,377	3,323	3,631	3,859	3,814	3,595	3,641	19,282
Patents (Mean)	13.84	14.06	18.62	18.73	18.87	20.54	22.13	18.41
Citations (Mean)	32.06	31.79	40.18	39.86	39.76	42.46	46.52	39.43

Table 1.6 presents the descriptive statistics on innovation and firm characteristics, separately for firm-years with internal control material weakness and those without. The mean innovation is significantly higher for firm-year observations with effective internal control 0.840(1.028) than for those with ineffective internal control 0.752 (0.951). This result provides preliminary evidence on the negative association between internal control material weaknesses and firm innovation.

Table 1.6: Firm Innovation and control variables by internal control effectiveness

Panel A: Firm-years with Effective Internal Control

Variable	5%	25%	Median	Mean	75%	95%	SD	N
Ln_PAT	0.000	0.000	0.000	**0.840**	1.386	3.871	1.415	17,066
LN_CITE	0.000	0.000	0.000	**1.028**	1.792	4.704	1.693	17,066
ICW	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**17,066**
LN_AGE	1.386	2.197	2.704	2.700	3.295	3.932	0.792	17,066
LN_MV	4.338	5.622	6.731	6.897	7.991	10.090	1.762	17,066
RDTA	0.000	0.000	0.000	0.057	0.055	0.264	0.181	17,066
ROA	- 0.308	0.062	0.114	0.094	0.171	0.292	1.478	17,066
PPETA	0.020	0.078	0.190	0.282	0.441	0.806	0.252	17,066
LEV	0.000	0.012	0.180	0.221	0.339	0.627	0.245	17,066
CAPEXTA	0.005	0.017	0.034	0.056	0.068	0.184	0.068	17,066
Q	0.845	1.153	1.538	2.281	2.312	4.960	20.799	17,066
KZINDEX	-40.317	-7.079	-1.621	-29.088	0.588	2.651	861.79	17,066
HINDEX	0.000	0.008	0.062	0.141	0.164	0.501	0.192	17,066

B. Firm-years with Ineffective Internal Control

Variable	5%	25%	Median	Mean	75%	95%	SD	N
Ln_PAT	0.000	0.000	0.000	**0.752**	1.386	3.689	1.305	2,216
LN_CITE	0.000	0.000	0.000	**0.951**	1.676	4.607	1.610	2,216
ICW	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**0.000**	**2,216**
LN_AGE	1.098	2.079	2.565	2.522	3.044	3.784	0.769	2,216
LN_MV	4.062	5.084	5.914	6.119	6.959	8.821	1.487	2,216
RDTA	0.000	0.000	0.003	0.057	0.067	0.197	0.237	2,216
ROA	-0.303	-0.003	0.073	0.031	0.130	0.246	0.266	2,216
PPETA	0.017	0.062	0.157	0.245	0.370	0.750	0.231	2,216
LEV	0.000	0.003	0.152	0.217	0.334	0.653	0.263	2,216
CAPEXTA	0.005	0.017	0.034	0.056	0.068	0.184	0.068	2,216
Q	0.825	1.120	1.510	2.045	2.201	4.555	2.313	2,216
KZINDEX	-40.837	-6.555	-1.171	-16.743	1.040	4.043	268.275	2,216
HINDEX	0.000	0.013	0.052	0.141	0.163	0.497	0.127	2,216

Table 1.7 presents spearman correlations among firm innovation, internal control material weaknesses, and control variables. As presented on Table 1.7, the correlation between firm innovation and internal control weakness is significantly negative. Most of the control variables are significantly correlated with innovations. The correlation coefficients significant at the 5% level are presented in boldface.

Table 1.7: Correlation Matrix (Spearman) (N=19,828)

		1	2	3	4	5	6	7	8	9	10	11	12	13
1	*LN_PAT*	1.00												
2	*LN_CITE*	0.98	1.00											
3	*ICW*	-0.03	-0.03	1.00										
4	*LN_AGE*	0.18	0.16	0.07	1.00									
5	*LN_MV*	0.32	0.30	-0.13	0.28	1.00								
6	*RDTA*	0.14	0.15	0.00	-0.11	-0.19	1.00							
7	*ROA*	-0.01	-0.01	-0.01	-0.03	0.07	0.16	1.00						
8	*PPTETA*	-0.23	-0.24	-0.04	0.05	0.15	-0.21	0.01	1.00					
9	*LEV*	-0.08	-0.09	0.00	0.02	0.04	-0.06	-0.01	0.27	1.00				
10	*CAPEX*	-0.14	-0.15	0.00	-0.10	0.05	-0.05	0.06	0.62	0.09	1.00			
11	*Q*	0.00	0.00	0.00	-0.01	0.01	0.03	0.95	-0.03	-0.02	0.01	1.00		
12	*KZ_INDEX*	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.03	-0.01	0.02	-0.02	1.00	
13	*H_INDEX*	-0.16	0.00	0.28	-0.01	-0.24	-0.03	-0.07	0.11	-0.06	0.14	-0.16	0.09	1.00

This table reports correlation coefficients for variables used in the study.

1.5. Empirical Results

1.5.1 Internal control material weaknesses and firm Innovation

Column (1) of Table 1.8 presents the regression results on the association between material internal control weaknesses and firm innovations. Year fixed effects YR_t and firm fixed effects $FIRM_i$ are included in all regressions but the coefficients are not reported. Coefficient estimates are shown in bold and their robust standard errors are displayed in parentheses below. *** (**) (*) indicates significance at the 1% (5%) (10%) two-tailed level.

Table 1.8. Regression specifications with innovation measured by the number of patents and non-self-citations

Dependent Variables	(1) LN_PAT_t	(2) LN_CITE_t
ICW_t	**- 0.121*****	**- 0.151*****
	(0.032)	(0.039)
LN_MV_t	**0.184****	**0.213*****
	(0.012)	(0.014)
LN_AGE_t	**0.296*****	**0.337*****
	(0.005)	(0.006)
$RDTA_t$	**1.736*****	**2.098****
	(0.082)	(0.098)
ROA_t	**0.278**	**0.379**
	(0.055)	(0.066)
$PPETA_t$	**-1.574*****	**-1.958*****
	(0.050)	(0.060)
LEV_t	**- 0.065*****	**-0.121*****
	(0.038)	(0.046)
$CAPEXTA_t$	**0.618***	**0.791***
	(0.174)	(0.209)
Q_t	**- 0.043**	**-0.045**
	(0.004)	(0.005)
$KZINDEX_t$	**0.000**	**0.000**
	(0.007)	(0.000)
$HINDEX_t$	**0.005**	**0.105**
	(0.080)	(0.080)
INTERCEPT	**-1.297*****	**-1.373*****
	(0.046)	(0.056)
Year Fixed Effects	*Yes*	*Yes*
Industry Fixed Effects	*Yes*	*Yes*
Number of Obs. Used	19,282	19,282
Adjusted R^2	0.220	0.226

The result shows that the coefficient on *ICW* is negative and significant (p = 0.000), indicating that firm innovations is lower for firm-years with material internal control weaknesses. Similarly, column (2) of Table 1.8 also presents the result using patent citations as measures of innovations. Similarly, the coefficient on *ICW* continues to be significantly negative (p= 0.003). The coefficients on the control variables also suggest that innovation is higher for larger firms, older firms, firms with more investment in Research and Developments, and firms with higher profitability, but lower for firms with higher leverage.

1.5.2 Change Analyses

To provide further evidence on the association between internal control effectiveness and firm innovation productivity, I conduct a change analysis using the sample of firms with material weaknesses in the sample period. The advantage of a change analysis is that it uses the same firm as its own control and thus mitigates the omitted correlated variable concern by controlling for time-invariant firm characteristics. Specifically, I examine whether the changes in internal control effectiveness are associated with the changes in innovation productivity in a way consistent with the levels regression results documented earlier:

$$\Delta INNOV_{t+1} = \alpha + \beta \Delta ICMW_{t+1} + \gamma \Delta CONTROLS_{t+1} + \varepsilon_{it+1}, \quad (2)$$

$$\Delta INNOV_{t+1} = \alpha + \beta_1 \Delta\, IC\_DETERIORATED_{it} + \beta_1 \Delta\, IC\_IMPROVED_{it} + \varphi \Delta\, CONTROLS_{t} + \varepsilon_{it}, \quad (2'')$$

where $\Delta INNOV_{it+1}$ refers to the change in patenting activity from year t-1 to t, $\Delta ICMW_{it}$ refers to the change in internal control material weakness dummy from year t-1 to t, i.e., ΔICMW equals 1 if the firm reports no material weaknesses in year t-1 but reports material weaknesses in year t, 0 if the firm does not experience any changes in the effectiveness in internal control, and -1 if the firm reports material weaknesses in year t-1 but reports no material weaknesses in year t. Accordingly, $IC\_DETERIORATE_{it}$ is an indicator variable that equals 1 if the firm reports no material weaknesses in year t-1 but reports material weaknesses in year t, and zero otherwise, whereas $IC\_IMPROVED_{it}$ is an indicator variable that equals 1 if the firm reports material weaknesses in year t-1 but reports no material weaknesses in year t, and zero otherwise. Similarly, $\Delta CONTROLS_{it}$ refers to the changes in the other determinants of innovations from year t-1 to t. However, except for firm age in which the changes are minimal or constant. Thus, *LN_AGE* is excluded from the analyses. All the control variables are defined in Appendix A.

Table 1.9 present the regression results of estimating model (2''). Despite the small sample, the inferences are similar to those based on Table 1.8. In Column (1), I find that the coefficient on *ΔICMW* is significantly negative (p =0.008), indicating that the improvement in internal control effectiveness is positively associated with the change in firm innovations and/or the deterioration in internal control effectiveness is negatively associated with the change in firm innovation. In Column (2), I find that the coefficient on *IC_DETERIORATED* is significantly negative (p = 0.023), while the coefficient on *IC_IMPROVED* is significantly positive (p = 0.05). These results indicate that improvement (deterioration) in the internal control is associated with an increase (decrease) in innovation productivity. Taken together, the change analyses results are consistent with those reported in Section 1.5.1 and provide further evidence on the negative association between material internal control weakness and firm innovations.

Table 1.9: OLS Regression results for the change analysis using patents and citations as innovation measures

Dependent Variables	ΔLN_PAT	ΔLN_CITE
IC_DETERIORATED$_{it}$	**- 0.005****	**- 0.029****
	(0.034)	(0.043)
IC_IMPROVED	**0.013***	**0.016***
	(0.056)	(0.043)
ΔLN_MV	**0.104*****	**0.142*****
	(0.032)	(0.037)
ΔRDTA$_1$	**-0.400****	**0.475**
	(0.461)	(0.431)
ΔROA	**-0.021**	**0.207**
	(0.155)	(0.154)
ΔPPETA	**-0.083**	**-0.205**
	(0.245)	(0.294)
ΔLEV	**-0.104*****	**-0.103****
	(0.193)	(0.220)
ΔCAPEXTA	**0.488**	**0.426****
	(0.345)	(0.377)
ΔHINDEX	**0.121**	**0.110**
	(0.244)	(0.301)
ΔQ	**0.032**	**0.057**
	(0.018)	(0.020)
ΔKZINDEX	**-0.002**	**-0.019**
	(0.023)	(0.025)
INTERCEPT	**-0.266*****	**-0.283*****
	(0.022)	(0.025)
Year Fixed Effects	*Included*	*Included*
Industry Fixed Effects	*Included*	*Included*
Number of Obs. Used	4,227	4,227
Adjusted R^2	0.189	0.173

1.6. Conclusions

In this essay, I examine whether effective internal control has implications on firm innovations. Using a sample of firms that reported internal control opinions under SOX 404 during the period 2004-2010 and patenting activities to measure innovations, I find that innovation productivity is significantly lower in firms disclosing material weaknesses in internal control than in other firms. The finding holds after controlling for factors associated with firm innovations. To provide further insight, I also conduct change analysis and subsample tests. The results from the change analysis and subsample tests also provide additional evidence on the negative association between internal control weaknesses and firm innovation.

Overall, my study documents that effective internal control not only helps external users make more informed decision but also enhances firms' innovation productivity. This finding complements an emerging literature that examines the implications of internal control beyond financial reporting (e.g., Cheng et al. 2013; Feng et al. 2013; Bauer 2013; Chen et al. 2015). It also informs the debate on the costs versus benefits of SOX 404 reporting, which is relevant and timely given that regulators have recently grant non-accelerated filers permanent exemption from SOX 404 under.

Chapter 2: Business Risk and Audit Fees: Evidence from Innovation Firms

2.1. Introduction

This study extends the prior research on the relationship between business risk and audit fees (e.g., Bell, Landsman, and Shackleford (2001), Johnstone (2000), Morgan and Stocken (1998), O' Keefe, Simunic, and Stein (1994), Pratt and Stice (1994), Seetharaman, Gul, and Lynn (2002)). Much of the prior literature on business risk focuses on litigation risk, which is the risk of incurring liability payments and the risk of damaged reputation for the services auditors provide (Palmrose (1988), Simunic and Stein (1996)). This study also follows the approach used in litigation risk studies but examines a topic that, to my knowledge, is not explored in the literature. I examine whether patenting activities of the firm that potentially increases business risk (infringement risk), are associated with audit fees. I find a strong association between audit fees and firms' patent portfolio. In general, I find a positive association between audit fees and the size of firms' patent portfolio measured in the number of patent granted in a year and the number of non-self forward patent citations received. In contrast, audit fees are smaller for chemical and pharmaceutical firms that are subject to patent-related regulations.

Over the past few decades, developed economies such as the United States' have shifted from a manufacturing-based economy to a knowledge-based economy (Singh and Van der Zahn 2008). Consequently, investments in intangibles and values attributed to intellectual property (IP) have increased significantly. Alan Greenspan, former chairman of the Federal Reserve, note that Intangibles represents 75 percent of the firm's values in 2003 compared to 40 percent in the 1980s. Similarly, recent report by the US Department of Commerce (2016) indicates that Intellectual Property-intensive industries contribute more than $6 trillion dollars to U.S. gross domestic product, accounting for 38.2 percent of the economy.

Patents are intellectual property that provides exclusive rights over inventions. Over the last few decades the number of patent rights has proliferated dramatically. According to the recent USTPO statistics, the number of patent applications more than quadrupled between 1985 and 2015, from 132,665 to 629,647. However, patenting activities pose substantial business risk (infringement risk). First, the abstract nature of patents makes it challenging to clearly identify one patent from another; and existing patent system fails to establish clear boundaries and efficient guidelines to protect patented inventions. As a result, more than one entity can use or claim an invention at the same time, resulting in frequent and costly infringement suits. Second, patent infringement is a "strict liability" tort, and liability on patent infringements can be imposed on a party regardless of the party's knowledge or intention (such as copying or bad faith or negligence). According to the 35 U.S. Code 271, a patent infringement occurs when another party makes, uses, or sells a patented item without the permission of the patent holder. Consequently, everyone up and down the supply chain could be sued for infringement. i.e., distributors can be sued for selling a patented invention, whereas end users can be sued for using the invention. Therefore, patenting activities involve potential business risks almost at every stage — from discovery to production, to licensing and distribution, to negotiation and execution, to compliance and monitoring.

According to a recent Pricewaterhouse Coopers study (2016), the number of patents granted in the United States over the past 25 years has increased at a compound annual growth rate of about 4.9 percent, whereas the number of patent infringement lawsuits filed in the U.S. has increased at a compound annual growth rate of about 6.7 percent (i.e. 130

percent higher). The PwC report also shows that the annual median damage award between 1995 and 2015 ranged from $2.0 million to $17.0 million, with an overall median award of $5.8 million over the last 20 years**.** The ten largest awards in the period ranged from $467 million to $1.67 billion. In addition to the direct legal cost, the aggregate costs of infringement suits include business costs such as loss of market share, management distractions, preliminary injunctions, negative publicity, temporary product boycotts, higher regulatory scrutiny and strained relationships with customers and industry members. By the late 1990s, alleged infringers bore expected costs of over $16 billion per year, reflecting a substantial cost. Several stakeholders and institutions including the U.S. congress, General Accountability Office (GAO), USTPO, and AIPLA have raised concerns over the inefficiency of the current patent system and substantial litigation costs that hinders innovation by blocking new ideas from entering the marketplace. After nearly a decade of legislative efforts, President Barack Obama signed the Leahy-Smith America Invents Act (LH-AIA) into law in September 2011. AIA includes specific provisions intended to reduce the average patent processing time and patent litigations while increasing the ability of American inventors to protect their IP abroad.

Recognizing the strategic importance of intellectual property (IP) and business risks associated with patent-related litigations, audit firms provide consulting services on IP management and contracts. For example, PwC maintains a database of US patent infringement actions extending from 1980 through 2015. The database includes detailed information on liability outcomes, damages awarded, time-to-trial, trier of fact, type of entity (practicing vs. non-practicing), industry, district court and judge. PwC also publishes annual reports on patent infringements to increase awareness of concerned parties about recent developments in patent litigations and to help executives and litigators assess their patent enforcement or defense strategies.

Auditors also operate in a very litigious environment. State and Federal laws in the US allow third parties such as investors to sue auditors in an effort to recover damages. Historically, these litigation related costs have been substantial. Litigation costs of the Big Six auditing firms in 1991 were $477 million, representing 9 percent of their domestic auditing revenues (Cook et al. 1992). The litigations costs of Big Six accounting firms have substantially increased, and by 1993 amounted to nearly 12 percent of these firms' total accounting and auditing revenue (Lambert 1994). Even with the enactment of the Private Securities Litigation Reform Act of 1995 (PSLRA), the Center for Audit Quality (CAQ, 2008) reported an increase in auditor litigation costs to 15.1 percent of their domestic auditing revenues for the Big Six auditing firms for 2007. Recent reports further note that claims against auditors across the country have increased by about 35 percent to 40 percent between 2005 and 2011 (Eigelbach 2011). Following this rising trend in litigation, insurers have increased auditor liability insurance premiums resulting in substantial costs for audit firms. For instance, Linville and Thornton (2001) report that some small audit firms are left without profits after paying for legal liability and associated insurance premiums. In addition to these direct costs, there are also significant indirect costs of litigation for auditors. These indirect costs include potential opportunity costs arising from reputational damage linked to litigation (Palmrose 1988; Francis 2011). Given the magnitude of these direct and indirect costs, and also the uncertainties inherent in the determination of legal liability, it is presumed that auditors will take actions to both compensate for litigation-related losses and to avoid future litigation. Using audit fee, a common proxy for audit risk premium in the audit literature, this study examines the relation between audit fees and Patent Portfolios in innovation firms.

I argue that, in general, the business risks (infringement risk) of firm increases with the patenting activities of the firm. Thus, I predict a positive association between audit fees and the size of firms' patent portfolio. In contrast, I expect patent-related regulations (e.g., product filing with the FDA) in the chemical and pharmaceutical industries to decrease the business risk. Regulations increases the standard and transparency of innovation processes to reduce potential business risks. Hence, I predict a negative association between audit fees and regulation pertaining to the firm's patent portfolio.

Consistent with the prediction, I find a significantly positive association between audit fees and the size of firm's patent portfolio. In contrast, I find a negative association between audit fees and patent-related regulation that chemical and pharmaceutical firms are subject to.

This essay is important in that it is the first to relate the firm-level business risk (infringement risk) to evidence of audit litigation risk. Audit engagement risk assessments are critical for the determination of audit fees and enable auditors to balance engagement return with their engagement risk within their client portfolios. Therefore, this study provides important but previously unknown information about the audit market and how audit firms manage business risk related to technology-based IP. This study contributes to the literature by identifying a statistically significant and positive relationship between audit fees and business risk.

This essay is organized as follows. Section 2.2 discusses the relevant literature. Section 2.3 develops and forwards the hypotheses. Section 2.4 describes the empirical design, involving sample selection, variable measurements and model specification. Section 2. 5 presents the empirical results. Section 2.6 concludes the study.

2.2. Literature Review

This section examines the relevant literature on innovation, intangibles, intellectual property, and business risk (infringement risk). The development of this section is therefore geared to present and discuss the most relevant literature to the research questions under examination and to build a theoretical rationale for the selection of the dependent and independent variables applied in this essay.

2.2.1. Defining Innovation

The term innovation has a broad meaning in the literature and has been used to cover numerous concepts and variables, including new ideas, new concepts, new processes, new technology, new products, and so on. Academic researchers and practitioners have been interested in understanding the meaning and manifestations of innovation for many decades. An examination of the literature on innovation shows that scholars have classified innovations on the basis of the specific context of the research setting, such as product, technology, and organizational innovation. In this section, I first review the different definitions of innovation.

According to Schumpeter (1934), innovation is "the commercial or industrial application of something new—a new product, process or method of production; a new market or sources of supply; a new form of commercial business or financial organization." Similarly, Van de Ven (1986) defines innovation as "the development and implementation of new ideas by people who engage in transactions with others within an institutional order (p590)". This definition focuses on four basic factors: new ideas, people, transactions, and institutional context.

OECD (2005) defines innovation as "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations. Innovation activities are all scientific, technological, organizational, financial and commercial steps which actually, or are intended to, lead to the implementation of innovations.

Roberts (1988) considers innovation as having two parts: (1) the generation of an idea or invention and (2) the conversion of that invention into a business or other useful application. Therefore, innovation includes all stages from the actual invention to the final commercialization. The overall management of technological innovation therefore includes the organization and direction of human and capital resources toward effectively (1) creating new knowledge; (2) generating technical ideas aimed at new and enhanced products, manufacturing processes, and services; (3) developing those ideas into working prototypes; and (4) translating them into manufacturing, distribution, and use.

Lev (2001) also note that innovation typically involves three interconnected stages: (1) learning and discovery, whether internal to an organization or externally in networks or with partners, focused on the generation and acquisition of knowledge and skills (the research stage) (2) implementation demonstrating technical feasibility (the development stage); and (3) commercialization promoting product diffusion and facilitating financial and economic returns. In the movement from stage to stage, the complexities of the innovative process become obvious as outputs from different phases become inputs for others.

2.2.2. Intellectual Property

Innovation requires a sustained investment in physical as well as intangible assets. Intangible assets are claims to future benefits that do not have a physical or financial embodiment (Lev, 2001). Intangible assets are non-physical sources of value (claims to future benefits) generated by innovation (discovery), unique organizational designs, or human resource practices. Therefore, innovation is driven by a firm's (or any entity's) investment in tangible capital (such as computer networks) or intangible capital (such as organizational structure, human capital/training). These innovative activities could lead to tangible outputs (e.g., new or improved products or processes) and intangible ones (e.g., more experienced employers likely to engage in future innovations).

Intangibles are intrinsically connected to business value and the demarcation lines between intangible assets and other forms of capital are often blurry. Intangibles are frequently embedded in physical assets (for example, the technology and knowledge contained in an airplane) and in labor (the tacit knowledge of employees), leading to considerable interaction between tangible and intangible assets in the creation of value. These interactions pose serious challenges to the measurement and valuation of intangibles. When such interactions are intense, protecting and managing intangibles become increasingly difficult.

Intangible assets are also commonly referred to as "knowledge assets" in the economic literature and as "intellectual assets" in the business management literature. When the claims are legally secured (protected), such as in the case of patents, trademarks, or copyrights, the asset is generally referred to as intellectual property (Lev 2001). Therefore, intellectual property is a sub-set of intangible assets that includes patents, trademarks, and copyrights, as well as other types of "know-how" that may be less easily defined.

The World Intellectual Property Organization (WIPO) defines intellectual property (IP) as "the creations of the mind: inventions; literary and artistic works; and symbols, names and images used in commerce." Similarly, Bagley and Savage (2006, p. 367) describes IP as "any product or result of a mental process that is given legal protection against unauthorized use." WIPO further divides IP into two categories: (1) Industrial Property and (2) Copyrights. Industrial property includes patents for inventions, trademarks, industrial designs and geographical indications; whereas Copyrights cover literary works (such as novels, poems and plays), films, music, artistic works (e.g., drawings, paintings, photographs and sculptures) and architectural design (WIPO 2004, p.25).

Firms invest substantial resources in research and development (R&D) programs to create IP and other intangible assets that provide competitive advantages to generate future revenues and growth opportunities. Firms also invest in IP and other intangibles by acquiring other firms. The premium paid in an acquisition (i.e., the difference between purchase price and fair value of net assets) reflects intangibles that cannot be separately identified, measured, and disclosed in financial statements. These intangibles are disclosed as accounting goodwill.

Over the past few decades, developed economies such as the United States' have shifted from a manufacturing-based economy toward a technology-based economy (Singh and Van der Zahn 2008). Firms increasingly strive to develop institutional knowledge to achieve growth, to gain economic returns, and to maintain competitive advantages (Bismuth and Tojo 2008). Consequently, the proportion of market value attributed to intellectual property has noticeably increased for many firms. Alan Greenspan, the former chairman of America's Federal Reserve, noted in 2003 that "the economic product of the United States has become predominantly conceptual. He further noted that 75 percent of the values of companies lie in intangible assets, up from 40 percent in the 1980s. Similarly, Bagley and Savage (2006) state that in 2004 IP represents about 87 percent of an average firm's value compared to 62 percent in 1992 and 38 percent in 1982 (p.367). This shows that IP-intensive industries are a major, integral, and growing parts of the U.S. economy. The

Department of Commerce recently issued a report that identified industries that rely most heavily on patents, trademarks, or copyrights as IP-intensive. According to the report, from a total of 313 industries in the U.S., 81 industries are IP-intensive. The report further states that IP-intensive industries supported 45 million jobs (30 percent of employment) and contributed $6.6 trillion in value added in 2014, equivalent to 38.2 percent of U.S. GDP. Similarly, revenue specific to the licensing of IP rights totaled $115.2 billion in 2012, with 28 industries deriving revenues from licensing. Moreover, exports of service-providing IP-intensive industries totaled about $81 billion in 2012 and accounted for approximately 12.3 percent of total U.S. private services exported in 2012. Similarly, a European Union report from 2013 finds that IP-intensive industries directly support 56.5 million jobs (26 percent of employment) while generating €4.7 trillion worth of economic activity, accounting for 39 percent of the European Union's GDP.

2.2.3. Accounting Standards for Intellectual Property (Intangibles)

Accounting for intangibles is specified in the Accounting Principles Board (APB) No. 17, the Financial Accounting Standards Board (FASB) Statement of Financial Accounting Standards (SFAS) No. 2, SFAS 141, and SFAS 142. APB Opinion 17 related to intangible assets was issued in August 1970. Nearly three decades later in June 2001, the FASB issued SFAS 142, which superseded No. 17. Under APB Opinion No. 17, intangible assets purchased from other entities are recorded at cost and disclosed in the balance sheet as intangible assets. After determining the intangible asset useful life, which cannot exceed 40 years, amortization expenses will be deducted annually. Therefore, the balance of the intangible asset will be eventually eliminated at the end of its estimated useful life. When intangible assets cannot be identified separately or developed internally, the costs associated with these intangibles will be expensed as incurred and will not be recognized as an asset on the balance sheet.

The FASB issued Statement No. 2 Accounting for Research and Development in 1974 after considering four alternatives of accounting for research and development costs. This document points out that firms can, "a.) Charge all costs to expense when incurred; b.) Capitalize all costs when incurred; c.) Capitalize costs when incurred if specified conditions are fulfilled and charge all other costs to expense; d.) Accumulate all costs in a special category until the existence of future benefits can be determined" (FASB 1974, p.12). After evaluating these four alternatives, the FASB required expensing research and development costs when incurred.

In 2001, the FASB issued SFAS 141 and 142. Both statements have implications for accounting issues related to intangible assets. SFAS 141, Business Combinations, supersedes APB No. 16 and SFAS 38. Prior accounting standards allowed managers to choose one of two methods to account for business combination transactions: the pooling of interest method and the purchase method. SFAS 141 eliminated the pooling of interest option; hence, all business combination transactions will be accounted for by using the purchase method. The new standard, SFAS 141, improves disclosure of intangible assets since the purchase method allows the recognition of intangible assets acquired in a business combination transaction (FASB 2001a).

SFAS 142, Goodwill and Other Intangible Assets, does not allow the amortization of goodwill. Instead it requires entities to perform annual impairment test to determine the fair value and carrying amount of goodwill. SFAS 142 applies only to intangible assets that are developed internally or purchased either individually or as a group that were not part of a business combination transaction (FASB 2001b). The rule allows for the disclosing of intangible assets and requires that they be recognized based on their fair value. However, when it is not possible to identify an intangible asset on a balance sheet, such as an internally developed intangible asset, it should be expensed when incurred. An intangible asset with a finite useful life is amortized over its estimated useful life. Entities are required to estimate the useful life of an intangible asset by taking into account contractual, economic and legal factors. The FASB provides examples to assist entities in determining the useful life of intangible assets. In the absence of factors that may indicate the limits of an intangible asset's useful life, it is considered to have an indefinite useful life and straight-line amortization can be used. The FASB emphasizes the distinction between intangible assets with an indefinite useful life and intangible assets with an infinite life.

Contrary to APB 16, which also permitted negative goodwill, the new standard does not allow the amortization of goodwill, but requires entities to perform an annual impairment test based on fair value. Prior to SFAS 142, goodwill was treated as an asset, which subsequently was amortized over a period not exceeding 40 years. The standard also gave entities discretion in the process of evaluating the carrying value of goodwill.

First, goodwill has to be assigned to a reporting unit that is expected to economically benefit from goodwill resulting from a business combination transaction. Second, the unit's carrying value is compared with its fair value to determine if an impairment charge is needed. If the carrying value is less than the fair value then no additional testing is required. Otherwise, additional steps are required to measure the implied fair value of goodwill. To determine the fair value of goodwill, the fair value of net assets is deducted from the fair value of the reporting unit. Third, an impairment loss may have an effect on net income and income taxes depending on the timing of the charge. Under the new rule, managers have some discretion to consider taking larger impairment losses at the time of adoption, which will appear in the income statement between extraordinary items and net income, or defer all or some of the impairment charges in hope that the fair value will increase in future periods. The risk that managers take when they defer impairment losses to periods after adopting the rule is that impairment losses must be disclosed in the income statement as a line item before net income.

To summarize, recent accounting standards issued by the FASB (e.g., SFAS 141 and SFAS 142) address issues related to intangible assets and goodwill. Among the objectives of these standards is measurement of accounting and disclosures of intangible assets, including goodwill, because of the increased significance of intangible assets in today's economy.

2.2.4. Defining a Patent and its economic benefits

WIPO defines patent as "an exclusive right granted for an invention – a product or process that provides a new way of doing something, or that offers a new technical solution to a problem." A patent provides patent owners with protection for their inventions for a limited period, generally 20 years.

Patents provide incentives to individuals by recognizing their creativity and offering the possibility of material reward for their marketable inventions. These incentives encourage innovation, which in turn enhances the quality of human life. Therefore, at the heart of the matter, a patent is a bargain between the government and the inventor. The government grants a protection and time-limited monopoly over the invention to reward the inventor for enriching public knowledge with the workings of the invention. In return for patent protection, all patent owners are obliged to publicly disclose information on their inventions in order to enrich the total body of technical knowledge in the world. This ever-increasing body of public knowledge promotes further creativity and innovation. Patents therefore provide not only protection for their owners but also valuable information and inspiration for future generations of researchers and inventors.

Patent protection means an invention cannot be commercially made, used, distributed or sold without the patent owner's consent. Patent rights are usually enforced in courts that, in most systems, hold the authority to stop patent infringement. Conversely, a court can also declare a patent invalid upon a successful challenge by a third party. However, a patent owner has the right to decide who may – or may not – use the patented invention for the period during which it is protected. Patent owners may give permission to, or license, other parties to use their inventions on mutually agreed terms. Owners may also sell their invention rights to someone else, who then becomes the new owner of the patent. Once a patent expires, protection ends and the invention enters the public domain. This is also known as becoming off patent, meaning the owner no longer holds exclusive rights to the invention, and it becomes available for commercial exploitation by others.

The first step in securing a patent is to file a patent application. The application generally contains the title of the invention, as well as an indication of its technical field. It must include the background and a description of the invention, in clear language and enough detail that an individual with an average understanding of the field could use or reproduce the invention. Such descriptions are usually accompanied by visual materials – drawings, plans or diagrams – that describe the invention in greater detail. The application also contains various "claims", that is, information to help determine the extent of protection to be granted by the patent.

2.2.5. Patent Systems and Laws in the United States

Advancement of scientific knowledge and innovation has deep foundations that are embedded in the U.S. constitution. The U.S. constitution stresses the importance of patents and copyright protection laws by giving Congress the power "to promote the progress of Science and useful arts, by securing for limited times to authors and inventors the exclusive rights to their respective writings and discoveries" (Article I, Section 8, Clause 8). In the 1790s Congress passed the first federal patent laws in the United States (Campbell 1891; Stobbs 2000; Flynn 2006).

According to the 35 U.S. Code 271, patent infringement occurs when another party makes, uses, sells, or offers to sell a patented item without the permission of the patent holder. The law also prohibits importing of infringing technology or its equivalent. Sect ion 271 (b) stipulates that whoever actively induces infringement of a patent shall be liable as an infringer. Consequently, the old adage that "ignorance is no excuse" holds true for IP, and everyone is responsible for knowing the IP laws and abide by them. Therefore, the patent holder may choose to sue the party that may have contributed to the infringement either directly or indirectly to stop its activities, as well as to receive compensation for the unauthorized use.

After nearly a decade of legislative efforts, President Barack Obama signed the Leahy-Smith America Invents Act (AIA) into law in September 2011. Proponents of the bill suggested that technology companies are subject to an unprecedented wave of patent lawsuits, stifling innovation and creating an overburdened and lethargic patent system. The law represents the most significant change to the U.S. patent system since 1952, and it is intended to level the playing field for all inventors by removing the tricks a well-funded infringer can currently use against a startup owning patented technology. In general, AIA is expected to help businesses, inventors, and entrepreneurs in four immediate ways:

(1) A fast track option for Patent Processing within 12 Months**:** Instead of an average wait time of almost three years, the USPTO will be able to offer startups growing companies an opportunity to have important patents reviewed in one-third the time – with a new fast track option that has a guaranteed 12-month turnaround.

(2) Reducing litigation: USPTO will offer entrepreneurs new ways to avoid litigation regarding patent validity, at costs significantly less expensive than going to court.

(3) Increasing patent quality: USPTO has re-engineered its quality management processes to increase the quality of the examinations and has issued guidelines that clarify and tighten its standards for the issuance of patents. The legislation gives the USPTO additional tools and resources to further improve patent quality, and allows patent challenges to be resolved in-house through expedited post-grant processes.

(4) Increasing the ability of American Inventors to protect their IP abroad: The new law will harmonize the American patent process with the rest of the world to make it more efficient and predictable, and make it easier for entrepreneurs to simultaneously market products in the U.S. and for exporting abroad. The USPTO has also expanded work-sharing with other patent offices around the world to increase efficiency and speed up patent processing for applicants seeking protection in multiple jurisdictions.

2.2.6. Inefficiency of the Patent Systems in the United States

An efficient property system establishes clear and easily determined property rights and boundaries. The clear notices and boundaries help non-owners avoid trespass and other violations of property rights, and, when desirable, negotiate permission to use the property. However, patents fail to provide clear notice of the scope of patent rights. Thus, innovators find it increasingly difficult to determine whether a technology will infringe upon anyone's patents, giving rise to inadvertent infringement. Similarly, they find it increasingly costly to find and negotiate the necessary patent licenses in advance of their technology development and adoption decisions. Bessen and Meuer (2008) outline a combination of four factors that explains the poor performance of patents as a property system, and the associated high rate of patent infringements and litigations. These include fuzzy and unpredictable boundaries, public access to boundary information, broad claims without actual possessions, and increasing number of patents.

First, patents have fuzzy or unpredictable boundaries. Surveying plant assets is straight-forward as surveyors can simply map the words in a deed to a physical boundary. However, it is much harder to map the words in an IP to technologies. In case of patents, not only are the words that lawyers use sometimes vague, but the rules for interpreting the words are also sometimes unpredictable. There is thus no reliable way of determining patent boundaries short of litigation. Therefore, the existing patent law lacks stable doctrine and institutions designed to transmit clear notice to other innovators. Although the patent examiners determine the boundaries of each patent, patent examiners do not record their interpretation of the boundaries of the patent, and the courts pay little attention to the boundaries that patent examiners use to make these determinations. Moreover, patent documents are typically long and obscure. The most obscure and most important part of each patent is the set of claims found at the end of the document. Patent claims create property rights. Each claim is a single sentence which might run on for several paragraphs. Collectively, the claims determine the scope of the owner's right to exclude and serve as fences that mark the inventor's property. According to Giles Rich (1990), the most famous patent judge of modern times, patent applicants often game the system by drafting ambiguous patent claims that can be read narrowly during examination, so that they avoid a rejection, and broadly during litigation, which supports a finding of infringement.

Furthermore, patent examiners are given an average of eighteen hours to read and understand the application and make sure that each claim is valid (Limely, 2001). Time pressure means that inventors will often be able to push through questionable claims, and limited resources mean that the United States Patent and Trademark Office (USPTO) does a poor job of monitoring the clarity of patent claims. Critics of the patent system rightly complain that the Patent Office frequently approves of claims that are vague, or lack novelty. The approval of vague claims might give rise to patent disputes (GAO, 2014).

Second, although most patent documents are publicly available, inventors are allowed delay release of important boundary information. Many inventors act strategically to hide their claims from potential infringers. Inventors are allowed to draw out the patent application process for years if that serves their interest—and it does frequently. They often monitor the technology choices of other firms and write their patent claims to cover the technology of potential licensees. The targeted firms might get locked into a technology choice and find themselves in unfavorable bargaining positions with the patent owner. One practice used to keep claims hidden is to file "continuing" applications. Under USPTO, once an original application is filed, one or more continuing applications based on the same invention, but with different claims, can be filed. This gives the patent applicant additional opportunities to change the claims over time, possibly catching unsuspecting innovators by surprise. The number of continuing applications has increased seven-fold since 1984, to about 120,000 per year (Quillen and Webster, 2006). Continuing applications now constitute about one-third of all patent applications. Moreover, applicants can change claim language in patents without updating the published applications. The final claim language is published only after the patent is issued. Moreover, publication does little to prevent patent applicants from introducing unanticipated new claims via continuing applications.

Third, most patent claims are "too broad" insofar as the inventor did not really possess all the claimed technology. Thus, many patent claims have been read broadly to cover infringing technologies that are distant from the invention actually possessed by the patent owner. The increase of patents with abstract claims has led to increasing lawsuits against later-developed technologies. The expansive reading of patent rights increases uncertainty and costly disputes.

Fourth, a large number of property rights held by many different owners can make the clearance of rights for new investment costly. If clearance costs grow too large, then complete clearance becomes infeasible as firms will only do a cursory clearance or, perhaps, none at all. Over the last few decades the number of patent rights has proliferated dramatically. The number of patent applications more than quadrupled between 1985 and 2015, from 132,665 to 629,647. The growth in patent applications and grants has been accompanied by comparable growth in the number of claims per patent. Even though each patent is supposed to protect only one invention, inventors write multiple claims to protect different aspects of an invention, and many patents have dozens of claims. Furthermore, they write claims of varied coverage to hedge against the risk that certain claims will be invalidated or read narrowly. Allison and Lemley (2002) compared patents from the mid-1970s to patents from the mid-1990s and found that the mean number of claims per patent had grown from 9.94 to 14.87, a nearly 50 percent increase. According to David M. Martin, CEO of a patent risk management firm, "if you're selling online, at the most recent count there are 4,319 patents you could be violating. If you also planned to advertise, receive payments for, or plan shipments of your goods, you would need to be concerned with approximately 11,000" (Streitfeld, 2003). The growth in the number of patents and the number of claims imply a considerable increase in search costs associated with clearance and probability of patent dispute. The cost of clearance ratchets up even more when patents have fuzzy boundaries and when many patents are likely to be found to be invalid. With these uncertainties, a technology investor will have to examine many patents of vague scope and dubious validity. This introduces an element of risk into clearance decisions and it disrupts attempts to invent around patents. Even reliance on expert opinion may not avoid infringement.

Therefore the four aspect of the notice problem can be summarized as follows. First, inventors can hide patent claims, and thus boundary information, from the public. Second, even when the relevant public has access to the patent claims, the claims are often very difficult to interpret. Third, even assuming the claims are available and clear, there is a danger that the meaning of claim language will change (and become broader) over time. Finally, even when claims are available, clear, and fixed over time, the cost of searching for relevant patents can be quite high. High search costs arise directly because of the high number of patents that potentially apply to certain technologies, and indirectly because of the high rate of invalidity discourage innovators from initiating a patent search. In combination, these four problems can reinforce each other and make clearance procedures very costly and futile.

2.2.7. Legal Costs, Damage Awards, and Aggregate Costs of Patent Infringement

In its 2013 survey, the American Intellectual Property Law Association (AIPLA 2013) asked patent litigators to estimate the expected legal fees associated with patent lawsuits under six different scenarios. Specifically, the survey divided cases into three different intervals based on stakes, and asked for estimates for cases that concluded at the end of discovery, and cases that reached trial. The survey report indicates the estimated cost through trial was $650,000 when the stakes are less than $1 million, $2.5 million when the stakes are between $1 million and $25 million, and $5 million when the stakes are over $25 million. The estimated cost through discovery was $650,000 when the stakes are less than $1 million, $1.5 million when the stakes are between $1 million and $25 million, and $3 million when the stakes are over $25 million. Similarly, a report released by PwC (2016) states that the annual median damages award between 1995 and 2015 ranged from $1.9 million to $17.0 million, with an overall median award of $5.4 million over the last 20 years.

In addition to the direct legal cost and damage awards, the aggregate cost of patent litigation includes indirect business costs. Indirect business costs of patent litigation can take many forms. First, business can be disrupted as managers and researchers spend their time producing documents, testifying in depositions, strategizing with lawyers, and appearing in court. Second, litigation often strains the relationship between the two parties and may jeopardize cooperative development of the patented technology or cooperation on some other front in the future. Third, firms in a weak financial position might see their credit costs soar because of possible bankruptcy risk created by patent litigation. Fourth, preliminary injunctions can shut down production and sales while the litigation remains pending. But even without a preliminary injunction, customers may stop buying a product. Frequently, products require customers to make complementary investments; they may not be willing to make these investments if a lawsuit poses some risk that the product will be withdrawn from the market. Furthermore, patent owners can threaten customers and suppliers with patent lawsuits because patent infringement extends to every party who makes, uses, or sells a patented technology without permission, and sometimes to those who participate indirectly in the infringement. Some of these costs persist even after settlement.

Even simple delay can impose large business costs. Consider, for example, litigation against Cyrix, a startup firm that introduced Intel-compatible microprocessors. Intel, the dominant microprocessor manufacturer, sued Cyrix and the suit lasted a year and a half. During that time Cyrix had difficulty selling microprocessors to computer manufacturers, who were almost all also customers of Intel and who were reluctant to break ranks to go with a product that might be found to infringe. In the meantime, Intel responded by accelerating its development of chips that would compete against Cyrix's offerings. In the end, Cyrix won the lawsuit, but lost the war, having lost much of its competitive advantage. In effect, Cyrix lost the window of opportunity to establish itself in the marketplace. Litigation exacted a heavy toll indeed.

In their study examining the aggregate costs of patent litigation, Bessen and Meurer (2005) find that alleged infringers lose about half a percentage point of their stock market value upon being sued for patent infringement. This corresponds to a mean cost of $28.7 million in 1992 dollars. Bhagat, Bizjak, and Coles (1998), Bhagat, Brickley, and Coles (1994), and Lerner (1995) all estimated the combined loss of plaintiffs and defendants upon patent lawsuit announcements to be 2–3 percent, indicating a very substantial expected loss. By the late 1990s, alleged infringers bore expected costs of over $16 billion per year. This amounts to 19 percent of these firms' R&D spending, a ratio that exceeds some estimates of the value of patents granted relative to R&D (Bessen and Meurer, 2008). Moreover, Thomas Hopkins (1995) estimates the costs of complying with the patent system—annual infringement risk to be around $4.5 million.

2.3. Hypothesis Development

2.3.1. Business Risk

According to the AICPA [1992], business risk has two components: (1) the client's business risk and (2) the auditor's business risk. Client's Business risks refers to factors that could prevent or hinder the achievement of organizational goals and objectives. Business risks facing an organization can be wide-ranging and diverse, and they are mainly associated with the entity's survival and profitability. The concept recognizes that because of internal and external factors, there's a possibility that the client may not achieve its profit goals or even continue in existence. Hence, the ultimate business risk any organization faces is the risk that it seizes to be a going concern, and business risks therefore compromise any factors that may contribute towards business failure. Examples of business risks include loss of customers, increase in production costs, decline in product demand, litigations and claims, technological obsolescence, increase in market competition, inadequate financing, and so on.

Auditor's business risk is the risk of potential litigation costs and other expenditure from association with a client irrespective of whether or not an audit failure is asserted. It must be stressed that it is often impossible for the auditor to avoid being sued regardless of due diligence efforts. O'Malley (1993, 93) argues that "the auditors may be sued by anyone who suffered a financial loss even though that person may never have so much as glanced at an audit report. The auditors need not have done anything to cause the loss". In 1990, the seventh largest accounting firm in the United States, Laventhol and Horwath, filed for bankruptcy. The failure of Laventhol and Horwath was mainly attributed to incurred and anticipated litigation costs. The firm's chief executive officer contended that litigation arose, not from inadequacies in its professional performance, but from the perception that the firm had a "deep pocket" (Arthur Andersen, et al. (992, 3). Similarly, O'Malley (1993, 84–85), chairman and senior partner of Price Waterhouse, claimed that "unwarranted litigation and forced settlements constitute the vast majority of claims against accountants" and that shareholders demand compensation from auditors even if the auditor is not responsible for shareholders' losses.

Therefore, business risk is the risk to the auditor of a lawsuit that remains after taking all steps required under the Statements of Auditing Standards (SAS) while performing the audit and issuing an audit report. Arens and Loebbecke (2000) define business risk as "the risk that the auditor or audit firm will suffer harm because of a client relationship even though the audit report rendered for the client was correct" (p. 262). Client litigation (e.g. patent infringement suits) could lead to a decline in the well-being of the client for several reasons, including developing public relations campaigns and legal defenses, facing consumer boycotts, and facing new regulations. Client patent infringement suits could also damage the reputation of the auditor for being associated with the client.

Historically, these litigation related costs have been substantial. Litigation costs of the Big Six auditing firms in 1991 were $477 million, representing 9percent of their domestic auditing revenues (Cook et al. 1992). The litigations costs of Big Six accounting firms have substantially increased, and by 1993 amounted to nearly 12percent of these firms' total accounting and auditing revenue (Lambert 1994). Even with the enactment of the Private Securities Litigation Reform Act of 1995 (PSLRA), the Center for Audit Quality (CAQ, 2008) reported an increase in auditor litigation costs to 15.1percent of their domestic auditing revenues for the Big Six auditing firms for 2007. Recent reports further note that claims against auditors across the country have increased by about 35percent to 40 percent between 2005 and 2011 (Eigelbach 2011). Following this rising trend in litigation, insurers have increased auditor liability insurance premiums resulting in substantial costs for audit firms. For instance, Linville and Thornton (2001) report that some small audit firms are left without profits after paying for legal liability and associated insurance premiums. In addition to these direct costs, there are also significant indirect costs of litigation for auditors. These indirect costs include potential opportunity costs arising from reputational damage linked to litigation (Palmrose 1988; Francis 2011). Given the magnitude of these direct and indirect costs, and also the uncertainties inherent in the determination of legal liability, it is presumed that auditors will take actions to both compensate for litigation-related losses and to avoid future litigation. Using audit fee, a common proxy for audit risk premium in the audit literature, this study examines the relation between audit fees and Patent Portfolios in innovation firms.

2.3.2. Business risk and Audit fees

Growing litigation exposure and fierce competition among audit firms for clients have driven auditors to engage in risk-management practices in the audit market (Huss and Jacobs 1991; Francis and Reynolds 1998; and Johnstone 2000). As potential costs from post-audit litigations are the substantial components of the audit engagement risk, audit firms take various risk reduction and adaptation measures. Professional standards suggest that audit firms should establish procedures for making the client engagement decision. However, even though the engagement decision is an increasingly important auditing task, professional standards do not provide specific guidance on how to actually make this decision (Shibano 1990; Houston et al. 1999). Huss and Jacobs (1991, p. 20) state that '. . . the pre-engagement decision process is a -perhaps the most - critical step in the audit process'. Similarly, (Simunic and Stein 1990; Jones and Raghunandan 1998) also note that, in any event, an evaluation of the risks involved is necessary for auditors when they make auditing acceptance decisions. Therefore, before beginning an audit, auditors assess an overall risk to determine whether a relationship should be established (continued) with a potential (an existing) client. Examples of factors that may influence the overall risk assessment can be seen in FRISK, a risk-management tool used by PricewaterhouseCoopers (Winograd, Gerson, & Berlin 2000), and KRisk, a client acceptance-continuation decision aid developed by KPMG (Bell, Bedard, Johnstone, & Smith 2002). Johnstone (2000) and Johnstone and Bedard (2001) also examine the client acceptance-continuation process and identify multiple factors affecting the auditor's risk assessment approach.

As potential costs from post-audit litigation are one component of the auditor's overall business risk, audit firms take various actions to reduce and adapt post-audit litigation risks. Among those actions identified in the literature are the following: (1) risk avoidance - screening - (declining to accept) potential clients assessed as exhibiting high future risk; (2) risk elimination, deciding not to continue audit relationships with existing clients that exhibit continuing high future risk; (3) increasing audit effort - changing the nature, timing, or extent of audit procedures to mitigate the risk. The aforementioned measures are specific actions directed toward reducing the engagement risk.

Once the engagement risk is reduced to the lowest possible level, and if the residual risk is acceptable, the auditor and the client then negotiate an acceptable audit fee structure. Prior research provides a mixed evidence as to whether audit clients with higher perceived residual risk bear the expected costs of this risk with higher audit fees. Bell, Bedard, Johnstone, and Smith (2002) note that the long-term profitability of an audit firm depends on the audit firm's ability to recover total audit costs, including costs associated with auditor business risk. Similarly, Simunic (1980), Francis (1984), Simon (1985), Palmrose (1986), Francis and Simon (1987), and Simon and Francis (1988) all relate the size of audit fees to possible future losses the auditor may suffer. Likewise, Hill, Ramsay, and Simon (1994); Jubb, Houghton, and Butterworth (1996); Bell, Landsman, and Shackelford (2001); Niemi (2002); Johnstone and Bedard (2001, 2003); and Bedard and Johnstone (2004) all find a positive relationship between various types of engagement risk and audit fees.

Other studies, however, such as Morgan and Stocken (1998) and Johnstone and Bedard (2004), fail to find some types of pre-audit engagement risk fully reflected in audit fees, indicating that the linkage may be situational rather than general. Pratt and Stice (1994) also find that a portion of audit fees appears to be explained by litigation risk, after conditioning on the amount of audit evidence. Simunic and Stein (1996) note that previous studies reporting a positive association between audit fees and litigation risk fail to decompose audit fees into their components: billing rates, and hours of audit effort. Examining the association between audit fees and three measures of litigation risk, Simunic and Stein (1996) conclude that the positive association is entirely attributable to hours of audit effort.

Subsequent studies suggest that audit firms balance risk and return within their portfolios of clients through client acceptance and retention decisions and through the determination of audit billing rates and hours (Bell, Landsman, & Shackelford (2001); Johnstone & Bedard (2001, 2003, 2004)). Because pre-audit risk assessments are a significant input for the determination of audit fees and effort (Johnstone & Bedard (2003, 2004)), examining the association between fees and post-audit litigation risk omits a critical antecedent causal variable likely to have a mediating effect on the influence of the audit fee variable. Moreover, despite the extensive literature correlating audit fees and litigation risk, there is no evidence that audit rates (as opposed to audit hours) mitigate or modify post-audit litigation risk.

The literature review has identified possible association between patenting activities and business risk (infringement risk) that is to be examined in this study. How do auditors manage the business risk related to patenting activities? Do they use audit fees as a risk adaptation mechanism and pass on the residual business risk to their clients through higher audit fee, as shown by Bell, Landsman, and Shackelford (2001)? To answer this research question, the following alternate hypothesis is forwarded:

H1: There is a positive association between audit fees and business risk as measured by the patenting activities of the firm

Business risk (infringement risks) associated with patents may also vary by the firm's regulatory environment. Patent law depends on comparisons between technologies. To ascertain whether a technology infringes on a patent necessitates a comparison to a patented technology. And these comparisons relatively determine the boundaries of the patents. However, potential infringers can only comply with this demand if they are aware of the patent's existence, and if the clearance costs (discovery cost) to obtain or understand the information about relevant patents is economically feasible. The cost to trace and understand relevant claims to a property depends on the existence of a standardized and predictable representations. If groups of items have a certain nomenclature (i.e., standardized and predictable representations), these groups are "indexable," as such representations make it possible to build an efficient index of the items. For instance, dictionary words and real estate properties are both indexable. Dictionary words can be organized alphabetically, whereas claims on real estate properties can be organized by their geographic coordinates or locations. Therefore indexable real estate properties have lower discovery costs.

Chemical and pharmaceutical patents are "indexable," as relevant patents can be efficiently retrieved by chemical formula. The FDA annually releases a document entitled the "Approved Drug Products with Therapeutic Equivalence Evaluations**"**. This publication, colloquially known as the "Orange Book," allows pharmaceutical patents to be looked up based on the chemical formula of the active ingredient. FIZ Karlsruhe is also another

European institution that provides an electronic database services which allows researchers to pull up relevant literature on particular molecules, including patents. As a result, discovery costs for patents in the chemical and pharmaceutical industries are low, and inadvertent infringement by firms in these industries is rare. Moreover, FDA conducts regulatory supervision and rigorous approval process for biological, chemical, and pharmaceutical products at virtually every stage. The regulatory supervisions requires firms to disclose important boundary information about their new products. For instance, current regulation for all firms involves four general stages associated with the development of a new drug: discovery, safety tests in animals, human trials, and filing of marketing applications with the FDA. During the stage of human trials of a new drug, an increasingly rigorous FDA approval process is required for each of the three phases of clinical tests on humans. This practice is expected to further decrease the infringement risk for the patents of chemical and pharmaceutical companies. Consequently, I expect the audit fee associated with patent portfolio of FDA regulated firms to be lower than other industries. To test this conjecture, the following alternate hypothesis is forwarded:

H2: Audit fees are significantly smaller for firms in chemical and pharmaceutical industries, that are subject to patent-related regulations.

2.4. Research Design, Variable Measurements and Sample Selection

2.4.1 Research Design

The seminal study of Simunic (1980) posits that audit fees are a positive function of three client-specific factors: client size, client complexity, and client-specific risk. Prior empirical studies generally provide supporting evidence (e.g DeFond et al. 2002; Frankel et al. 2002; Whisenant et al. 2003; Chaney et al. 2004 Francis and Wang 2005; Krishnan et al. 2005; Ghosh and Pawlewicz 2009; Choi et al. 2010). Parallel and subsequent studies also argue and provide empirical evidence that auditor characteristics, e.g., big 4 auditors, auditor specialization (DeAngelo 1981a; Francis 1984; Francis and Stokes 1986, Craswell et al. 1995; Francis et al. 2005); auditor-client relation, e.g., initial audit engagement and auditor tenure (DeAngelo 1981b; Ettredge and Greenberg 1990; Craswell and Francis 1999), regulation, e.g., SOX Act (Raghunandan and Rama 2006), affect the audit fees.

Following prior literature, I estimate the following audit fee model with an emphasis on controlling for fee determinants. Specifically, I regress audit fees (LN_AFEE) on the patenting activity variables and a vector of variables controlling for risk, audit effort, and other determinants of audit fees. After controlling for these factors in the audit fee regressions, I interpret the coefficient estimates on the patenting activities as capturing the pricing of the incremental component of each attribute.

AUDIT FEE MODEL

$$\mathbf{LN\_AFEE_{it} = \alpha + \beta PATENTS_{it}\,(CITATIONS_{it}) + \gamma\, REG_{it} + \lambda\, CONTROLS_{it} + \varepsilon_{it}, \ (1);}$$

where LN_AFEE_{it} is natural logarithms of firm *i*'s audit fee in year *t*; and PATENTS and CITATIONS are patenting activities of firm *i* in year *t* measured as number of patents granted and number of citations respectively. Consistent with prior research (e.g., Simunic 1980; Palmrose 1986; Francis et al. 2005; Hay et al. 2006), I include several control variables. To control for audit effort, I include total assets (LTA); the presence of mergers (*MERGER*) or foreign operations (*FOREIGN*); the number of business segments (*SEGMENT*); audit lag (*AUD_LAG)*; and the issuance of a going concern opinion (GC). To control for audit risk, I include: *CR; CA_TA; ARINV; ROA; LOSS, ICW, RESTATEMENT;* and *INTANG*. Leverage (LEVERAGE) is included as a measure of the long-term financial structure of the client. I include an indicator variable if the company has a calendar year-end

(*BUSY*). Finally, to control for the effect of patent related regulation on infringement risk, I include REG. The variables are defined in the Appendix B.

2.4.2. Variable Measurement

I obtain information on firms' patenting activities from the latest version of the KPSS patent database which provides annual information from 1926 to 2010 on patent assignee names, the number of patents, the number of citations received by each patent, a patent's application year, and a patent's grant year, etc. Most empirical studies on innovation use a patent's application year instead of its grant year as the application year is argued to better capture the actual time of innovation (Griliches, Pakes, and Hall (1988)). However, since this study is designed to examine the business risk (infringement risk), and since patent infringements suits are often filed after the issuance of a patent, I use patent's grant year instead of its application year. Based on the information retrieved from the KPSS patent database, I use two measures for a firm's patenting activity in a specific year. These include (1) number of patents the firm has been granted in a year (*PATENTS*); and (2) number of non-self forward citations the firm made on the patents it has been granted in a specific year (*CITATIONS*).

2.4.3. Sample Selection and Descriptive Statistics

To form the sample, I first identified all the firms with the patenting activity data. Firm-year patent grants and patent citations information is retrieved from the patent database created by Kogan, Papanikolaou, Seru and Stoffman (KPSS 2014). The audit fees, audit opinion, internal control assessment, and audit firm identification are obtained from Audit Analytics database. I obtain the financial statement data from the COMPUSTAT annual data file. After merging the data from KPSS with the Audit Analytics and COMPUSTAT sample, I retain firms that have Big 4 auditors and observations in

COMPUSTAT with non-missing financial data. Big 4 is defined as the audit firms of Deloitte & Touche, Ernst & Young, KPMG, or PricewaterhouseCoopers. Restricting the sample to Big 4 auditors in order to ensure relative homogeneity in audit quality among the sample and avoid a potential confounding effect. In addition, I exclude financial services firms (SIC codes 6000-6999). Moreover, to mitigate the influence of outliers, I winsorize all continuous dependent and independent variables at the top and bottom one percentile of their distributions. Audit fee and internal control data in audit analytics database dates back 2004 and KPSS patent database provides data on patenting activities only through 2010. As result, the sample used in this study covers firm-year observations between 2004 and 2010. Consequently, the sample for the audit fee model consists of 18,025 firm-year observations and 3,688 unique firms for fiscal years 2004 through 2010 with the required data from KPSS database, Audit Analytics and COMPUSTAT financial data for the audit fee model. Table 1 presents the sample selection procedure and the number of observations used for the test.

Table 2.1: Sample Selection Criteria for the Audit Fee Model Estimation

	Observations
Observations from the Audit Analytics on audit fees from 2004 through 2010	39,859
Less: observations related to multiple auditors in one year	(1,028)
Less: observations with missing or zero audit fees	(1,175)
Less: firms located in other countries	(1,318)
Less: firms not identified in COMPUSTAT database	(4,745)
Less: Financial institutions (SIC code: 6000-6999)	(2,389)
Less: observations with insufficient data for audit fee model	(1,937)
Less: firms audited by non-big 4 auditors	(5,471)
Number of observations for the audit fee model	18,025
Unique firms for the audit fee model	3,688

Table 2.1 provides the descriptive statistics of the variables used in this study. The mean (median) audit fees are $1,398,220 ($3,023,684). On average, a firm in the final sample has 18.5 granted patents, with the median of zero granted patents. Similarly, a firm has a mean non-self forward citation of 39.67, with the median of zero citations. In general, the distribution of audit fees and patenting activities in the pooling sample is right skewed, with the 75th percentile of the distribution at zero. Due to the right-skewed distributions of granted patents and non-self forward citations, I then use the natural logarithm of the weight-factor adjusted patent counts and the natural logarithm of the citation-lag adjusted citations, LN_PATENTS and LN_CITEATIONS, as measures of patenting activities in the analysis. To avoid losing firm-year observations with zero patents or citations, I add one to the actual values when calculating the natural logarithm. Moreover, for about *75%* of the observations the fiscal year ends in December and about 13.4 % of the observations report a loss. Table 2.2 also reports the summary statistics of the variables.

Table 2.2: Descriptive Statistics for the Variables in the Audit Fee Model

VARIABLE	**25%**	**Median**	**Mean**	**75%**	**SD**
LN_AFEE	13.570	14.150	14.276	14.888	1.038
LN_PATENTS	0	0	.741	1.098	1.385
LN_CITATIONS	0	0	.935	1.451	1.670
LN_LAG	4.043	4.127	4.197	4.304	0.353
ICW	0	0	.066	0	.248
GC	0	0	0.023	0	0.19
RESTATEMENT	0	0	.112	0	0.316
LN_AGE	1.945	2.564	2.549	3.218	0.898
LN_AT	5.797	6.922	7.075	8.223	1.788
REC_INV	0.084	0.187	0.216	0.311	0.161
LEVERAGE	0.325	0.502	0.516	0.659	0.336
CR	1.283	1.934	2.790	3.039	5.912
CA	0.258	0.444	0.455	0.635	.0242
ROA	0.066	0.115	0.086	0.170	0.249
INTAN	.015	.109	0.179	.291	0.194
RD	0	.001	0.054	.055	0.170
RESTRUCTURE	0	0	0.342	1	0.474
MERGER	0	0	0.457	1	0.498
FOREIGN	0	0	0.380	1	0.485
BUSY	0	1	0.749	1	0.433
LOSS	0	0	0.134	0	0.340
REG	0	0	0.080	0	0.271
VARIABLE	25%	Median	Mean	75%	SD
LN_AFEE	13.570	14.150	14.276	14.888	1.038
LN_PATENTS	0	0	.741	1.098	1.385
LN_CITATIONS	0	0	.935	1.451	1.670
LN_LAG	4.043	4.127	4.197	4.304	0.353
ICW	0	0	.066	0	.248
GC	0	0	0.023	0	0.19
RESTATEMENT	0	0	.112	0	0.316
LN_AGE	1.945	2.564	2.549	3.218	0.898

2.5. Empirical Analysis and Results

2.5.1. Univariate Analysis

Table 2.3 reports the Pearson (Spearman) correlation coefficients among the variables of interest. It shows that audit fees (*LN_AFEE*) are positively correlated with both patenting activities (*LN_PATENTS* and *LN_CITATIONS*). Moreover, consistent with prior literature, the correlation matrix shows that the patenting activities increase with the level of firms' investment in research and developments (*RD*), and intangible assets (*INTAN*). The correlation coefficients are statistically significant at the 1% level or better.

Table 2.3 – Correlation Matrix

Variable	LN_AFEE	LN_PAT	LN_CIT	RD	INTAN	REG
LN_AFEE	**1.000**	0.181	0.177	- 0.095	0.327	- 0.223
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	0.000
LN_PAT	0.320	**1.000**	0.997	0.542	0.067	0.169
	(0.000)	**(0.000)**	(0.000)	(0.000)	(0.000)	(0.000)
LN_CIT	0.293	0.984	**1.000**	0.543	0.069	0.161
	(0.000)	(0.000)	**(0.000)**	(0.000)	(0.000)	(0.000)
RD	0.228	0.031	0.037	**1.000**	0.029	0.422
	(0.000)	(0.000)	(0.000)	**(0.000)**	(0.000)	(0.000)
INTAN	- 0.195	0.139	0.152	-0.101	**1.000**	- 0.133
	(0.000)	(0.000)	(0.000)	(0.000)	**(0.000)**	(0.000)
REG	- 0.194	0.103	0.096	- 0.092	0.438	**1.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	**(0.000)**

2.5.2 Multivariate Analysis

Table 2.4 reports OLS regression results of the audit fee model using, individually, the patenting activities of the firm as measures of business risk. To the extent that the patenting activities capture elements of business risk priced by auditors, I expect a positive coefficient estimate on both patenting activity variables, implying that auditors charge higher audit fee for firms with higher patenting activities.

The audit fees (LN_AFEE_{it}) are measured for firm *i* over its fiscal year *t*. The independent variable captures firm's patenting activities: the natural logarithm of one plus the number of patents granted for firm *i* in fiscal year *t* (*LN_PATENTS*) and the natural logarithm of one plus the number of non-self-citations per patent (*LN_CITATIONS*). Since both audit fees and patenting activities are in logarithm form, the regression coefficient estimate on patenting activities (*LN_PATENT* and *LN_CITATION)* give us the elasticity of audit fees to patenting activities.

Table 4 reports the OLS regression results estimating Eq. (1) with *LN_PATENTS* as the independent variable. In column (1), I examine the effect of a firm's patenting activities measured by the number of patents granted in year *t* on audit fees. The coefficient estimate of *LN_PATENTS* is positive and significant at the 1% level, suggesting that auditors charge higher audit fees for clients with higher patenting activities (more patents). The magnitude of *LN_PATENTS* from column(1) suggests that increasing patenting activity (increasing *LN_PATENTS*) by 10% increases the audit fees of the firm in the subsequent years by about 4.5% to 7%. In column (2) and (3), I replace the independent variable with the natural logarithm of the number of patents granted in the past one and two years, respectively. The coefficient estimates of LN_PATENTS continue to be positive and significant at the 1% level. Table 4 also provides evidence on the effect of patent-related regulations on audit fees in the chemical, medical and pharmaceutical industries (REG). Consistent with the prediction of hypothesis 2, the coefficient on REG is negative ranging between (-0.072) and (-0.097); and statistically significant at the 0.01 level. The coefficient on the interaction term REG*LN_PATENTS is also negative ranging from (-0.057) to (-0.073) and statistically significant at the 0.01 level. Thus, audit fees are smaller for firms in the chemical, medical and pharmaceutical industries, due to regulations that increase the transparency of firms' innovation process to decrease auditors' business risks associated with patenting activities of their clients.

$$LN\_AFEE_{it} = \alpha + \beta PATENTS_{it} + \gamma\ REG_{it} + \lambda\ CONTROLS_{it} + \varepsilon_{it},\ (1a)$$

Table 2.4. OLS Regression results using number of patents as innovation measure

	(1)		(2)		(3)	
	LN_AFEE_{it}		LN_AFEE_{it}		LN_AFEE_{it}	
	Coef.	**t-stat**	**Coef.**	**t-stat**	**Coef.**	**t-stat**
INTERCEPT	9.765***	158.55	9.67***	156.37	9.718***	157.08
LN_PATENT $_{it}$	**0.069*****	**21.17**				
LN_PATENT $_{it-1}$			**0.045*****	**12.3**		
LN_PATENT $_{it-2}$					**0.053*****	**15.75**
REG	**-0.072*****	**-3.29**	**-0.122*****	**-6.07**	**-0.097*****	**-4.53**
LN_PATENT $_{it}$***REG**	**-0.073*****	**-6.9**				
LN_PATENT $_{it-1}$ ***REG**			**-0.048*****	**-4.27**		
LN_PATENT $_{it-2}$ ***REG**					**-0.057*****	**-5.39**
INTAN	**0.694*****	**30.07**	**0.706*****	**30.32**	**0.697*****	**30**
RD	**0.0181**	**0.46**	**0.085****	**2.13**	**0.051***	**1.29**
LN_LAG	0.044***	3.69	0.049***	4.04	0.0482***	3.98
ICW	0.416***	24.93	0.425***	25.23	0.423***	25.22
RESTATEMENT	0.068***	5.57	0.069***	5.61	0.069***	5.65
LN_AGE	0.007	1.58	0.009***	2.04	0.007	1.52
LN_AT	.479***	158.67	0.487	162.07	0.483***	159.2
RECT_INV	0.344***	10.59	0.308***	9.42	0.327***	10.01
LEVERAGE	0.217***	17.43	0.209***	16.65	0.212***	16.92
CR	-0.010***	-15	-0.010***	-15	-0.010***	-14.99
CA	0.832***	31.57	.900***	34.17	0.866***	32.69
ROA	-0.185***	-6.47	-0.159***	-5.52	-0.172***	-5.97
RESTRUCTURE	0.223***	25.58	0.234***	26.67	0.229***	26.07
MERGER	0.085***	9.9	0.087***	10.14	0.086***	10.01
FCA	0.122***	14.84	0.129***	15.45	0.125***	15.01
BUSY	0.0405***	4.38	0.036***	3.88	0.038	4.11
LOSS	0.0094	0.59	22	1.37	0.015	0.98
Year Fixed Effects	Yes		Yes		Yes	
Adj R-squared	**0.7528**		**0.7501**		**0.7487**	
No. of Observations	**18,025**		**18,025**		**18,025**	

Table 2.5 reports the regression results estimating Eq. (1b) using patent citations (LN_CITATIONS*)* as independent variable. The coefficient estimates of LN_CITATIONS are positive and significant at the 1% level in columns (1), (2) and (3). For example, column (1) suggests that a 10% increase in firm's patent citations increase the audit fees by 5%. Similar to the result reported in Table 2.4, Table 2.5 also provides evidence on the effect of patent-related regulations on audit fees in the chemical, medical and pharmaceutical industries (REG). Consistent with the prediction of hypothesis 2, the coefficient on REG is negative ranging from (-0.064) to (-0.112) and statistically significant at the 0.01 level. The coefficient on the interaction term REG*LN_CITATIONS is also negative ranging from (-0.043) to (-0.060) and statistically significant at the 0.01 level. Thus, audit fees are smaller for firms in the chemical, medical and pharmaceutical industries, due to regulations that increase the transparency of firms' innovation process to decrease auditors' business risks associated with patenting activities of their clients.

$LN\_AFEE_{it} = \alpha + \beta CITATIONS_{it} + \gamma\ REG_{it} + \lambda\ CONTROLS_{it} + \varepsilon_{it}$, (1b)

Table 2.5. OLS Regression Results using number of citations as innovation measure

	(1)		(2)		(3)	
	CITATION $_{it}$		**CITATION $_{it-1}$**		**CITATION $_{it-2}$**	
	Coef.	**t-stat**	**Coef.**	**t-stat**	**Coef.**	**t-stat**
INTERCEPT	9.742***	158.39	9.701***	156.94	9.665***	156.33
LN_CITATION **$_{it}$**	**0.056*** **	**20.9**				
LN_CITATIONS **$_{it-1}$**			**.042*** **	**15.14**		
LN_CITATIONS **$_{it-2}$**					**0.036*** **	**12.24**
REG	**- 0.064*** **	**-2.9**	**-.094*** **	**-4.35**	**-0.112*** **	**-5.44**
LN_CITATIONS **$_{it}$ *REG**	**-0.060*** **	**-6.64**				
LN_CITATIONS **$_{it-1}$ *REG**			**-.046*** **	**-5.07**		
LN_CITATIONS **$_{it-2}$ *REG**					**-0.043*** **	**-4.53**
INTAN	**0.688*** **	**29.74**	**.694*** **	**29.8**	**0.702*** **	**30.09**
RD	**0.019**	**0.49**	**0.054**	**1.37**	**0.082** **	**2.08**
LN_LAG	0.046***	3.82	.049***	4.04	0.049***	4.09
ICW	0.414***	24.81	.423***	25.17	0.424***	25.21
RESTATEMENT	0.067***	5.54	.069***	5.64	0.069***	5.66
LN_AGE	0.008	1.76	0.007	1.66	0.009**	2.04
LN_AT	0.480***	160.37	.485***	160.68	0.488***	163.23
RECT_INV	0.357***	10.94	.334***	10.18	0.315***	9.6
LEVERAGE	0.218***	17.51	.212***	16.96	0.209***	16.65
CR	-0.010***	-14.92	- .0104***	-14.94	-0.010***	-14.96
CA	0.825***	31.18	.864***	32.52	0.895***	33.88
ROA	-0.184***	-6.43	-.170***	-5.91	-0.159***	-5.5
RESTRUCTURE	0.224***	25.69	.230***	26.16	0.234***	26.58
MERGER	0.085***	9.9	.086***	10.02	0.088***	10.15
FCA	0.122***	14.82	.125***	15.03	0.128***	15.35
BUSY	0.039***	4.32	.037***	4.05	0.036***	3.87
LOSS	0.01	0.62	0.0168	1.04	0.02	1.29
Year Fixed Effects	Yes		Yes		Yes	
Adj R-squared	**0.7526**		**0.7498**		**0.7487**	
No. of Observations	**18,025**		**18,025**		**18,025**	

In summary, I document a positive relationship between firm's patenting activities and firm audit fees controlling for the other factors that have been identified to affect audit fees. The adjusted R-square for all the results reported on table is above 74%, suggesting that the model explains a meaningful portion of the variation in patenting activities of the sample firms. The results support the hypothesis that patenting activities increases business risk thereby audit fees.

2. 6. Conclusions and Limitations of the Study

Previous research provides mixed evidence on whether audit clients with higher perceived business risk bear the expected costs of this risk in the form of higher audit fees. In this study I extend that research, which focuses on the risk of litigation, by examining the relation between audit fees and business risk in innovation firms. The business risk I examine was patenting activities in innovation firms. The results show that clients that engage in more patenting activities incur higher audit fees. To conduct the tests of the relation between patenting activities and audit fees, I control for the determinants of audit fees including audit effort and audit risk in the audit fee models among others. I infer that if audit clients are involved in more patenting activities, audit firms increases their audit fees to reflect the insurance premium to cover future losses associated with the business risk. This evidence is consistent with an audit market where auditors assess business risk at a client level and pass its expected costs to the client in the form of higher audit fees.

The results imply that auditors perceive patenting activities in innovation firms as risky business, even if it is not to be reported on the financial statements. Although infringement risk might be a glaring example of business risk, it seems likely that auditors price other types of business risks as well, even if it is not explicitly part of the auditors' responsibilities. For example, Lyon and Maher (2005) show that audit fees might well reflect auditors' concerns about the behavior of clients if the client behaves in a manner that the press and the officials might criticize, although the behavior is not illegal.

Limitations of this study include the use of patenting activities as measures of business risk and the difficulty of precluding other explanations for the results. For example, patenting activities are not a perfect measure of innovations and business risk as many inventions are protected as trade secrets. Furthermore, like other empirical studies that use cross-sectional regression models, I cannot rule out other possible explanations for the findings. Although I control a series of factors argued to determine audit fees in the literature, it is impossible to rule out other explanations for higher audit fees. As a result, readers are advised to view the findings with an appropriate degree of skepticism.

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APPENDICES

Appendix A – Definition of Variables Used in Chapter 1 (Essay I)

Variables	Definition and Measurement
1.1. Measures of innovation	
LN_PAT$_t$	Natural logarithm of one plus firm *i*'s total number of patents filed (and eventually granted) in year *t*;
LN_CITE$_t$	Natural logarithm of one plus firm *i*'s total number of non-self-citations received on the firm's patents filed (and eventually granted), scaled by the number of the patents filed (and eventually granted) in year *t*;
1.2. Measures of Internal Control weakness (Dependent Variable)	
ICW	An indicator variable for ineffective internal control that takes a value of one if a firm reports a material weakness in internal control over financial reporting for fiscal year t, and zero otherwise;
1.3.Measures of control variables	
Size (LN_MV$_t$)	Natural logarithm of firm *i*'s market value of equity (#25×#199) measured at the end of fiscal year *t*;
Firm's Age (LN_AGE$_t$)	Natural logarithm of one plus firm *i*'s age, approximated by the number of years listed on COMPUSTAT.
Investment in Innovation (R&D$_t$)	Research and development expenditure (#46) scaled by book value of total assets (#6) measured at the end of fiscal year *t*, set to 0 if missing;
Profitability (ROA$_t$)	Return-on-assets ratio defined as operating income before depreciation (#13) scaled by book value of total assets (#6), measured at the end of fiscal year *t*;
Asset tangibility *(PPETA$_t$)*	Firm *i*'s Net Property, Plant & Equipment (#8) scaled by book value of total assets (#6) measured at the end of fiscal year *t*;
Financial Constraint (KZ_INDEX$_t$)	Firm *i*'s KZ index measured at the end of fiscal year *t*, computed as -1.002 × Cash Flow ((#18+#14)/#8) plus 0.283 × Q ((#6+#199×#25-#60-#74)/#6) plus 3.139 × Leverage ((#9+#34)/(#9+#34+#216)) minus 39.368 × Dividends ((#21+#19)/#8) minus 1.315 × Cash holdings(#1/#8), where #8 is lagged;
Capital Expenditure (CAPEX$_t$)	Capital expenditure (#128) scaled by book value of total assets (#6) measured at the end of fiscal year *t*;
Leverage (LEV$_t$)	Firm *i*'s leverage ratio, defined as sum of long-term debt and current liabilities (#9+#34) scaled by book value of total assets (#6) measured at the end of fiscal year *t*;
Growth Opportunity (Tobin's Q$_t$)	Firm *i*'s market-to-book ratio during fiscal year *t*, computed as [market value of equity (#199× #25) plus book value of assets (#6) minus book value of equity (#60) minus balance sheet deferred taxes (#74, set to 0 if missing)] scaled by book value of total assets (#6);
Herfindahl Index (H_INDEX$_t$)	Herfindahl index of 4-digit SIC industry *j* where firm *i* belongs, measured at the end of fiscal year *t*;

Appendix B – Definition of Variables Used in Chapter 2 (Essay II)

Variables	Definition and Measurement
1.1 Dependent Variable (Patenting Activities)	
Audit Fees *LN_AFEE*	Natural Logarithm of firm i's Audit fees in year t,
1.2. Measures of Patenting Activities (Independent Variable)	
LN_PATENT_t	Natural logarithm of one plus the number of patents firm *i* has been granted in year t
$LN\_CITATION_t$	Natural logarithm of one plus the number of non-self-citations firm *i's* received in year t
1.3.Measures of control variables	
Assets (LN_AT_t)	Natural logarithm total assets (# 6) measured at the end of fiscal year *t*;
Firm's Age *(LN_AGE_t)*	Natural logarithm of one plus firm *i*'s age, approximated by the number of years listed on COMPUSTAT.
Current Assets (CA)	Firm *i*'s current ratio defined as current assets (#4) divided by total assets (#6) measured at the end of fiscal year *t*;
Current Ratio (CR)	Firm *i*'s current ratio defined *as* current assets (#4) divided by current liabilities (#5) measured at the end of fiscal year *t*;
AR_INV	Firm *i*'s sum of accounts receivable (# 2) and inventory (#3) divided by total assets (#6) measured at the end of fiscal year *t*;
Leverage (LEV_t)	Firm *i*'s leverage ratio, defined as long-term debt (#9) scaled by book value of total assets (#6) measured at the end of fiscal year *t*;
Investment in *Innovation ($R\&D_t$)*	Firm *i*'s research and development expenditure (#46) scaled by book value of total assets (#6) measured at the end of fiscal year *t*, set to 0 if missing;
Intangible Intensity *(INTAN)*	Firm *i*'s intangible intensity of the firm defined as intangible assets scaled by book value of total assets (#6) measured at the end of fiscal year *t*;
Audit Lag *(AUD_LAG)*	Firm *i*'s audit lag defined as the number of days between audit opinion signature date and fiscal year end for firm i in year t;
Segments (SEG)	Natural Logarithm of the number of business segments in year t;
Foreign Operations *(FOREIGN)*	An indicator variable for foreign operations that takes a value of one if firm has any foreign operations (#64), zero otherwise;
Mergers *(MERGER)*	An indicator variable for Mergers & Acquisitions that takes a value of one if the firm reported the impact of a Mergers and Acquisitions on net income (#360), zero otherwise;
Internal Control *Weakness* *(ICW)*	An indicator variable for ineffective internal control that takes a value of one if a firm reports a material weakness in internal control over financial reporting for fiscal year t, and zero otherwise;
Busy *(BUSY)*	An indicator variable for foreign operations if a company's fiscal year is December 31st, zero otherwise;
Return on Assets *(ROA_t)*	Firm *i*'s return-on-assets ratio defined as operating income before depreciation (#13) scaled by book value of total assets (#6), measured at the end of fiscal year *t*;
Loss *(LOSS)*	An indicator variable for loss that takes a value of one if firms incurred a loss (#172) in year t, zero otherwise;
Going Concern *(GC)*	An indicator variable for Going Concern opinion that takes a value of one if

	the auditor issues a going concern audit opinion, zero otherwise;
REG	An indicator variable for membership in the chemical and pharmaceutical industries. It takes a value of one if firm's SIC code is 283 , zero otherwise;